Joint development of a new Agricultural Operator Exposure Model

Project Report

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2013-01-29

Impressum

BfR Wissenschaft

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Agricultural Operator Exposure Model
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Federal Institute for Risk Assessment
Press and Public Relations
Max-Dohrn-Str. 8-10
10589 Berlin, Germany

Berlin 2013 (BfR-Wissenschaft 07/2013)
259 pages, 38 figures, 9 tables
€ 10,-

Printing: Cover, contents and binding
BfR-printing house Marienfelde

ISBN 3-943963-03-8
ISSN 1614-3795 (Print) 1614-3841 (Online)

Inhalt

1 Abstract

A predictive model for the estimation of agricultural operator exposure has been developed on the basis of new exposure data. More than 30 unpublished GLP exposure studies conducted between 1994 and 2009 mainly for the purpose of plant protection product authorisation were chosen for evaluation according to a set of quality criteria defined by an expert group. All data including information about the studies were compiled in a database and used for a statistical analysis of exposure factors.

The statistical analysis resulted in six validated models for typical scenarios of pesticide mixing/loading, and application outdoors including downwards and upwards spraying with vehicle-mounted/-trailed or hand-held equipment. As a major factor contributing to the exposure of operators, the amount of active substance used per day was identified. Other parameters such as formulation type, droplet size, presence of a cabin or density of the canopy were selected as factors for particular sub-scenarios. However, in the case of knapsack mixing/loading, and hand-held application directed downwards, the number of data was too small for identifying reliable exposure factors; instead the relevant percentiles of the exposure distribution were used.

The new operator exposure model represents current application techniques and practices in Europe and allows for a tiered approach considering personal protective equipment (if necessary). The new model is intended to be used for national authorisation and for registration procedures of plant protection products in the EU.

2 Summary

Exposure models have been used for about 20 years to estimate the exposure of professional operators during application of plant protection products. Exposure estimation is an integral part of the approval of plant production products in Europe, but despite several attempts no harmonised European model is available so far. In addition, the existing models pose a further disadvantage: They are based on old data and do not reflect current application equipment and practices.

Faced with these issues a project team was established to develop a new exposure model for relevant outdoor application scenarios that is suitable for the authorisation process of plant protection products in European Member States. For that purpose 34 unpublished exposure studies which all met a set of quality criteria (e.g. GLP conformity, compliance with OECD series No. 9 on the conduct of agricultural exposure studies) were selected and evaluated. The exposure data and additional information such as application rate, number of product containers handled etc. were compiled in a large database and subjected to statistical analysis of the major impact factors of operator exposure. Six scenarios, two for mixing/loading (knapsack, tank) and four for application (low crop hand-held, high crop hand-held, low crop tractor-mounted, high crop tractor-mounted), were identified and modelled with least squares regression assuming different combinations of impact factors. On the basis of diagnostic values, such as the p-value or R^2 the most suitable factors were chosen for each scenario and used for final modelling with quantile regression. The method of quantile regression was used for modelling because it is more robust with respect to measurements below the limit of quantification and does not assume the variability to be independent of the amount of active substance handled. In addition to the model predicting the 75^{th} percentile a second model predicting the 95^{th} percentile was developed to account for acute exposure estimation which might be relevant in the future. Due to only a small number of datasets it was not possible to identify impact factors for two scenarios (knapsack mixing/loading, low crop hand-held application). For these scenarios it was appropriate to calculate the 75^{th} percentile (medium term exposure) and the 95^{th} percentile (acute exposure) of the absolute ex-

posure values. After the modelling process an internal model validation (cross validation) was performed by analysing the model prediction when different sets of data or complete studies were excluded from the database. Additionally, independent study data (a separate set of data which could not be used for modelling because mixing/loading and application exposure were not measured separately) were compared with the exposure estimates calculated with the model. The exposures predicted by the model were in good agreement with those measured.

As most of the exposure data were log normally distributed the exposure is described by log-linear models. The amount of active substance applied per operator per day was identified as the major impact factor. Where appropriate, additional factors were selected such as formulation type for tank mixing/loading or presence of a cabin for high crop tractor-mounted application. Special sub-scenarios such as hand-held application in dense canopy or downward-spraying with equipment for small area application are also addressed using the corresponding factors.

The exposures associated with mixing/loading and application (including cleaning) of the plant protection product are estimated separately. Each task consists of inhalation exposure and dermal exposure of the head, the body and the hands which are all addressed separately by the model. For the overall operator exposure, during a whole working day, the respective single exposures from mixing/loading and from application are added. Depending on the use of personal protective equipment (PPE) different variables are used for the calculation. In general, the model assumes that the operator is wearing at least one layer of work clothing and sturdy footwear. Therefore, the overall exposure for considering no PPE results from the (potential) inhalation exposure for mixing/loading and application, the (potential) head exposure for mixing/loading and application, the total hand (potential hand) exposure for mixing/loading and application and the ‘inner’ body (actual body) exposure for mixing/loading and application (measured exposure beneath work clothing). Exposure when specific personal protective equipment (e.g. gloves, face shield) is worn was also modelled and can be used instead of potential exposure. Additionally, defined risk reduction factors for further PPE can also be included in the model to allow a tiered approach. The model is based on exposure data that mostly reflect a usual working day. For that reason the areas (hectare/day) from the studies are used to estimate the amount of active substance applied per day. Nonetheless, the default values for the application area can be adapted to national requirements. The results of the exposure modelling have been used to develop an exposure calculator which is distributed with this report.

The new operator exposure model is a novelty: For the first time the model choice was determined by the exposure data using a comprehensive statistical approach. Hence, the new model is believed to give exposure predictions that are closer to ‘real’ exposures. Furthermore, the model covers the most relevant scenarios for pesticide application outdoors and considers current application techniques.

3 Introduction

A prerequisite for the approval of plant protection products in Europe is the estimation of operator exposure using suitable exposure models where available. Up to now no harmonised European operator exposure model exists; therefore, the Member States apply different approaches resulting in different estimates for the same exposure scenario. With the implementation of zonal registrations this practice has become questionable as different exposure estimates are not compatible with a joint authorisation of plant protection products in European Member States.

EFSA recently addressed this problem in an opinion which included a draft guidance document on pesticide exposure assessment providing proposals for standard exposure models (EFSA, 2010). However, the models recommended by the draft guidance document are based mainly on data obtained for outdated equipment and agricultural practices and are, in some cases, less suitable for the purpose of predicting exposure under present conditions of use.

To overcome these problems a new database was established using data from more recently conducted operator exposure studies. Collected for a range of representative application techniques and scenarios, the new data are much more suitable for the development of a new model that is applicable for present conditions in Europe.

4 Legal requirements

According to Regulation No 1107/2009 on the placing of plant protection products on the market and Commission Regulation No 545/2011 implementing Regulation No 1107/2009 the use of plant protection products shall not have any harmful effects on human health. Therefore, an estimation of operator exposure as part of a risk assessment is required for the approval of plant protection products and should be accomplished by using suitable exposure models where available. It is stated that calculations have to be made for each type of application and equipment used and have to consider the mixing/loading operations, the application of the plant protection product and also the cleaning and the routine maintenance of application equipment. The requirements for handling the undiluted or diluted product, the climatic conditions or the type and the size of the product containers have to be taken into account as well. A tiered approach is considered for the calculation of operator exposure: The first estimation should be based on the assumption that the operator is not using any PPE (only work clothing), but where appropriate, a stepwise evaluation can be carried out for operators using different levels of PPE.

5 Existing models

The current risk assessment for operators is based on the comparison of a reliable exposure estimate with the respective Acceptable Operator Exposure Level (AOEL) normally derived from subacute or subchronic toxicological studies. The use of a plant protection product is considered safe when the exposure estimate calculated for daily systemic exposure is below the AOEL. For the estimation of operator exposure two models are predominantly used in Europe: The German Model (Lundehn et al., 1992) and the UK Predictive Operator Exposure Model (UK POEM; www.pesticides.gov.uk).

Both, the German Model and the UK POEM are deterministic models that rely on empirical data from exposure studies conducted before 1990 and allow exposure predictions for mixing/loading and application. Exposure in the models largely depends on the total amount of active substance used, the duration of exposure or the container size and number of mixing/loading tasks. Moreover, the formulation type and the spray equipment are important factors, too. In the German Model actual exposure is calculated for professional operators wearing T-shirts and shorts that are assumed to completely cover the respective body parts while in the UK-POEM professional operators are assumed to wear work clothes that cover the whole body and are permeable for a certain fraction of the contaminating pesticides. Additional protective equipment for the operators (e.g. protective gloves) can be chosen in both models in order to reduce the exposure prediction.

Both models share the assumption that dermal exposure during mixing/loading is determined only by exposure to the hands while during application the exposure to the whole body surface including head, torso, arms and legs is relevant. Inhalation exposure, which usually contributes relatively little to the overall exposure, is considered for mixing/loading and application in the German Model but only for application and handling solids in the UK POEM.

Despite the large number of studies the above mentioned models do not cover all relevant scenarios, e.g. the German Model does not have a scenario for hand held applications directed downwards.

Historically, efforts have been made to develop a harmonised operator exposure model, e.g. in the EUROPOEM project. However, this database contained in part outdated exposure data that do not represent current agricultural equipment any more or data from research studies that lacked essential transparency and were unsuitable for predictive modelling.

6 Scope

The objective of this project was to develop a harmonised operator exposure model based on empirical data from modern and scientifically valid exposure studies according to present scientific knowledge and agricultural practices, i.e. studies were performed according to accepted criteria and are representative for relevant application systems. Most, if not all, of these studies have been used to support product registrations in the EU in recent years. The new model is intended to provide estimates of daily exposure for current outdoor application techniques, in particular for:

- Low crop application using vehicle-mounted or vehicle-trailed boom sprayers (LCTM)
- Low crop application using hand-held spray equipment directed downwards (LCHH)
- High crop application using vehicle-mounted or vehicle-trailed broadcast air-assisted sprayers (HCTM)
- High crop application using hand-held spray equipment directed upwards (HCHH)

The model is considered to be appropriate for exposure estimation in authorisation procedures within the EU (especially for zonal registration). For this purpose, it was decided to initially use default agronomic parameters (e.g. for areas treated). Nevertheless, the model was designed to be adjustable and allow the use of national agronomic parameters in case the defaults significantly deviate from local conditions.

In order to ensure a flexible use of the model and to allow a defined consideration of risk mitigation measures the exposure from mixing/loading and the exposure from application should be calculated separately and segregated into the different exposure routes:

Mixing/loading

Dermal exposure:
- Potential dermal exposure (body, hands and head separately)
- Actual dermal exposure (body, hands and head separately)

Inhalation exposure:
- Potential inhalation exposure

Application (including cleaning)

Dermal exposure:
- Potential dermal exposure (body, hands and head separately)
- Actual dermal exposure (body, hands and head separately)

Inhalation exposure:
- Potential inhalation exposure

The entire modelling process was intended to be as transparent as possible. Thus, all data used and all decisions made are reported. Since the model was primarily established for assessing the relevant risks of operators (e.g. seasonal uses), the 75th percentile was used for all statistical issues as recommended by EFSA (EFSA, 2010). For assessing the risks from acute exposure, which will become relevant in the near future, a model based on the 95th percentiles has also been developed.

7 Model development

7.1 Database

7.1.1 Exposure studies

The new operator exposure model is based on data from exposure studies that have not previously been used in official regulatory exposure models. The European Crop Protection Association (ECPA), its member companies as well as the companies Agriphar and Globachem NV provided a pool of studies and an expert group consisting of regulatory body representatives and industry representatives analysed the studies regarding their suitability for the model. To ensure a very high quality of data the studies that were accepted for inclusion in the model had to meet a set of criteria, which are listed below.

- Compliance with OECD Series No. 9 [1)]
- Full compliance with GLP
- Monitoring of professional agricultural operators (e.g. farmers and contractors) working in accordance with GAP (Good Agricultural Practice)
- Data recording and observations according to current scientific knowledge
- Consistent field recovery (any outlying data must be explainable on a scientific basis)
- Suitable data form for model development (e.g. separately measured head, hand and body exposure)
- Whole body dosimetry for dermal exposure (exclusion of patch data)
- Inhalation exposure determined with appropriate inhalation fraction samplers
- Representative application methods and application techniques reflecting current agricultural application practices in Europe

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1) compliance with the criteria of that guidance was also confirmed for studies conducted before 1997

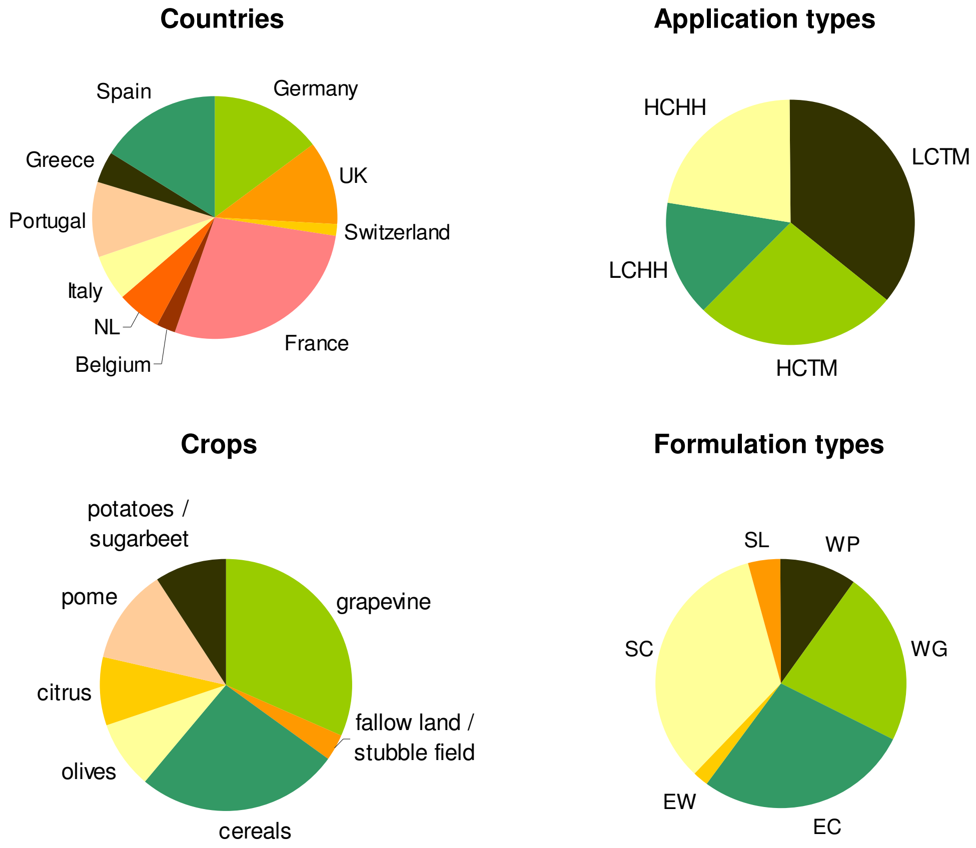


Figure 1: Study overview; most of the operators were monitored in France, Spain or Germany and they treated grapevine or cereals; in the majority of the studies the operators used vehicle-mounted/vehicle-trailed spray equipment in low crops (LCTM) and high crops (HCTM); hand-held applications in low crops (LCHH) were performed with knapsack sprayers while spray lances (connected to a tank) were used for hand-held application in high crops (HCHH); different formulation types were applied, liquid formulations (EC = emulsifiable concentrate; EW = emulsion, oil in water; SC = suspension concentrate; SL = soluble concentrate) were the most commonly used ones, two studies were performed with powder formulations (WP = wettable powder) and eight studies were performed with granular formulations (WG = water soluble granules).

According to these criteria 34 studies were chosen. Both mixing/loading/application studies (MLA studies), in which the exposure from mixing/loading and application was monitored as one whole operation (using the same dosimeters/air samplers for the whole working day), and mixing/loading + application studies (ML+A studies), in which the exposure from mixing/loading and the exposure from application were monitored separately (using separate sets of dosimeters/air samplers for each task), were selected.

The studies were conducted between 1994 and 2009 in different European countries. Fifteen studies took place in the central zone and 19 studies in the southern zone (one of which was conducted jointly in Switzerland and France). Typical application techniques and scenarios for outdoor treatment of low and high crops were presented in the studies. The equipment used comprised vehicle-mounted/-trailed or self-propelled sprayers as well as hand-held spray guns and knapsack (backpack) sprayers (Figure 1). Cabins were found on almost all large-scale sprayers predominantly used for the treatment of cereals or potatoes but only on half of the sprayers predominantly used for the treatment of vineyards or orchards. Hand-held applications were conducted with knapsack sprayers or lances connected to a tank. By chance the former sprayers were exclusively used for applications directed downwards, whereas the latter ones were used for applications directed upwards.

Most of the selected studies were designed to monitor exposure during a typical working day comprising the mixing and loading as well as the application of the pesticide product. Cleaning of the equipment was not performed by each operator. Thus, the exposure of this task was not always assessed. In the cases where cleaning was performed it was usually not monitored separately but included in the application task. Depending on the study design the exposure from mixing/loading and application was not measured separately in some studies but recorded as overall exposure.

Mixing/loading and application were conducted by either the same operator or different operators performing work according to their usual work practices. Except for one female operator all monitored subjects were male. The operators were experienced but varied in body weight and age (Figure 2). Target area and total amount of active substance (sum of active substance applied per day) varied depending on the type of application and equipment used. The largest areas and highest amounts of active substance per day were observed for vehicle-mounted/vehicle-trailed application in low crops (Figure 3 and Figure 4).

Two different scenarios were monitored for the mixing/loading task: filling a tank and filling a knapsack (observed exclusively for LCHH application). With respect to the duration of the task both scenarios were quite similar, though knapsack filling tended to be performed faster (Figure 5). The average duration of application was three to four hours. Working days with ten or eleven hours of spraying were occasionally observed for vehicle-mounted/vehicle-trailed application (Figure 6).

7.1.2 Sampling methodology

According to the selection criteria the exposure data were obtained by whole body dosimetry and personal air sampling. Dermal exposure was sampled with separate dosimeters/procedures for the head, the body and the hands. All dosimeters were supplied by the study team at the beginning of the studies and collected for analysis at the end of the working day. Both actual and potential body exposures were assessed by analysing the outer and inner layers of sampling clothing. The outer body dosimeter usually consisted of a coverall (mainly jacket and long trousers); the inner dosimeter (representing the skin) consisted of a long sleeved shirt and long underpants. Actual exposure and potential exposure were also determined for the hands. The protective gloves worn by the operators during mixing/loading or application were analysed in addition to inner cotton gloves or hand washes, which were analysed for hand exposure. Various dosimeters, ranging from caps and hoods to headbands or face/neck wipes, were used to assess head exposure. In several studies the operators wore face shields during the mixing/loading procedure.

7.1.3 Data entry

The exposure data were extracted from the selected studies and compiled to create a database for the new model. Numerous columns and sections were created to enable the transfer of the original, non-aggregated values without losing information. In addition to the exposure data further information regarding the pesticide product (e.g. total amount used, formulation type), the work task (e.g. duration, size of treated area), the working conditions (e.g. row distance, temperature), the equipment (e.g. sprayer type, cabin present or not) and the operator (e.g. body weight, description of PPE) was collected in the database. Overall, more than 50 parameters which describe application conditions and might affect the extent of exposure were defined and compiled.

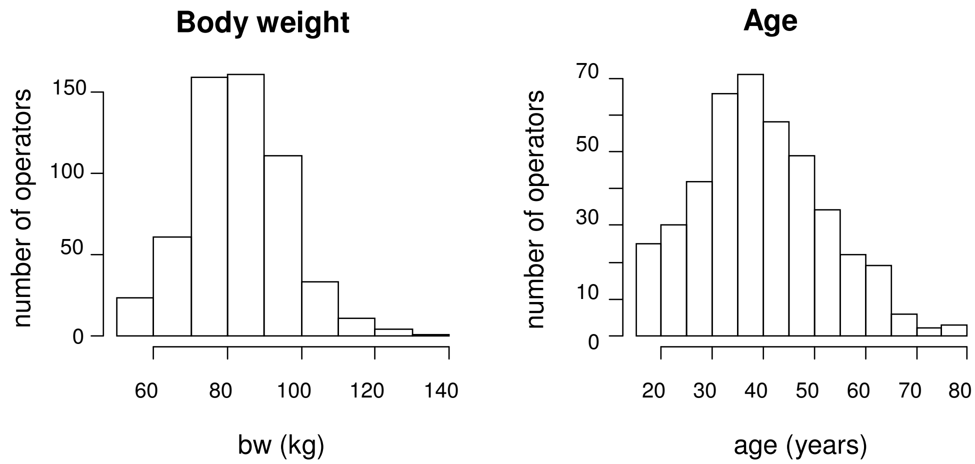


Figure 2: Body weight (BW) and age of the monitored subjects; the body weight ranged from 52 to 132 kg (median: 83 kg), the age varied from 16 to 77 years (median: 39 years); all subjects were male except for one female operator.

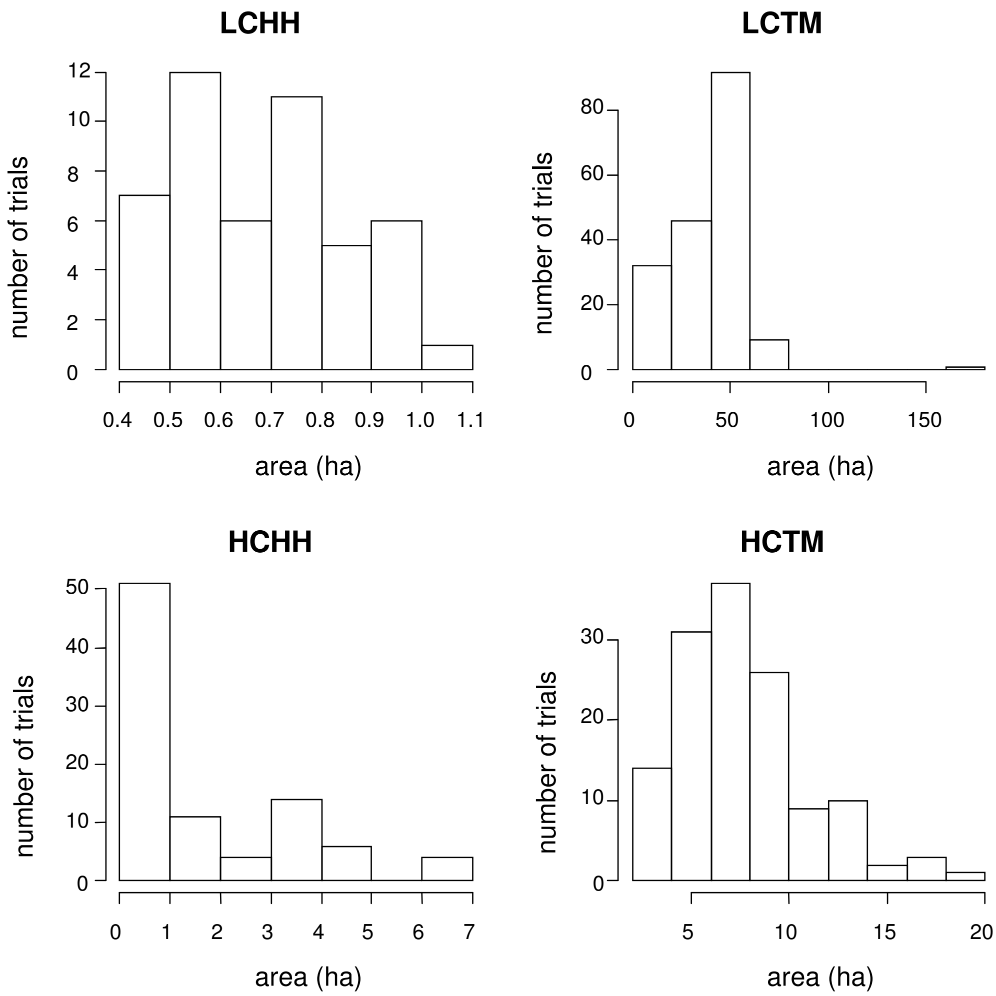


Figure 3: Target area; most of the LCTM studies were conducted with about 50 ha, small areas of only 4 to 6 ha were sprayed in one study on herbicide application in vineyards and in one study in maize and fallow fields; the maximum target area for HCTM application was 20 ha but areas between 4 to 10 ha were treated most commonly; the target area for application with knapsack sprayers (LCHH) was in a small range of 0.4 to 1.1 ha while up to 6.8 ha were treated during hand-held application using spray guns connected via hose to a tank in high crops; in about half of the HCHH trials the target area was in the same range as for the LCHH scenarios.

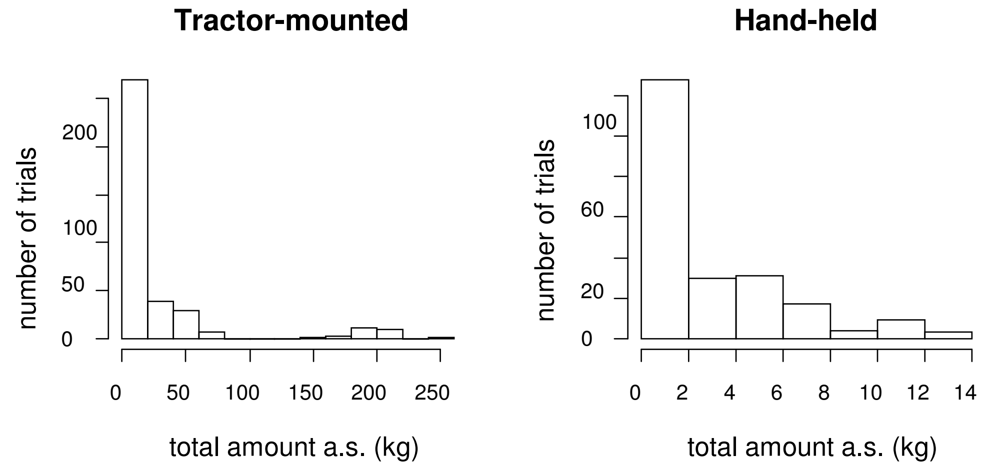


Figure 4: Sum of active substance used per day (total amount a.s.); the amount ranged from 0.9 kg to 250 kg for LCTM application (median: 9.0 kg) and from 0.3 to 37.8 for HCTM application (median: 3.8 kg); 0.1 to 1.5 kg were used in LCHH application (median: 0.2 kg) and 0.3 to 13.5 kg in HCHH application (median: 3.8 kg).

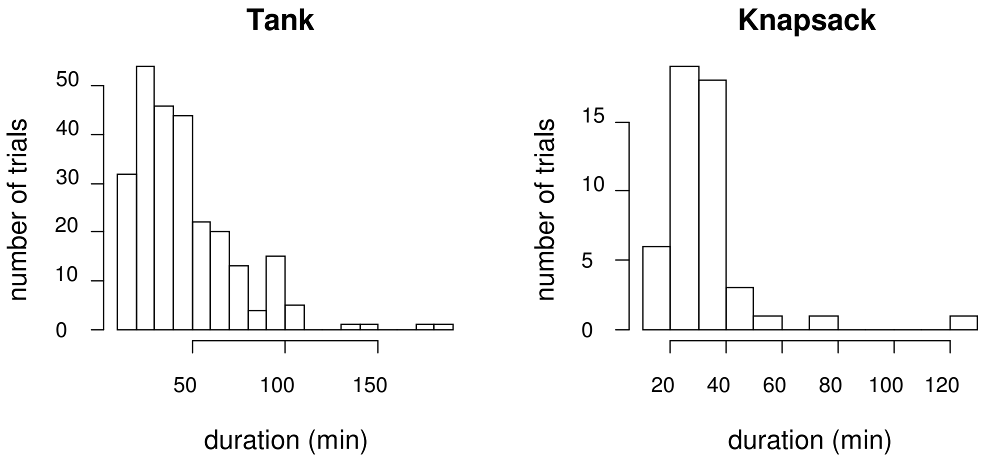


Figure 5: Duration of mixing/loading; in case of filling a tank the whole mixing/loading procedure was completed after 10 to 182 min (median: 40 min), in case of filling a knapsack the task was finished after 17 to 130 min (median: 30 min).

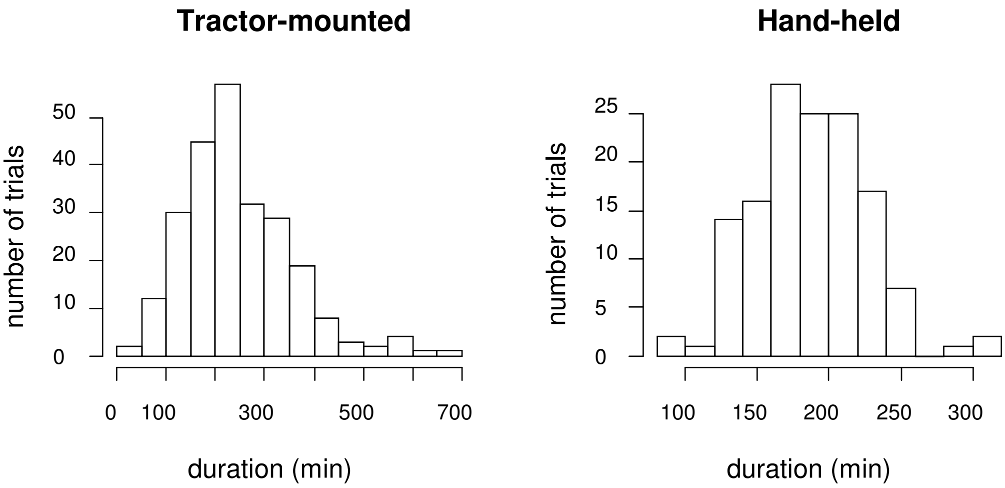


Figure 6: Duration of application; the operators sprayed between 40 to 671 min (median: 235 min) with vehicle-mounted/vehicle-trailed equipment, application with hand-held spray equipment was completed after a median duration of 188 min (range: 80 to 304 min).

7.1.4 Quality control

On completion of data entry by an evaluator, to ensure that information had been correctly transcribed, a second evaluator independently checked the data transcription.

7.1.5 Exposure data

The database for the new operator exposure model comprises a large number of exposure values. A total of 595 operators performing mixing/loading, application or both were monitored in the selected studies resulting in 595 sets of data records for operator exposure. In principle, each data record consists of exposure values for inhalation, the head, the body and the hands. The dermal exposure of the body (excluding head and hands) is compiled from the measured residues on inner dosimeters (representing the exposure of the skin below one layer of work clothing) and the measured residues on the outer dosimeters (normal work clothes). Depending on the use of protective gloves the values for the actual hand exposure are categorized as those for gloved hands (protective gloves always used) and those for unprotected/partially gloved hands (no protective gloves used/protective gloves occasionally used). Inhalation exposure and dermal head exposure are determined by the amount of active substance quantified on the respective specimens.

Based on the study design different types of exposure data exist in the database: Mixing/loading data from monitoring mixing/loading (ML data) activities, application data from monitoring application (A data) activities and mixing/loading/application data from monitoring both tasks as a whole (MLA data). In some cases ML data, A data and MLA data were obtained from the same operator depending on the part of the body monitored (e.g. ML and A data for hand exposure but MLA data for body exposure). All types of data were included in the database but only the separate mixing/loading data and application data were used for model development while the MLA data were used to validate the model.

Because of deficiencies in the exposure sampling (e.g. failure of air sampling pump) or unusual operator activities during the trial (e.g. extensive repair of the spray equipment) some values had to be excluded from the database after completion of data entry. The complete application data from one study (LCTM 3, see study descriptions in Appendix 1) were also not considered for the model since the exposure scenario in the study was considered unusual and irrelevant (herbicide application on a small area of maize or fallow fields with small vehicle-mounted/vehicle-trailed spray equipment). Omitting these data as well as all the combined MLA data, more than 2,900 individual values (consisting of 280 mixer/loaders and 344 applicators with the majority being involved in vehicle-mounted or -trailed applications) remained for model development (Table 1).

Different product formulations were used in the selected studies. While liquid formulations were frequently applied throughout all application scenarios no data were available from the database for:

1. High crop hand-held applications with WG formulations
2. Low crop hand-held and vehicle-mounted/-trailed applications with WP formulations

The spray equipment that was used in the studies differed between application types. Sprayers for normal LCTM applications were generally equipped with a cabin while half of the sprayers used for HCTM applications did not have cabins. Induction hoppers were almost exclusively used in combination with spray equipment for LCTM applications. Hand-held applications directed downwards were performed with knapsack sprayers only. Cleaning of the equipment was included in the monitoring of the application task in less than half of the trials.

Table 1: Agricultural operator exposure database and its characteristics; number of values without MLA data and excluded data (see text). Some operators are counted twice (for ML and for A) since they were monitored during mixing/loading and during application with separate sets of dosimeters/personal air samplers.

	Replicates per task		Cleaning	Cabin			Loading	Formulation				Equipment	
	M/L	A	included	cabin	no cabin	closed cabin	induction hopper	WG	WP	EC/EW	SC/SL	tank	knapsack
LCTM	108	97	43	93	4	56	57	34	-	63	41	138	-
HCTM	79	109	41	54	55	33	1	55	-	12	66	133	-
LCHH	49	48	48	-	-	-	-	19	-	60	9	-	88
HCHH	44	90	12	-	-	-	-	-	60	14	60	134	-
all	280	344	144	147	59	89	58	108	60	149	176	405	88

Table 2: Number of mixing/loading data and application data available for the model development.

	Mixing/Loading						Application					
	Inhalation	Hands	Gloves	Body $_{inner}$	Body $_{outer}$	Head	Inhalation	Hands	Gloves	Body $_{inner}$	Body $_{outer}$	Head
LCTM	77	96	108	56	57	57	66	85	74	45	46	46
HCTM	52	66	77	41	41	40	83	97	92	72	72	71
LCHH	40	49	49	40	40	40	39	48	20	39	39	39
HCHH	32	44	44	32	32	32	90	90	90	90	90	90
all	201	255	278	169	170	169	278	320	276	246	247	246

Table 3: Application parameters from the selected studies. The parameters for LCTM application were separated regarding the use of normal equipment or small equipment.

	Area [ha]			Total amount a.s. [kg a.s.]			Application rate [kg a.s./ha]		
	75th perc.	95th perc.	Max.	75th perc.	95th perc.	Max.	75th perc.	95th perc.	Max.
LCTM	50.1	63.9	180.0	51.0	201.2	250.0	1.1	4.0	4.5
LCTM (small equip.)	4.4	5.6	6.0	1.0	1.2	1.2	0.2	0.2	0.2
HCTM	9.6	14.0	20.0	7.9	17.8	37.8	0.9	1.8	2.1
LCHH / HCHH (tank)	3.8	6.3	6.8	5.9	11.8	13.5	1.4	1.7	1.7
LCHH / HCHH (knapsack)	0.8	1.0	1.1	0.2	1.5	1.5	0.4	1.5	1.5
HCHH (dense culture)	0.7	1.1	1.4	4.1	7.7	9.4	13.1	17.2	18.4

Since in some of these trials cleaning was performed only if necessary (with no further comments made in the study report) the actual number of monitored cleaning tasks remains uncertain.

The total number of mixing/loading data and application data for inhalation and dermal head, body and hand exposure is summarised in Table 2. The majority of the data that were used for modelling were from LCTM and HCTM studies. Nevertheless, hand-held applications in low crop and high crop are represented by reasonably sized data sets. The raw data and a description of the respective studies are presented in Appendix 1.

In most of the selected studies the area treated corresponded to a typical work day. For the different application methods the application area, the total amount of active substance applied per day and the application rate are presented in Table 3.

7.1.6 Data processing

In a first step the original exposure data were transferred from the study reports into the database without modifying the values. Nevertheless some processing was necessary. In cases where the value was below the limit of quantification (LOQ) it was agreed to use 50 % of the LOQ. Moreover, all values below the limit of detection (LOD) were considered as “zero”, but due to statistical analysis reasons a value of 0.01 µg per sample was used instead. If the field recovery was below 70 %, a correction for the field recovery was generally made or accepted. Other modifications were only done in rare cases, in which an extrapolation of the value was necessary. In fact, three values for inhalation exposure had to be adjusted for the whole working time since the air sampling pump failed to work the entire time or was not turned on for a certain time of exposure. The extent of adjustment was, however, limited. In seven cases, in which the duration of pump failure exceeded 30 % of the total working time, the values were discarded.

Further processing of the exposure data took place after data entry. Several correction factors were established to account for the different head dosimeters used in the studies. For a conservative estimation of the whole head exposure the values derived from headbands were adjusted by a factor of 4, values from hats or caps by a factor of 2, values from hoods by a factor of 1.5 and values from face/ neck wipes by a factor of 2. Face/neck wipe data for head exposure during mixing/loading were flagged and evaluated separately when it was stated in the report that the operator was wearing a face shield. These data do not reflect potential exposure as the amount of pesticide on the face shields was not determined.

Actual hand exposure data obtained by sampling hand washes or inner cotton gloves were used for the model without adjustment. Some operators rinsed their protective gloves after completion of the working task or after handling contaminated surfaces in order to follow good occupational practice. Thus, not all of the potential hand exposure would have been captured. Therefore, the respective data for gloves and hands were evaluated separately. In some studies separate hand exposure values for cleaning were recorded. As cleaning is assumed to be part of the application task, hand exposure from cleaning was added to the hand exposure from application. In the case that the actual exposure of the hands was not separately determined for mixing/loading and application but mixing/loading data (ML data) and application data (A data) exist for the protective gloves used in the study, the value for the actual hand exposure was split by calculation into one value for mixing/loading and one value for application according to the individual ratios of the ML and A values obtained for the gloves. This procedure was applied to 24 values in total.

A similar procedure was carried out for 17 MLA values for ‘inner’ body exposure; these values were split into ML values and A values according to the ratio of the respective mixing/loading exposure and application exposure of the outer body. Body exposure data for different body parts of the same operator (e.g. torso, lower arms/legs, upper arms/legs) were summed up to one value for ‘inner’ body exposure or ‘outer body’ exposure. Values for socks (if analysed) were included in the ‘inner’ body exposure (only relevant for MLA studies). Furthermore, adjustments were adopted for ‘inner’ body exposure that had been made in some studies to extrapolate from short underwear to long-sleeved or long-legged underwear.

The exposure via inhalation was calculated from the amount of residue determined on the filter or tube of the air sampler and the flow rate of the air sampling pump assuming a default breathing rate of 1.25 m^3/h. This rate corresponds to light work activity and is used as standard for estimating inhalation exposure of operators applying biocides (TNsG 2007).

All values which had been modified or adjusted during the data processing were annotated and flagged.

7.1.7 Exposure scenarios

The exposure from mixing/loading (handling the undiluted product) and the exposure from application (handling the diluted product) result from inhalation exposure and from dermal exposure of the body, the head and the hands. With respect to risk assessment two different exposure scenarios are possible for each work task: exposure without using any personal protective equipment (PPE) and exposure when using personal protective equipment.

This issue, however, is only partly addressed by exposure studies, which are designed to reflect normal work practice. PPE is only worn according to good agricultural practice or if label instructions on the product recommend their use. Another problem for the development of the model is that actual exposure is not always detectable by the dosimeters/samplers when using PPE. In the case of inhalation exposure, measured exposure values usually neglect personal protective equipment due to the methodology of exposure monitoring (use of external air samplers). Hence, mixing/loading and application data given for inhalation exposure in the database represent exposure without personal protective equipment. Also the majority of the head values were obtained for exposure without using PPE. Operators wore hats or hoods in some studies but only as dosimeters to assess exposure of the head. At least the impact of wearing face shields during mixing/loading on the head exposure was detected by conducting face/neck wipes in several studies. Consequently, head data for both scenarios (with or without PPE) are available for the mixing/loading task, but only head data for the exposure without PPE are available for the application task.

Two different kinds of exposure were monitored for the body during mixing/loading and application, the first representing an outer layer of clothing (outer body dosimeter) and the second representing the skin below (inner body dosimeter). Following good occupational hygiene practice it is reasonable to assume that operators are wearing long work clothes covering their skin. Thus, the resulting body exposure generally corresponds to the exposure measured below the outer layer of clothing. The outer clothing as used in the studies was not certified as protective clothing but could be considered as usual work clothes. Consequently, the relevant body exposure for both work tasks corresponds to exposure without special personal protective equipment but with work clothes. For the exposure scenario with personal protective equipment (e.g. a Tyvek suit) no data exist in the database.

In the case of the hands the database provides additional exposure data for using protective equipment. During mixing/loading operators continuously wore protective gloves in almost all studies (following good hygienic practice). The residues on the hands beneath protective gloves (determined by a pair of inner gloves or hand wash) give the exposure when using protective equipment, whereas the exposure when using no protective equipment results from the residues found on the gloves plus the residues found on the hands. For the application task the exposure scenarios are more complex: in some studies protective gloves were permanently worn, but in others only sometimes or not at all. Despite the fact that hands were not (always) covered by protective gloves, they can be considered as protected, as long as the operator applied the pesticide while staying in a closed cabin and used protective gloves whenever doing maintenance work outside or cleaning. In all other cases (open or no cabin, maintenance work or cleaning without gloves) hands are considered unprotected. For the exposure without any protective equipment all hand data are used: the residues found on protected or unprotected hands and the residues found on the respective gloves (if used) are summed up to one value for potential or total hand exposure which is consistent with hand exposure without PPE. An overview of the different scenarios is given in Table 4.

7.2 Statistical evaluation

7.2.1 Variables

The new exposure model provides estimates for the following variables which were evaluated separately for mixing/loading and application. All variables refer to exposure data for individual operators; exposure data were not combined from different operators.

Inhalation exposure: All residues that were found on air sampling filters or tubes, calculated for a generic respiration rate of 1.25 m^3/h; this is considered to be representative of inhalation exposure.

Head exposure: All residues that were found on head dosimeters including correction factors: headband 4, hat or cap 2, hood 1.5, face/neck wipe 2; this is considered identical to head exposure without using any personal protective equipment.

'Inner' body exposure: All residues that were found on an inner layer of clothing beneath an outer layer of clothing (head and hands excluded); this is considered identical to actual body

Table 4: Relevant exposure scenarios considered for model development.

		Inhalation	Head	Body	Hands
Mixing/ loading (undiluted product)	without PPE (with working clothes)	Exposure determined by personal air sampling (default breathing rate: 1.25 m^3/h)	Exposure determined by head dosimeters (incl. correction factors)	Exposure determined beneath outer layer of clothing (inner body dosimeter)	Bare hands (no gloves at all); gloves plus hands partially under gloves; gloves plus hands permanently under gloves
	with PPE	No data	Face/neck wipe data in case that face shields were worn	No data	Hands permanently under gloves
Application (diluted product)	without PPE (with work clothes)	Exposure determined by personal air sampling (default breathing rate: 1.25 m^3/h)	Exposure determined by head dosimeters (incl. correction factors)	Exposure determined beneath outer layer of clothing (inner body dosimeter)	Bare hands (no gloves at all); gloves plus hands partially under gloves; gloves plus hands permanently under gloves
	with PPE	No data	No data	No data	Hands permanently under gloves; hands partially under gloves (gloves worn during maintenance and cleaning, closed cabin); bare hands (closed cabin, no maintenance work or cleaning)

exposure and body exposure without using special personal protective equipment but with normal work clothes (according to good occupational hygiene recommendations).

Total body exposure: All residues that were found on an inner layer of clothing ('inner' body exposure) and on an outer layer of clothing ('outer' body exposure), excluding head and hands; this is considered identical to potential body exposure.

Protected hand exposure: All residues that were found on the hands of operators protected in any case of exposure; this is considered identical to hand exposure using personal protective equipment.

Total hand exposure: All residues that were found on the hands and gloves of the operator; this is considered identical to potential hand exposure and exposure without using any personal protective equipment.

7.2.2 Model structure

The model should allow a separate calculation of exposure for mixing/loading and for application. With respect to mixing/loading it was intended to differentiate between filling a tank and filling a knapsack. Both scenarios are generally possible for hand held equipment while only tank filling is possible for vehicle sprayers. Different scenarios were also considered for the application task: Models were developed for application with vehicle-mounted/vehicle-trailed equipment, either directed downwards (LCTM) or upwards (HCTM), and for hand-held sprayers, either directed downwards (LCHH) or upwards (HCHH). The scenarios for mixing/loading and application as well as their possible combinations are illustrated in Figure 7.

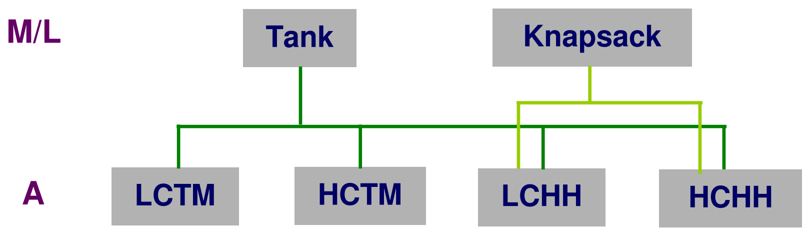


Figure 7: Scenarios (and their combinations) for which models were developed.

7.2.3 Form of the model

As expected, the exposure data were close to log-normally distributed. Therefore, a log-linear model was assumed to discribe the exposure values X by A, e.g. the total amount of active substance used, and a number of additional categorical factors F_1, F_2, ... such as formulation type or presence of a cabin (see section 5.2.4). The general form of the model is:

$$\log X = \alpha \cdot \log A + \Sigma [F_i]$$

This translates into the following form:

$$X = A^{\alpha} \cdot \Pi c_i$$

The logarithmic model has several desirable properties: The factors of the model contribute to the resulting exposure in a multiplicative way and the logarithmic model is capable of describing the dependency of exposure on the total amount of active substance used as sublinear ($\alpha < 1$), which is expected to be realistic for an exposure model. However, a logarithmic model may also result in a superlinear dependency ($\alpha > 1$) which is assumed to be implausible. In this case, the exponent needs to be forced to 1.

7.2.4 Choice of factors

The data were collected for different application scenarios and under varying conditions. In order to cope with the information collected in the database and to minimise the number of factors to be checked during model development several decisions were made:

- The location of the test site can be ignored as the model will cover application conditions for the whole of Europe.
- The crop was differentiated into low crop and high crop only.
- Data on weather conditions are not considered.
- The physicochemical properties of the active substance (e.g. vapour pressure, log Kow) are not considered for the model development.

The focus was set on a selection of key factors on which the exposure is expected to mainly depend. For mixing/loading the following factors were considered:

- Formulation type
- Total amount a.s. used
- Number of containers handled
- Number of mixing/loading tasks
- Concentration of active substance in the product
- Equipment (induction hopper)
- Duration of mixing/loading

Eight factors were chosen to be examined for the exposure during application:

- Formulation type
- Total amount a.s. used
- Concentration of active substance in spray solution
- Equipment (cabin/no cabin)
- Size of area treated
- Droplet size
- Cleaning
- Duration of application

The impact of each factor alone and the impact of combinations of several factors (without interactions) were explored by the following process: A large number of models were fitted by least squares regression and model diagnostics such as p-value, R^2 and AIC were tabulated. These tables were discussed at the expert meetings and suitable factors were chosen. With these factors, the fitting process was started, i.e. the fit was inspected in detail and irrelevant factors, if any, were removed (see section 5.2.10). This approach was chosen in order to make consistent choices for the different exposure variables, to avoid over-prediction and to minimise the impact of implausible findings which may arise by chance. For instance, the experts rejected the idea that formulation type (WG, WP, liquid formulation) may have an impact on exposure during application (as opposed to mixing/loading where the impact was judged plausible).

7.2.5 Software

Data entry was organised using MS Excel 2003. Statistical evaluation was performed using R version 2.15.0 (R development core team, 2012) with the packages quantreg (Koenker, 2012) and DAAG (Maindonald et al., 2012). R is widely used in research; it provides a modern language for statistical computation.

In the box-and-whisker-plots, the bold line represents the median; the box boundaries represent the first and the third quartile and the whiskers represent the "upper and lower level", i.e. some range which is deemed plausible based on the height of the box (technically: median $\pm 1.58 \times IQR/\sqrt{n}$).

7.2.6 Special issues

Prior to the statistical analysis a closer look was taken at some aspects which required clarification with respect to the decisions based on them.

Hand dosimeter

The hand exposure values in the database were obtained by different sampling methods. Hand wash specimens, cotton gloves and/or nitrile glove dosimeters were analysed to determine the exposure. Where cotton gloves were used these were worn in the vast majority below protective nitrile gloves. A rather unusual design, however, was chosen in two studies where the hand exposure was determined with two pairs of cotton gloves – one pair worn beneath and one pair worn above a pair of protective nitrile gloves.

To confirm the assumption that the different sampling methods gave equivalent results all values for protected hand exposure and total hand exposure collected for vehicle-mounted/vehicle-trailed applications were compared (Figure 8). As the distribution of the values was quite similar and displayed the same trend with increasing total amount of active substance handled it was concluded that all study results could be used for the model without restriction.

Protected hand exposure

The application scenario for protected hands includes data from operators wearing gloves all the time and data from operators applying the plant protection product from a closed cabin and wearing gloves in case of exposure (e.g. exiting the cabin to deal with blocked nozzles). Data from operators not using gloves in case of exposure or applying while not staying in a closed cabin were not considered for the estimation of protected hand exposure.

The comparison of the different data categories for LCTM and HCTM application (Figure 9) revealed that the results for the two categories representing the protected hand scenario ('gloves all the time', 'gloves when necessary') are similar (although the data for the scenario of the hands being protected when necessary cover a wider range than the data for the scenario of the hands being protected all the time, which is probably due to the higher number of data points) while the results for the partially protected/unprotected hands are

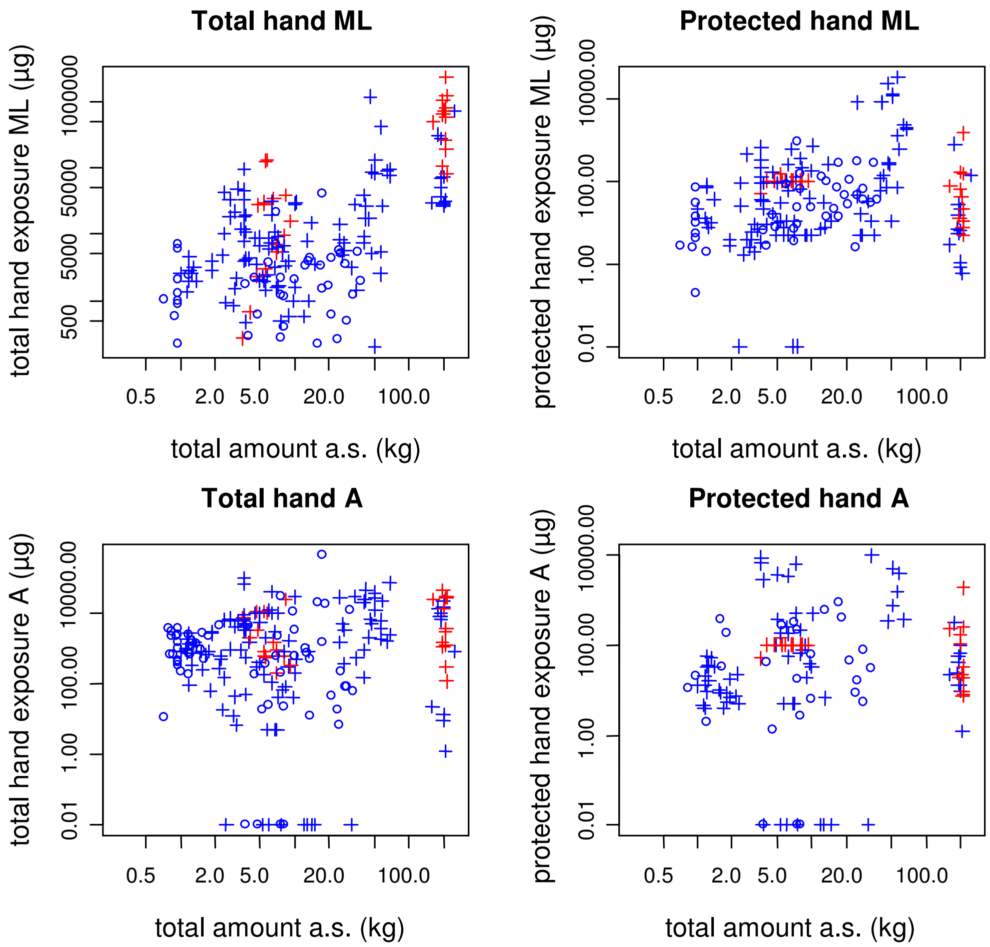


Figure 8: Comparison of hand exposure data (LCTM and HCTM) with respect to the method of sampling; red: cotton gloves beneath and above protective gloves; blue: protective gloves (if used) and inner cotton gloves or hand wash; o = WG, Δ = WP, + = liquid.

significantly higher. This result justifies the categorization of the actual hand data made for the model.

Total hand exposure

Total hand exposure is defined as the total amount of active substance to which the hands of the operators are potentially exposed to regardless of the use of protective gloves. Neverthe-less, the use of protective gloves might have an impact on the working practice of the opera-tor.

This issue was addressed by analysing the different application scenarios for total hand ex-posure (Figure 10). The analysis revealed that wearing gloves all the time results in a similar total hand exposure to that incurred if the gloves were only worn when operators identified a specific need to do so (e.g. maintenance operations during the application phase). Thus, wearing gloves or not has no impact on the total exposure of the hands and the data from all scenarios can be pooled for total hand exposure.

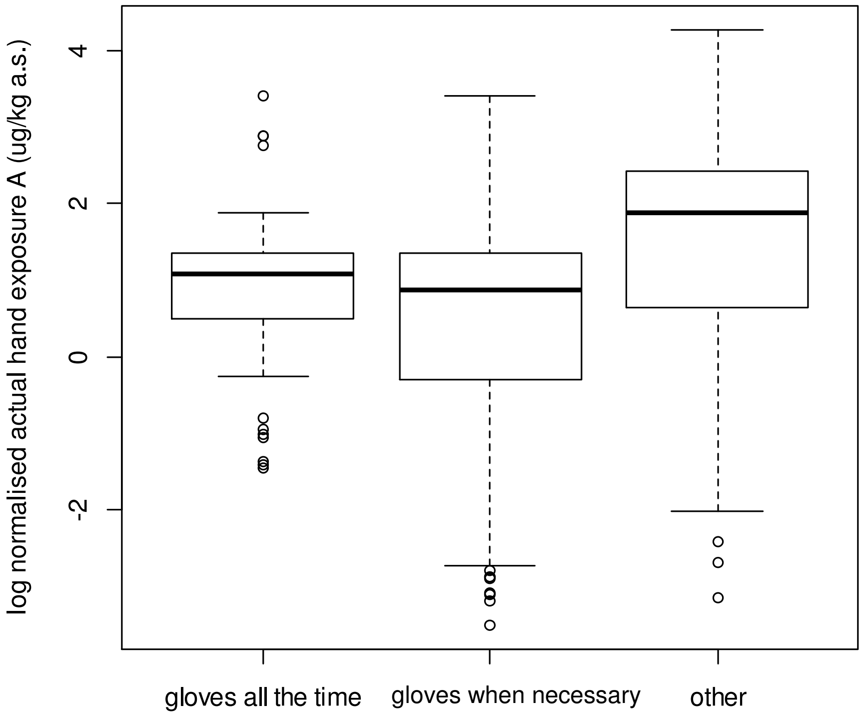


Figure 9: Distribution of values for protected hands ('gloves (worn) all the time', 'gloves (worn) when necessary') and partially protected/unprotected hands ('other'); shown are box plots of log normalized data for LCTM and HCTM application; the box plots were generated with the statistical program R and represent the first and the third quartile, the median and the upper and lower level.

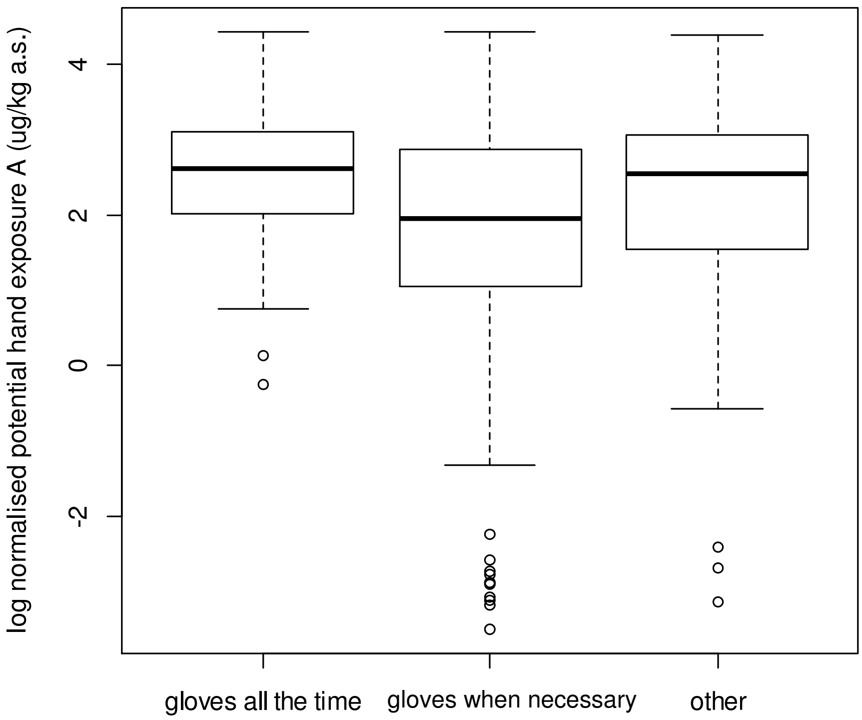


Figure 10: Total hand exposure data categorised with respect to the use of gloves; shown are box plots of log normalised data for LCTM and HCTM application; the box plots represent the first and the third quartile, the median and the upper and lower level.

Induction hoppers

The use of induction hoppers might have an impact on exposure during mixing/loading. Therefore, exposure during mixing/loading using induction hoppers and using conventional equipment was compared. However, the data did not show an impact on hand, body and inhalation exposure. The head exposure was even increased in the presence of induction hoppers, albeit at a low level (Figure 11). Hence, the use of an induction hopper was not considered as a factor for the model.

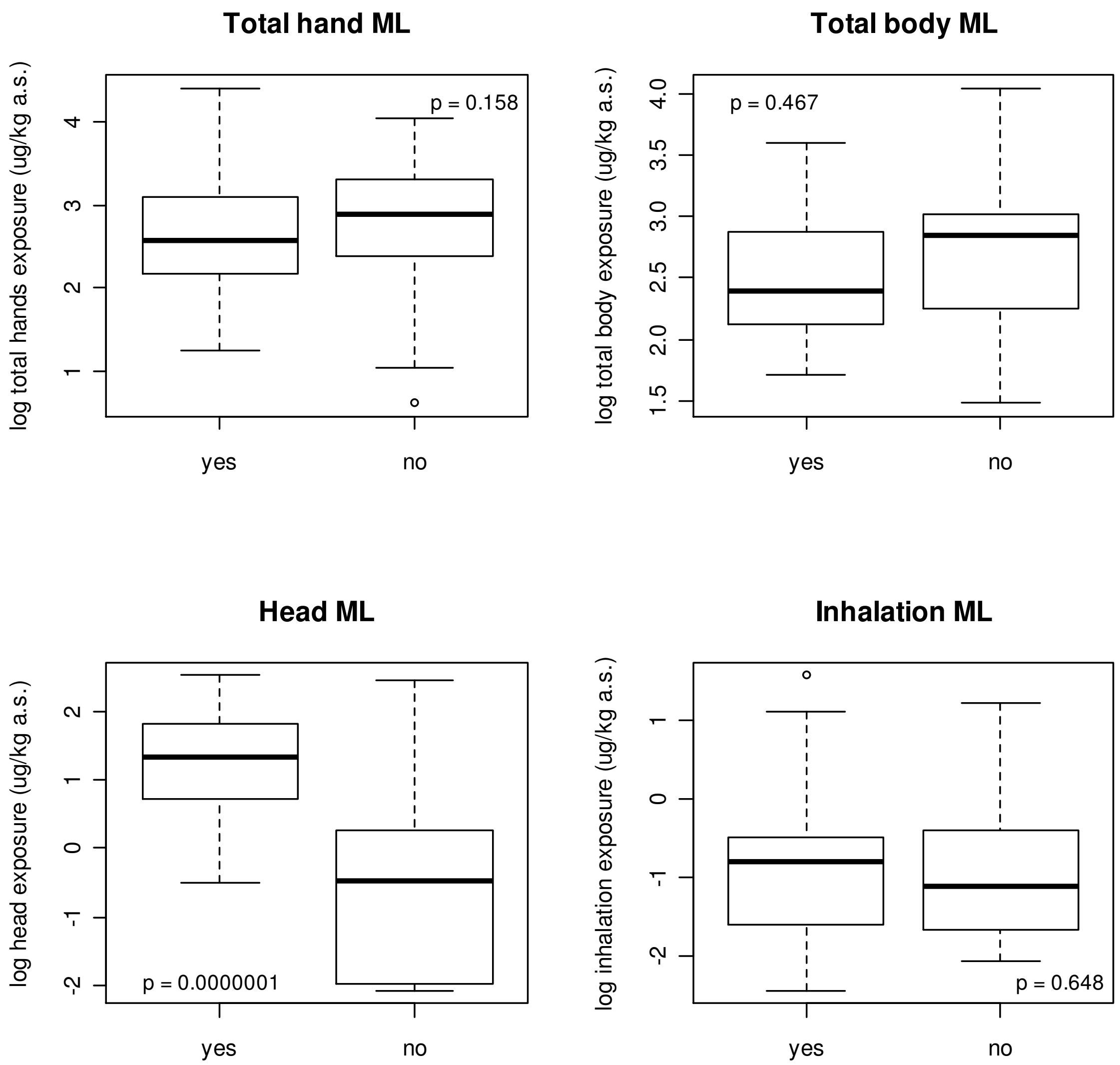


Figure 11: Comparison of mixing/loading data for using an induction hopper (yes) or not (no). Shown are data for vehicle sprayers only; the box plots represent the first and the third quartile, the median and the upper and lower level.

7.2.7 Correlations and dependencies

Before choosing the scalar predictors for the model key parameters were checked for pair-wise correlations in order to reveal possible dependencies amongst them. Four parameters were selected for the investigation of the mixing/loading task:

- number of containers handled
- amount of active substance applied per day (total amount a.s.)
- ML duration
- number of ML tasks

In all cases only weak or no correlations were observed between these factors (Figure 12), but different ranges for the different application types (indicated by different colours) were apparent.

Clear correlations were, however, found between some factors of application (Figure 13).The factors chosen were:

- application area
- amount of active substance applied per day (total amount a.s.)
- concentration of active substance in spray solution
- application duration

The amount of active substance applied per day and the application area (ha) were identified to be highly correlated (log scale, Pearson's r = 72 %, Spearman's ρ = 77 %) and also the amount of active substance and the concentration of the active substance in the spray solution displayed a strong dependency on each other (r = 67 % and ρ = 56 %). Area or concentration of the spray solution should, therefore, not be chosen as modelling factors in combination with total amount. The fourth parameter, the application duration, was not correlated with any of these factors.

7.2.8 Choice of exposure reference value and summation of percentiles

The 75th percentile is used for all statistical issues concerning the development of the model. In parallel, the 95th percentile is used to account for acute exposure estimation in order to comply with possible future requirements for acute risk assessment. In general, the confidence in the estimate of a 95th percentile is lower than the confidence in the estimate of the 75th percentile as higher percentiles depend much more on the measured values at the edge of the distribution which are less dense than in the centre of the distribution. In particular, for small (sub) datasets of the available database or for highly variable measurements, the confidence decreases with higher percentiles.

7.2.9 Methods

There are numerous methods for fitting linear regression models, the most common being least squares regression. In this project, two different methods were used in parallel for modelling the data: ordinary least squares regression and quantile regression.

Ordinary least squares regression (for an overview see Montgomery et al., 2012) has the advantage of being well understood, so model selection using diagnostic figures such as R^2 or the p-value is standard. Once fitted, not only the expected value (mean) can be predicted, but also any required percentile (by adding the respective variation to the predicted value) – provided the model assumptions are valid. However, least squares regression is sensitive to outliers and in particular to the assumed values of measurements below the limit of quantification. In order to obtain a prediction for some percentile, the appropriate multiples of the estimated parameters' standard deviations have to be added to the regression line.

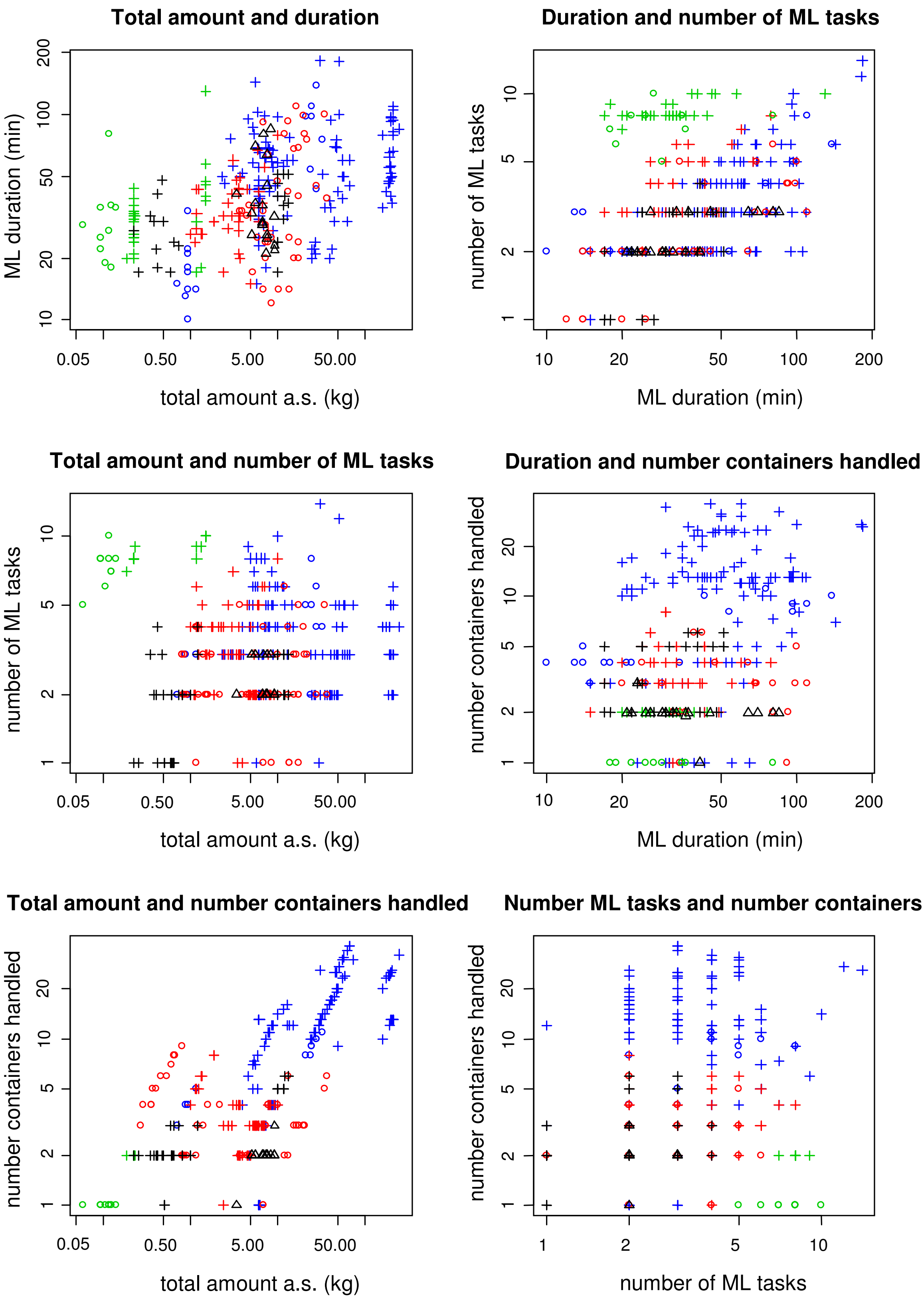


Figure 12: Dependencies between total amount of active substance applied per day, mixing/loading duration, number of mixing/loading tasks and number of containers handled; logarithmic scales used; blue = LCTM, red = HCTM, green = LCHH, black = HCHH; o = WG, Δ = WP, + = liquid.

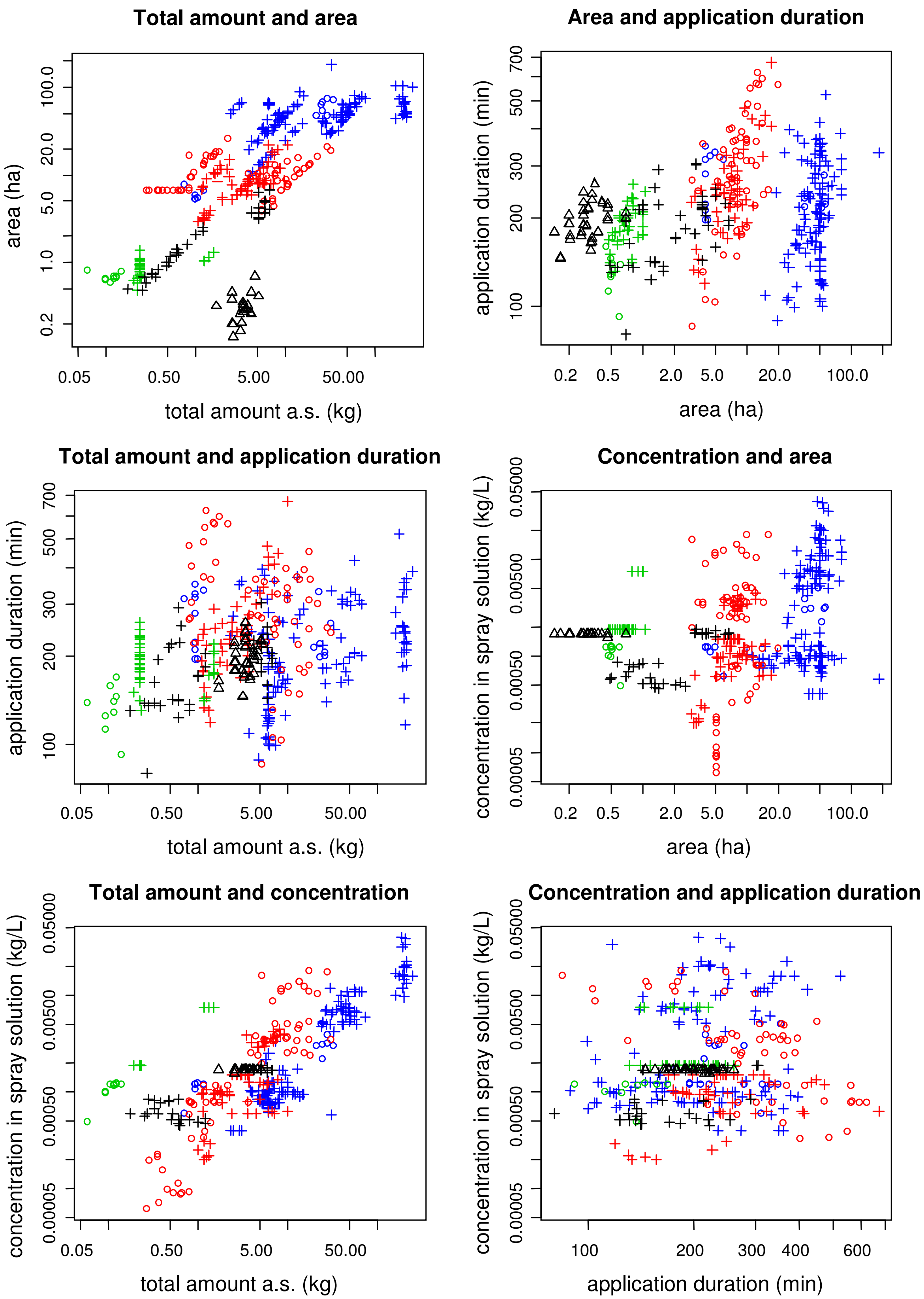


Figure 13: Dependencies between total amount of active substance applied per day, application duration, area and concentration of active substance in the spray solution; logarithmic scales used; blue = LCTM, red = HCTM, green = LCHH, black = HCHH; o = WG, Δ = WP, + = liquid.

In least squares regression a lot of assumptions are implicit. Normality of the distribution is assumed at each exposure level and with the same standard deviation over the whole range. If these assumptions can be trusted then a relatively small dataset can provide the information on the (mean) regression line and on the standard deviation. But these assumptions may be violated even by peculiarities of the given dataset, especially by the presence of non-detected values.

Quantile regression (Koenker, 2005) is a non-parametric method which gives an independent estimate for every percentile. Therefore it seems wise to prefer quantile regression over least squares regression, similar to preferring the empirical percentile over some “theoretical” percentile. As long as the percentile is well within the range of measured data, the resulting fit can be expected to be more robust than the least squares fit. In particular, it will not depend on the actual choice of the value substituted for non-detects.

Non-detected values on a logarithmic scale have to be set to a fixed finite value which is rather arbitrary or might be handled as censored data by some sophisticated method. If the chosen value is too small the standard deviation is over-estimated, if the value is too large the standard deviation is under-estimated. Quantile regression deals with that problem simply by not keeping track of the value but only counting it as small.

In least squares regression the mean is characterised by minimising the “distance” of the regression line to the data points, expressed by the sum of squares of the residuals. Similarly in quantile regression the median is characterised by minimising the sum of absolute values of the residuals; any other percentile can be realised by minimising other variants of ‘distance’ as shown in Figure 14.

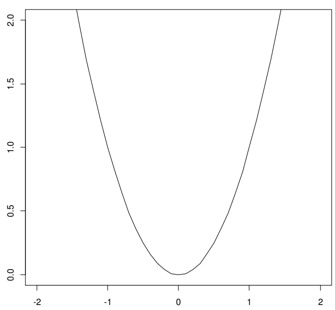
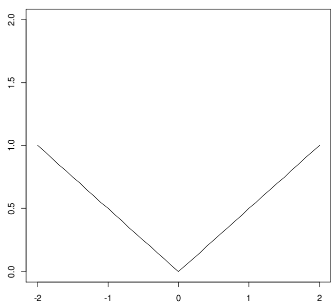
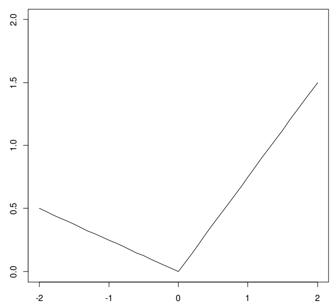
Least squares regression	**Quantile regression: 50 %**	**Quantile regression: 75 %**
 square of residuals	 absolute value of residuals	 absolute value of residuals (weighted)
small deviations are well tolerated, while large deviations are penalised disproportionate	all distances to the left and to the right will be weighted linearly	deviation to the right is penalised three times as much as deviation to the left

Figure 14: The penalty on the residuals determines the type of regression.

The strengths of both methods were used in this project: For model selection, the least squares method was used; for prediction of the 75th percentile (and 95th percentile) the quantile regression method was used. However, the predictions of both methods were similar.
In the case of the LCHH studies (knapsack mixing/loading, LCHH application) a meaningful model could not be fitted since the total amount of active substance used per day was very low in most of the cases (< 0.5 kg). In the range up to 1.5 kg no dependence on the total amount of active substance could be established. Therefore, the respective percentile of all measured values was calculated and assumed valid when applying no more than 1.5 kg of active substance. Several variants exist for the definition of percentiles which differ slightly. In order to have a consistent approach, we chose to determine the empirical percentile by quantile regression (without any influencing factors).

7.2.10 Results

A statistical analysis of the selected data was conducted for each variable including various combinations of possible factors. The results of the evaluation are described in the following sections and are summarised in Table 5. Except for knapsack ML and LCHH A, the model fits were generally very good; the diagnostic plots showed no signs of unsuitability of the model.

ML tank
The inhalation exposure and the dermal exposure to head, hands and body were clearly correlated with the total amount of active substance handled and the formulation type both of which have been used to model the exposure. Three categories of formulations can be distinguished: WP formulations which were associated with relatively higher exposure, WG formulations which were associated with relatively lower exposure and liquid formulations which were associated with intermediate exposure. The data for the liquid formulations had to be pooled as no robust differentiation between EC (organic solvent-based) and SC/SL formulations (water-based) was possible.

The data from operators who rinsed their gloves were included in the modelling of total hand exposure and protected hand exposure. In the case of total hand exposure the data form a subset that is considered to be irrelevant with respect to estimating exposure for authorisation purposes. The face/neck wipe data for operators who wore a face shield during mixing/loading also form a subset and can be used as a PPE scenario for head exposure (head protection face shield plus hood).

ML knapsack
Due to the small number of data for knapsack mixing/loading no modelling factors could be identified for predicting the exposure. Instead, it was proposed to calculate the 75th percentile. The 75th percentiles are based on the absolute exposure values and are assumed valid for up to 1.5 kg of active substance. A linear extrapolation for higher amounts will be possible as a ‘worst case’ assumption, because exposures are not expected to increase as much as this model predicts. Plausibility of the predicted results should be assessed.

All head exposure data were obtained from operators wearing a face shield. As the exposure to the head is generally considered as low during that task it was accepted to apply the data for the non-PPE scenario and the PPE scenario (face shield and hood).

Table 5: Results of the statistical evaluation – modelling factors and subsets for the mixing/loading and application scenarios.

	Mixing/loading		Application			
	Tank	Knapsack	LCTM	HCTM	LCHH	HCHH
Factors	Total amount of active substance Formulation type (WP, WG, liquids)	None (75^{th} percentile)	Total amount of active substance Droplet size (coarse, other)	Total amount of active substance Cabin status (cabin, no cabin)	None (75^{th} percentile)	Total amount of active substance
Subset	Face shield Glove rinse	None	Herbicide application in high crops	None	None	Application in dense crops

LCTM application
A good correlation with the exposure was observed for the total amount of active substance and the size of the treated area, but using both as predictor was excluded as previously justified (see section 5.2.7 and Figure 13). The impact of the area referred to one exposure study for herbicide application in grapevine where small areas were treated but the resulting exposure was relatively high. The spray equipment used in the study was smaller and the vehicles were not fitted with cabins. Therefore, it was decided to create a subset for herbicide application in high crops consisting of data from this study instead of describing the exposure using the area. As a further factor for the model the droplet size was identified. All nozzles for field crop sprayers that have been classified for at least 50 % drift reduction have a so called "coarse droplet spectrum" (according to the definition developed by the Julius Kühn Institut). Operators using sprayers with this type of nozzle had a lower exposure than operators spraying with other types of nozzles.

In contrast, the cabin status had no great impact on exposure when differentiating between a closed cabin and other (e.g. open cabin or no cabin). Applying plant protection products while sitting in a closed cabin was only correlated with a lower total hand exposure – possibly an artefact. A clear impact on the exposure was obvious when distinguishing between cabin (closed cabin or open cabin) and no cabin. However, only the smaller spraying equipment used for herbicide application in grapevine was not equipped with a cabin, a fact which is already addressed when considering this application scenario as a subset of LCTM application.

A correlation with exposure was found for the concentration of active substance in the spray solution. Nevertheless, it was not considered as a factor as exposure was strongly correlated with the total amount of active substance (see section 5.2.7). The statistical analysis also revealed that cleaning is not a major factor for exposure. The total hand exposure of operators was similar regardless of whether they conducted a cleaning operation or not.

HCTM application
The inhalation exposure and the exposure to the head and the body were clearly correlated with the total amount of active substance and the cabin status (cabin versus no cabin). For the total hand exposure and the protected hand exposure conclusive correlations are less obvious. Nevertheless, it was decided to apply the same model for all exposure variables.

In general, the overall exposure of operators using vehicles with cabins was much lower than the exposure of operators applying the plant protection product without cabins (Figure 15). The impact of cleaning was analysed as well but a clear trend was not observed and cleaning was not considered further as a modelling factor. No data were available to distinguish between coarse and non-coarse droplet size.

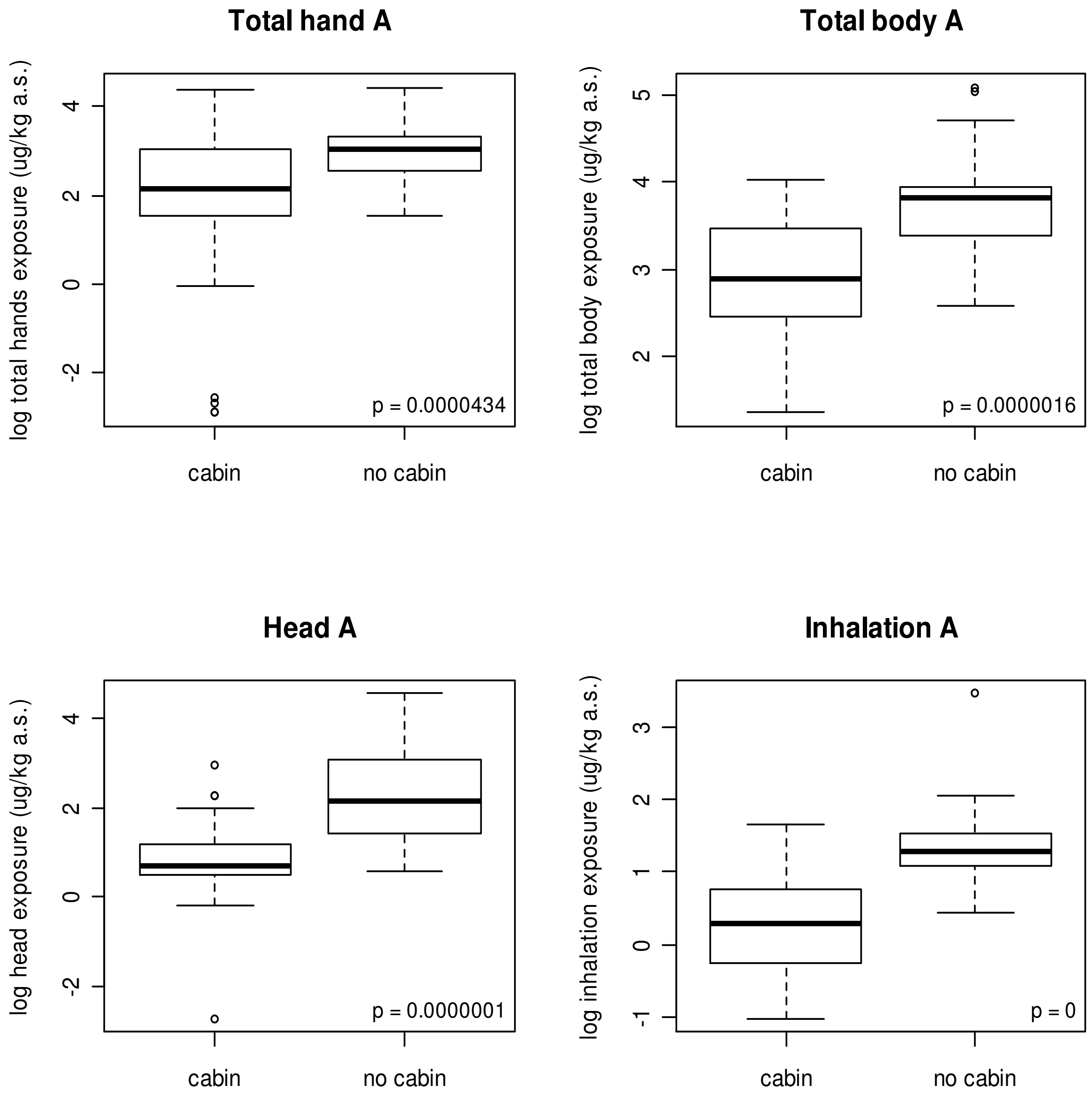


Figure 15: Comparison of mixing/loading data with respect to the cabin status; shown are data for HCTM application only; the box plots represent the first and the third quartile, the median and the upper and lower level.

LCHH application

Only a few data were available from the database for LCHH application. Instead of modelling the exposure it was therefore decided to calculate the 75th percentile. The 75th percentile is based on the absolute exposure values and is assumed to be valid for up to 1.5 kg of active substance. A linear extrapolation for higher amounts will be possible as a 'worst case' assumption, because exposures are not expected to increase as far as this model predicts. Plausibility of the individual results should be assessed.

HCHH application
The exposure for HCHH application was highly correlated with the total amount of active substance handled. Additionally, the statistical evaluation indicated a strong dependency between the extent of exposure and the formulation type. The impact of the formulation type was identified as an artefact and referred to two exposure studies with WP formulations conducted in dense citrus orchards. The operators incurred significant exposure to the plant protection product while walking through the dense canopy. It was decided not to consider the formulation type but to define a subset for application in dense crops – a special scenario where intensive contact with sprayed crops cannot be avoided and exposure is mainly based on dislodgeable spray deposits.

7.3 Validation

The model is based on the statistical analysis of an existing group of stand-alone studies. This introduces some complications like data gaps, confounded factors (i.e., factors that appear always together in all the studies) or heteroscedasticity (unequal variances between groups). Consequently, the results of this analysis should not be used to determine the 'true' importance of a factor in relation to exposure. Studies specifically designed to determine the impact of those factors would be required instead. However, the aim of modeling was to obtain realistic predictions for exposure scenarios, not to reveal the importance of factors.

The robustness and predictive capabilities of any mathematical model can be demonstrated independently of the nature of the model by appropriate validation. Robustness was established in what follows through the use of cross-validation; this approach also permits to establish the relative impact of the different studies in the overall exposure estimation. The predictive capability of the model was demonstrated by using it to predict the exposure in the MLA studies and compare it with the measured MLA data from the database.

Ultimately, it is the predictive performance of a model in relation to a novel dataset that provides confidence in its practical use.

7.3.1 Robustness analysis through cross validation

The approach of cross validation is to repeatedly remove a portion of the data ("test set") and to compare the models obtained with the reduced data sets ("training set"). For this purpose, the function CVlm for cross validation from the DAAG package for R had to be adapted to quantile regression. In addition to random partitioning of the data sets the revised version was also defined to allow the specification of subsets (test sets). Once the subsets were determined, for each of them the following was done:

1. The model equation was fitted to the reduced data set, i.e. data set without subset;
2. For each data point, the 75th percentile predicted by the reduced model was computed;
3. For the test set, the observed values were plotted against these predictions together with a line connecting the points in the test set's specific colour. Additionally, all measurements were plotted against their predicted values (full model, 75th percentile), with colour and plotting character indicating the subsets.

The diagrams in Figure 16, Figure 17, Figure 18 and Figure 19 each show ten random subsets of the data together with the model line (in the same colour) that would be obtained with the subset removed. The comparison revealed that, in general, the resulting models were quite similar, even if measurements with large deviations from the prediction were removed. This indicates robustness, i.e. to some degree independence from the actual measured data. As a variant, the subsets were not chosen randomly but whole studies were removed (see Appendix 6). It is more difficult to visualise the lines in these pictures as they are quite narrow, but the predictions for the respective excluded studies were reasonable.

7.3.2 Prediction capability

The MLA data originate from studies in which mixing/loading and application were monitored as one process (with the same dosimeter/air sampler for both tasks). These data could not be used for the development of the model which is based on separate sets of values for mixing/loading and application. Instead, the data were used to check the prediction of the model.

A comparison of the measured value for mixing/loading/application (MLA data) with the predicted (75th percentile) exposure for mixing/loading and application (model) is shown in Figure 20 and Figure 21. Ideally, 75 % of the points should be below (Figure 20) or left of the green line (Figure 21) which symbolises the coincidence of the observed exposure with the model's 75th percentile-prediction. The variation is large, but the prediction is in the correct range and not systematically biased. This is particularly impressive with respect to the difference in methodology between ML+A and MLA studies.

A check of the prediction was only possible for the LCTM scenario and the HCTM scenario; for the hand-held scenarios no MLA data or only an insufficient number of MLA data were available from the database.

7.3.3 Whole body prediction

One issue with the approach taken in this project which has not yet been addressed is that body parts are modelled separately and the predictions are added for whole body exposure. It is well known that, in general, the sum of 75th percentiles does not result in the 75th percentile of the sum, but modelling the whole body exposure was not intended because a defined and stepwise consideration of personal protective equipment or clothing must be possible.

In this project, however, it can be expected that the result is reasonably close to the 75th percentile because the single exposures of an operator are correlated, i.e. an operator with a high body exposure will most likely also have a high exposure of the hands.

In order to check whether the approach is reasonable, the observed whole body exposures were plotted against the 75th percentile predictions as is shown in Figure 22 for potential exposure (head exposure + total body exposure + total hand exposure) and for actual exposure considering work wear and protective gloves (head exposure + 'inner' body exposure + protected hand exposure). The approach is judged reasonable as roughly 75 % of the data points were below the green line which represents the correct 75th percentile of whole body exposure. The estimate is consistent across studies and through a large range of values.

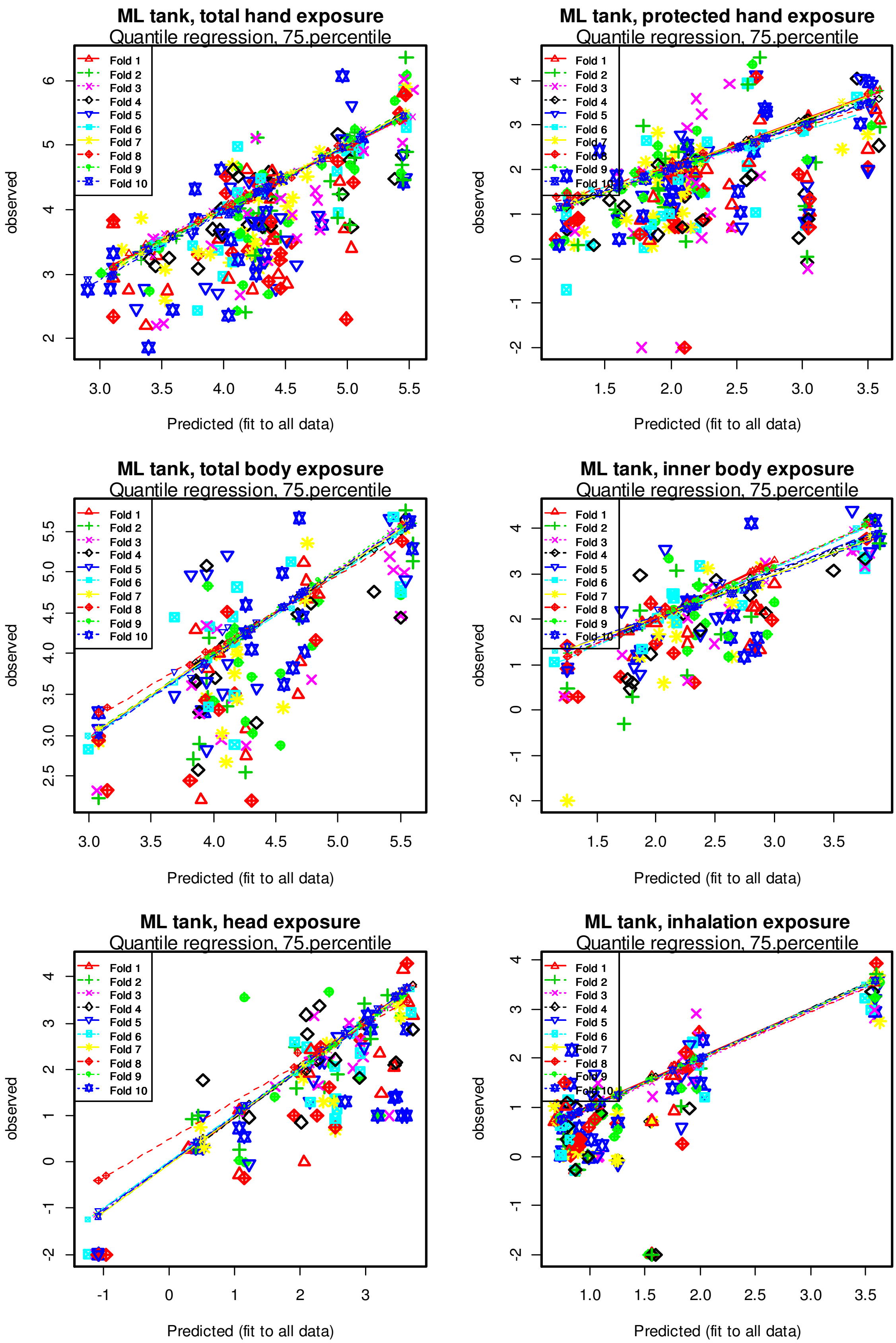


Figure 16: Cross validation of the tank mixing/loading model; shown are random subsets of the model (in different colours) together with the model prediction (same colour line) of the reduced datasets.

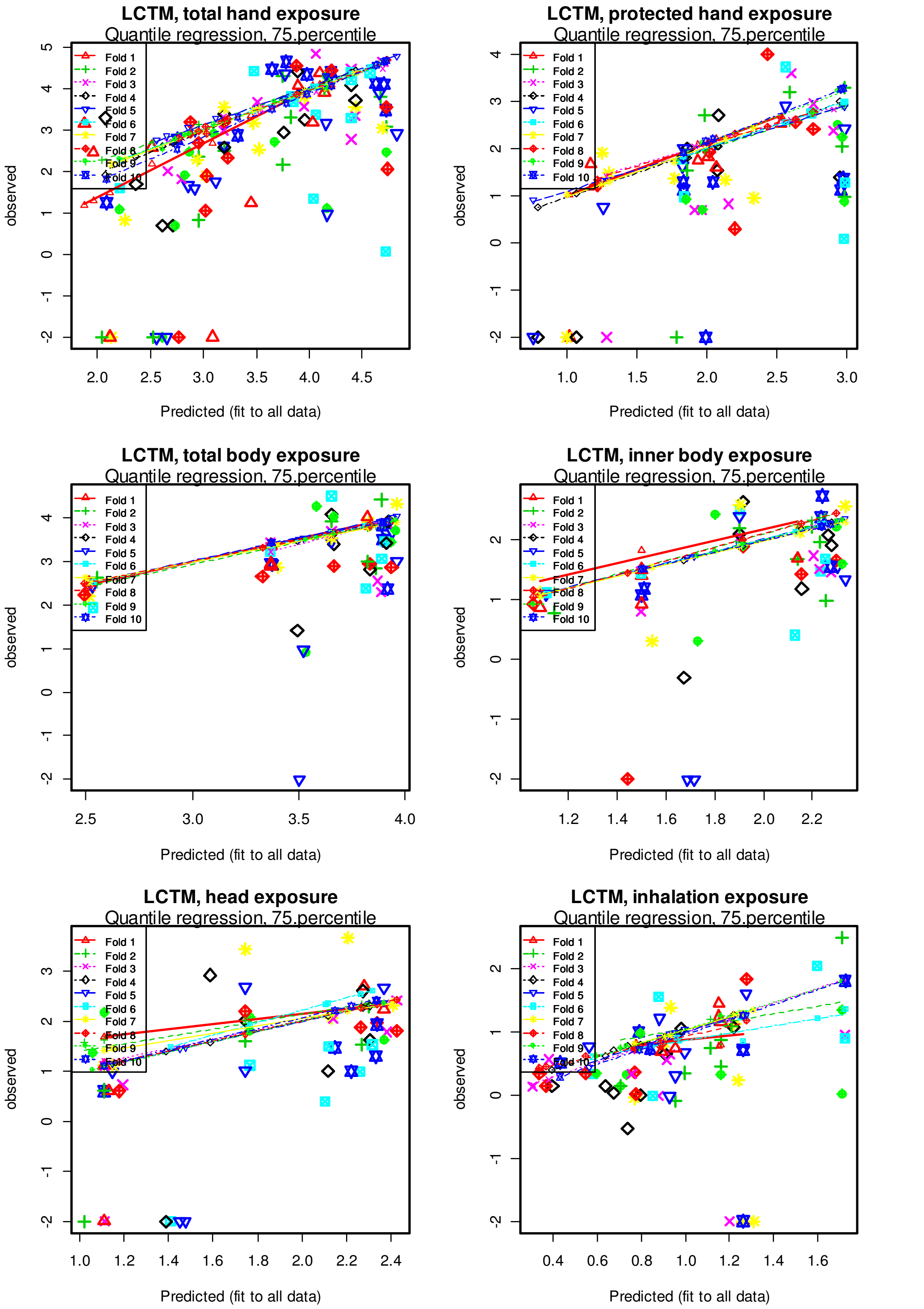


Figure 17: Cross validation of the LCTM application model; shown are random subsets of the model (in different colours) together with the model prediction (same colour line) of the reduced datasets.

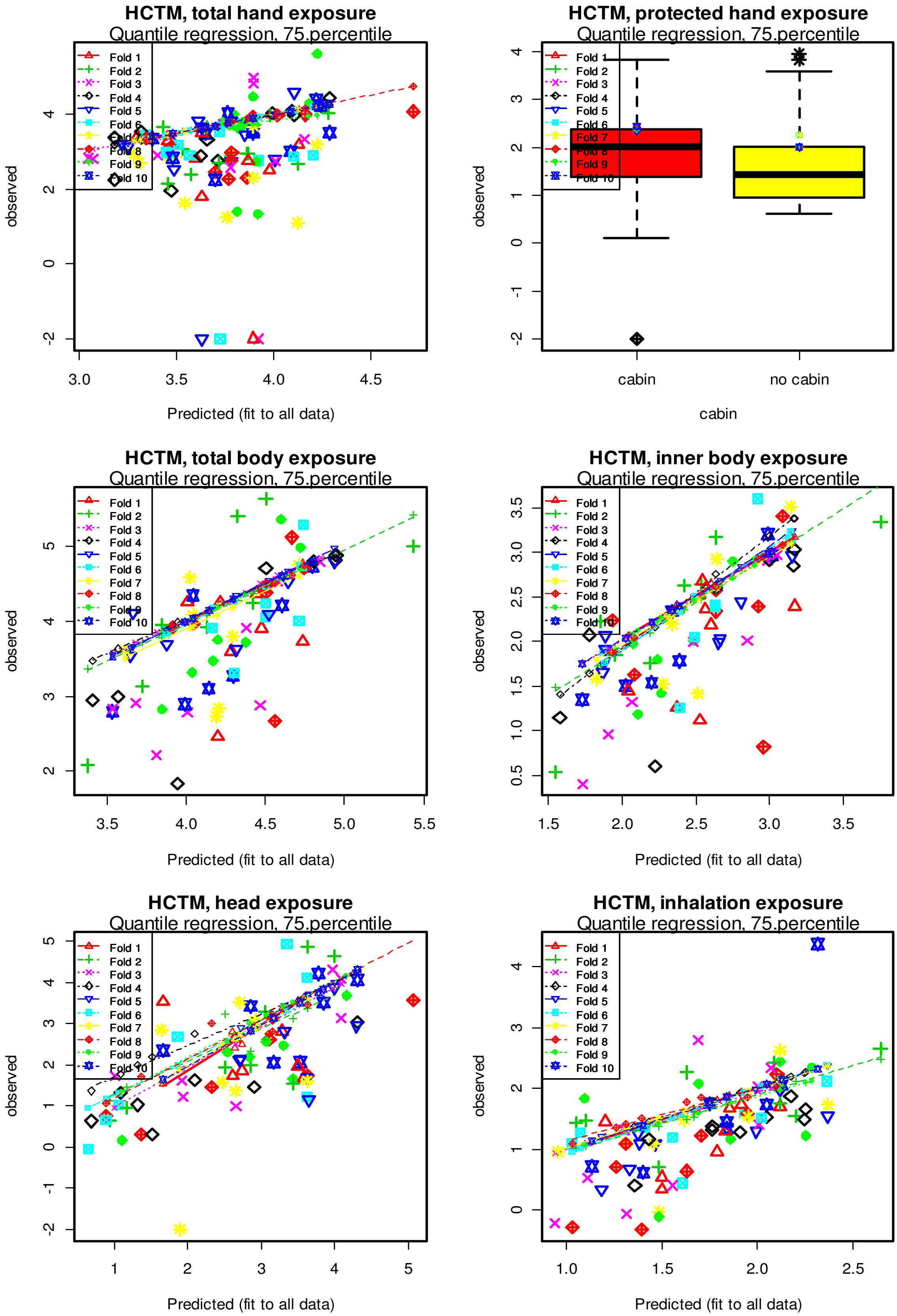


Figure 18: Cross validation of the HCTM application model; shown are random subsets of the model (in different colours) together with the model prediction (same colour line) of the reduced datasets. The model for protected hand exposure does not depend on total amount; therefore the respective part of the figure is realised as a box plot.

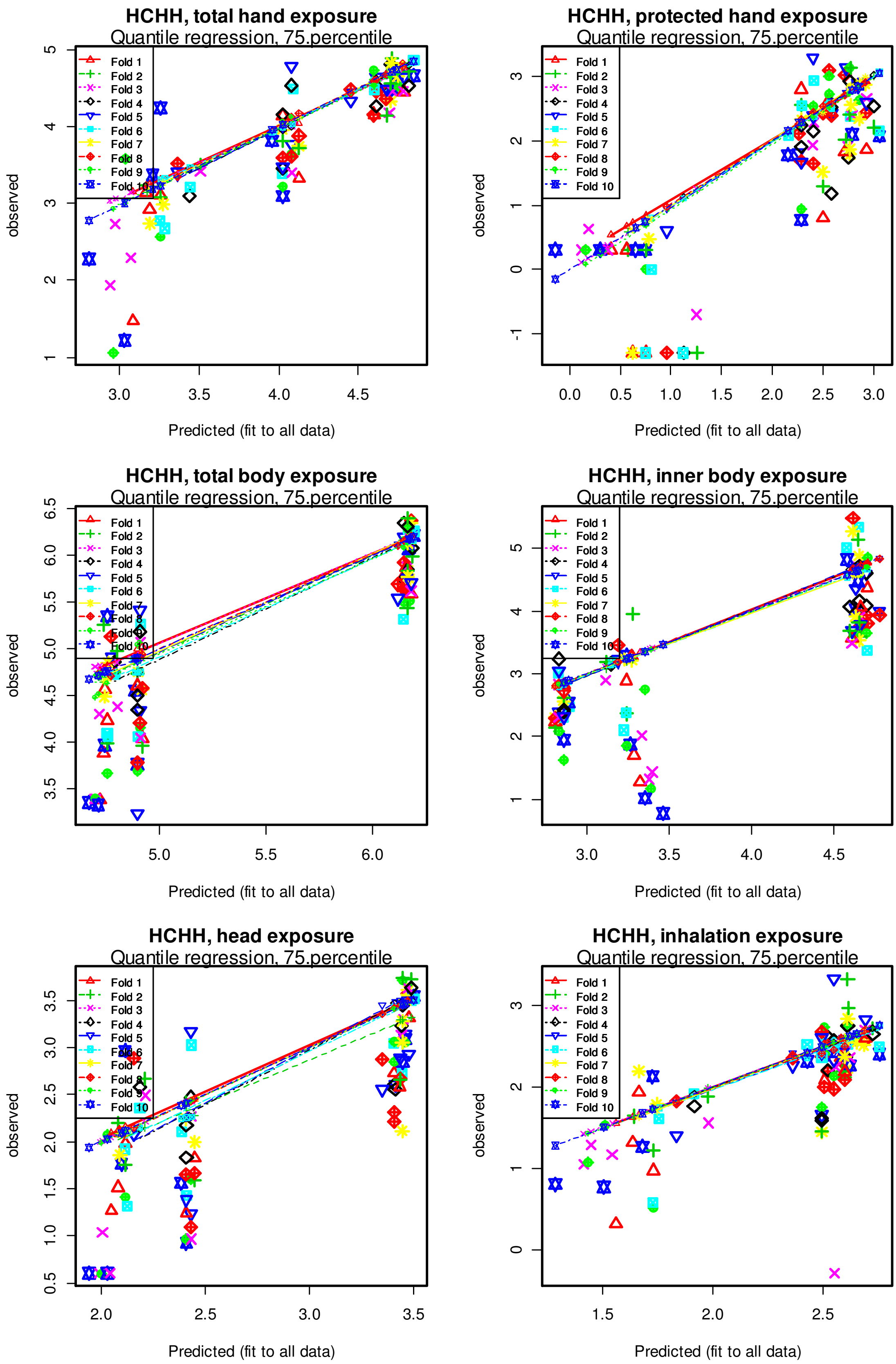


Figure 19: Cross validation of the HCHH application model; shown are random subsets of the model (in different colours) together with the model prediction (same colour line) of the reduced datasets.

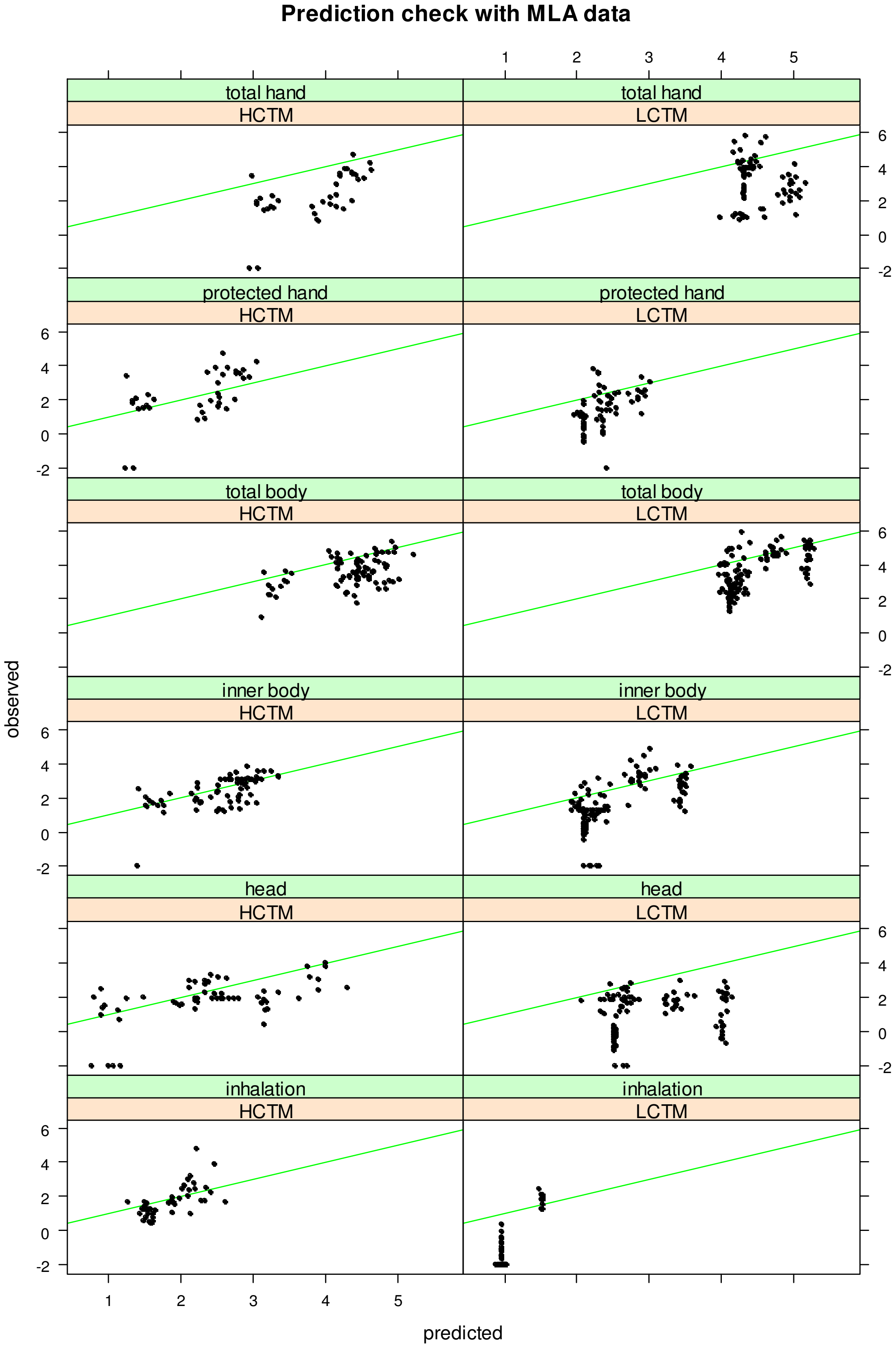


Figure 20: Comparison of the exposure for mixing/loading/application determined in the MLA studies (observed) with the exposure for mixing/loading and application calculated by the model (predicted); for HCHH and LCHH no or only a small number of MLA values were available in the database.

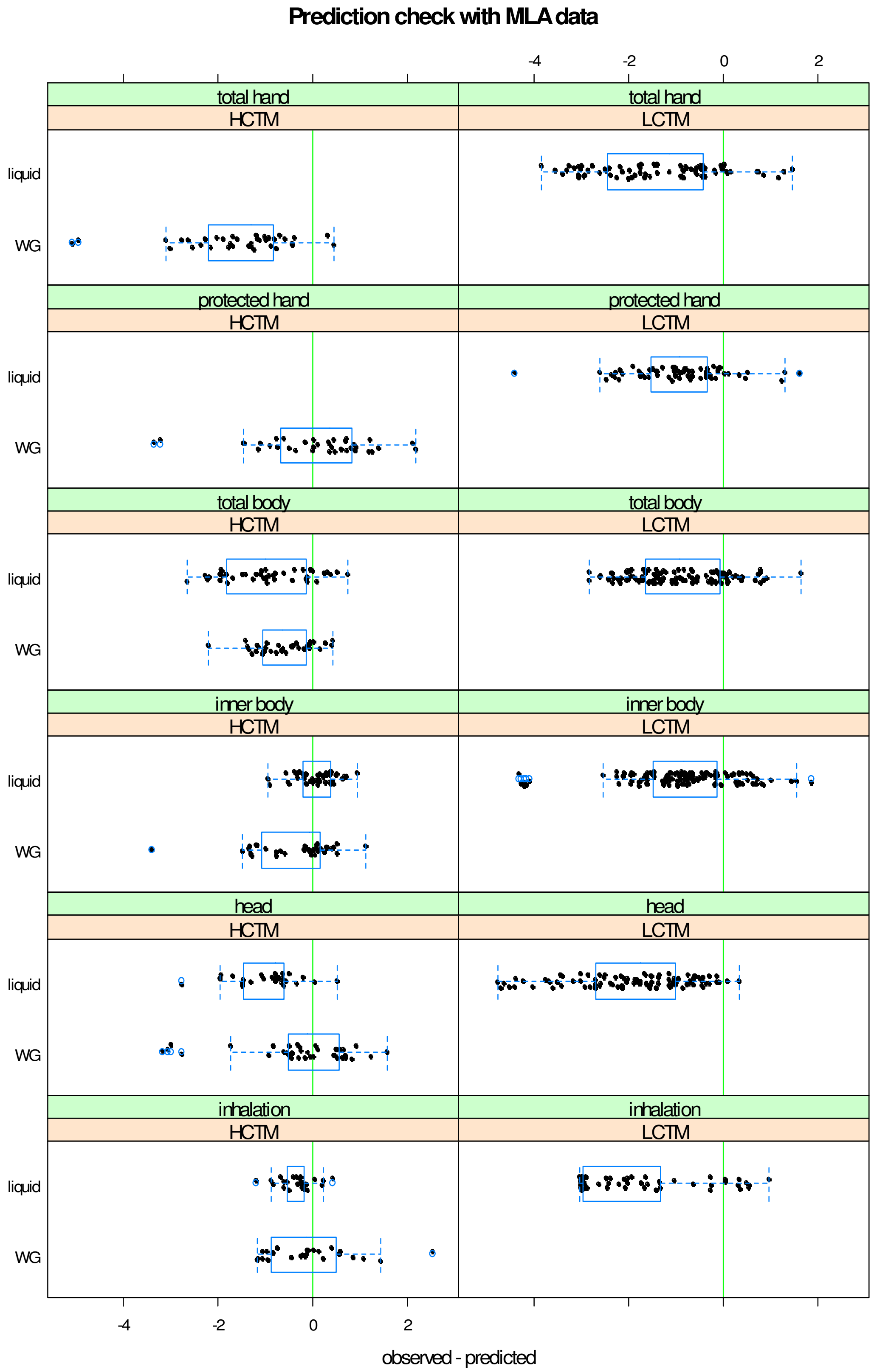


Figure 21: Comparison of the exposure for mixing/loading/application determined in the MLA studies (observed) with the exposure for mixing/loading and application calculated by the model (predicted); the data presented in Figure 20 are aggregated to a box plot by calculating the difference of observed exposure and predicted exposure. Ideally, the right edge of the boxes should coincide with the vertical green line.

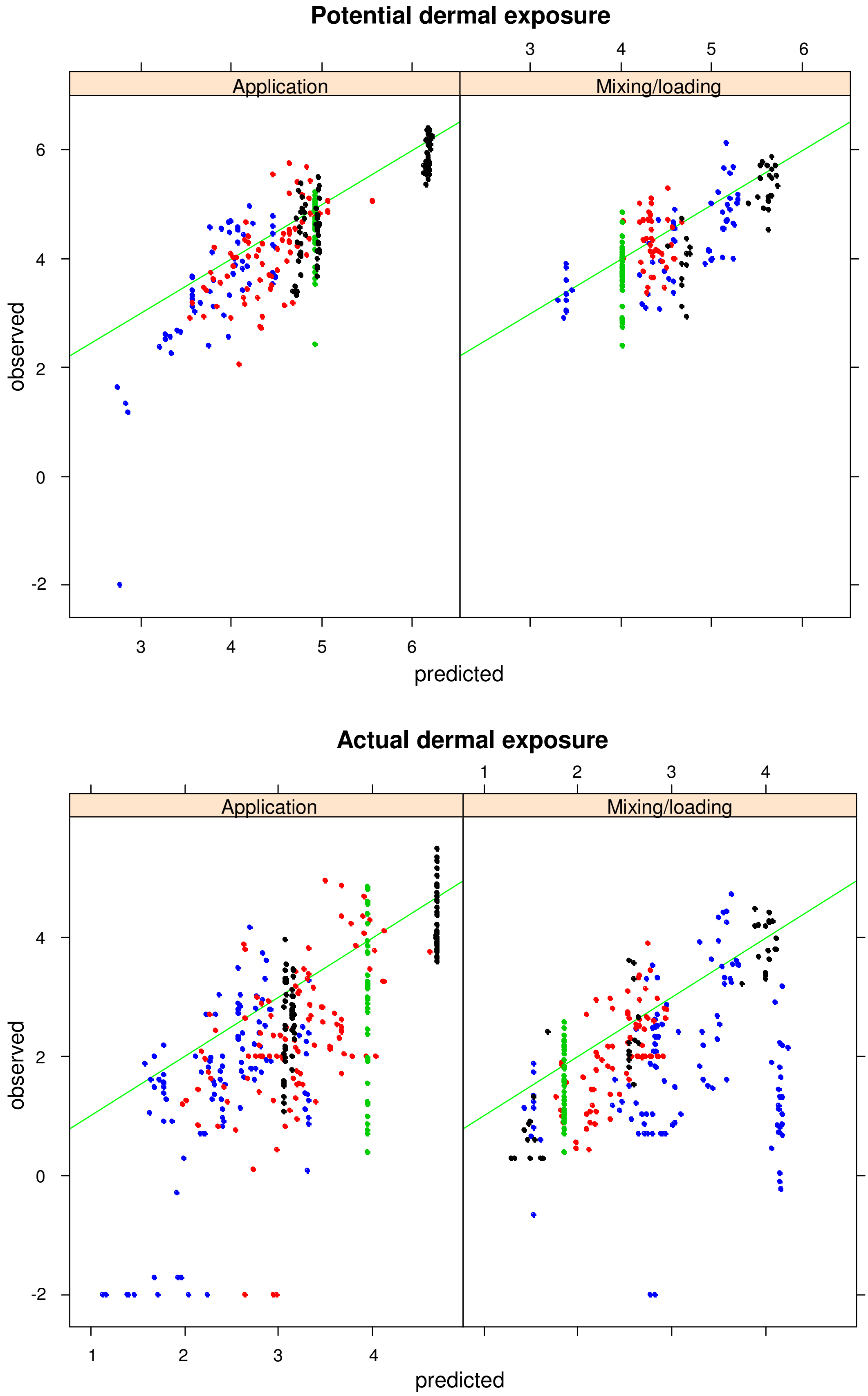


Figure 22: Comparison of the dermal exposure (work wear, protective gloves) as determined in the studies (observed) with the exposure as calculated by the model (sum of 75th percentile predictions); the green line represents the prediction of the 75th percentile of the model. (blue: LCTM, red: HCTM, green: LCHH, black: HCHH)

8 Predictive exposure model

8.1 Model

8.1.1 Calculation

The following exposure scenarios for the application of plant protection products are addressed by the new operator exposure model:

- Low crop tractor-mounted (LCTM)
- High crop tractor-mounted (HCTM)
- Low crop hand-held tank ($LCHH_T$)
- Low crop hand-held knapsack ($LCHH_K$)
- High crop hand-held tank ($HCHH_T$)
- High crop hand-held knapsack ($HCHH_K$)

For every scenario the model estimates the overall operator exposure (E_O). The overall operator exposure (in mg/kg bw/d) corresponds to the exposure of a professional operator (wearing PPE or not) during a whole working day comprising mixing/loading and application of the pesticide. It is composed of the dermal exposure DE_O (including head, body and hands) and the inhalation exposure IE_O from both tasks:

$DE_O = DE_{OML(H)} + DE_{OML(B)} + DE_{OML(C)} + DE_{OA(H)} + DE_{OA(B)} + DE_{OA(C)}$ $IE_O = IE_{OML} + IE_{OA}$

$E_O = DE_O + IE_O$

Each single systemic exposure contribution results from the specific dermal exposure ($D_{x(y)}$) or specific inhalation exposure (I_x) taking account of the dermal or inhalative absorption of the active substance (DA; IA), a default body weight of the operator and, if necessary, the risk mitigation factor for using PPE:

$DE_{OX(Y)} = (D_{X(Y)} \times (PPE) \times DA) / BW$ $IE_{OX} = (I_X \times (PPE) \times IA) / BW$

The overall exposure for an operator wearing one layer of work clothes covering torso, legs and arms consists of the following specific exposures or variables:

- Inhalation exposure (= potential inhalation exposure) ML, A
- Total hand exposure (= potential hand exposure) ML, A
- Head exposure (= potential head exposure) ML, A
- 'Inner' body exposure (= actual body exposure) ML, A

In the case that protective gloves are considered for the operator the total hand exposure is replaced by protected hand exposure; the total body exposure (= potential body exposure) is used instead of the inner body exposure when reduction factors for wearing PPE for the body (e.g. protective suit against chemicals) are considered.

The values for the specific exposure are based on equations obtained from exposure modelling using quantile regression. In total, six models are available, two for mixing/loading and four for application (see Table 6 for prediction of the 75th percentile and Table 7 for prediction of the 95th percentile). The factors contributing to the specific exposure are discussed in section 5.2.10 and vary between the different scenarios. In most cases the total amount of active

Table 6: Model equations based on quantile regression modelling (prediction level: 75th percentile); the total amount of active substance (TA) is the major parameter for exposure, the slope α was set to 1 in case α > 1; exposure is given in µg/person; the 75th percentiles of the respective exposure values from the database (in µg) are given for knapsack ML and LCHH A.

Tank ML		log exp = α·log TA + [formulation type] + constant
	total hands	log $D_{M(H)}$ = 0.77·log TA + 0.57 [liquid] + 1.27 [WP] - 0.29 [glove wash] + 3.12
	protected hands	log $D_{M(Hp)}$ = 0.65·log TA + 0.32 [liquid] + 1.74 [WP] + 1.22
	total body	log $D_{M(B)}$ = 0.70·log TA + 0.46 [liquid] + 1.83 [WP] + 3.09
	inner body	log $D_{M(Bp)}$ = 0.89·log TA + 0.11 [liquid] + 1.76 [WP] + 1.27
	head	log $D_{M(C)}$ = log TA + 0.90 [liquid] + 1.28 [WP] + 1.79 [no face shield] - 0.98
	inhalation	log I_M = 0.30·log TA - 1.00 [liquid] + 1.76 [WP] + 1.57
Knapsack ML		75th percentile (above 1.5 kg a.s. linear extrapolation)
	total hands	9495
	protected hands	18
	total body	803
	inner body	25
	head	5
	inhalation	25
LCTM A		log exp = α·log TA + [droplets] + [equipment] + constant
	total hands	log $D_{A(H)}$ = log TA + 0.37 [normal droplets] - 1.04 [normal equipment] + 2.84
	protected hands	log $D_{A(Hp)}$ = 0.54·log TA + 1.11 [normal droplets] + 0.29 [normal equipment] - 0.23
	total body	log $D_{A(B)}$ = log TA + 0.81 [normal droplets] - 1.43 [normal equipment] + 2.54
	inner body	log $D_{A(Bp)}$ = log TA + 0.70 [normal droplets] - 1.09 [normal equipment] + 0.74
	head	log $D_{A(C)}$ = log TA + 0.88 [normal droplets] - 0.53 [normal equipment] + 0.24
	inhalation	log I_A = 0.50·log TA + 0.01 [normal droplets] - 0.71 [normal equipment] + 0.72
HCTM A		log exp = α·log TA + [cabin] + constant
	total hands	log $D_{A(H)}$ = 0.89·log TA + 0.28 [no cabin] + 3.12
	protected hands	log $D_{A(Hp)}$ = log TA - 1.55 [1)]
	total body	log $D_{A(B)}$ = log TA + 0.48 [no cabin] + 3.47
	inner body	log $D_{A(Bp)}$ = log TA + 0.23 [no cabin] + 1.83
	head	log $D_{A(C)}$ = log TA + 1.89 [no cabin] + 1.17
	inhalation	log I_A = 0.57·log TA + 0.82 [no cabin] + 0.99
LCHH A		75th percentile (above 1.5 kg a.s. linear extrapolation)
	total hands	1544
	protected hands	5
	total body	88868
	inner body	8903
	head	12
	inhalation	26
HCHH A		log exp = α·log TA + [culture] + constant
	total hands	log $D_{A(H)}$ = 0.84·log TA - 0.83 [normal culture] + 4.26
	protected hands	log $D_{A(Hp)}$ = log TA - 0.88 [normal culture] + 2.26
	total body	log $D_{A(B)}$ = 0.16·log TA - 1.29 [normal culture] + 6.08
	inner body	log $D_{A(Bp)}$ = - 1.64 [normal culture] + 4.65 [2)]
	head	log $D_{A(C)}$ = 0.32·log TA - 1.09 [normal culture] + 3.27
	inhalation	log I_A = 0.83·log TA - 0.26 [normal culture] + 2.17

1) the dependency of the factor [cabin] was not significant
2) the factor [total amount] had an inverse effect on exposure, thus the factor was removed

Table 7: Model equations based on quantile regression modelling (prediction level: 95th percentile; acute exposure); the total amount of active substance (TA) is the major parameter for exposure, the slope α was set to 1 in case α > 1; exposure is given in µg/person; the 95th percentiles of the respective exposure values from the database (in µg) are given for knapsack ML and LCHH A.

Tank ML		log exp = α·log TA + [formulation type] + constant
	total hands	log $D_{M(H)}$ = 0.78·log TA + 0.45 [liquid] + 1.15 [WP] - 0.84 [glove wash] + 3.80
	protected hands	log $D_{M(Hp)}$ = log TA + 0.80 [liquid] + 1.81 [WP] + 1.50
	total body	log $D_{M(B)}$ = 0.29·log TA + 0.65 [liquid] + 1.25 [WP] + 4.21
	inner body	log $D_{M(Bp)}$ = log TA + 0.37 [liquid] + 1.50 [WP] + 1.79
	head	log $D_{M(C)}$ = log TA + 0.50 [liquid] + 0.35 [WP] + 1.25 [no face shield] + 0.70
	inhalation	log I_M = 0.02·log TA – 0.96 [liquid] + 1.28 [WP] + 2.41
Knapsack ML		95th percentile (above 1.5 kg a.s. linear extrapolation)
	total hands	25483
	protected hands	164
	total body	2787
	inner body	103
	head	11
	inhalation	26
LCTM A		log exp = α·log TA + [droplets] + [equipment] + constant
	total hands	log $D_{A(H)}$ = 0.73·log TA + 0.61 [normal droplets] - 0.21 [normal equipment] + 2.96
	protected hands	log $D_{A(Hp)}$ = 0.12·log TA + 1.79 [normal droplets] + 2.19 [normal equipment] - 0.46
	total body	log $D_{A(B)}$ = log TA + 1.51 [normal droplets] - 0.82 [normal equipment] + 1.94
	inner body	log $D_{A(Bp)}$ = log TA + 1.05 [normal droplets] - 0.77 [normal equipment] + 0.47
	head	log $D_{A(C)}$ = log TA + 1.03 [normal droplets] - 1.12 [normal equipment] + 1.16
	inhalation	log I_A = 0.58·log TA + 0.33 [normal droplets] - 1.14 [normal equipment] + 1.27
HCTM A		log exp = α·log TA + [cabin] + constant
	total hands	log $D_{A(H)}$ = log TA + 0.48 [no cabin] + 3.32
	protected hands	log $D_{A(Hp)}$ = log TA + 0.08 [no cabin] + 2.88
	total body	log $D_{A(B)}$ = log TA + 0.79 [no cabin] + 3.92
	inner body	log $D_{A(Bp)}$ = log TA + 0.15 [no cabin] + 2.21
	head	log $D_{A(C)}$ = log TA + 1.56 [no cabin] + 2.29
	inhalation	log I_A = log TA + 0.60 [no cabin] + 1.32
LCHH A		95th percentile (above 1.5 kg a.s. linear extrapolation)
	total hands	4213
	protected hands	22
	total body	137007
	inner body	62630
	head	85
	inhalation	26
HCHH A		log exp = α·log TA + [culture] + constant
	total hands	log $D_{A(H)}$ = 0.77·log TA - 0.47 [normal culture] + 4.41
	protected hands	log $D_{A(Hp)}$ = log TA - 0.51 [normal culture] + 2.61
	total body	log $D_{A(B)}$ = 0.01·log TA - 1.09 [normal culture] + 6.34
	inner body	log $D_{A(Bp)}$ = - 1.99 [normal culture] + 5.27 [1)]
	head	log $D_{A(C)}$ = 0.33·log TA - 0.59 [normal culture] + 3.50
	inhalation	log I_A = 0.60·log TA - 0.26 [normal culture] + 2.52

[1)] the factor [total amount] had an inverse effect on exposure, thus the factor was removed substance applied per operator and day (kg a.s./d) is the main factor for exposure which contributes to the estimated exposure with an exponent factor between zero and one (in case the exponent factor was higher than one, the exponent was fixed to a value of one). For two models (ML Knapsack, A LCHH) exposure factors could not be identified due to the small number of data. Instead, the calculations are based on the 75th percentile (or the 95th percentile for acute exposure) of the absolute exposure values calculated with quantile regression.

The model predictions are presented in Appendix 2 and Appendix 4. A comparison of the percentile obtained by quantile regression with the empirical percentile and the parametric estimate of the percentile calculated according to EFSA (EFSA, 2010) is given in Appendix 3 and Appendix 5.

8.1.2 Applicability domain

The new exposure model was developed for the estimation of professional operator exposure as part of the risk assessment for plant protection products. It represents relevant outdoor exposure scenarios and is applicable to conditions all over Europe due to the broad spectrum of exposure studies included in the database.

The model provides two scenarios for LCTM applications. In addition to the typical scenario for application with normal equipment (either trailed or mounted sprayers) a special scenario for application with equipment used on small areas was created. The data for the special scenario are based on one exposure study conducted for herbicide treatment in vineyards. The equipment used in this study was substantially different from the equipment normally used for LCTM application. Some sprayers had cabins and some did not, but all had small booms (1 to 3 m) and small tanks (300 to 400 L). The respective exposure data are assumed to be suitable for other downward spray applications with small equipment in high crops or on small areas.

The spray equipment used in the studies for the treatment of normal areas generally had cabins, large spray booms (12 to 39 m) and large spray tanks (750 to 5200 L). Hence, the model for normal LCTM application is applicable when standard spray equipment is used and normal areas are treated (default assumption: 50 ha). For such sprayers, which are equipped with nozzles classified for at least 50 % drift reduction (according to the definition developed by Julius Kühn Institut) a further sub-scenario exists, because the production of coarse droplets by this type of nozzle is associated with a lower exposure. In general, the model is applicable for liquid formulations as well as for WG and WP formulations. However, the exposure estimation for WP formulations is covered by exposure data for up to 9 kg of active substance only applied per day.

The model for HCTM application is based on representative exposure studies in grapevine and apples/pears conducted in south and central Europe. A broad spectrum of typical, old and modern spray equipment was used either with or without a cabin. As the presence or absence of a cabin had an impact on the exposure, the model addresses different scenarios for applications with or without cabin. No differentiation is made for whether the cabin is totally closed during application or partly open (e.g. open window).

The LCHH model was developed using data for knapsack spray equipment only. However, it is assumed that the exposure from application with hand-held lances either connected to a knapsack or to a tank is similar. For exposure due to mixing/loading a tank the ML model based on data for the tank application types is used. In contrast to LCHH application the model for HCHH application is only based on data for hand-held spray equipment with large tanks. The operators were either walking along the rows or sitting on the spray equipment. Nevertheless, it is again assumed that the exposure for application with tank spray equipment is similar to the application with knapsack sprayers. The ML model for LCHH application with knapsacks is applied for assessing the exposure of knapsack mixing/loading for HCHH.

In most of the selected studies the treated area corresponded to a typical work day. Therefore, the areas used in the model are based on the areas treated in the studies (roughly the 75th percentile of the respective data; see Table 3). The default values for the area range from 50 ha for LCTM with normal equipment to 1 ha for knapsack sprayers in low or high crop as well as for HCHH in dense culture. For HCTM application and LCTM application with small equipment (on small areas) an area of 10 ha is assumed and for hand-held application using tank sprayers with lances a default of 4 ha is used. However, the values for the area can be adjusted to specific conditions in different countries if necessary.

8.1.3 Operations

In general, operator exposure to pesticides results from preparing and/or loading the spray solution (mixing/loading) and from applying the spray solution in the field (application).

The mixing/loading task comprises all operations starting with opening the product containers/bags and ending with filling the tank with product and water. The appropriate amount of product is poured directly into the tank (from the containers or using measuring vessels) or a pre-mix with water is prepared. Loading of the product occurs either via the top opening of the tank or by means of an induction hopper. Rinsing the containers or vessels is also included in the task.

The application task begins with the end of the mixing/loading task. The operator drives or walks to the field, unfolds the boom if necessary and starts spraying. Routine checks and minor repair work (e.g. changing nozzles) are included in the task as well as small breaks in the field. Cleaning the equipment after having finished spraying is also part of application.

8.1.4 Work clothes and personal protective equipment

The model calculation of the overall operator exposure starts with the assumption that the operator is wearing at least one layer of work clothing completely covering the body, arms and legs when mixing/loading or applying pesticides. The respective exposure values for the body were provided by the database and were used for modelling the 'inner' body exposure.

According to the data wearing work clothes reduces the body exposure by 85 to 98 % depending on the scenario considered (Table 8). The work clothing, used in the studies as dermal exposure dosimeters, consisted of coveralls or long-sleeved jackets and trousers that were made of cotton (> 300 g/cm^2) or cotton/polyester (> 200 g/cm^2). Generally, the clothing was laundered twice in hot water before use (90 °C). The actual exposure can be further reduced by considering personal protective equipment (PPE).

Exposure data for protected hands (using protective (nitrile) gloves continuously during mixing/loading or application) were available from the database and revealed an exposure mitigation of 89 to 99 % in comparison with bare hands (Table 8). For the model, hand exposure values were also considered to represent the 'protected hand' scenario when

Table 8: Spotlight on distribution of penetration factors for gloves and work clothes derived from data available in the database. Shown are percentiles and coefficients of variation of the ratio of gloved hand exposure (gloves continuously worn) and total hand exposure as well as of 'inner' body exposure and total body exposure; n = number of data.

		Gloves			Work clothes		
		n	75th percentile	CV%	n	75th percentile	CV%
ML	Tank WG	29	0.03	152	29	0.04	97
	Tank WP	20	0.05	91	20	0.04	42
	Tank liquid	155	0.02	329	63	0.02	256
	Knapsack	49	0.01	159	40	0.07	156
	all	**253**	**0.02**	**333**	**152**	**0.04**	**192**
A	LCTM	12	0.11	175	44	0.05	134
	HCTM	44	0.11	154	55	0.04	104
	HCHH	90	0.02	214	90	0.03	110
	LCHH	19	0.03	137	39	0.15	121
	all	**165**	**0.03**	**210**	**228**	**0.04**	**159**

gloves were not continuously worn during application but only during contact with the spray solution or when the operator was sitting in a closed cabin during application.

Head exposure data obtained by analysing face and neck wipes of operators who wore a face shield during mixing/loading were used to create a PPE scenario for the head. The model for head exposure during tank mixing/loading considers these data with an additional adjustment factor by which the exposure is increased when a face shield (+hood) is not used. The head exposure of operators wearing a face shield was on average about 50 times lower than the head exposure of operators wearing no face shield (i.e. ca. 2 % of potential head exposure).

The values for head exposure during knapsack mixing/loading are exclusively based on face/neck wipe data for using face shields. As the vast majority of the values were below the limit of quantification (LOQ) no correction was made to create a non-PPE scenario. Instead, the values were used for the non-PPE scenario and for the PPE scenario.

In addition to the risk mitigation derived from the exposure data in the database default factors for specified PPE can be used (see section 8.1.5).

8.1.5 Tiered approach

The model can be used for a tiered approach. The Tier I scenario corresponds to the exposure considering no PPE but one layer of work clothes covering torso, arms and legs; in the Tier II scenario dermal and/or inhalation PPE factors can be chosen if the exposure calculated in Tier I exceeds the AOEL.

Table 9 gives an overview over the PPE that are included in the model.

Table 9: List of PPE with respective reduction factors in relation to stated routes of exposures.

Personal protective equipment	Reduction factor	Concerned exposure
Respiratory protection (ML)	e.g. 0.08	I_M
	e.g. 0.8	$D_{M(C)}$
Respiratory protection (A)	e.g. 0.08	I_A
	e.g. 0.8	$D_{A(C)}$
Protective gloves (ML)	**acc. model**	$D_{M(H)}$
Protective gloves (A)	**acc. model**	$D_{A(H)}$
Workwear + sturdy footwear (ML)	**acc. model**	$D_{M(B)}$
Workwear + sturdy footwear (A)	**acc. model**	$D_{A(B)}$
Protective suit against chemicals	e.g. 0.01	$D_{M(B)}$
Protective suit against chemicals	e.g. 0.01	$D_{A(B)}$
Hood and face shield (ML)	**acc. model**	$D_{M(C)}$
Hood and face shield (A)	0.05	$D_{A(C)}$
Head protection (e.g. hat)	e.g. 0.5	$D_{M(C)}$
Head protection (e.g. hat)	e.g. 0.5	$D_{A(C)}$

8.2 Operator exposure calculator and user guidance

An excel spreadsheet (distributed with this report) has been created for users allowing the calculation of operator exposure with the new model. A guidance note for the use of the calculation sheet is given in Appendix 7.

8.3 Data gaps

Despite the large number of data used for the development of the model, additional exposure values are needed to address certain scenarios. As previously mentioned, few data exist in the database for knapsack mixing/loading and for hand-held application in low crops. Due to the limited data (e.g. no available exposure for WP formulations, only a small range of total amount of active substance applied per day) no statistical model could be derived from them. In addition, data are completely lacking for high crop applications with knapsack sprayers and for low crop applications using tank sprayers with hand-held lances. As these data are not available it has to be assumed that hand-held application in low/high crops is the same irrespective of the equipment used.

A further deficiency consists in the availability of exposure data for WP formulations. The database contains only two studies with this formulation type, both conducted in Spain on hand-held application of the same insecticide in citrus. Hence, the application conditions and the equipment used were quite similar and the range of applied amount of active substance is small.

8.4 Future perspectives

The operator exposure model has been developed on the basis of a large database and in due consideration of relevant exposure scenarios including modern application techniques. Nevertheless, the technical progress is continuing and the exposure patterns might change significantly in the future. In addition, the number of data available for certain scenarios (knapsack mixing/loading, application LCHH) is relatively small and less robust for modelling exposure. Therefore, it is reasonable to allow for an update of the model from time to time depending on the availability of new exposure studies. Data from appropriate studies would be incorporated into the existing database in order to enable a more confident statistical analysis of exposure factors or to simply enhance the robustness of the models. In addition, exposure scenarios, for which no data are currently available in the database (e.g. application in greenhouse), could be addressed and modelled accordingly. National authorities should agree on the updating of the model and coordinate the process.

9 Conclusions

A new model for prediction of exposure of professional operators applying plant protection products outdoors has been developed using previously unpublished field data collected between 1994 and 2009. It provides calculations for estimating the exposure for typical scenarios including the mixing/loading and the application of plant protection products. The underlying equations are based on log linear models for prediction of the 75th percentile and consist of exposure factors that were selected after a statistical analysis. The exposure mainly depends on the total amount of active substance used per day and is further described by additional factors or particular sub-scenarios. The model allows a tiered approach starting with estimating exposure for an operator wearing at least one layer of clothing; risk mitigation by using personal protective equipment can be considered if the AOEL is exceeded.

The model reflects current application techniques and typical work conditions in Europe. It is, therefore, applicable for zonal registrations and national authorisations of plant protection products in member states of the EU. Updated versions of the model will be periodically created if new data become available.

10 Supplementary information

Additional information on the data and the model are given in the supplementary information. The file comprises a complete list of the raw data used for the model development, a table with percentiles of the raw data and the detailed model computations.

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12 Abbreviations

A	application
AIC	Akaike information criterion
a.s.	active substance
CV	coefficient of variation
EC	emulsifiable concentrate
EW	emulsion, oil in water
HCHH	high crop hand-held
HCTM	high crop tractor-mounted
IQR	interquartile range
LCHH	low crop hand-held
LCTM	low crop tractor-mounted
ML	mixing/loading
MLA	mixing/loading/application
SC	suspension concentrate
SL	soluble concentrate
TA	total amount of active substance (in kg a.s./d)
WG	water dispersible granules
WP	wettable powder

13 Glossary

A data:	exposure data for the application task, obtained by using a separate set of dosimeters/personal air samplers for the exposure during application
applicator:	professional operator who applies the pesticide product
mixer/loader:	professional operator who handles the formulated product, prepares the spray solution and loads it into the tank of the sprayer

mixer/loader/applicator:	professional operator who mixes and loads the spray solution and applies it afterwards
ML data:	exposure data for the mixing/loading task, obtained by using a separate set of dosimeters/personal air samplers for the exposure during mixing/loading
MLA data:	exposure data for the mixing/loading and application task as a whole, obtained by using one set of dosimeters/personal air samplers for both tasks
MLA study:	exposure study in which the exposure for mixing/loading and application is determined together, usually one operator performing both tasks is monitored throughout the whole work day
ML+A study:	exposure study in which the exposure during mixing/loading and the exposure during application is determined separately; either two different operators, one performing mixing/loading and one performing application, or one operator, performing both but using separate dosimeters/personal air samplers for each task, are monitored
Total amount a.s.:	sum of active substance which was handled per operator per day (in kg a.s./d)

Appendix 1 Study descriptions

LCTM 1

Active substance: Flufenacet (600 g/kg)
Formulation type: Water dispersible granules
Pesticide function: Herbicide
Crop: Maize

Setting:
The dermal and inhalation exposure of workers towards flufenacet during mixing/loading and application in maize fields was determined in this study. Seven mixer/loaders and seven applicators handling 21.3 to 33.0 kg a.s. were monitored during April and May 2000 at different sites in Germany, which were typical and representative for maize cultivation. At each test site one operator performed mixing/loading and one operator performed application. Cleaning was not included in the tasks, but one cleaning operation was sampled separately (results not used for model). The area treated was in the range of 36.0 to 56.5 ha corresponding to a usual working day. The spray equipment was typical for large-scale treatment of low field crops and included mounted or trailed sprayers with spray booms of 15 to 24 m and tank sizes of 1,500 to 3,200 L. Tractors with closed cabins were used only. In two cases the windows of the cabin were temporarily open (operator B and J) so that spray drift could get inside the cab. The product was packed in bags of 5 kg and applied at a rate of 0.8 to 1.3 kg/ha (0.5 to 0.8 kg a.s./ha) in a water volume of 100 to 370 L/ha. Mixing/loading was performed two to eight times by using an induction hopper into which the product was poured. Only one operator (operator K) loaded the product directly via the top opening of the tank. Mixing/loading took between 43 and 110 min whereas application took between 214 and 355 min.

Exposure assessment:
Dermal exposure of the operators was measured by using whole body dosimeters consisting of a long-sleeved T-shirt, long underpants and a long-sleeved shirt as inner layer and long work trousers and a long-sleeved work jacket as outer layer. Head exposure was calculated from residues collected on a cap which was worn by each operator during the whole working time. Gloves worn during mixing/loading and for maintenance tasks during application as well as hand washes conducted after each mixing/loading or application cycle were analysed to quantify hand exposure. Inhalation exposure was determined from residues collected by an IOM sampler with glass fibre filter (mixing/loading) or by a Tenax® tube (application) attached to a personal air pump located in the breathing zone of the operator (flow rate ca. 2 L/min). The analysis of flufenacet was performed with LC-MS/MS detection after extraction with 2-propanol.

Results:
The results of the study are given below. All values were above the LOQ and were not corrected for field recovery since the field recovery was above 70 % for all matrices except for the nitrile gloves (mean field recovery only 24 %, due to a solvent effect). Inhalation exposure has been recalculated for a breathing rate of 1.25 m^3/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
A	25.1	338.1	0.291	4.673	0.716	11.184	1.179
C	28.2	31.4	0.036	3.502	0.047	2.243	0.020
E	28.5	63.1	0.065	0.437	0.114	7.550	0.074
G	21.3	824.9	0.104	0.509	0.494	19.866	0.705
I	25.0	280.2	0.046	5.698	0.107	3.170	0.072
K	24.0	73.1	0.002	0.254	0.029	0.850	0.022
M	33.0	235.3	0.031	1.166	0.168	2.623	0.076

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
B	25.1	1.4	0.016	0.209	0.013	0.146	0.006
D	28.2	2.1	0.079	$1.5x10^{-4}$	0.012	0.268	0.005
F	28.5	0.3	0.006	0.075	0.013	0.075	0.006
H	21.3	1.1	0.046	-	0.008	0.164	0.012
J	25.0	1.4	0.007	-	0.007	0.320	0.002
L	24.0	2.3	0.009	0.009	0.003	0.233	0.001
N	33.0	0.9	0.030	0.028	0.006	0.419	0.003

LCTM 2

Active substance: Fentin-hydroxide (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Fungicide
Crop: Potatoes

Setting:
The study was conducted in the UK during August 1999 to monitor exposure during mixing/loading and application of a fungicide containing fentin-hydroxide with ground boom sprayers in potatoes. Fifteen experienced operators, both mixing/loading and applying the product, were involved in the study. Cleaning of the equipment was not conducted. The farms (19.4 to 41.0 ha) were chosen according to a target area of ca. 30 ha and covered representative working conditions for potato growing. A broad range of large scale sprayers with induction hoppers and tank sizes of 1000 to 3500 L was used for application. All vehicles were equipped with cabins, which were kept closed during application. The product was applied at the recommended rate of 0.5 L/ha (0.25 kg a.s./ha) in a spray volume of 75 to 300 L/ha. The application duration varied from 89 to 205 min. Mixing/loading was performed one to seven times (product container size: 5 L) and took 43 min on average. During mixing/loading a face shield was worn.

Exposure assessment:
The operators were dressed in cotton coveralls with a hood to determine ‘outer’ body exposure and head exposure and a polyester/viscose long-sleeved T-shirt and a pair of long johns to determine ‘inner’ body exposure. Inhalation exposure was monitored with a Tenax filled air sampling tube connected to a personal air pump working at a rate of 1 L/min. The dosimeters for inhalation and body exposure were worn during the whole working day and no separation into mixing/loading and application was made. For monitoring hand exposure the operators were provided with cotton inner gloves and chemical resistant outer gloves. Sepa-

rate pairs of gloves were used for mixing/loading and application. During application the chemical resistant gloves were only worn when performing maintenance work outside the cabin. Fentin-hydroxide residues were extracted from the dosimeters with methanol, dissolved in acetonitrile/water (3:1) with 0.5 % glacial acetic acid and analysed using LC-MS/MS.

Results:
The results for the hand exposure are given below. In some cases the field recovery for the cotton gloves (52 to 99 %) and chemical resistant gloves (55 to 113 %) was below 70 %; thus, the respective values were adjusted. Values below the LOQ were set to ½ of the LOQ. The MLA data for inhalation, body and head exposure are not shown since they were not used for the model.

The exposure of operator 8 was significantly higher than that of the other operators. A serious contamination of the lower arms (due to accidental spillage during mixing/loading) as well as filling of the front tank via gravity was mentioned for this operator in the study report.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hood [mg]
1	9.0		* 0.005	** 0.580			
2	6.3		* 0.005	7.200			
3	6.8		n.d.	** 3.077			
4	10.0		* 0.005	1.600			
5	8.8		* 0.005	3.800			
6	7.3		** 0.125	1.500			
7	4.9		* 0.005	** 8.824			
8	10.3		0.740	** 29.412			
9	7.5		n.d.	0.480			
10	3.8		** 0.033	0.440			
11	5.8		* 0.005	** 2.364			
12	7.0		* 0.005	** 1.545			
13	7.9		** 0.066	5.200			
14	8.3		** 0.213	** 3.111			
15	9.6		0.040	0.930			

* ½ LOQ ** adjusted for field recovery n.d. - not detectable

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hood [mg]
1	9.0		*** 0.019	*** 1.594			
2	6.3		*** 0.056	* 0.050			
3	6.8		* 0.005	n.d.			
4	10.0		*** 0.034	0.160			
5	8.8		*** 0.098	0.210			
6	7.3		*** 0.500	0.110			
7	4.9		0.100	0.290			
8	10.3		0.500	n.d.			
9	7.5		n.d.	n.d.			
10	3.8		** 0	* 0.050			
11	5.8		* 0.005	n.d.			
12	7.0		* 0.005	n.d.			
13	7.9		*** 0.066	n.d.			
14	8.3		*** 0.082	n.d.			
15	9.6		0.040	n.d.			

* ½ LOQ ** no value given, calculated as '0' in study report *** adjusted for field recovery n.d. - not detectable

LCTM 3

Active substance: Atrazine (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Herbicide
Crop: Maize, fallow fields

Setting:
The objective of this study was to assess the operator exposure to atrazine. The study took place in 1994 at ten sites in Switzerland (trial 1-5, maize) and France (trial 6-10, fallow field) and was conducted with different operators for mixing/loading and application. The product was applied to a small target area of 5 ha except in trial 5 which was terminated after treatment of only 3 ha due to heavy wind. About 3 L product (1.5 kg a.s.) diluted in ca. 200 L water were sprayed per hectare using commercial ground boom sprayers. The equipment used in trial 1-5 (600 L tank volume, 15 to 24 m boom, no cabin) was owned by the company conducting the study whereas the sprayers used in trial 6-10 (600 to 2300 L tank volume, 20 to 24 m boom, cabin) were owned by the farmers themselves. Depending on the volume of the spray tank the number of product containers handled (pack size trial 1-5: 1 L; pack size trial 6-10: 5 L) varied between 3 and 15. An induction hopper was used in trial 9 only; in all other cases the product was loaded manually. Each trial (except trial 5) consisted of two tank mix preparations taking 27 min on average and two spraying operations taking 73 min on average. With the exception of trial 9 the boom was manually unfolded and folded. Cleaning of the equipment was not included in the monitoring.

Exposure assessment:
Each operator was provided with a cotton coverall, cotton undertrousers and a long sleeved undershirt for monitoring body exposure. In addition, the operators wore caps which were sampled for head exposure. Inner cotton gloves plus hand wash specimens and protective gloves plus outer glove wash specimens were sampled to determine the actual and potential hand exposure. During application the protective gloves were only worn in case of contact with the pesticide (maintenance). Inhalation exposure was determined by personal air sampling using OVS sampling tubes. The flow rate of the sampling pump was about 2 L/min.

Atrazine was extracted from the samples with methanol/water: After a cleanup by partition into dichloromethane the residues were quantified by GC-MS or HPLC with UV detection.

Results:
With respect to the unusual application scenario for low crop (treatment of small areas) only the results for mixing/loading are given below. The results for application are not used for the model. The mean field recovery ranged from 83 to 97 % for the different sample matrices except the nitrile gloves for which no field recovery was given. ½ LOQ was used for values below the LOQ. Inhalation exposure was recalculated for an assumed breathing rate of 1.25 m3/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hat [mg]
WM	7.5	** 2.7	0.071	15.890	0.085	** 5.608	0.002
JT	7.5	** 30.1	0.078	21.240	0.135	** 14.626	0.004
HM	7.5	** 2.5	0.030	25.420	0.162	20.229	0.011
JK	7.5	** 1.6	0.045	37.560	0.018	** 3.264	0.003
RV	4.5	** 3.8	0,050	40.910	0.277	9.912	0.005
YB	8.0	** 4.0	0.375	25.170	0.123	9.825	0.009
JM	8.0	** 12.2	0.122	14.260	0.085	65.400	0.007
JD	8.0	** 2.5	0.869	4.645	1.170	** 13.800	0.038
JB	7.5	** 1.6	0.024	0.738	0.289	2.774	0.004
EG	7.5	* 1.0	** 0.035	1.560	0.358	** 0.423	0.011

* ½ LOQ ** partly calculated with ½ LOQ

LCTM 4

Active substance: Clodinafop-propargyl (240 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Winter wheat

Setting:
Four operators were monitored in the UK in 1994 while applying clodinafop-propargyl at a rate of 0.06 kg a.s./ha. At each site one operator performed mixing/loading and one operator performed application. Cleaning of the tank at the end of the working day was included in the monitoring. A target area of approximately 50 ha of winter wheat were treated in 235 to 349 min with tractor drawn sprayers (tank size: 3500 L) equipped with induction hoppers, closed cabins and hydraulic folding booms (24 m). 150 L spray solution was brought out per hectare. Mixing/loading was performed in three cycles and took 46 to 76 min. All operators wore a face shield during mixing/loading.

Exposure assessment:
A cotton coverall as well as cotton undertrousers and a cotton long-sleeved undershirt were used as outer and inner body dosimeter. The air in the breathing zone of the operator was sampled with a Casella AFC 123 air monitor with GF/C filter. Head exposure was monitored with a cap worn throughout application or mixing/loading. Hand washes were taken at the end of each task and analysed to determine exposure of the hands. Additionally, protective nitrile gloves were provided. They were worn during mixing/loading and for maintenance work during application. The collected dosimeter samples were analysed for the active substance clodinafop-propargyl and its carboxylic acid metabolite by extraction with acetone and quantification with LC-MS/MS.

Results:
The active substance clodinafop-propargyl was shown to be stable during the study and the metabolite was in most cases not detectable or below the limit of quantification. Therefore, the amount of the active substance was considered only. The field recovery, which was only given for the clothing matrix, was on average 83 %. No corrections were made. The values for inhalation exposure were not used for the model since information on the measurement was scarce (flow rate of pump and sampling time not given).

Mixing/loading

Operator	TA a.s. [kg]	Inhalation* [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
SH	2.5		0.002	0.917	0.001	0.518	0.020
TS	2.3		n.d.	4.761	0.005	0.276	0.005
SC	3.1		0.002	2.133	0.015	0.147	** 0.001
THR	2.9		0.003	0.830	0.003	0.373	0.004

* poorly documented – not used for model ** ½ LOQ n.d. – not detectable

Application

Operator	TA a.s. [kg]	Inhalation* [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
SC	2.5		n.d.	-	n.d.	n.d.	n.d.
THR	2.3		0.009	0.009	** 0.001	0.026	n.d.
SH	3.1		0.007	-	0.002	0.006	n.d.
TS	2.9		0.012	-	n.d.	0.009	n.d.

* poorly documented – not used for model ** ½ LOQ n.d. – not detectable

LCTM 5

Active substance: Prosulfocarb (800 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Cereals

Setting:
The study was conducted during September and October 2004 to determine dermal and inhalation exposure of operators while mixing/loading and applying the herbicide Boxer 800 EC in cereals. Twelve experienced farmers, farm employees or contract operators were monitored for a typical working day at different sites in Germany. The area treated varied from 47 to 80 ha. Each operator performed mixing/loading (35 to 85 min) as well as application (206 to 521 min); cleaning was only performed by operator 2. The spray equipment consisted of trailed or self-propelled ground boom sprayers which were fitted with large tanks (2,500 to 4,000 L volume) and cabins. All operators except for operator 12 applied the product while keeping the door and windows of the cabin closed. Mixing/loading was performed two to five times by using induction hoppers in most of the cases (operator 1 to 10). On average 25 product containers (10 L) were handled. The product was applied at the label recommended rate of 2.5 to 5.0 L/ha (2.0 to 4.0 kg a.s./ha) in a volume of 100 to 250 L spray liquid/ha. Some operators wore a cap, which was not analysed for residues of the active substance.

Exposure assessment:
The operators were provided with outer body dosimeters consisting of cotton/polyester overalls and inner body dosimeters consisting of cotton long-sleeved T-shirts and long johns worn over the operator's regular underwear. Exposure of the head was determined by face/neck wipes taken at the end of the working day. The measurement of dermal body and head exposure was not separated for mixing/loading and application. Hand washes conducted after each mixing/loading or application cycle were analysed to assess hand exposure. Protective nitrile gloves used during the work were analysed as well. Each operator got one pair of gloves for mixing/loading and one pair of gloves for application. During mixing/loading the gloves were continuously worn. The air in the breathing zone of the operator was monitored with personal air sampling equipment (XAD-2/OVS sampling tubes). The air sampling pump was calibrated to a flow rate of 1.5 L/min. All collected samples were stored in a freezer until the residues were extracted from the sample matrices with n-hexane and quantified by LC-MS/MS.

Results:
The results of the study (except the MLA data for body exposure and head exposure) are presented in the following tables. All values were above the LOQ and adjustments for recovery were not necessary since the field recovery for air filters, hand washes and gloves was above 70 %. The exposure from inhalation has been calculated for an average breathing rate of 1.25 m^3/h. In case of operator 4 the value for inhalation had to be extrapolated because the air sampling pump was not turned on during the first application cycle (four application cycles in total – only ca. 75 % of the working time was monitored, extrapolation to 100 %).

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	200	0.8	0.001	26.226			
2	200	0.7	0.001	29.607			
3	192	9.6	0.029	70.616			
4	160	2.5	0.003	29.734			
5	192	4.5	0.005	278.049			
6	192	7.3	0.015	49.827			
7	208	4.9	0.001	31.823			
8	188	18.7	0.007	36.478			
9	200	3.5	0.021	73.898			
10	200	0.8	0.006	28.443			
11	179	0.8	0.802	315.031			
12	250	19.1	0.141	717.756			

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	200	2.8	0.100	14.723			
2	200	2.1	0.013	-			
3	192	27.9	0.042	8.400			
4	160	* 5.6	0.023	-			
5	192	13.2	0.013	6.373			
6	192	17.3	0.058	9.934			
7	208	1.7	0.001	-			
8	188	12.0	0.024	8.101			
9	200	14.5	0.068	20.866			
10	200	7.5	0.009	** (0.274)			
11	179	12.5	0.313	13.403			
12	250	69.7	0.819	-			

* extrapolated since first application cycle was not monitored ** gloves were not used

LCTM 6

Active substance: Azafenidin (800 g/kg)
Formulation type: Water dispersible granules
Pesticide function: Herbicide
Crop: Grapevine

Setting:
Ten mixer/loaders and ten applicators were monitored at ten representative locations in Southern France while using Azafenidin 80WG for herbicidal control in vineyards. The product was applied at the highest recommended rate of 0.3 kg/ha (0.24 kg a.s./ha) and was diluted in a water volume of 200 L/ha. According to the study protocol an area of 3 to 8 ha had to be treated within a working day of 4 to 8 h. Actually, the operators sprayed the herbicide on 4 to 6 ha using a typical range of small ground boom sprayers for herbicide application (tank size: 300 to 400 L). The spray boom (1 to 2 m) was either protected or unprotected and some of the vehicles were equipped with a cabin (open or closed). The product was packed in 0.3 kg bags and was directly loaded via the top opening of the tank. The workers handled 3 to 5 product bags and wore face shields during that operation. Mixing and loading (13 to 34 min) was repeated two to three times; application was finished after 195 to 348 min. All applicators except for operator 3 cleaned the tank at the end of the working day.

Exposure assessment:
Each operator was provided with two layers of clothing – a cotton coverall for sampling outer body exposure and a polyester/viscose long-sleeved T-shirt and long johns to determine ‘inner’ body exposure. After mixing/loading or application was completely finished, face and neck of the operators were wiped and hand washes were collected. Protective nitrile gloves worn during mixing/loading or for maintenance work during application were sampled as well. Exposure via inhalation was assessed with IOM samplers with GF/A filters (flow rate ca. 2.0 L/min). According to the sample matrix the residues were quantified either by HPLC with UV detection (clothing, air filter, face/neck wipes, hand washes) or by LC-MS (gloves).

Results:
The results of the study are summarised below. In general the exposure towards the active substance was very low, especially for inhalation and head. The field recoveries for the sample matrices were on average between 71 % and 94 %, therefore, no correction was made.

Values below the LOQ are reported as ½ of the LOQ. For estimation of exposure via inhalation an average breathing rate of 1.25 m^3/h has been assumed. The first mixing/loading cycle of operator 14 and the first application cycle of operator 13 were not considered because the trial was aborted due to increasing wind: The monitoring was restarted with the second cycle.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	1.0	16.5	0.030	6.026	0.025	0.939	n.d.
4	0.7	n.d.	0.003	1.034	0.011	0.659	n.d.
6	1.0	n.d.	0.004	1.266	* 0.002	0.991	n.d.
8	1.0	n.d.	$2x10^{-4}$	0.219	n.d.	0.827	n.d.
10	1,2	n.d.	* 0.002	2.366	* 0.002	0.209	n.d.
12	1.0	n.d.	0.072	0.897	** 0.003	0.167	n.d.
14	0.9	* 5.2	0.003	0.585	* 0.002	0.212	n.d.
16	1.0	* 5.2	0.014	2.071	0.008	1.890	n.d.
18	1.0	* 5.2	0.006	0.853	0.008	0.856	n.d.
20	1.0	n.d.	0.010	6.866	0.008	1.193	n.d.

* ½ LOQ ** partly calculated with ½ LOQ n.d. – not detectable

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	1.0	n.d.	0.021	2.464	0.029	2.105	n.d.
3	0.7	n.d.	0.005	0.007	n.d.	0.455	n.d.
5	1.0	n.d.	0.076	1.480	0.006	2.698	0.075
7	1.0	18.3	0.066	0.256	0.025	2.318	0.006
9	1.2	n.d.	* 0.002	0.750	* 0.002	0.749	* 0.002
11	1.0	n.d.	0.072	0.355	0.027	1.670	* 0.002
13	1.0	40.9	0.062	0.158	0.015	0.829	* 0.002
15	1.0	* 5.2	0.027	3.611	0.012	0.892	0.006
17	1.0	* 5.2	0.080	0.312	0.032	0.865	* 0.002
19	1.0	n.d.	0.009	0.972	0.008	0.792	n.d.

* ½ LOQ n.d. – not detectable

LCTM 7

Active substance: Prothioconazole (250 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Fungicide
Crop: Cereals

Setting:
The exposure of five experienced operators applying prothioconazole in cereals was assessed at five different sites in Germany in 2005. Each operator performed mixing/loading and application for a usual working day thereby treating an area of 19 to 67 ha. The amount of product varied from 0.7 L and 1.1 L/ha (0.2 to 0.3 kg a.s./ha) and was brought out in a spray volume of 155 to 238 L/ha. Depending on the area treated either small ground boom sprayers (1000 L tank, 15 m boom) or large ground boom sprayers (3000/4000 L tank, 18/30 m boom) were used. All vehicles were equipped with a closed cabin, but two operators

(A, B) applied the product while having one or more windows open. Induction hoppers were used by two operators (A, C), all other operators poured the product which was packed in 5 L containers directly into the tank. Each trial consisted of three to six mixing/loading and application cycles. Mixing/loading was finished in 32 to 87 min, application was completed in 242 to 396 min. Cleaning of the tank was mentioned for operator B.

Exposure assessment:
The exposure towards prothioconazole and its metabolite prothioconazole-desthio was assessed with whole body dosimeters. Each operator was dressed in normal work clothes (cotton long-sleeved shirt, cotton/polyester trousers) and cotton underwear (long-sleeved T-shirt and long johns). Moreover all operators (except for operator E) wore a cap to determine the exposure of the head. The hands of the operators were washed after the last application (and whenever the operators wished to wash their hands) with a wash lotion and (in case of the last wash) additionally with 2-propanol. No separation into mixing/loading and application was made for body, hand and head exposure. The exposure via inhalation was measured with personal air sampling pumps (flow rate 2.0 L/min) connected to an IOM sampler with glass fibre filter. Separate sampling devices were provided for the mixing/loading and application task. The operators also received a pair of protective gloves to be worn during the whole mixing/loading period. Another pair of gloves was provided in case of handling contaminated surfaces during application. Residues of prothioconazole and prothioconazole-desthio were extracted from the collected dosimeter samples with acetonitrile and finally analysed by LC-MS/MS.

Results:
The exposure values are given in the following tables. The results for prothioconazole-desthio were calculated as prothioconazole-equivalents applying a conversion factor of 1.103 (derived from the molecular weight ratio) and added to the results for prothioconazole. Further calculations were made for the hand data; the value obtained for mixing/loading/application was split into one value for mixing/loading and one value for application according to the ratio of exposure detected on the protective gloves. Corrections for field recovery were made for prothioconazole found on glass fibre filters (field recovery: 65 %) and gloves (field recovery: 69 %). For all other matrices (clothing, hand washes) the field recovery was above 70 %. Values below the LOQ have been calculated as ½ LOQ. The results for body and head exposure are not shown since MLA data are not used in the model. Due to a visible contamination during the first mixing/loading cycle operator C received new dosimeters and continued as operator C1. The dosimeter samples from the first mixing/loading cycle were not considered.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
A	14.0	* 3.9	*** 0.265	14.601			
B	4.0	** 1.4	*** 0.009	4.264			
C_1	6.0	** 1.4	*** 0.011	8.663			
D	13.1	** 1.4	*** 0.008	0.962			
E	5.3	** 1.4	*** 0.011	2.284			

* partly calculated with ½ LOQ ** ½ LOQ *** estimated value

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
A	14.0	* 2.2	*** n.d.	-			
B	4.0	** 1.4	*** 0.003	1.438			
C_1	6.0	** 1.4	*** n.d.	-			
D	13.1	** 1.4	*** 0.007	0.825			
E	5.3	** 1.4	*** n.d.	-			

* partly calculated with ½ LOQ   ** ½ LOQ   *** estimated value   n.d. – not detectable

LCTM 8

Active substance: Diclofop-methyl (378 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Winter wheat

Setting:
The study was conducted to determine the exposure of operators to diclofop-methyl while applying the herbicide at the maximum recommended rate of 3 L/ha (1.1 kg a.s./ha, diluted in ca. 100 to 200 L water/ha) in winter wheat. Twenty subjects either mixing/loading or applying according to their normal work practice were monitored in 1997/1998 at ten representative locations in the UK. A target area of 50 ha for a working day of 8 h had been defined in the study protocol; 40 to 60 ha were actually treated The spray equipment used was typical for herbicide application and covered a range of different manufacturer types. Tank sizes ranged from 900 to 3,000 L and boom length from 12 to 24 m. Most of the sprayers were equipped with an induction hopper; if no induction hopper was existent, the product was filled into the tank by gravity. During mixing/loading each operator had to handle about 30 containers with 5 L product, but with the exception of operator 14 who conducted twelve mixing/loading cycles in 180 min three to 5five mixing/loading cycles in 30 to 100 min were sufficient. All vehicles were fitted with closed cabins; operators 9 and 15, however, applied with open window(s). Spraying was finished within 200 to 420 min. No cleaning was mentioned in the report.

Exposure assessment:
Each operator received clothing to determine potential and actual body exposure as well as head exposure. The clothing consisted of an outer cotton coverall with hood and a short-sleeved cotton T-shirt and a pair of long johns. Protective gloves and cotton inner gloves were provided for monitoring hand exposure. The inner and outer gloves were permanently worn by the operators doing mixing and loading, whereas only the inner gloves were permanently worn by the applicators. The air in the breathing zone of the operators was sampled with personal air samplers (flow rate 0.9 to 1.4 L/min) containing Tenax tubes. All samples were extracted with acetone and analysed by GC with ECD detection.

Results:
The results of the study are given below. No corrections were made since the mean field recoveries for the different sample matrices were between 86 and 91 %. An average breathing rate of 1.25 m^3/h was used to calculate the exposure via inhalation. Due to a rather unusual exposure during an extensive repair of the sprayer, the results of operator 3 are not considered for the model. High exposure values were also observed for operator 12, who was not familiar with the sprayer type, and for operator 9, who contaminated his inner gloves while unblocking a nozzle. Nevertheless, these data were used for the model.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hood [mg]
2	56.4	13.4	1.268	1.221	-	41.055	0.501
4	47.3	23.9	0.272	87.060	0.039	10.566	0.911
6	58.6	7.6	0.602	25.762	0.046	12.518	1.898
8	51.0	10.5	13.219	66.998	0.152	45.967	3.037
10	68.0	6.9	1.805	73.804	0.239	43.598	0.985
12	45.9	14.8	23.262	1160.195	0.186	129.840	1.588
14	51.0	31.5	11.486	117.051	1.430	224.290	9.675
16	68.0	1.7	2.006	91.553	0.605	51.956	0.475
18	56.7	11.5	33.747	379.082	0.136	41.388	12.700
19	64.3	7.8	2.383	85.830	0.094	14.760	1.130

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hood [mg]
1	56.4	0.8	1.537	4.727	-	2.231	0.313
3	47.3	* 34.9	* 2.645	* 16.706	* 0.397	* 47.748	* 0.379
5	58.6	7.8	3.964	18.484	0.035	4.825	0.041
7	51.0	4.5	0.781	11.066	0.028	7.432	0.062
9	68.0	4.7	60.496	10.251	0.359	20.846	0.178
11	45.9	4.5	0.339	6.470	0.009	3.232	0.028
13	51.0	24.5	5.272	20.934	0.079	8.300	0.057
15	68.0	2.2	2.344	0.089	0.022	1.003	0.043
17	56.7	2.0	1.213	0.598	0.045	0.711	0.028
20	64.3	11.1	0.365	1.203	0.038	5.246	0.140

* value not used for model

LCTM 9

Active substance: Isoproturon (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Herbicide
Crop: Barley, wheat

Setting:
A total of 16 operators were monitored in 1997 while applying isoproturon for weed control in barley and wheat. The test sites were located in Northern France and encompassed a target area of 23 to 62 ha resembling a typical day's work. Each operator mixed and loaded the product and applied it on the field using both trailed and mounted ground boom sprayers with large tanks (2,000 to 4,000 L) and cabins. The mixing/loading step was repeated two to three times and took 20 to 94 min. In most of the cases the product was loaded on top of the tank since only two sprayers were equipped with an induction hopper. A face shield was worn during that task. Applications were made with 1.6 to 2.3 L product per ha (0.8 to 1.2 kg a.s./ha) diluted in 100 to 200 L water. Application was finished within 140 to 311 min. If necessary, the equipment was cleaned at the end of the application.

Exposure assessment:
The operators were provided with separate sets of dosimeters for mixing/loading and application. Before the start of the mixing/loading or application task the operators were dressed with the respective set on a clean area. Each set consisted of a pair of protective nitrile gloves (worn at the operators own discretion), a pair of inner cotton gloves (resembling the hand), a cap, a cotton coverall and cotton underwear (long-sleeved shirt and long johns). The inhalation exposure was measured with a GILAIR 3 personal air sampling pump connected to a filter cassette. The pump, which was used during mixing/loading and application, was calibrated to operate at a flow rate of 1 L/min. Separate filter sets were used for the different tasks. The samples were analysed for isoproturon by HPLC with UV detection after extraction with methanol and cleanup on a Florisil cartridge.

Results:
The study results are summarised in the following tables. No corrections were made for the field recovery, which was on average between 89 and 110 %. Some values were below the LOQ; for those ½ LOQ was used. The inhalation exposure refers to a breathing rate of 1.25 m^3/h. Operator 16 had only six month of experience and got seriously contaminated during mixing/loading. He was dressed in a new coverall, which was analysed in addition to the contaminated one.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	Bodyinner [mg]	Bodyouter [mg]	Cap [mg]
1	33.5	17.8	0.011	28.000	0.198	132.000	2.000
2	40.7	48.5	8.600	0.470	0.117	26.610	0.061
3	40.0	* 1.0	0.120	39.000	0.346	30.200	0.012
4	27.5	4.0	* 0.005	5.800	** 0.120	4.100	0.015
5	42.3	5.3	0.140	27.000	0.179	7.780	0.013
6	26.4	* 1.0	* 0.005	4.700	** 0.039	96.520	0.110
7	40.0	* 1.0	0.058	7.400	** 0.026	3.120	0.056
8	50.0	* 0.9	0.011	0.190	** 0.021	78.000	* 0.005
9	35.0	* 1.0	* 0.005	1.400	* 0.015	6.700	* 0.005
10	56.5	* 1.0	0.072	5.300	1.697	3.080	* 0.005
11	45.0	11.0	0.073	17.000	** 0.021	28.500	1.600
12	47.5	* 1.0	0.250	4.800	0.552	45.000	0.660
13	27.0	* 1.0	0.016	7.200	* 0.015	2.167	* 0.005
14	25.0	* 1.0	8.200	* 0.050	0.042	5.700	* 0.005
15	25.0	* 1.0	0.045	14.000	* 0.015	0.734	* 0.005
16	41.4	5.9	8.200	8.800	13.069	442.190	0.070

* ½ LOQ ** partly calculated with ½ LOQ

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
1	33.5	5.4	10.000	20.000	** 0.157	0.549	2.300
2	40.7	16.4	0.890	-	** 0.029	1.130	0.017
3	40.0	35.3	3.500	17.000	0.091	26.000	0.037
4	27.5	* 1.0	* 0.005	3.400	* 0.015	0.660	0.015
5	42.3	4.9	45.000	0.520	** 0.525	2.670	0.250
6	26.4	10.0	0.360	4.400	0.134	7.790	0.059
7	40.0	* 1.0	0.150	-	** 0.032	0.172	* 0.005
8	50.0	* 0.9	0.210	37.000	** 0.035	0.200	0.010
9	35.0	* 1.0	0.520	-	** 0.053	0.305	* 0.005
10	56.5	5.5	3.700	-	0.162	2.640	0.087
11	45.0	6.8	0.200	1.900	** 0.047	2.920	0.099
12	47.5	3.6	4.800	* 0.050	0.116	2.480	0.017
13	27.0	9.5	0.350	-	** 0.026	0.850	0.055
14	25.0	* 1.0	1.500	-	0.046	0.968	* 0.005
15	25.0	6.0	3.600	24.000	0.048	10.640	0.016
16	41.4	6.7	5.200	18.000	0.231	6.560	0.200

* ½ LOQ ** partly calculated with ½ LOQ

<u>LCTM 10</u>

Active substance: Prothioconazole (160 g/L; 250 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Fungicide
Crop: Cereals, canola

Setting:
The study was designed to assess the exposure of operators towards prothioconazole and its degradation product prothioconazole-desthio while applying the fungicides with 160 g prothioconazole/L and 250 g prothioconazole/L on several fields in Germany during May and June 2006. Seven operators were used in the conduct of the study each mixing/loading and applying the product for a usual working day (at least five hours). During that day 23 to 180 ha of cereals and canola were treated with prothioconazole at a rate of 0.2 kg/ha (spray volume 200 to 300 L/ha). The equipment used ranged from sprayers for small fields (15/21 m boom, 840 to 1,500 L water tank volume) to sprayers for large fields (24/36 m boom, 2,600 to 400 L tank volume). All vehicles were equipped with a cabin, but only in four cases (operators B, C, D, H) the cabin was kept closed during application. Operator A and operator E had to leave the cabin to manually unfold and fold the boom. Three operators loaded the product (packed in 5 L containers) exclusively via an induction hopper. Mixing/loading was divided in up to 14 cycles and was completed within 56 to 182 min. Application was finished after 231 to 359 min. Cleaning of the equipment was not included in the study.

Exposure assessment:
The operators wore two layers of sampling clothing above their own underwear throughout the monitoring period. The inner layer consisted of a long-sleeved cotton T-shirt and cotton long johns and the outer layer consisted of a cotton shirt and a pair of cotton/polyester trousers. A cap should be worn for estimation of head exposure, but the operators were not forced to do it. For that reason only three operators wore a cap. Protective gloves were continuously used during mixing/loading. Another pair of protective gloves was provided if the operators would handle contaminated surfaces during application. After the last application

cycle the operators washed their hands. The hand wash water was collected and analysed. Inhalation exposure sampling was performed with personal air sampling pumps (2 L/min flow rate) connected to IOM samplers with glass fibre filters. Separate sampling devices were used for mixing/loading and application. Residues of prothioconazole and prothioconazole-desthio in the dosimeters were determined by LC-MS/MS.

Results:
The values for inhalation and hand exposure as well as for glove contamination are presented below. The exposure of the body and the head is not shown since sampling of the body and the head was not separated into mixing/loading and application. Calculations were necessary for the hand values obtained from mixing/loading/application; the values were split into one value for mixing/loading and one value for application according to the ratio of exposure detected on the protective gloves. The results of prothioconazole-desthio were calculated as prothioconazole-equivalents applying a conversion factor of 1.103 (derived from the molecular weight ratio) and added to the prothioconazole results. The mean field recovery for prothioconazole and for prothioconazole-desthio in the different sample matrices was between 85 and 120 % and 86 and 95 %. Therefore, no corrections for the field recovery were made. Values below the LOQ are given as ½ LOQ and inhalation exposure is calculated for a breathing rate of 1.25 m^3/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
A	4.6	* 2.2	** 0.016	3.526			
B	12.8	* 2.2	** 0.031	7.947			
C	31.3	* 2.2	** 0.032	3.056			
D	12.0	* 2.2	** 0.007	0.560			
E	5.6	* 2.2	** 0.007	1.447			
F	7.1	* 2.2	** 0.011	6.236			
H	15.0	* 2.2	** 0.011	3.502			

* calculated with ½ LOQ ** estimated value

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
A	4.6	* 2.2	*** 0.001	0.287			
B	12.8	** 5.8	*** n.d.	-			
C	31.3	* 2.2	*** n.d.	-			
D	12.0	* 2.2	*** n.d.	-			
E	5.6	** 3.6	*** 0.010	1.971			
F	7.1	** 3.2	*** $1x10^{-4}$	0.040			
H	15.0	* 2.2	*** n.d.	-			

* calculated with ½ LOQ ** partly calculated with ½ *** estimated value n.d. – not detectable

<u>LCTM 11</u>

Active substance: Prosulfocarb (800 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Potatoes

Setting:
The study was conducted during April and May 2009 at several potato fields in Belgium. Twelve Operators were monitored while mixing/loading and applying an herbicide containing prosulfocarb according to their usual work practice. At each site the product was applied to an area of ca. 50 ha at a rate of 5 L/ha (4 kg a.s./ha). The requested water volume was 200 L/ha; actually 115 to 400 L/ha were sprayed in the study. The operators used tractor-mounted or stand-alone ground boom spray equipment with large spray booms (27 to 39 m width) and cabins. In four cases, application was conducted with open windows. The product was packed in 20 L containers and was poured directly into the tank or was loaded by an induction hopper. Depending on the tank size the mixing/loading step was repeated two to six times. Altogether mixing/loading took between 50 to 109 min, whereas application took between 117 to 335 min. Where necessary, cleaning of the equipment was conducted and included in the monitoring.

Exposure assessment:
Each operator received a cotton coverall, a long-sleeved cotton T-shirt, cotton underpants and cotton socks. The operator got dressed in the sampling clothing at the beginning of the monitoring and wore it throughout the working day. A headband was issued by the study team as well to monitor the exposure of the head. Separate pairs of monitoring cotton gloves were used for mixing/loading and application. For each mixing/loading or application task two pairs of cotton gloves were worn – one pair beneath and one pair above protective nitrile gloves. The nitrile gloves were not sampled. GGP-U sampling heads with glass fibre filter and adsorbent tubes were used to assess the inhalation exposure. The pump operated at a flow rate of 3.5 L/min. During long breaks (> 30 min) the pump was switched off. The samples were collected and analysed for prosulfocarb by HPLC-MS after an extraction with acetonitrile (filters, tubes) or methanol (cotton clothing).

Results:
The values for hands (inner cotton gloves) and gloves (outer cotton gloves) are reported in the following tables. No corrections were made for the field recovery (mean field recovery for cotton gloves 92 to 98 %). All values were above the LOQ. The results for inhalation, head and body exposure are not given since sampling of body, head and inhalation exposure was not separated into the two tasks.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Headband [mg]
1	197.4		0.044	732.686			
2	189.8		0.013	107.401			
3	207.0		0.011	79.461			
4	205.2		0.011	800.712			
6	203.0		0.008	266.496			
7	205.5		0.005	2346.731			
8	205.0		0.152	596.860			
9	206.8		0.021	1227.478			
11	192.8		0.066	1060.351			
12	193.1		0.167	634.842			
13	205.2		1.493	184.589			
14	157.2		0.078	487.025			

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Headband [mg]
1	197.4		0.023	13.069			
2	189.8		0.019	1.441			
3	207.0		0.019	0.099			
4	205.2		0.009	0.287			
6	203.0		0.007	3.076			
7	205.5		0.008	26.414			
8	205.0		0.253	0.954			
9	206.8		0.034	28.462			
11	192.8		0.109	1.022			
12	193.1		0.177	44.786			
13	205.2		1.911	1.801			
14	157.2		0.231	24.001			

<u>HCTM 1</u>

Active substance: Bitertanol (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Insecticide
Crop: Orchards

Setting:
The objective of this study was to provide data on the operator exposure to bitertanol during mixing/loading and application. The study was conducted in July 2002 in Italy and was designed to reflect representative conditions and work practices for the fruit growing areas in Europe. Ten subjects operating at ten different apple-growing sites were chosen for the study. The apple trees at these sites grew in rows of 1.5 to 8 m spacing and reached a height of 1.8 to 8 m. The application equipment owned by the operators consisted of trailed air blast sprayers without cabin and a tank size of 1,000 to 1,500 L. One of the vehicles had a cabin, but the windows and doors were open during application. The operators poured the product (packed in 0.5 L bottles) directly into the tank while wearing a face shield. In most cases two to four mixing/loading cycles were sufficient. The duration of the whole mixing/loading process was in a range of 24 to 43 min. The product was applied at the label recommended rate of 0.75 L/ha (0.375 kg a.s./ha) in a water volume of 388 to 1,947 L/ha. An area of 2.9 to 5.6 ha was treated during the working day and application was finished within 119 to 257 min. Cleaning was only conducted where necessary.

Exposure assessment:
The operators were dressed in outer and inner whole body dosimeters represented by cotton/polyester coveralls, long sleeved vests and long johns. Face/neck wipes were conducted at the end of the working day to assess head exposure. Caps were worn during application, but were not analysed. In addition each operator was equipped with a personal air sampling pump (flow rate: 2 L/min) connected to Tenax tubes. No separation into mixing/loading and application was made for sampling of the body, head and inhalation exposure. Hand exposure, however, was separately determined for the two tasks. After each mixing/loading or application cycle hand wash samples were taken and after completion of the whole task the protective gloves were collected as well. One pair of protective gloves each was provided by the study team for the whole mixing/loading and the application process. The gloves were worn by the operators throughout the respective task. All specimens were analysed for residues of bitertanol. The active substance was first extracted from the solid sample matrices with 2-propanol or acetonitrile and finally quantified with LC-MS/MS.

Results:
No major contamination events occurred during the field phase of the study. Thus, the exposure towards the hands was relatively low. The mean field recovery for the sample matrices was above 70 % except for the protective gloves (43 %). Since the low recovery for the gloves was ascribed to a solvent effect, no correction was made.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	1.4		0.037	1.960			
2	1.2		0.010	2.760			
3	1.2		0.080	4.410			
4	1.3		0.010	3.150			
5	1.0		0.021	2.490			
6	1.2		0.013	1.320			
7	1.9		0.004	2.760			
8	1.9		0.003	4.000			
9	1.2		0.071	1.860			
10	1.3		0.008	2.480			

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	Bodyinner [mg]	Bodyouter [mg]	Face/neck [mg]
1	1.4		0.034	1.140			
2	1.2		0.009	1.360			
3	1.2		0.058	2.700			
4	1.3		0.053	1.460			
5	1.0		0.013	0.803			
6	1.2		0.021	1.870			
7	1.9		0.007	2.580			
8	1.9		0.018	3.030			
9	1,2		0.034	0.056			
10	1,3		0.035	0.299			

HCTM 2

Active substance: Dodine (450 g/L)
Formulation type: Suspension concentrate
Pesticide function: Fungicide
Crop: Orchards

Setting:
The exposure of 15 operators was assessed during mixing/loading and application of dodine for fungicidal control in orchards. The field phase of the study took place in July 2008 at 15 farms in the Netherlands. The treated orchards mainly consisted of apples and pears and had a size of 6 to 12 ha. Application was conducted with a broad range of trailed sprayers. In more than half of the trials a mowing machine was placed between the tractor and the sprayer. The tractors were either equipped with a closed cabin or not. All operators used spray drift reducing nozzles. For mixing and loading the operator opened one or two product containers (5 L) and poured the content into the tank. He rinsed the containers, added the required amount of water and started spraying. 1.3 to 2.3 L product (0.6 to 1.0 kg a.s./ha) was applied per hectare diluted in a water volume of about 200 L/ha. In most cases the op-

erator had to fill up the tank twice to treat the whole target area. Mixing/loading and application was completed after 124 to 402 min. If cleaning was conducted it was included in the monitoring.

Exposure assessment:
Whole body dosimeters were issued by the study team. Each operator had to wear a cotton coverall above a cotton long-sleeved shirt and cotton long underpants as well as cotton socks throughout the monitoring period. Exposure of the head was determined with a headband and an IOM sampler with glass fibre filter was used to assess the exposure via inhalation. Two pairs of cotton gloves each were worn during mixing/loading and application to determine potential and actual hand exposure. Between the two layers of cotton gloves the operators wore a further pair of nitrile gloves, which were not analysed. After all samples were collected dodine was extracted from the matrices with an acidic mixture of methanol/water and quantified by HPLC-MS/MS.

Results:
The results for the hand exposure are summarised below. The amount of dodine found on the inner cotton gloves (= hands) was below the limit of quantification. Therefore, one half of the LOQ was used for these values. A larger amount of active substance was found on the outer cotton gloves (= gloves), especially on those worn during mixing and loading. The results for inhalation, head and body exposure are not given since sampling of body, head and inhalation exposure was not separated into mixing/loading and application. The field recovery was above 70 % for all sample matrices.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Headband [mg]
1	5.7		* 0.103	131.017			
2	8.2		* 0.103	38.493			
3	9.1		* 0.103	15.457			
4	6.8		* 0.103	5.169			
5	6.8		* 0.103	6.825			
6	5.3		* 0.103	30.148			
7	3.5		* 0.051	0.216			
8	5.4		* 0.103	127.541			
10	5.2		* 0.154	27.640			
11	4.6		* 0.103	2.218			
12	6.5		* 0.103	34.844			
13	4.7		* 0.103	27.263			
14	7.9		* 0.103	9.355			
15	5.4		* 0.103	2.869			
17	4.0		* 0.103	0.561			

* ½ LOQ

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Headband [mg]
1	5.7		* 0.103	9.708			
2	8.2		* 0.103	24.455			
3	9.1		* 0.103	0.214			
4	6.8		* 0.103	0.802			
5	6.8		* 0.103	* 0.103			
6	5.3		* 0.103	0.676			
7	3.5		* 0.051	6.967			
8	5.4		* 0.103	0.448			
10	5.2		* 0.154	10.710			
11	4.6		* 0.103	10.550			
12	6.5		* 0.103	1.437			
13	4.7		* 0.103	3.233			
14	7.9		* 0.103	0.482			
15	5.4		* 0.103	0.495			
17	4.0		* 0.103	1.981			

* ½ LOQ

HCTM 3

Active substance: Methomyl (200 g/L)
Formulation type: Soluble (liquid) concentrate
Pesticide function: Insecticide
Crop: Grapevine

Setting:
The study was conducted to obtain data on the exposure to methomyl while applying it to grapevines. The field phase took place at several vineyards in Southern France during July and August 2001. Twelve mixer/loaders and twelve applicators were separately monitored for a defined working day of four to eight hours. The insecticide was applied on an area of 5.2 to 8.4 ha at the maximum label rate of 2.25 L/ha (0.45 kg a.s./ha) in a water volume of 300 L/ha. Typical spray equipment was used covering a range of self-propelled mist blowers with tank sizes of 400 to 1,000 L. Up to 16 rows were simultaneously treated. Two operators (3, 7) used a tractor which was equipped with a cabin. Face shields were provided for the mixing/loading task. Mixing/loading was performed in three steps, in some cases four or more steps were necessary. The product was packed in 5 L containers and was directly poured into the tank. The duration of mixing/loading ranged from 17 to 60 min. Application was completed after 169 to 294 min. Cleaning of the equipment was not mentioned in the report.

Exposure assessment:
Dermal exposure of the mixer/loaders and applicators was measured by using whole body dosimeters consisting of a long-sleeved T-shirt and long johns as inner layer and a cotton coverall as outer layer. Gloves worn during mixing/loading and for maintenance tasks during application as well as hand washes conducted after the final mixing/loading or application cycle were analysed to quantify hand exposure. For assessing head exposure the face and neck of the operators were wiped twice after completion of their work. Inhalation exposure was determined from residues collected by an IOM sampler with glass fibre filter attached to a personal air pump located in the breathing zone of the operator (flow rate ca. 2 L/min). The

analysis of methomyl was performed by HPLC with post-column derivatisation and fluorescence detection.

Results:
The results are given in the following tables. Values below the LOQ have been calculated with 50 % of the LOQ. No correction for the field recovery was made since the mean field recovery was above 70 % for all matrices. The value for inhalation exposure refers to an average breathing rate of 1.25 m^3/h. Operator 10 wore a helmet during application. The helmet was analysed as well and the amount of active substance found was added to the result of the face/neck wipe.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	2.7	* 5.2	0.004	18.000	** 0.005	4.393	* 0.001
4	2.4	* 5.2	0.026	42.000	0.017	4.050	* 0.001
6	2.7	* 5.2	0.450	32.000	0.055	19.420	0.004
8	3.0	* 5.2	0.004	1.500	* 0.002	** 0.795	* 0.001
9	3.4	* 5.2	0.007	12.000	0.015	1.930	0.003
12	3.6	* 5.2	0.090	46.000	0.014	2.871	0.005
14	3.6	* 5.2	0.003	3.900	0.006	0.658	* 0.001
16	3.6	* 5.2	0.037	32.000	0.021	94.320	* 0.001
18	3.2	* 5.2	0.009	49.000	0.009	2.089	0.005
19	3.6	* 5.2	0.670	96.000	0.152	4.940	0.029
22	3.0	10.4	0.006	22.000	** 0.004	1.939	* 0.001
24	3.8	10.4	0.021	19.000	0.077	2.900	* 0.001

* calculated with ½ LOQ ** partly calculated with ½

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	Bodyinner [mg]	Bodyouter [mg]	Face/neck [mg]
1	2.7	54.2	0.300	0.640	0.102	5.150	0.023
3	2.4	28.1	0.110	0.032	0.015	0.664	* 0.001
5	2.7	33.3	6.400	0.410	0.100	8.010	0.017
7	3.0	* 5.2	0.011	0.032	** 0.004	0.064	* 0.001
10	3.4	166.7	0.260	0.660	0.154	8.000	*** 0.024
11	3.6	270.8	1.100	2.800	0.217	24.000	0.028
13	3.6	93.8	0.680	2.500	0.262	17.300	0.024
15	3.6	416.7	1.400	3.300	0.379	29.100	0.020
17	3.2	260.4	0.810	4.900	0.229	22.850	0.058
20	3.6	135.4	0.320	8.700	0.246	10.960	0.008
21	3.0	218.8	0.560	3.600	0.440	17.200	0.047
23	3.8	114.6	0.460	0.098	0.098	12.350	0.007

* calculated with ½ LOQ ** partly calculated with ½ *** including helmet worn during application

HCTM 4

Active substance: Dinocap (350 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Fungicide
Crop: Grapevine

Setting:
Twelve operators were monitored during application of the fungicide to grapevine at several sites in France in 1995. Mixing/loading as well as cleaning was not included in the study. The operators used trailed air blast sprayers (600 to 800 L tank volume) with up to ten spray cannons (front or rear) and treated an area of 5.3 to 11.4 ha within three to four hours. The tractors used were not equipped with a cabin. In most trials four rows were sprayed at the same time. The product was applied at a rate of about 0.6 L per ha (0.2 kg a.s./ha) diluted in a water volume of ca. 200 to 230 L. Application was conducted in two spraying sessions. Two operators (11, 12) performed a routine check during application including removal, inspection and replacement of all easily accessible sprayer filters.

Exposure assessment:
To assess outer and inner body exposure the operators were provided with cotton coveralls as well as cotton long sleeved T-shirts and cotton trousers worn underneath the coverall. The hood of the coverall was sampled to determine the head exposure. Protective gloves worn by the operators throughout the application task were analysed for potential hand exposure. The actual hand exposure was quantified by sampling cotton gloves worn underneath the protective gloves. Inhalation exposure was assessed by using personal air samplers with glass fibre filters operating at a flow rate of 2 L/min. The samples were extracted with a mixture of dichloromethane and pentane. After a clean up the extract was methylated with diazomethane and analysed by gas chromatography.

Results:
The exposure determined for application is given below. The field recovery for the nitrile gloves was on average 34 %, which was explained by loss of substance from the glove surface. Since the procedural recovery was above 70 %, no correction was made. All values were above the LOQ. Inhalation was recalculated assuming a breathing rate of 1.25 m^3/h.

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hood [mg]
1	2.2	106.3	0.023	0.559	0.061	1.802	0.193
2	1.7	39.6	0.004	0.644	0.063	2.922	0.272
3	1.5	18.8	0.010	0.792	0.057	8.262	1.296
4	1.8	38.5	0.009	0.785	0.026	5.688	0.942
5	1.6	53.1	0.009	0.242	0.035	1.245	0.246
7	2.2	19.8	0.007	0.276	0.018	3.985	0.431
8	1.3	14.6	0.016	0.711	0.042	9.267	0.812
9	1.8	34.4	0.006	0.058	0.033	0.671	0.076
10	2.3	25.0	0.005	0.505	0.018	2.042	0.427
11	1.2	21.9	0.013	0.744	0.031	0.589	0.064
12	1.1	19.8	0.005	0.959	0.032	0.752	0.103
13	1.2	28.1	0.004	0.905	0.028	18.037	1.767

HCTM 5

Active substance:	Metiram (700 g/kg)
Formulation type:	Water dispersible granules
Pesticide function:	Fungicide
Crop:	Grapevine

Setting:
The study was conducted during July 2002 to assess data on the exposure of 27 operators either mixing/loading or applying metiram during a typical work day. Twelve farms in Germany were chosen, which reflected typical conditions for fungicide application in vineyards using water rates between 300 to 900 L/ha. The product was applied at a rate of 2.0 to 3.0 kg/ha (1.4 to 2.1 kg a.s./ha) on an area ranging from 3.0 to 14.6 ha. In each trial one operator doing mixing/loading and one or two operators doing application were monitored. The product (packed in 10 kg packages) was mixed with water in a large mixing-tank or directly loaded into the spray tank. Mixing/loading was repeated two to six times; the average duration for the complete task was 74 min. Application was conducted with air blast sprayers (tank volume 400 to 1100 L), which, in most of the cases, were equipped with a cabin. Only four operators sprayed without a cabin (2A, 2B, 7A, 9B), whereas five operators applied the product at least for some time with one or more windows of the cabin open (1B, 4A, 5A, 6A, 8A). Spraying was completed within 130 to 450 min. After finishing application the spray equipment was cleaned if the equipment was not used for the same treatment next day.

Exposure assessment:
Each operator wore two layers of standardised clothing for body sampling. The outer body dosimeter consisted of a polyester/cotton long sleeved shirt/jacket and trousers, the inner body dosimeter consisted of a long sleeved T-shirt and long johns. Head exposure was determined by face/neck wipes conducted at the end of the mixing/loading or application task. Protective gloves used throughout mixing/loading or for maintenance work during application as well as hand wash samples taken at times when the operator would usually wash his hands were analysed to quantify potential and actual hand exposure. Potential inhalation exposure was assessed by using an IOM sampler with glass fibre filter attached to a personal air pump located in the breathing zone of the operator (flow rate ca. 2 L/min). For analysis the sample material was treated with EDTA to release the ethylenebisdithiocarbamate (EBDC) ligand, which was quantified by HPLC with electrochemical detection after performing a reversed phase chromatography.

Results:
The study results are summarised in the following tables. All values had to be adjusted for the respective field recovery, which was on average between 31 % and 64 %. The LOQ was not given in the study report, but all values were above the LOQ. The inhalation exposure refers to a breathing rate of 1.25 m^3/h. High exposure values for application were measured in those cases where the vehicles were not equipped with a cabin or the cabin was left open. Overfilling of the tank was reported for operator 14M who had a high overall exposure from mixing/loading.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1M	35.5	19.4	0.160	1.583	0.230	11.698	0.030
2M	37.8	16.3	0.020	0.608	0.465	7.389	0.028
3M	17.5	89.8	0.150	12.608	1.491	20.261	0.140
4M	12.3	61.5	0.070	1.014	0.130	4.579	0.073
5M	17.5	105.0	0.008	0.472	0.580	15.216	0.072
6M	7.0	32.2	0.002	6.526	0.104	28.180	0.010
7M	13.5	9.6	0.008	1.200	0.104	1.738	0.021
8M	15.8	34.7	0.012	0.063	0.213	2.479	0.015
9M	21.0	23.9	0.015	1.329	1.307	8.544	0.014
10M	7.0	10.4	0.004	2.145	0.037	3.025	0.006
11M	19.8	33.4	0.026	0.504	0.080	2.559	0.040
14M	16.8	211.8	0.038	1.034	0.530	66.780	0.361

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1A	18.4	16.8	0.233	5.303	0.248	5.105	0.017
1B	15.8	41.8	1.134	5.487	2.533	129.039	0.104
2A	7.1	219.6	1.219	-	1.604	52.687	0.326
2B	30.7	441.6	6.765	-	2.183	97.723	0.873
3A	17.5	117.4	0.512	0.196	1.393	8.849	0.032
4A	12.3	2.8	0.001	0.314	0.007	0.462	0.009
5A	17.5	626.6	2.170	130.142	3.291	52.992	0.806
6A	5.3	0.5	0.010	-	0.026	0.513	n.d.
7A	10.0	34.8	1.819	-	0.709	65.125	0.261
8A	13.7	182.0	0.272	-	0.928	15.556	0.049
9A	5.5	22.1	0.151	0.035	0.480	17.526	0.004
9B	9.8	131.2	0.078	3.399	0.926	61.951	0.211
10A	7.0	12.2	0.182	0.077	0.107	4.111	0.010
11A	10.0	15.6	0.035	0.176	0.102	0.656	0.007
14A	12.9	30.3	0.345	0.047	0.811	33.170	0.021

<u>HCTM 6</u>

Active substance: Phosalone (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Insecticide
Crop: Orchards

Setting:
The objective of this study was to obtain operator exposure data for the application of an insecticide in orchards. The field phase of the study took place during July and August 1996 at 17 farms in France. At each farm one operator was monitored during a normal working day including the mixing/loading task as well as the application task. The operators worked with their own equipment according to their usual practice. Most of the sprayers used were of the jet spray type operating at a pressure of ten to 20 bars. Cabins were present on six vehicles (operator 9 and operators 13 to 17). Mixing/loading was mainly performed in three to five

cycles and was finished after 15 to 79 min. The product was packed in 5 L containers and was directly poured into the tank (1,000 to 3,000 L). A total of 5 to 17 ha were treated with the insecticide at a rate of 0.7 to 1.4 L/ha (0.4 to 0.8 kg a.s./ha) in a water volume of 400 to 1,200 L/ha. After 217 to 671 min spraying was completed. The cultures treated were mainly apple trees of up to 6 m height growing in rows of 4 m distance. Cleaning was reported for six operators (exposure included in application).

Exposure assessment:
The operator exposure was assessed with two different sets of whole body dosimeters, one set for mixing/loading and one set for application. After completion of a mixing/loading or application cycle the sets were changed and stored in a clean area during the time they were not used. Each set consisted of a cotton hat, cotton work suit, a pair of cotton gloves and a pair of protective nitrile gloves. The use of the nitrile gloves was left to the discretion of the operators. For the determination of the 'inner' body exposure undergarment was provided by the study team at the beginning of the trial, but was worn throughout mixing/loading and application. Exposure via inhalation was measured by a filter cassette connected to a personal air sampling pump (flow rate: 1 L/min). The pump was fitted with different filters for each task. At the end of the trials the samples were collected and analysed. The amount of active substance on the samples was determined by gas-liquid chromatography after an extraction with acetone.

Results:
The results for mixing/loading and application are given below. Values below the LOQ are stated as ½ of the LOQ. No correction for the field recovery was made, since the field recovery for the different sample matrices was on average between 76 % and 100 %. Inhalation exposure was recalculated using a generic respiration rate of 1.25 m^3/h. In some cases (operator 6, operator 9) the air sampling pump was not turned on at the beginning of the task. Extrapolation of the value to the whole working time was, however, only done, if the work duration without air sampling was short (< 30 % of total working time). If not, the value was not used for the model. Further calculations were necessary for the undergarment. The data representing exposure during mixing/loading/application were split into values for mixing/loading and values for application according to the ratio of exposure detected on the coverall (outer body). Except for operator 6 and operator 17 all monitored persons wore gloves during the whole mixing/loading task resulting in a lower exposure of the hands. During application only seven operators (2, 4, 8, 11 to 14) continuously wore gloves. A major contamination was reported for operator 2 and operator 8, who had a high exposure of the body during mixing/loading.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	Bodyinner [mg]	Bodyouter [mg]	Hat [mg]
1	4.5	* 1.0	0.170	8.500	**** 0.017	5.060	0.080
2	3.6	* 1.0	0.210	7.600	**** 0.912	117.690	0.070
3	3.6	6.3	0.340	11.300	**** 0.076	22.220	0.040
4	5.0	31.3	0.010	2.000	**** 0.082	10.070	0.120
5	2.4	10.4	0.090	10.200	**** 0.154	92.730	0.200
6	7.2	** 31.3	8.230	0.800	**** 0.372	28.220	0.010
7	8.0	145.8	0.360	6.200	**** 0.041	2.720	0.260
8	6.3	4.2	0.060	30.900	**** 3.403	159.010	2.320
9	6.7	*** 1.3	0.610	10.300	**** 2.206	14.190	-
10	10.0	10.4	0.180	28.300	**** 0.250	17.750	0.010
11	6.3	14.6	0.250	19.400	**** 0.160	32.300	0.020
12	6.0	12.5	0.100	5.800	**** 0.004	0.470	0.180
13	3.8	* 1.0	0.090	4.100	**** 0.084	6.450	0.130
14	5.0	31.3	0.090	6.500	**** 0.028	2.060	0.150
15	3.6	* 1.0	0.130	18.500	**** 0.022	4.540	0.010
16	5.4	10.4	0.030	1.900	**** 0.047	1.000	0.010
17	3.8	4.2	10.590	-	**** 0.022	2.210	0.010

* calculated with ½ LOQ ** not used for model (pump not on during first two cycles) *** extrapolated (air sampling pump was not on during first ML cycle) **** estimated value

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hat [mg]
1	4.5	72.9	9.660	-	*** 0.793	230.580	8.280
2	3.6	50.0	9.080	88.900	*** 0.398	51.320	6.590
3	3.6	56.3	66.920	-	*** 1.474	431.470	36.320
4	5.0	35.4	3.850	5.600	*** 0.278	33.960	1.620
5	2.4	33.3	6.260	-	*** 0.426	257.090	43.930
6	7.2	** 16.7	6.620	3.200	*** 0.828	62.750	6.140
7	8.0	23614.6	0.220	0.600	*** 0.929	61.230	2.410
8	6.3	45.8	0.180	38.800	*** 4.017	187.680	22.210
9	6.7	12.5	0.610	2.300	*** 0.844	5.430	-
10	10.0	54.2	28.240	-	*** 1.070	76.030	5.790
11	6.3	16.7	3.530	6.200	*** 0.250	50.400	3.790
12	6.0	31.3	0.260	12.100	*** 0.796	95.430	10.660
13	3.8	12.5	2.860	1.700	*** 0.156	11.990	1.700
14	5.0	12.5	0.380	5.200	*** 0.112	8.100	0.240
15	3.6	20.8	6.800	-	*** 0.188	38.100	0.350
16	5.4	4.2	0.190	-	*** 0.013	0.280	0.020
17	3.8	12.5	3.300	-	*** 0.218	21.960	0.110

* calculated with ½ LOQ ** not used for model (pump not on during first two cycles) *** estimated value

HCTM 7

Active substance: Tolylfluanid (500 g/kg)
Formulation type: Water dispersible granules
Pesticide function: Fungicide
Crop: Orchards

Setting:
A total of twelve operators were monitored in August 2000 at several farms in the Netherlands, Belgium and Germany to obtain data on the exposure from mixing/loading and application of a fungicide to pome fruits. The operators, both mixing/loading and applying the product, were working for a typical working day in professional fruit plantations (tree height: 2 to 4 m, row distance: 2.8 to 3.5 m) using different types of trailed air blast sprayers (tank size: 600 to 1,500 L). All tractors were equipped with a closed cabin; however, in three cases (operator G, K and L) the window/door of the cabin was (temporarily) open during spraying. For preparation of the spray solution the operators opened the product bags (5 kg bags) and added an appropriate amount of product to the tank, which was finally filled up with water. The mixing/loading step had to be at least repeated twice and was completed within 24 to 64 min. During application an area of 6.5 to 12 ha was treated. The operators applied the product at a rate of 1.0 to 2.3 kg/ha (0.5 to 1.2 kg a.s./ha) diluted in water volume of 150 to 640 L water/ha. After 3½ to 6 h spraying was finished. Cleaning was included in the monitoring, but was actually reported for only three operators (operators F to H).

Exposure assessment:
All operators were dressed in sampling clothing consisting of a hat, long cotton underpants, a long-sleeved cotton T-shirt and a long-sleeved cotton shirt plus long work trousers worn above the underpants and the T-shirt. During mixing/loading the operators also wore a work jacket, which they took off for application. The whole clothing was not changed until the end of the trial. In addition to the clothing every operator was provided with protective nitrile gloves, one pair of gloves for mixing/loading (continuously worn) and one pair of gloves for application (worn for maintenance work). Most of the operators rinsed their mixing/loading gloves with running water before they took them off. At the end of the trials the hands of the operators were rinsed with 2-propanol. The rinsing of both hands were collected and analysed for the actual hand exposure. Inhalation exposure sampling was performed by use of a personal air sampling pump connected to an IOM sampler with glass fibre filter and a Tenax adsorbent tube. Different sets of filters and tubes were used for mixing/loading and application. Prior to use the pumps were calibrated to operate at a flow rate of 2 L/min. Residues of the active substance tolylfluanid and its degradation product DMST were extracted from the samples and quantified by liquid chromatography using MS/MS-detection.

Results:
The exposure data for inhalation as well as for the hands and gloves are presented below. No separate values exist for the body and head exposure with respect to mixing/loading and application. The separate mixing/loading and application values for the hand exposure given in the table are calculated from mixing/loading/application data by using the ratio of exposure detected on the protective gloves. Results for DMST were calculated as tolylfluanid equivalents by multiplication with the molar ratio factor of 1.62 and added to the results for tolylfluanid. The field recovery was above 70 % for all matrices except for the nitrile gloves (mean field recovery 48 %, due to a solvent effect) and the Tenax tubes (no field recovery data). No correction for the field recovery was made. Values below the LOQ were calculated with ½ of the LOQ. Inhalation exposure refers to a breathing rate of 1.25 m^3/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hat [mg]
A	4.0	24.6	** 0.003	0.283			
B	8.0	1.8	** 0.064	0.326			
C	7.5	* 42.7	** 0.009	1.209			
D	4.5	* 8.3	** 0.015	2.142			
E	7.5	* 24.8	** 0.948	1.204			
F	8.0	* 106.3	** 0.147	1.030			
G	13.5	187.5	** 0.099	4.257			
H	10.0	132.3	** 0.024	2.022			
I	7.5	* 3.9	** 0.024	0.244			
J	3.8	* 44.9	** 0.006	1.757			
K	6.0	63.6	** 0.086	3.523			
L	4.8	* 45.1	** 0.008	0.583			

* calculated with ½ LOQ ** estimated value

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Hat [mg]
A	4.0	* 4.8	** 0.043	4.475			
B	7.6	* 3.4	** n.d.	-			
C	7.5	* 5.1	** 0.222	29.709			
D	4.5	* 2.5	** 0.001	0.180			
E	7.5	* 0.9	** n.d.	-			
F	8.0	* 2.2	** 0.003	0.019			
G	13.5	* 4.4	** $3x10^{-4}$	0.013			
H	10.0	* 2.5	** 0.007	0.568			
I	7.5	* 0.8	** 0.018	0.188			
J	3.8	* 0.9	** n.d.	-			
K	4.3	* 14.5	** 0.001	0.025			
L	4.8	18.1	** n.d.	-			

* calculated with ½ LOQ ** estimated value

<u>HCTM 8</u>

Active substance: Iprovalicarb (90 g/kg)
Formulation type: Water dispersible granules
Pesticide function: Fungicide
Crop: Grapevine

Setting:
The dermal and inhalation exposure of operators towards iprovalicarb during application of a fungicide in grapevine was assessed in this study. Sixteen applicators were monitored at different representative vineyards in the major grape production areas of France during June 2005. Mixing and loading were not part of the study and were conducted by the study team or farm workers not involved in the study. The area treated was in the range of 5.3 to 20.0 ha corresponding to a typical working day. Application was performed as closely as possible to normal practice using diverse spray equipment with or without a cabin. Seven operators

sprayed while sitting in a completely closed cabin whereas five operators sprayed without a cabin. The fungicidal product was applied at a rate of 0.7 to 1.4 kg/ha (0.06 to 0.13 kg a.s./ha) in a water volume of 80 to 367 L/ha. After 220 to 620 min application was finished. Cleaning was included in the monitoring when it was part of the operator's usual daily routine. Actually, six operators did a monitored cleaning of the equipment (rinsing sprayer outside and tank inside).

Exposure assessment:
Dermal exposure of the operators was determined by using whole body dosimeters consisting of a long-sleeved vest and long johns (inner layer of clothing) and long work trousers and a long-sleeved jacket/shirt (outer layer of clothing). For the cleaning activities the operators wore a Tyvek coverall instead of the outer body dosimeter. Face/neck wipe samples were collected when requested by the operator and at the end of the trial to assess head exposure. Gloves (if used for maintenance tasks) as well as hand washes conducted when requested by the operator and at the end of the trial were analysed to quantify hand exposure. Inhalation exposure was calculated from residues collected by an IOM sampler with glass fibre filter attached to a personal air pump located in the breathing zone of the operator (flow rate ca. 2 L/min). The analysis of iprovalicarb residues was performed with HPLC-MS/MS after extraction with 2-propanol.

Results:
The results of the study are given below. The mean field recovery for all sample matrices was between 83 to 108 %. Values below the LOQ were calculated with ½ of the LOQ and inhalation exposure has been recalculated for a breathing rate of 1.25 m^3/h. The results for the Tyvek coverall (cleaning) were added to the outer sampling clothing.

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	1.6	29.1	0.373	2.280	0.117	12.964	0.011
2	1.3	26.7	0.127	1.528	0.119	0.867	0.002
3	1.5	69.1	0.408	0.450	0.045	3.411	0.005
4	1.6	3.4	0.032	0.477	0.009	0.803	0.001
5	1.2	12.3	1.723	0.644	0.022	0.602	0.003
6	0.8	0.6	0.011	0.667	0.003	0.116	$4x10^{-4}$
7	0.9	20.9	2.973	-	0.079	7.411	0.012
8	0.9	9.1	1.349	0.934	0.173	8.107	0.071
9	1.4	18.4	0.169	1.202	0.038	4.085	0.027
10	0.8	56.4	0.013	3.542	0.169	8.759	0.027
11	1.2	0.5	0.020	0.161	* 0.003	0.676	0.002
12	0.9	9.0	0.066	0.596	0.014	0.879	0.002
13	2.2	2.2	2.083	2.531	0.021	0.144	0.005
14	1.8	5.2	0.189	1.986	0.070	1.295	0.004
15	1.2	46.3	0.614	0.080	0.094	* 1.992	0.014
16	0.9	23.8	0.366	1.895	0.082	4.927	0.005

* partly calculated with ½ LOQ

LCHH 1

Active substance: Azafenidin (800 g/kg)
Formulation type: Water dispersible granules
Pesticide function: Herbicide
Crop: Grapevine

Setting:
The exposure of 20 operators applying azafenidin for herbicidal control in vineyards at several sites in France in 2000 was determined in this study. Ten operators were monitored while conducting mixing and loading and 10 operators were monitored while spraying the spray solution. Cleanout of the spray tank was included in the application task. The operators were requested to treat an area of 0.5 to 1.0 ha during a usual working day of 2 to 4 h and used typical hand-held spray equipment (knapsack sprayers) with either protected or unprotected lances. Mixing/loading was completed within 18 to 80 min and application within 92 to 169 min. During mixing/loading all operators wore a face shield. The product (0.3 kg bag) was directly loaded into the tank except for operator 20 who prepared a pre-mix in a large vessel and used it to refill the sprayer when empty. Overall five to ten mixing/loading steps were necessary. The product was sprayed at the highest recommended rate of 0.3 kg/ha (0.24 kg a.s./ha) in a water volume of 200 L/ha.

Exposure assessment:
All operators were dressed in body dosimeters consisting of an inner layer of clothing (polyester/viscose T-shirt plus long johns) and an outer layer of clothing (cotton coverall). In addition to that, each operator wore protective nitrile gloves for the duration of the working task. Hand washes and face/neck wipes were collected at the end of the mixing/loading or application task to assess the actual hand and head exposure. Inhalation exposure was determined with IOM samplers with glass fibre filter. The personal air sampling pump operated at a flow rate of 2 L/min. The determination of azafenidin was carried by extraction into methanol followed by detection with HPLC-UV or LC-MS.

Results:
The following tables summarise the results of the study. The exposure from inhalation and the head exposure were generally low with most of the values below the limit of quantification (reported as ½ LOQ). The mean field recovery was in a range of 72 to 97 %; hence, no corrections were made. Inhalation exposure was recalculated using a generic respiration rate of 1.25 m^3/h. The exposure data of operator 7 are not considered for the model. The trial had to be restarted after a defect of the sprayer and only the dosimeters of the second part were analysed. Operator 17 sprayed tall weed, this might explain the high amount of active substance found on the legs of his coverall.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	0.1	* 5.2	* 0.002	0.519	* 0.002	** 0.032	* 0.002
4	0.1	n.d.	n.d.	0.166	0.038	** 0.054	n.d.
6	0.1	n.d.	0.006	0.638	n.d.	0.163	* 0.002
8	0.1	n.d.	* 0.002	0.595	n.d.	** 0.071	* 0.002
10	0.1	n.d.	0.007	0.350	* 0.001	0.367	* 0.002
12	0.1	* 5.2	0.018	3.598	0.010	0.905	* 0.002
14	0.1	n.d.	* 0.002	0.449	0.006	0.855	n.d.
16	0.1	n.d.	0.009	0.194	n.d.	1.084	n.d.
18	0.1	* 5.2	0.005	0.721	0.006	0.046	n.d.
20	0.1	n.d.	0.131	2.638	0.169	8.919	* 0.002

* ½ LOQ ** partly calculated with ½

Application

	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	0.1	n.d.	* 0.002	0.156	** 0.010	5.307	* 0.002
3	0.1	n.d.	n.d.	n.d.	0.036	** 0.231	n.d.
5	0.1	n.d.	n.d.	0.149	0.003	3.320	* 0.002
*** 7	0.1	n.d.	* 0.002	1.126	0.020	3.083	* 0.002
9	0.1	n.d.	n.d.	0.120	0.013	4.102	* 0.002
11	0.1	* 5.2	0.022	1.761	0.071	12.596	* 0.002
13	0.1	n.d.	0.004	0.181	0.075	6.532	* 0.002
15	0.1	* 5.2	* 0.002	0.942	0.089	4.398	n.d.
17	0.1	* 5.2	n.d.	0.218	0.233	72.987	* 0.002
19	0.1	n.d.	0.012	0.491	0.260	13.804	0.008

* ½ LOQ   ** partly calculated with ½ LOQ   *** not used for model

LCHH 2

Active substance: Simazine (500 g/L)
Formulation type: Suspension concentrate
Pesticide function: Herbicide
Crop: Stubble field

Setting:
Ten operators were monitored while applying the herbicidal substance simazine with commercial knapsack sprayers according to the product label recommendations. The field phase of the study took place in October 1994 in the UK. In each trial 0.8 to 1.0 ha of stubble field were treated with the herbicide at a rate of 3 L product/ha (1.5 kg a.s./ha) and a water volume of 200 L/ha. Each operator performed the mixing/loading as well as the application task including cleaning. Mixing/loading was performed in eight to ten cycles and was finished within 17 to approximately 130 min. Spraying was completed after 140 to approximately 220 min.

Exposure assessment:
The body exposure was determined with two layers of sampling clothing. The inner layer consisted of a cotton long-sleeved undershirt and undertrousers and the outer layer was represented by a cotton coverall. Both layers of clothing were worn during mixing/loading and during application. Head exposure was calculated from residues collected on a cap which was also worn during the whole working day. Inhalation exposure and hand exposure were separately assessed for both tasks. At the beginning of each mixing/loading or application cycle the operators got a new pair of nitrile gloves (outer gloves) and cotton gloves (inner gloves), which they wore throughout the working task. A separate set of inner and outer gloves was also used for cleaning. Inhalation exposure was determined from residues collected on a face shield, but with respect to the sampling method the results were not considered for the model. Residues of simazine were extracted from the samples with methanol and quantified by GLC.

Results:
The results for the hands (= inner cotton gloves) and gloves (= outer nitrile gloves) are given below; the results for the body exposure and the hat are not shown, since no separate data exist for mixing/loading and application. In case that the values were below the LOQ they were calculated with ½ of the LOQ. No field recovery for the cotton gloves or nitrile gloves was given in the study report. The procedural recovery, however, was above 70 %. The results for application include the data obtained for cleaning.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
AA	1.5		* 0.003	0.631			
AB	1.5		* 0.003	0.873			
AC	1.5		0.005	9.490			
AD	1.5		* 0.003	0.268			
AE	1.5		0.005	2.892			
AF	1.5		0.048	0.979			
*** AG	1.4		** 0.009	0.351			
AH	1.2		* 0.003	0.887			
AI	1.4		0.008	1.110			
AJ	1.2		0.005	0.715			

* ½ LOQ ** partly calculated with ½ LOQ *** not used for model

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Cap [mg]
AA	1.5		* 0.005	* 0.100			
AB	1.5		* 0.005	0.210			
AC	1.5		0.064	0.310			
AD	1.5		* 0.005	** 0.212			
AE	1.5		** 0.008	0.640			
AF	1.5		0.011	** 0.428			
*** AG	1.4		0.005	0.100			
AH	1.2		* 0.003	0.104			
AI	1.4		0.005	0.100			
AJ	1.2		0.010	0.100			

* ½ LOQ ** partly calculated with ½ LOQ *** not used for model

LCHH 3

Active substance: Fluazifop-P-butyl (125 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Grapevine

Setting:
The exposure of 15 mixer/loaders and 15 applicators applying fluazifop-P-butyl for inter-row weed control at several sites in Portugal during March 2002 was recorded in this study. The farms were located in the Torres Vedres region and were chosen to cover a range of representative working conditions for vine growers. Application (spot spraying as well as broadcast application) was monitored for a typical working day and was conducted with hydraulically operated knapsack sprayers with flat-fan nozzles. The product was supplied in 1 L containers and was directly poured into the tanks of the knapsack sprayers. In each trial, which consisted of eight or nine tank mix preparations and eight or nine spraying operations, one mixer/loader and one applicator worked together as a pair. All mixer/loaders used a face shield during their work. The whole mixing/loading process was finished after 26 to 44 min. Application was performed for 131 to 246 min; in that time an area of 0.5 to 1.1 ha was treated. The product was used at a rate of 1.7 to 3.5 L/ha (target rate: 3 L/ha) in a water volume of 113 to 211 L/ha. At the end of the working day the applicators cleaned their equipment. The cleaning procedure was included in the monitoring of the application task.

Exposure assessment:
Operator exposure was determined by passive dosimetry using whole body dosimeters. The operators were provided with an inner dosimeter consisting of a short-sleeved cotton T-shirt and briefs and an outer dosimeter consisting of a polyester/cotton coverall. The exposure to the head was determined from face/neck wipe specimen taken whenever the operator wished to wash his face and at the end of the monitored procedure. Face shields were mostly worn during mixing/loading, but were not taken for analysis. Protective nitrile gloves used during mixing/loading or during application were sampled to measure potential hand exposure. Actual hand exposure was assessed with hand washes also taken whenever the operator wished to wash his hands and at the end of the monitored procedure. Glass fibre filters were collected from IOM samplers (pump flow rate: ca. 2 L/min) after the operators had finished their task to determine the exposure via inhalation. Besides passive dosimetry operator exposure was also assessed with biomonitoring (results not used for model). The samples were analysed for residues of the active substance by extraction in acetonitrile followed by detection with GC-MS.
Results:
The results from passive dosimetry are summarised in the following tables. The actual exposure to the legs and lower arms was estimated from the respective outer exposure based on the permeation values of the torso and is included in the 'inner' body exposure. The hand wash data were corrected for recovery, since the field recovery was below 70 % (24 % at the low and 35 % at the high fortification level). All air filter and face/neck wipe specimens were found to be below the LOQ. The respective values are reported as ½ of the LOQ. Inhalation exposure refers to a respiration rate of 1.25 m³/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	0.2	* 26.0	* 0.003	5.174	** 0.082	** 0.278	* 0.003
3	0.2	* 26.0	0.022	5.125	** 0.059	** 0.771	* 0.003
4	0.2	* 26.0	0.150	11.110	** 0.025	** 0.209	* 0.003
5	0.2	* 26.0	** 0.164	5.557	** 0.012	0.622	* 0.003
7	0.2	* 25.4	0.140	6.222	** 0.012	0.531	** 0.008
8	0.2	* 23.7	* 0.003	13.650	** 0.029	2.758	* 0.003
9	0.2	* 26.7	0.145	9.244	** 0.013	** 0.365	* 0.003
10	0.2	* 26.0	0.124	3.837	** 0.010	** 0.110	0.010
11	0.2	* 25.4	0.340	6.985	** 0.023	** 0.376	* 0.003
12	0.2	* 26.0	0.165	2.341	** 0.052	** 0.097	0.006
13	0.2	* 26.0	* 0.005	3.847	** 0.016	* 0.015	* 0.003
14	0.2	* 26.0	0.046	3.692	** 0.012	** 0.853	* 0.003
15	0.2	* 24.2	* 0.003	2.685	** 0.103	** 0.240	* 0.003
16	0.2	* 26.0	0.123	9.909	** 0.017	0.704	* 0.003
17	0.2	* 23.7	* 0.003	25.480	** 0.061	** 0.913	* 0.003

* ½ LOQ ** partly calculated with ½ LOQ

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	Bodyinner [mg]	Bodyouter [mg]	Face/neck [mg]
19	0.2	* 26.0	* 0.003	2.494	** 2.341	70.059	* 0.003
20	0.2	* 26.0	0.111	4.102	** 1.244	28.189	* 0.003
21	0.2	* 24.8	0.480	-	40.254	63.459	* 0.003
22	0.2	* 26.7	*** 1.259	-	** 0.974	42.362	* 0.003
23	0.2	* 26.0	2.397	-	62.630	74.377	* 0.003
24	0.2	* 26.0	1.106	-	** 37.405	75.172	* 0.003
25	0.2	* 26.0	0.859	-	70.260	92.602	* 0.003
26	0.2	* 26.0	0.228	-	** 1.695	31.749	* 0.003
27	0.2	* 26.0	0.520	-	17.159	80.062	* 0.003
28	0.2	* 23.7	2.013	-	** 0.879	19.300	* 0.003
29	0.2	* 26.0	0.362	-	7.326	65.438	* 0.003
30	0.2	* 26.0	1.544	-	5.491	47.339	* 0.003
31	0.2	* 24.8	0.302	-	** 1.425	40.329	* 0.003
32	0.2	* 26.0	0.410	-	** 1.846	36.214	* 0.003
33	0.2	* 26.0	0.405	-	24.404	96.582	* 0.003

* ½ LOQ ** partly calculated with ½ LOQ *** exposure of one hand only

LCHH 4

Active substance: Fluazifop-P-butyl (125 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Herbicide
Crop: Grapevine

Setting:
The objective of the study was to obtain data for the dermal and inhalation exposure of operators who mixed/loaded or applied fluazifop-P-butyl to weeds growing in vine by using knapsack spray equipment. The field phase of the study took place in March 2003 at several sites in the Douro region of Portugal. The operators worked in pairs of one mixer/loader and one applicator each. Application (spot spraying as well as broadcast application) was monitored for a typical working day and was conducted with hydraulically operated knapsack sprayers with flat-fan nozzles. The product was supplied in 1 L containers and was directly filled into the tanks without pre-mixing. Mixing and loading was repeated seven to eight times and was completed after 20 to 32 min. The product was sprayed over an area of 0.5 to 0.8 ha at a mean rate of 3 L/ha (0.4 kg a.s./ha) in 146 to 250 L water per ha. Application was finished within 141 to 260 min and included the cleaning of the sprayer.

Exposure assessment:
To measure potential and actual dermal exposure the mixer/loaders and the applicators wore two layers of sampling clothing. The outer layer consisted of a polyester/cotton coverall and the inner layer consisted of a short-sleeved cotton T-shirt and briefs. Exposure to the hands was determined by collecting hand wash specimens whenever the operators wished to wash their hands and at the end of the operation. Protective nitrile gloves used during the mixing/loading procedure were analysed as well. Actual exposure to the head was measured by wiping the operators face and neck. Face shields were mostly worn during mixing/loading but were not included in the analysis. Inhalation exposure was determined from residues collected by an IOM sampler with glass fibre filter attached to a personal air pump located in the breathing zone of the operator (flow rate ca. 2 L/min). Exposure was also assessed by biomonitoring, but the results were not considered for the model. The samples were analysed

for residues of fluazifop-P-butyl by extraction in acetonitrile followed by detection with GC-MS.

Results:
The data given below were obtained by passive dosimetry. The actual exposure to the legs and lower arms was estimated from the respective outer exposure based on the permeation values of the torso and is included in the inner body exposure. Moreover, the hand wash data was corrected for the field recovery, which was 39 % at the high and 44 % at the low fortification level. Values below the LOQ were calculated with ½ of the LOQ and inhalation exposure was recalculated using a respiration rate of 1.25 m³/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	0.2	* 2.6	0.004	4.810	** 0.040	0.105	* 0.003
4	0.2	* 2.6	0.005	12.110	0.120	0.487	* 0.003
5	0.2	* 2.6	0.005	19.430	** 0.006	0.242	* 0.003
6	0.2	* 2.6	0.012	46.630	** 0.025	0.472	* 0.003
7	0.2	* 2.6	0.002	13.580	** 0.005	0.798	* 0.003
8	0.2	* 2.6	0.003	4.797	** 0.004	0.407	* 0.003
9	0.2	* 2.6	0.001	2.923	** 0.002	0.242	* 0.003
10	0.2	* 2.6	0.001	9.072	** 0.012	1.082	* 0.003
11	0.2	8.0	0.006	9.312	** 0.002	0.259	* 0.003
12	0.2	8.3	0.008	54.760	0.023	17.455	* 0.003
13	0.2	* 2.5	0.002	14.790	** 0.015	0.350	* 0.003
14	0.2	* 2.4	* $3x10^{-4}$	9.934	** 0.004	0.292	* 0.003
15	0.2	10.3	0.003	6.784	** 0.003	0.126	* 0.003
17	0.2	* 2.6	0.002	12.870	** 0.001	0.458	* 0.003
18	0.2	* 2.6	* $3x10^{-4}$	9.042	** 0.002	0.092	* 0.003

* ½ LOQ ** partly calculated with ½ LOQ

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
19	0.2	6.9	1.198	-	8.516	80.352	0.024
20	0.2	9.4	3.231	-	8.903	66.313	0.017
21	0.2	2.6	4.813	-	24.321	95.528	0.042
23	0.2	12.5	3.256	-	0.620	42.967	0.014
24	0.2	10.2	2.610	-	0.917	39.198	* 0.003
25	0.2	8.0	0.312	-	1.735	43.352	0.006
26	0.2	7.3	1.794	-	25.260	70.315	0.011
27	0.2	7.5	4.636	-	1.251	44.589	0.112
28	0.2	12.7	0.879	-	1.661	33.155	* 0.003
30	0.2	14.6	0.493	-	0.625	23.384	* 0.003
31	0.2	9.8	0.928	-	5.672	29.781	0.008
33	0.2	8.6	0.899	-	35.806	70.591	* 0.003
34	0.2	8.6	0.166	-	1.525	38.686	* 0.003
35	0.2	7.1	2.089	-	0.518	16.439	0.018
36	0.2	12.5	0.186	-	0.765	20.042	* 0.003

* ½ LOQ ** partly calculated with ½ LOQ

HCHH 1

Active substance: Thiodicarb (375 g/L)
Formulation type: Suspension concentrate
Pesticide function: Insecticide
Crop: Grapevine

Setting:
The study presents exposure data obtained from twelve trails which were conducted during May and June 2001 in Greece. In each trial 0.5 to 1.4 ha of vine were treated with 0.9 to 1.4 L product/ha (0.36 to 0.53 kg a.s./ha) during a typical working day. The spray volume applied ranged from ca. 500 to 900 L to yield good crop coverage. The vine grew in rows of 2.0 to 2.5 m distance and had a height of 1.5 to 2.0 m. Mixing/loading and application were performed by different operators working in pairs of one mixer/loader and one applicator. The operators used spray guns which were connected to mix-tanks of 200 to 1,100 L size. Most of the applicators sat on a vehicle whilst spraying; applicator 20 and applicator 26 walked behind the vehicle. None of the vehicles were equipped with a cabin. Application was completed after 80 to 291 min including cleaning if necessary. Mixing/loading was conducted between one to four times and was finished after 17 to 48 min. The product was contained in 0.75 L bottles and was directly poured into the tank.

Exposure assessment:
For the mixer/loader replicates the exposure of the hands only was determined. The operators were provided with a pair of nitrile gloves, which was worn throughout all mixing/loading cycles and collected for analysis at the end of the trial. Actual exposure beneath the gloves was determined by hand washes, which were taken after each mixing/loading cycle and whenever the operator would have usually washed his hands. During application protective gloves were used as well and were collected in addition to hand wash specimens according to the procedure described for mixing/loading. Besides hand exposure also the body, head and inhalation exposure of the applicators were determined. Each applicator wore an inner body dosimeter (cotton long-sleeved vest, cotton long johns) and an outer body dosimeter (polyester/cotton coverall) to measure actual and potential body exposure. Head exposure was assessed by face/neck wipes collected during and at the end of the work period and Tenax sampling tubes which were connected to a personal air sampling pump (flow rate: 2 L/min) were used to determine inhalation exposure. Thiodicarb present in the specimens was extracted with a mix of dichloromethane/methanol and quantified by HPLC with fluorescence detection.

Results:
The results are given below. The values for the gloves were corrected for the field recovery, which was 69 % at the low and 67 % at the high fortification level. For all other sample matrices the field recovery was above 70 %. One half of the LOQ was used for values below the LOQ. Exposure via inhalation has been recalculated for a breathing rate of 1.25 m^3/h. High body exposure was observed for some applicators. This was ascribed to several factors mentioned in the field observations. In the case of operator 10 wind gusts of up to 3 m/s were recorded while operator 12 applied in dense crop and operator 14 sprayed with high pressure.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	0.2		* 0.002	0.558			
3	0.3		* 0.002	0.559			
7	0.4		0.007	0.064			
9	0.8		0.266	0.008			
11	0.5		* 0.004	0.153			
13	0.3		* 0.006	7.383			
15	0.5		0.021	2.699			
17	0.4		* 0.002	1.725			
19	0.6		* 0.002	0.169			
21	0.7		* 0.002	0.539			
23	0.4		* 0.004	0.154			
25	0.4		* 0.008	0.531			

* ½ LOQ

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	0.2	6.5	* 0.002	0.188	* 0.006	** 2.263	* 0.002
4	0.3	11.4	* 0.002	0.085	** 0.027	2.428	* 0.002
8	0.4	* 2.1	* 0.002	0.028	** 0.019	2.369	0.009
10	0.6	135.6	* 0.002	17.478	1.938	218.252	0.460
12	0.5	44.1	* 0.002	1.712	8.980	168.555	0.079
14	0.3	34.4	* 0.002	3.784	0.561	51.158	0.060
16	0.5	20.8	* 0.002	1.380	** 0.050	7.562	0.016
18	0.3	19.6	0.004	0.538	** 0.021	2.464	0.005
20	0.3	12.0	* 0.002	0.009	** 0.015	2.460	* 0.002
22	0.5	18.8	* 0.002	2.351	0.075	9.255	0.029
24	0.3	5.9	* 0.002	0.015	** 0.010	2.119	* 0.002
26	0.4	14.9	* 0.002	0.193	** 0.105	19.667	* 0.002

* ½ LOQ   ** partly calculated with ½ LOQ

<u>HCHH 2</u>

Active substance: Carbaryl (850 g/kg)
Formulation type: Wettable powder
Pesticide function: Insecticide
Crop: Citrus

Setting:
Ten mixer/loaders and 20 applicators were monitored in August 2001 while applying an insecticide in citrus during a typical working day of 4 to 6 h. The citrus groves were located in the Valencia region of Spain and were in most of the cases characterised by a dense canopy. A single application of the product was performed at a rate of 7.9 to 21.7 kg/ha (6.7 to 16.1 kg a.s./ha) over an area of 0.29 to 0.82 ha per trial (0.14 to 0.41 ha per applicator). Water volumes ranged from ca. 7,200 to 10,800 L/ha. In each trial the test subjects worked in groups of one mixer/loader and two applicators. The applicators walked through the citrus grove and sprayed the citrus trees at close range using commercial hand-held spray equip-

ment, which consisted of a tank (1,100 to 4,000 L) with two lances. The product (5 kg bags) was weighed in a bowl and directly added to the tank without pre-mixing (except for operator 30 who prepared a pre-mix prior to loading). Each trial consisted of two to three tank mix preparations and two to three spraying operations. Mixing/loading was finished after 21 to 45 min; application was finished after 169 to 260 min. Cleaning of the spray equipment was not mentioned in the report.

Exposure assessment:
Whole body dosimeters consisting of a cotton coverall, a cotton long-sleeved vest and long johns were issued to the operators to assess the potential and actual exposure of the body during mixing/loading or application. In addition, hand wash and face wipe specimens were taken at various times during the working period to monitor exposure of the hands and face. Protective nitrile gloves were worn throughout mixing/loading or application and were sampled as well. To assess the exposure by inhalation the operators wore personal air sampling pumps connected to Tenax sampling tubes. The pumps operated at a mean flow rate of 1.7 to 2.0 L/min. The analysis of residues of carbaryl in the samples was performed with LC-MS after an extraction in acetone.

Results:
The exposure data are summarised below. The mean field recovery for the different sample matrices was between 82 to 102 %; thus, no corrections were made. All values were above the limit of quantification. Inhalation exposure has been recalculated for a breathing rate of 1.25 m^3/h. The mixer/loaders and applicators were highly exposed towards carbaryl. Due to the formulation of the product a lot of dust arose while loading the product resulting in contamination of the mixer/loaders. The applicators sprayed the citrus trees at close range thus working in dense spray mist and rubbing against previously sprayed trees.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	7.7	3978.3	3.389	93.130	13.231	332.930	0.514
4	5.6	1217.9	1.069	31.640	3.439	102.052	0.053
9	5.1	1411.2	4.179	52.300	24.891	425.190	0.353
10	6.8	665.2	0.283	85.620	2.190	49.994	0.035
13	6.8	1697.4	0.614	18.940	1.333	63.999	0.045
16	9.4	559.4	0.916	71.240	7.687	214.874	0.412
22	7.5	2801.3	2.997	38.600	2.780	97.223	0.090
25	7.7	4982.5	2.200	77.390	15.105	426.450	0.477
26	6.8	897.9	0.095	58.680	2.266	53.639	0.112
30	9.2	4272.0	0.350	132.800	5.213	187.518	0.364

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
2	3.8	385.7	0.710	36.910	23.313	1373.600	0.689
3	3.8	389.3	0.741	46.720	10.531	1172.160	0.610
5	2.7	252.4	0.269	43.780	39.583	1498.600	0.202
6	2.7	421.7	0.335	33.390	40.507	2145.500	0.181
7	2.6	121.1	0.431	13.940	23.146	565.690	0.267
8	2.6	101.5	1.257	12.810	6.295	422.070	0.082
11	3.4	333.2	0.239	31.940	217.320	1638.000	0.265
12	3.4	168.1	0.062	21.270	77.549	609.180	0.065
14	2.6	155.8	0.251	28.480	8.533	831.570	0.104
15	2.6	161.4	0.015	18.100	12.467	540.590	0.201
17	4.2	364.4	0.266	60.080	305.040	2041.000	1.882
18	4.2	328.7	0.763	56.710	188.037	2030.100	2.024
19	3.3	270.6	0.081	14.950	8.216	738.200	0.681
20	3.2	230.9	0.067	28.480	11.567	729.800	0.190
21	3.2	214.4	1.043	21.760	5.732	430.550	0.235
23	3.5	185.0	0.126	30.670	30.327	1110.100	0.352
24	3.5	234.0	0.254	28.590	52.057	1296.900	0.984
27	3.3	237.7	0.056	29.340	14.508	672.150	0.847
28	5.1	255.5	0.119	45.780	66.565	1538.600	1.748
29	5.1	313.5	0.145	73.560	103.924	1681.900	1.640

HCHH 3

Active substance: Carbaryl (850 g/kg)
Formulation type: Wettable powder
Pesticide function: Insecticide
Crop: Citrus

Setting:
This study was performed to monitor dermal and inhalation exposure to carbaryl when applying it to citrus. The study was conducted during July 2002 at several sites in the Valencia region of Spain and reflected a typical working day of about 4 to 6 h. At each test site one mixer/loader and two applicators operated as a team and treated 0.3 to 1.4 ha per trial (0.17 to 0.70 ha per applicator) at a rate of 6.2 to 22.6 kg product/ha (5.3 to 19.2 kg a.s./ha) diluted in 3,100 to 11,300 L water. Application was performed with a broad range of commercial hand-held sprayers which consisted of a pair of hand-held lances connected to a spray tank (1,000 to 4,000 L). The product was supplied in 5 kg bags and was either directly filled into the tank or pre-mixed with water before loading. Mixing/loading was repeated two to three times and was completed within 23 to 85 min. During application the tank was parked in or close to the citrus grove and both applicators walked through the grove and sprayed the trees at close range. The duration of spraying was 145 to 243 min.

Exposure assessment:
Operator exposure was assessed with biomonitoring (results not used for the model) and passive dosimetry. The latter one was conducted by using two layers of sampling clothing for the body. The inner layer consisted of a short-sleeved cotton T-shirt and briefs and the outer layer consisted of a polyester/cotton coverall. In addition to that all operators wore protective nitrile gloves, which were sampled to determine potential hand exposure. Actual hand exposure was assessed with hand washes taken whenever the operator requested to wash his hands and at the end of the monitored procedure. Face/neck wipe specimen were collected

according to the procedure described for the hand washes and were used to determine head exposure. Inhalation exposure was calculated from residues collected in Tenax sorbent tubes. The flow rate of the air sampling pumps was adjusted to approximately 1.9 to 2.0 L/min. The samples were extracted in acetone and analysed by LC-MS.

Results:
The results obtained from passive dosimetry are reported in the following tables. The actual exposure to the legs and lower arms was estimated from the respective outer exposure based on the permeation values of the torso and is included in the ‘inner’ body exposure. All values were above the LOQ. The mean field recovery for the different sample matrices was in a range of 82 to 98 %. Therefore, no correction for the field recovery was made. Inhalation exposure has been recalculated for a respiration rate of 1.25 m^3/h. The mixer/loaders and applicators were highly exposed towards carbaryl. Due to the formulation of the product a lot of dust arose while loading the product resulting in contamination of the mixer/loaders. The applicators sprayed the citrus trees at close range thus working in dense spray mist and rubbing against previously sprayed trees.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
3	5.1	964.6	11.210	134.500	3.124	152.398	0.507
6	7.7	8504.4	8.082	171.500	15.222	553.230	1.305
7	3.4	1684.68	0.290	48.450	1.173	56.338	0.081
10	5.6	2284.9	11.310	117.700	4.333	467.332	0.300
18	7.0	1857.3	9.265	86.650	5.982	233.540	0.212
21	6.8	958.8	0.115	48.700	1.450	27.851	0.202
24	6.8	1765.6	0.105	5.740	2.129	25.731	0.033
30	8.5	4861.8	2.225	90.580	15.060	408.930	0.739
33	9.4	3528.1	1.292	80.240	4.631	129.336	0.231
34	7.7	5132.7	0.970	63.680	3.036	76.473	0.150

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	2.6	345.3	0.338	29.910	2.390	202.640	0.559
2	2.6	249.2	0.537	39.470	4.411	305.130	0.355
4	3.8	397.0	0.436	32.850	4.290	316.110	0.565
5	3.8	355.6	0.218	44.620	8.092	543.900	1.607
8	1.7	185.5	0.066	21.650	10.106	331.360	0.179
9	1.7	229.1	0.128	29.750	8.554	473.980	0.370
12	2.6	540.5	1.025	52.470	71.781	1326.480	0.570
16	3.2	266.1	1.357	29.740	6.161	569.650	0.388
17	3.2	156.3	0.103	13.910	3.901	263.910	0.226
19	3.4	2136.3	0.254	36.580	6.727	662.420	0.568
20	3.4	551.4	1.381	56.790	41.000	1850.400	2.588
22	3.4	562.2	0.836	63.940	51.393	1945.200	1.394
23	3.4	692.4	0.075	50.310	3.423	584.100	0.568
26	4.3	399.0	0.073	28.460	3.642	376.720	1.024
27	4.3	503.7	0.463	28.210	3.039	406.760	2.141
29	4.3	675.4	0.390	43.630	4.889	496.620	0.424
31	4.7	528.4	0.163	51.510	4.835	962.460	2.637
32	4.7	449.9	0.345	33.810	11.669	1184.300	2.124
35	3.4	949.1	1.368	76.670	136.393	2334.000	2.697
36	3.4	392.8	0.356	66.430	44.920	1278.800	0.947

HCHH 4

Active substance: Carbaryl (480 g/L)
Formulation type: Suspension concentrate
Pesticide function: Insecticide
Crop: Olives

Setting:
The study provides exposure data obtained from twelve trails which were conducted during July 2002 in Spain. A minimum of 6 to a maximum of 13.5 ha of olive trees with a height of 1 to 8 m and growing in a distance of 6 to 16 m were treated in each trial (3.3 to 6.8 ha per applicator). The insecticide was applied for a typical working day of at least 4 h at a rate of 1.7 to 3.5 L product /ha (0.8 to 1.7 kg a.s./ha) diluted in a water volume of about 480 to 1,000 L. Mixing/loading and application were performed by different operators using a variety of typical hand-held sprayers. The sprayers consisted of a pair of spray guns, which were connected to a tank (2,000 to 6,000 L tank volume). Two operators sprayed in parallel standing back to back or side by side on a vehicle at the rear of the spraying device while the vehicle drove between the rows. Mixing/loading was conducted two or three times by pouring the product directly into the spray tank. Overall five to six product containers (5 L) were handled by the mixer/loaders while wearing a face shield (except for operator 24 who did not use a face shield). The duration of mixing/loading was between 17 and 51 min the duration of application was in a range of 143 to 304 min.

Exposure assessment:
Body dosimeters consisting of a cotton coverall, a cotton short-sleeved T-shirt and briefs were issued to the mixer/loaders and applicators to assess actual and potential body exposure. Exposure to the head and hands was determined by face/neck wipes and hand washes

which were taken at the end of the working task and whenever the operator requested it. Face shields were worn during mixing/loading but were not part of the analysis. The protective nitrile gloves used by the operators were analysed. After the last mixing/loading or application cycle the protective gloves were removed and collected. Tenax sorbent tubes were used to determine the exposure via inhalation. The average flow rate of the air sampling pump was about 2 L/min.

Residues of carbaryl were extracted in acetone and quantified by gas chromatography with mass selective detection.

Passive dosimetry and biomonitoring were concurrently applied in the study; the data from biomonitoring, however, was not used for the model.

Results:
The following tables summarise the results obtained by passive dosimetry. The actual exposure to the legs and lower arms was estimated from the respective outer exposure based on the permeation values of the torso and is included in the 'inner' body exposure. Values below the limit of quantification were calculated with ½ of the LOQ. The mean field recovery for the sample matrices was in a range of 71 to 84 %. Inhalation exposure is based on a generic breathing rate of 1.25 m^3/h.

Mixing/loading

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
3	10.1	* 0.5	0.062	2.010	0.029	1.162	0.007
6	12.1	1.1	0.143	6.264	0.045	1.011	$5x10^{-4}$
9	10.1	* 0.5	0.071	3.712	0.050	0.514	$3x10^{-4}$
12	11.8	* 0.5	** 0.030	0.677	0.004	0.153	$2x10^{-4}$
15	11.8	1.6	1.774	9.657	0.244	11.054	0.002
18	10.1	* 0.5	0.150	15.080	0.020	1.454	$5x10^{-4}$
21	13.5	* 0.5	0.414	7.820	0.047	3.717	$5x10^{-4}$
24	10.1	* 0.5	3.903	10.940	0.215	39.653	0.003
27	13.5	1.6	0.102	14.810	0.058	1.353	0.005
30	10.1	* 0.5	0.080	7.401	0.006	0.350	0.001
33	11.8	* 0.5	0.003	3.317	0.119	5.062	1.816
36	10.4	* 0.5	0.051	0.544	0.004	0.736	0.006

* calculated with ½ LOQ   ** one hand wash discarded in error

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
1	5.1	44.6	0.006	1.240	0.088	5.736	0.004
2	5.1	57.6	0.009	1.632	0.042	4.878	0.005
4	6.0	359.4	0.878	29.670	1.033	180.749	0.528
5	6.0	177.6	0.192	12.050	0.674	115.419	0.092
7	4.2	334.0	0.121	7.731	0.303	76.723	0.063
8	4.2	207.5	0.060	6.480	0.351	35.313	0.018
10	5.9	214.1	1.958	4.011	0.242	21.358	0.009
11	5.9	134.9	0.353	3.988	0.123	14.270	0.020
13	5.9	378.5	0.142	34.160	1.732	150.462	0.148
14	5.9	2165.6	0.252	60.290	1.113	253.260	0.736
16	5.1	28.0	0.213	8.821	0.366	55.345	0.087
17	5.1	29.2	0.365	6.178	0.411	52.440	0.128
19	6.8	238.0	0.033	5.547	0.201	36.031	0.049
20	6.8	154.3	0.006	2.106	0.171	10.802	0.033
22	5.1	257.4	0.629	13.260	0.658	39.180	0.009
23	5.1	229.8	0.350	2.123	0.201	11.328	0.014
25	6.8	132.5	0.020	5.155	0.139	8.877	0.019
26	6.8	123.9	0.264	7.362	0.200	37.275	0.023
28	5.1	42.3	0.079	2.731	0.269	30.972	0.075
29	5.1	38.9	0.177	14.120	0.241	22.042	0.034
31	5.9	95.6	0.045	4.048	0.638	15.399	0.006
32	5.9	* 0.5	0.087	2.443	0.200	10.929	0.005
34	5.1	480.2	0.048	3.858	0.530	5.440	0.022
35	5.1	400.2	0.047	2.948	0.204	1.535	0.012

* calculated with ½ LOQ

HCHH 5

Active substance: Fenthion (500 g/L)
Formulation type: Emulsifiable concentrate
Pesticide function: Insecticide
Crop: Olives

Setting:
Fourteen operators were monitored during September 2001 to obtain data on the exposure derived from applying an insecticide to olives. The field phase took place at nine representative locations in the Abruzzi and Puglia region of Italy and comprised application but not mixing and loading of the product. The area ranged from 1.0 ha to 2.55 ha per operator and was treated in 123 to 253 min. Application was performed with typical hand-held spray guns which were connected to a tank with a capacity of 800 to 1,200 L. Four operators (7, 8, 13, 14) had their own tank with a single spray gun and sprayed both sides of the row while walking behind the tractor. The rest of the operators worked in pairs spraying either side of the row. The trees were 4 to 6 m high and grew in a distance of 1 to 10 m of each other. On average the operators sprayed 1 L product per ha (0.5 kg a.s./ha) diluted in 1,000 L/ha. Cleaning of the equipment was not mentioned in the study report.

Exposure assessment:
The operators were dressed in two layers of sampling clothing represented by a cotton/polyester coverall and a long-sleeved cotton shirt with long underpants worn beneath the coverall. The clothing was collected at the end of the working task and used to determine the

exposure of the body. Hand exposure was assessed by analysing the protective gloves used during application as well as the hand wash specimens taken after the gloves had been removed. Face/neck wipe samples were collected to estimate the exposure to the head and exposure via inhalation was monitored by Tenax sorbent tubes located in the breathing zone of the operators (pump flow rate 2 L/min). During application all operators wore a hat, which was not part of the monitoring clothing. For analysis fenthion was extracted from the samples with 2-propanol and oxidised to fenoxon sulphone, which was finally quantified by gas chromatography using flame photometric detection.

Results:
The results for applicator exposure are given below. All values shown were not corrected for field recovery, which was higher than 70 %, except for protective gloves. Recovery for the gloves was only 9 %, but was attributed to field exposure conditions not relevant for the monitoring of the operators. Actual exposure of the hands was generally low with half of the values below the limit of detection (reported as ½ LOQ). Inhalation exposure has been recalculated for a respiration rate of 1.25 m^3/h.

Application

Operator	TA a.s. [kg]	Inhalation [µg]	Hands [mg]	Gloves [mg]	$Body_{inner}$ [mg]	$Body_{outer}$ [mg]	Face/neck [mg]
3	0.8	66.9	* $5x10^{-5}$	3.309	2.834	129.970	0.385
4	0.8	25.6	0.004	2.543	1.704	80.010	0.059
5	1.0	58.1	* $5x10^{-5}$	1.256	1.472	69.879	0.191
6	1.0	83.8	* $5x10^{-5}$	1.633	1.496	51.885	0.114
7	1.1	77.1	* $5x10^{-5}$	3.213	1.523	91.665	0.233
8	1.2	36.5	$2x10^{-4}$	2.642	0.789	23.220	0.155
9	0.6	9.4	* $5x10^{-5}$	1.271	0.766	16.347	0.048
10	0.6	16.9	0.002	1.212	0.230	9.516	0.028
11	0.6	3.3	0.001	0.372	0.071	4.525	0.013
12	0.6	3.9	* $5x10^{-5}$	0.597	0.240	12.342	0.042
13	0.6	62.5	0.003	0.973	1.720	68.663	0.065
14	0.6	41.3	0.001	0.475	0.126	11.275	0.010
15	0.5	87.3	* $5x10^{-5}$	0.834	1.881	34.826	0.061
16	0.5	157.3	* $5x10^{-5}$	0.547	1.644	28.789	0.036

* ½ LOQ

Appendix 2 Model predictions (75th percentile)

A 2.1 ML tank

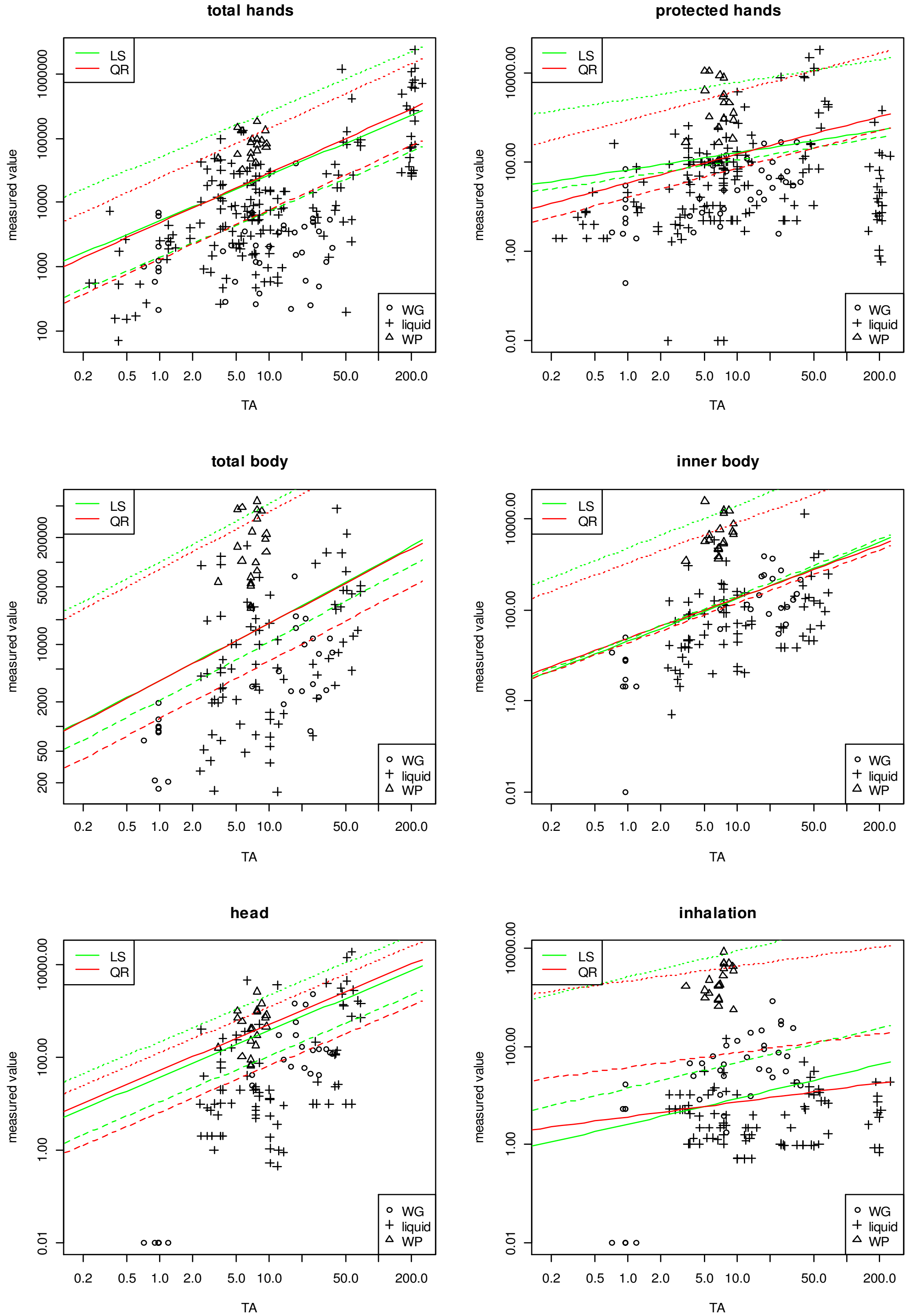

Figure A 1: Model prediction for ML tank; green: prediction with least squares regression, red: prediction with quantile regression; solid line: liquid formulations, thin broken line: WP formulations, thick broken line: WG formulations

A 2.2 LCTM application

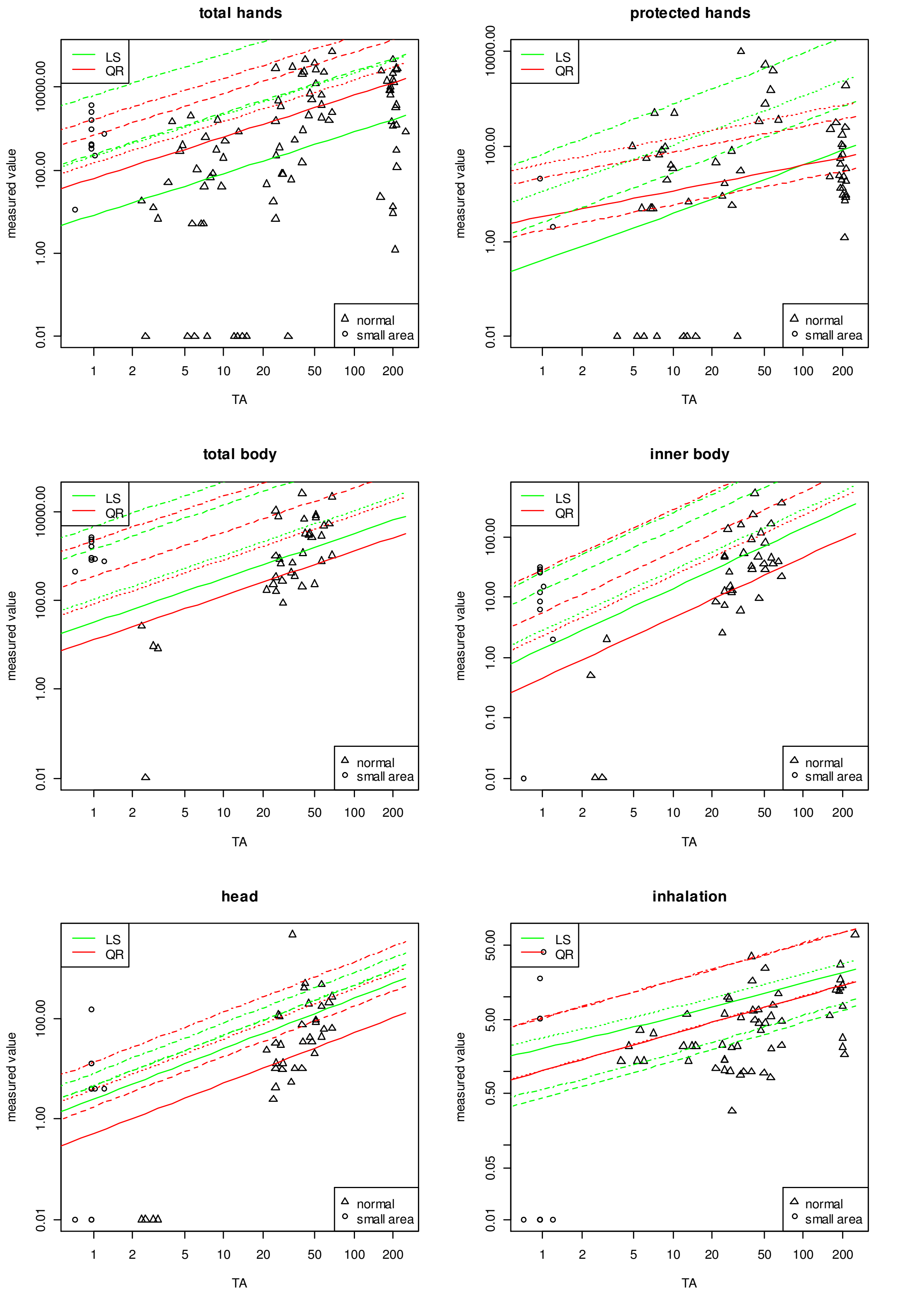

Figure A 2: Model prediction for LCTM; green: prediction with least squares regression, red: prediction with quantile regression; solid line: normal equipment, broken line: equipment for small areas; impact of droplet size (normal, coarse) is not shown

A 2.3 HCTM application

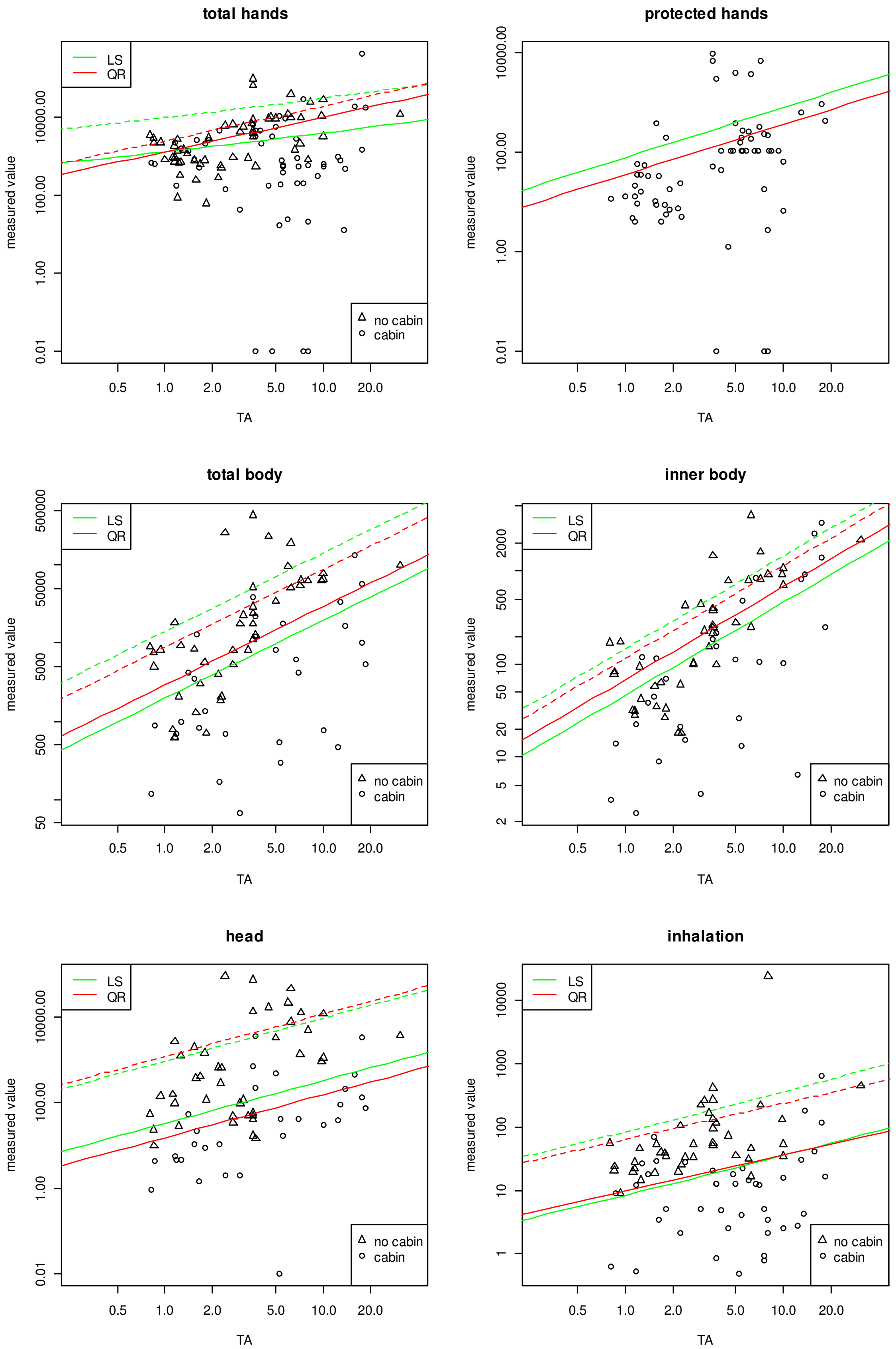

Figure A 3: Model prediction for HCTM; green: prediction with least squares regression, red: prediction with quantile regression; solid line: cabin, broken line: no cabin

A 2.4 HCHH application

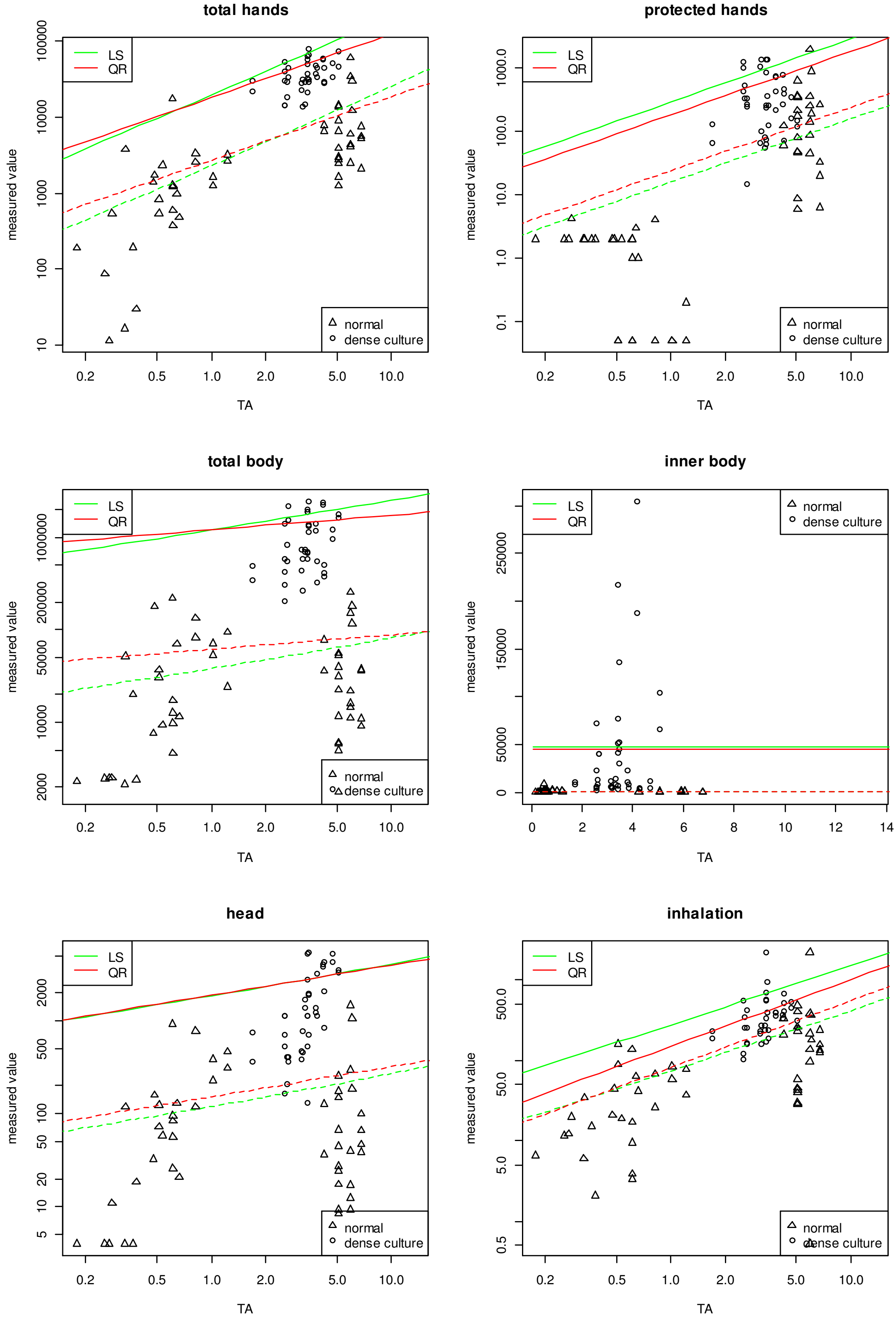

Figure A 4: Model prediction for HCHH; green: prediction with least squares regression, red: prediction with quantile regression; solid line: dense culture, broken line: normal culture

Appendix 3 Estimation of the 75th percentile

A 3.1 Knapsack mixing/loading

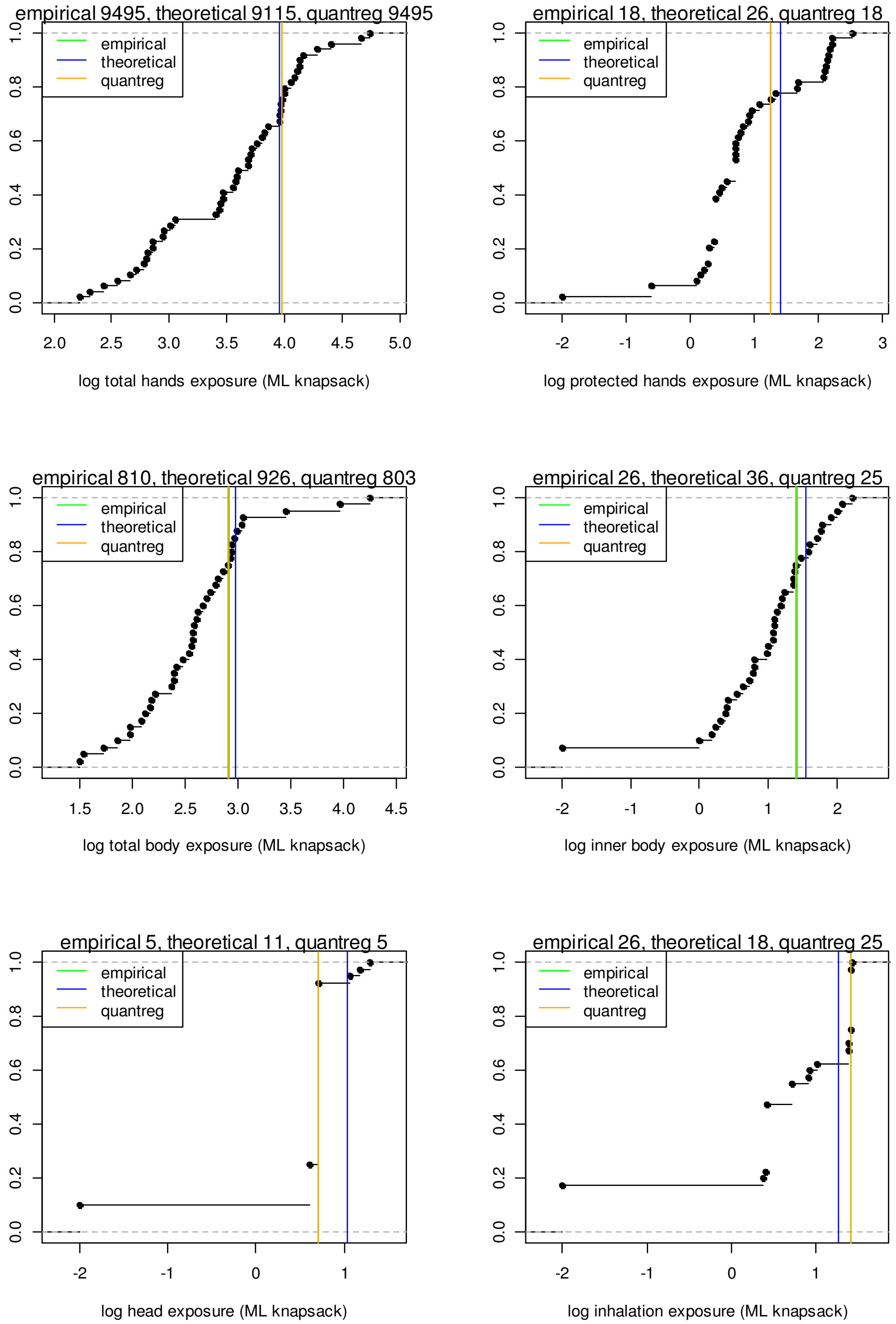

Figure A 5: Comparison of the empirical 75th percentile (green line) with the parametric estimate of the percentile calculated acc. to EFSA (blue line) and the 75th percentile obtained by quantile regression (orange line); the y-axis gives the proportion of data with values below a certain level of exposure.

A 3.2 LCHH application

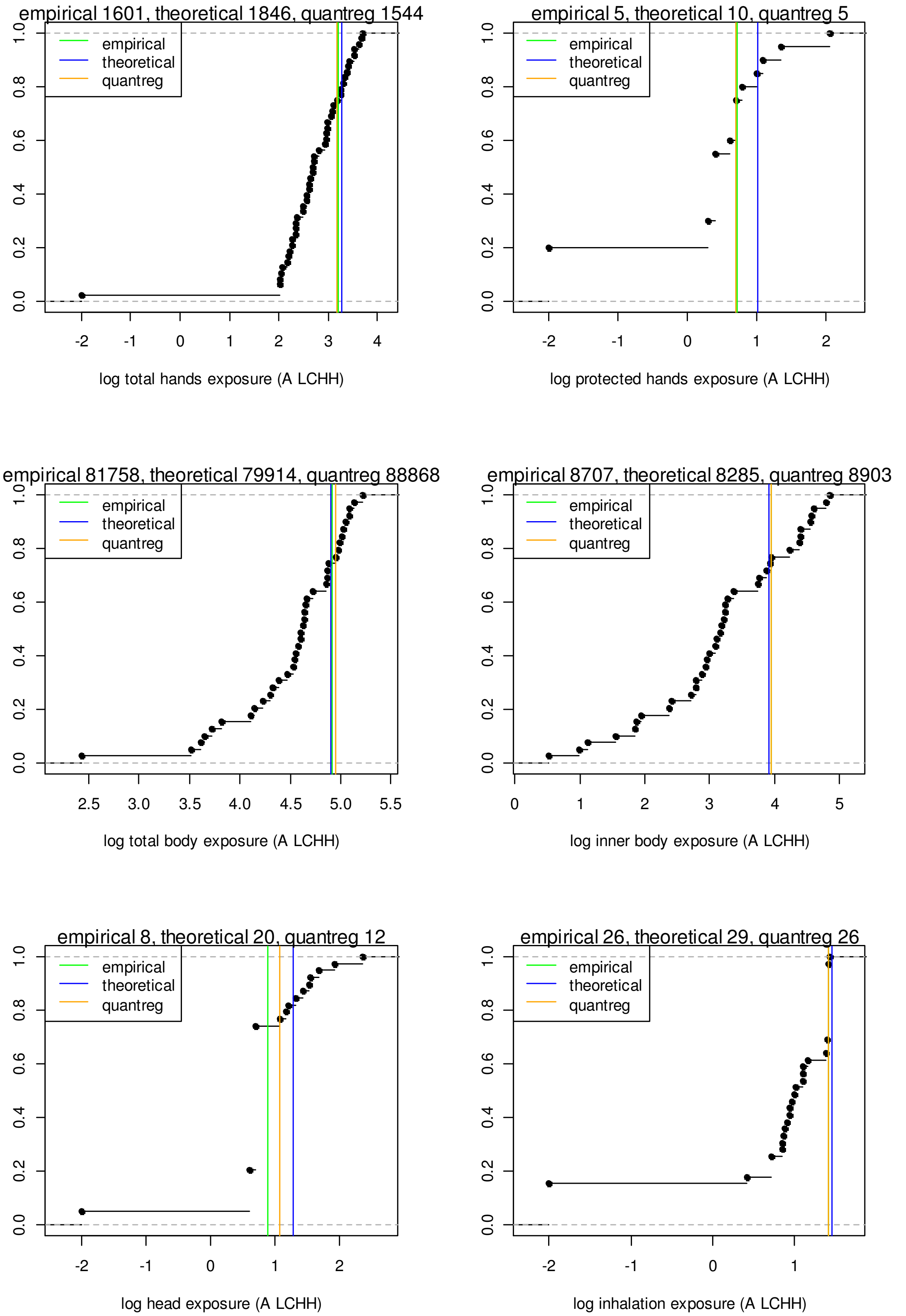

Figure A 6: Comparison of the empirical 75th percentile (green line) with the parametric estimate of the percentile calculated acc. to EFSA (blue line) and the 75th percentile obtained by quantile regression (orange line); the y-axis gives the proportion of data with values below a certain level of exposure.

Appendix 4 Model predictions (95th percentile)

A 4.1 Tank mixing/loading

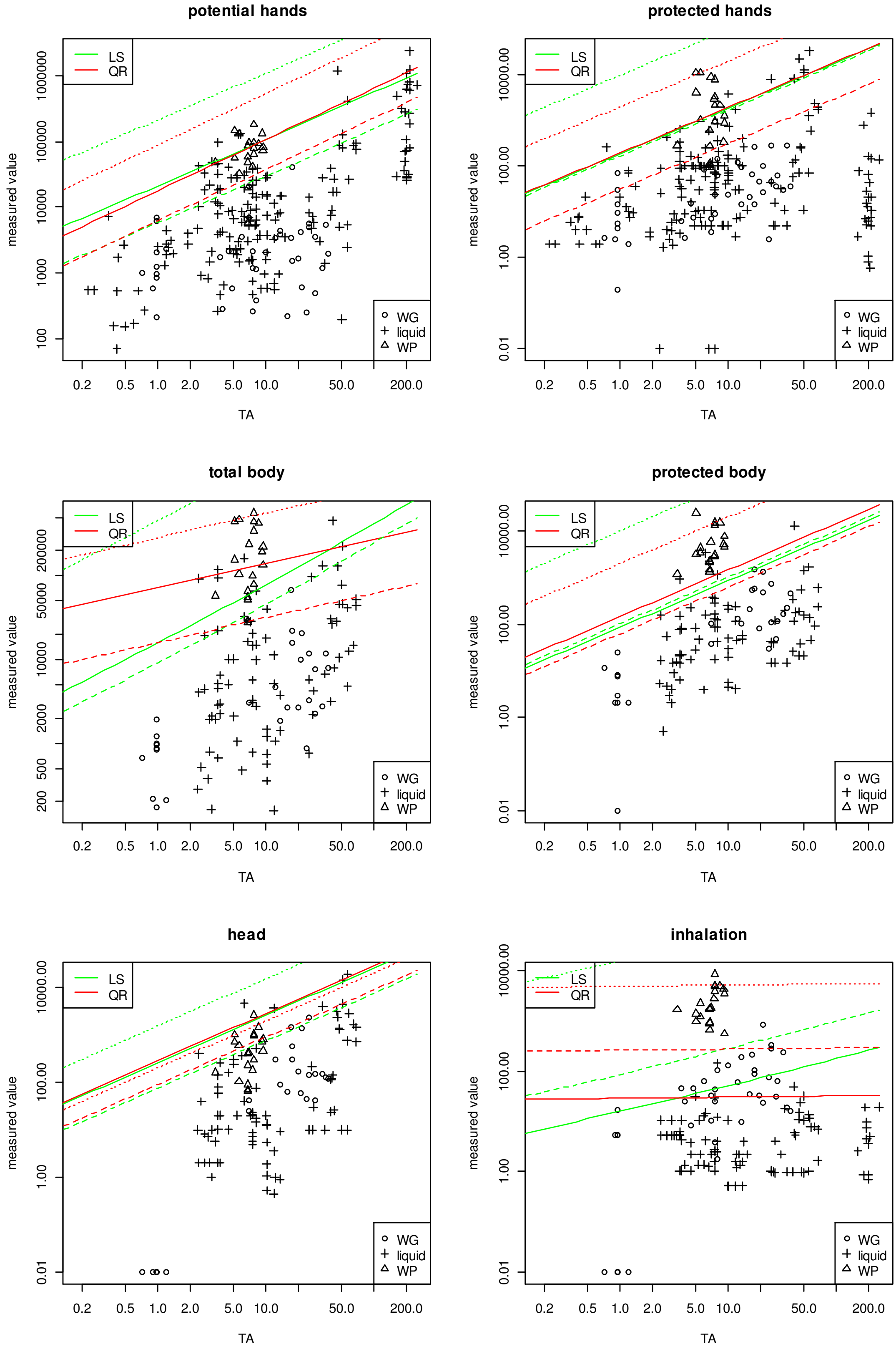

Figure A 7: Model prediction (95th percentile) for ML tank; green: prediction with least squares regression, red: prediction with quantile regression; solid line: liquid formulations, thin broken line: WP formulations, thick broken line: WG formulations

A 4.2 LCTM application

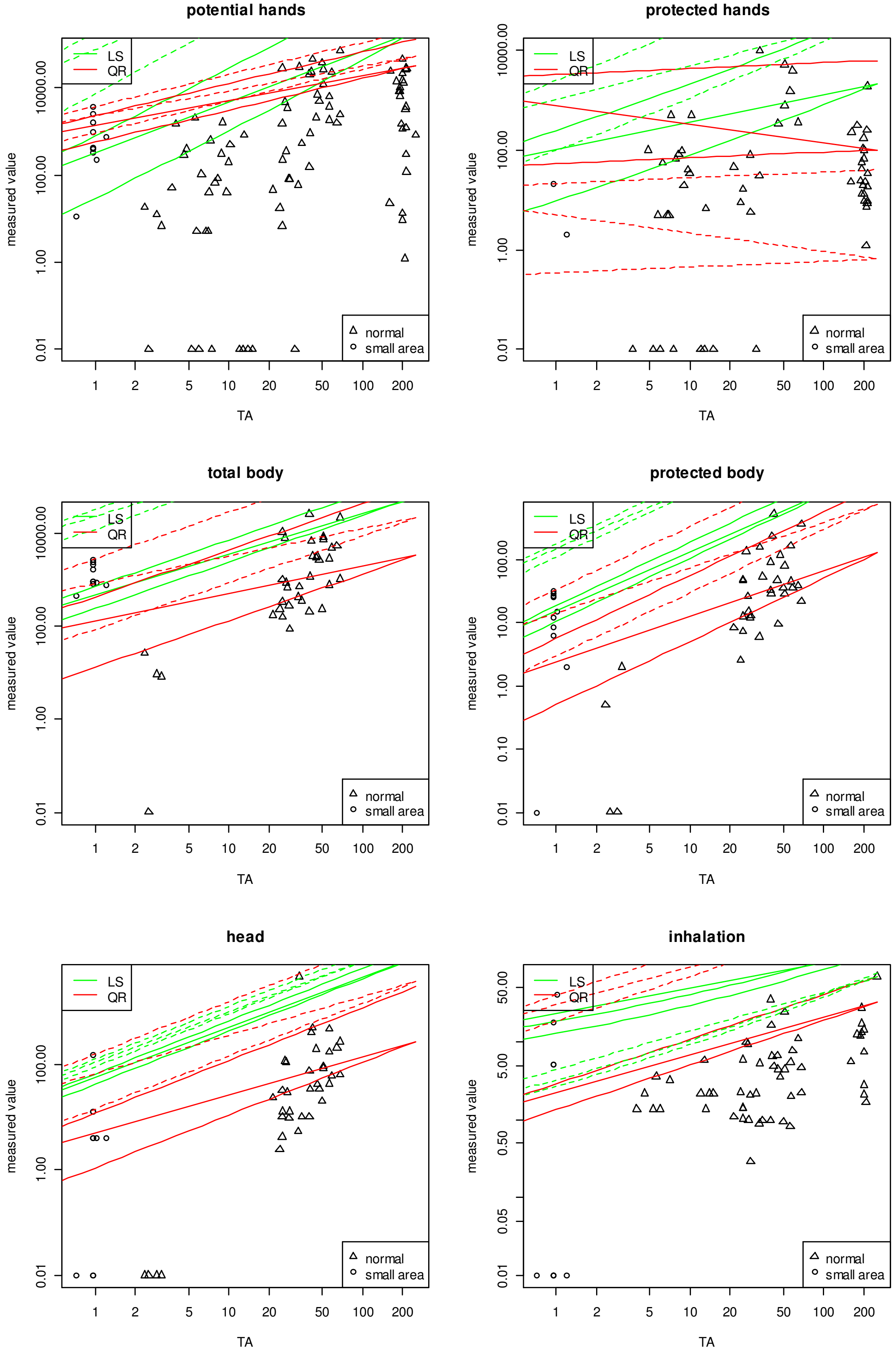

Figure A 8: Model prediction (95th percentile) for LCTM; green: prediction with least squares regression, red: prediction with quantile regression; solid line: normal equipment, broken line: equipment for small areas; impact of droplet size (normal, coarse) is not shown

A 4.3 HCTM application

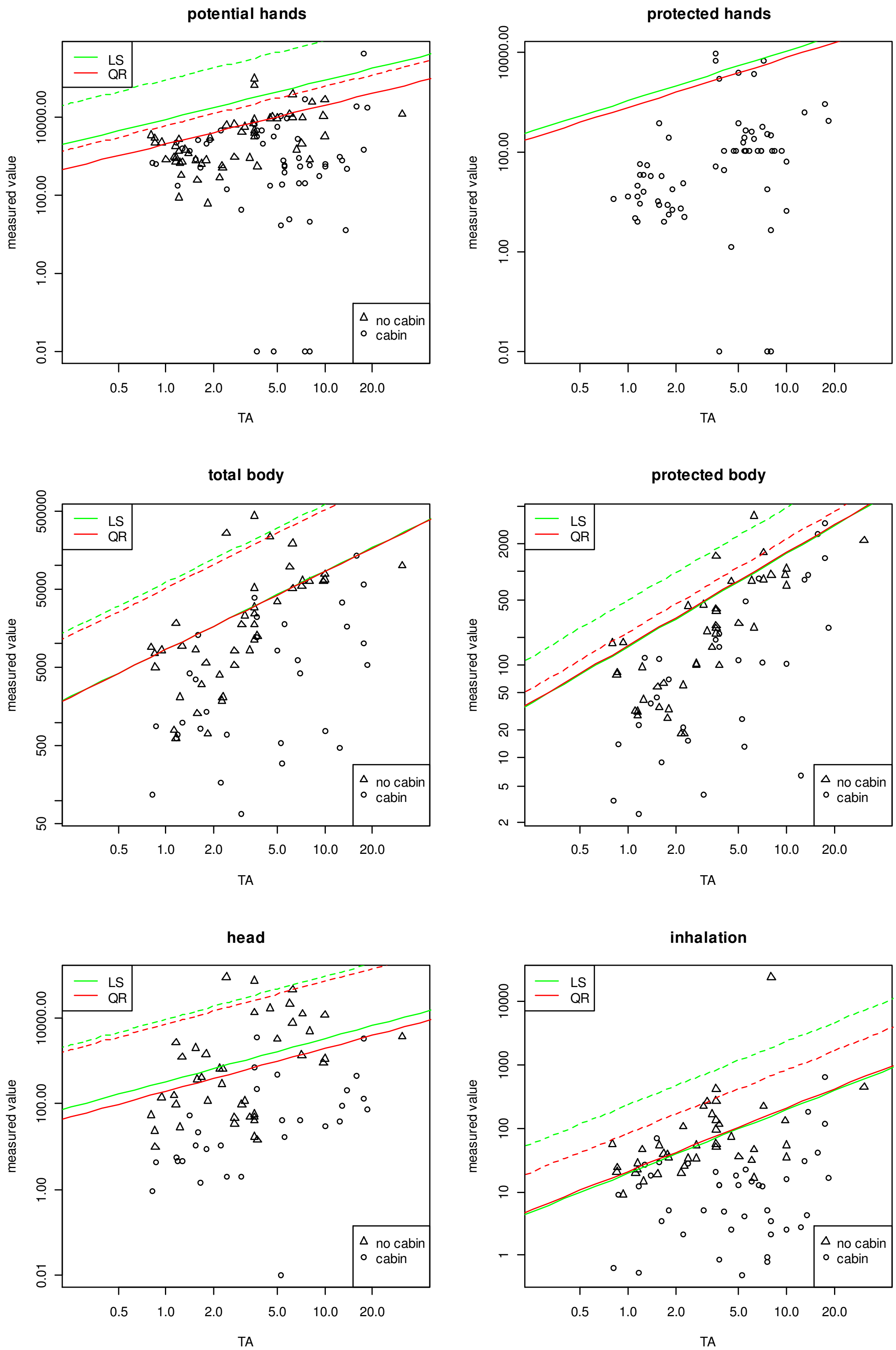

Figure A 9: Model prediction (95th percentile) for HCTM; green: prediction with least squares regression, red: prediction with quantile regression; solid line: cabin, broken line: no cabin

A 4.4 HCHH application

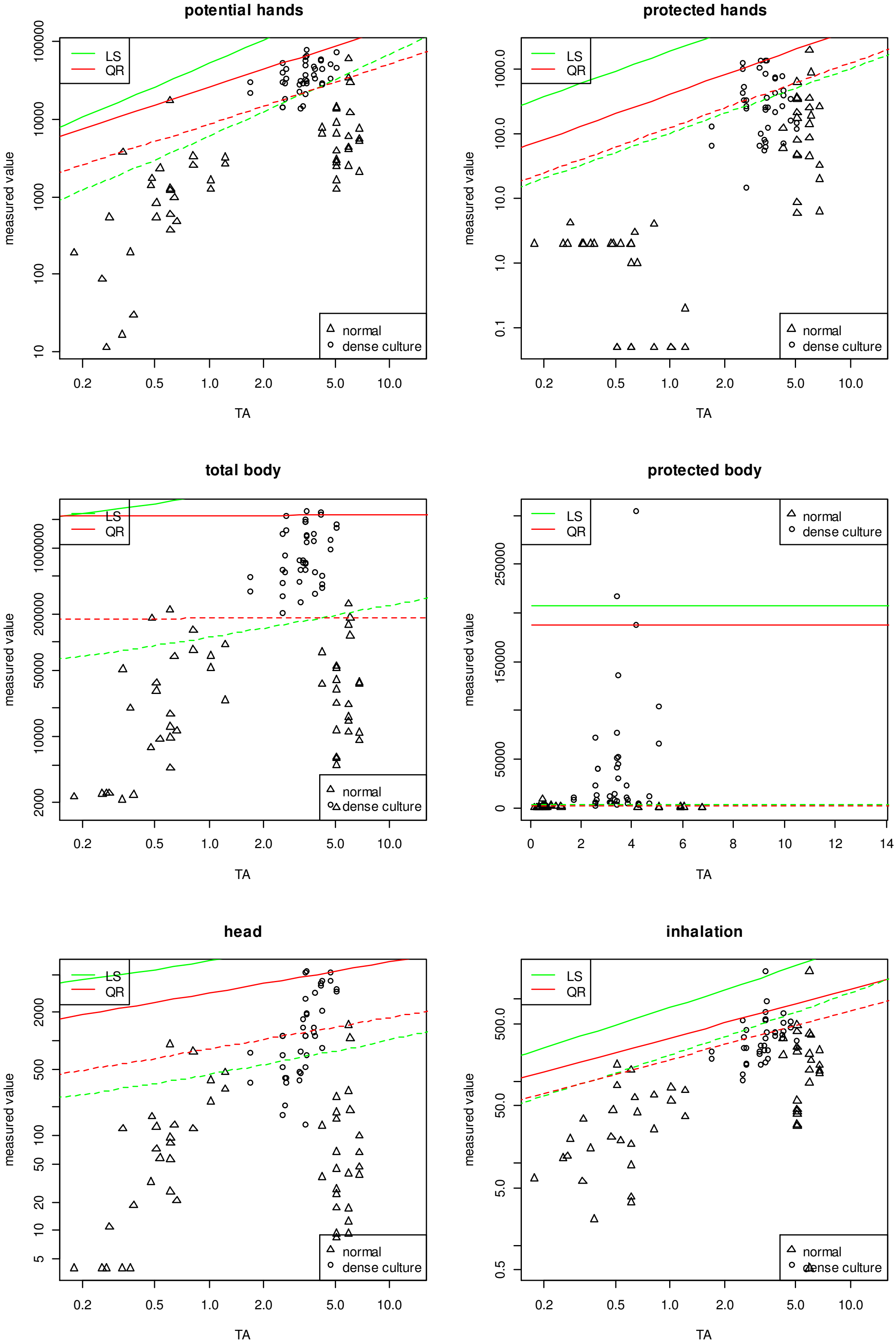

Figure A 10: Model prediction (95th percentile) for HCHH; green: prediction with least squares regression, red: prediction with quantile regression; solid line: dense culture, broken line: normal culture

Appendix 5 Estimation of the 95th percentile

A 5.1 Knapsack mixing/loading

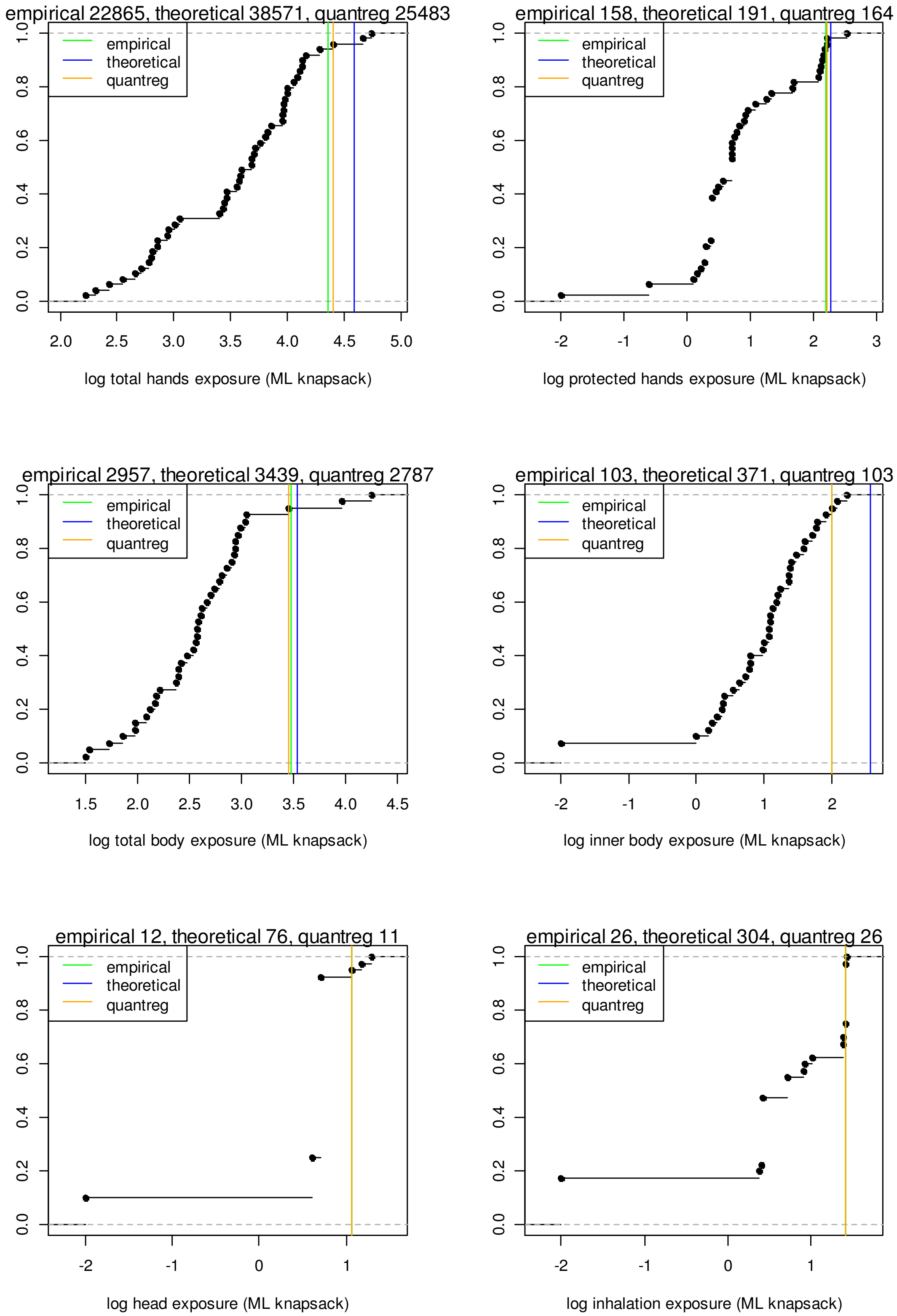

Figure A 11: Comparison of the empirical 95th percentile (green line) with the parametric estimate of the percentile calculated acc. to EFSA (blue line) and the 95th percentile obtained by quantile regression (orange line); the y-axis gives the proportion of data with values below a certain level of exposure.

A 5.2 LCHH application

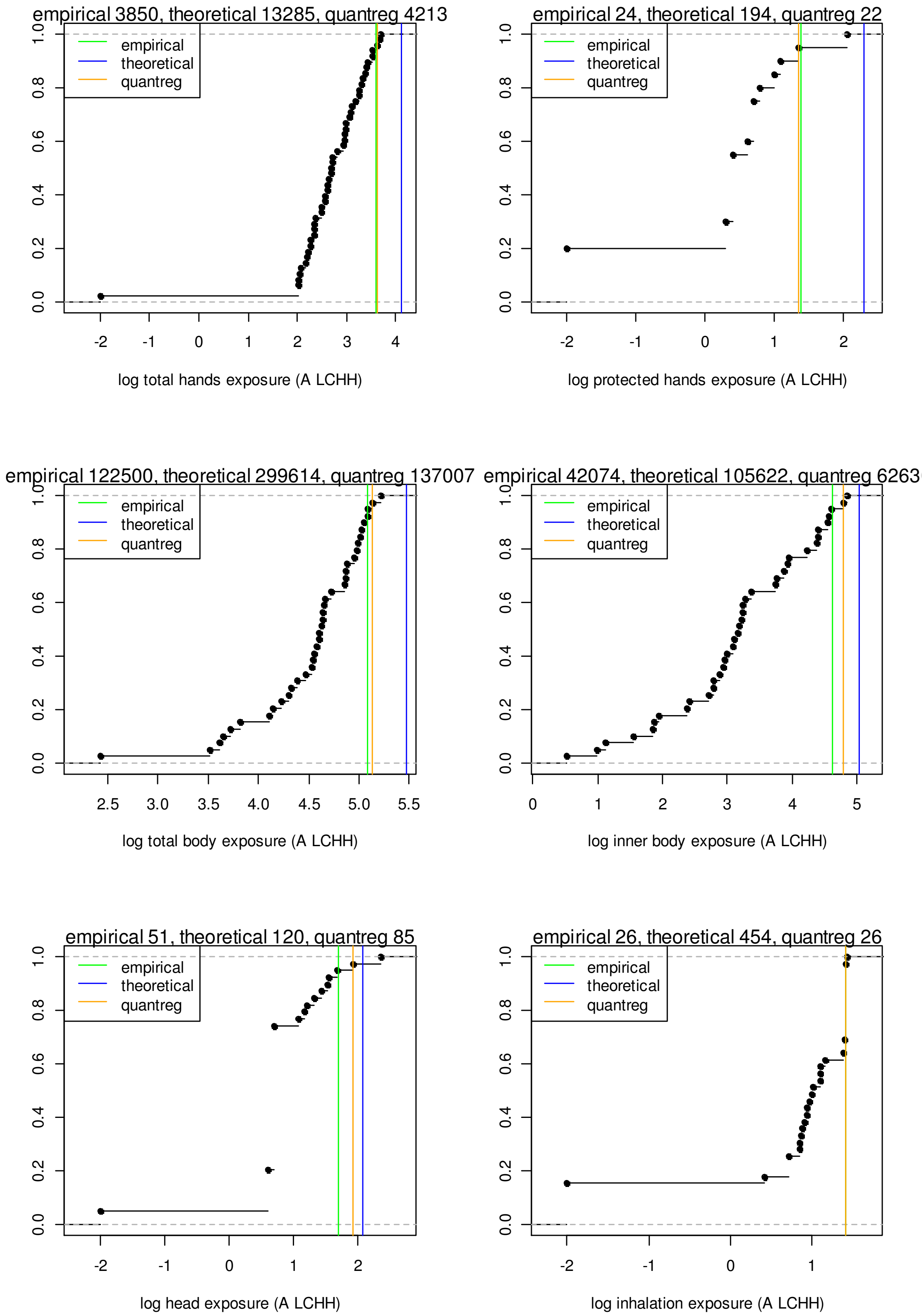

Figure A 12: Comparison of the empirical 95th percentile (green line) with the parametric estimate of the percentile calculated acc. to EFSA (blue line) and the 95th percentile obtained by quantile regression (orange line); the y-axis gives the proportion of data with values below a certain level of exposure.

Appendix 6 Cross validation (study impact)

A 6.1 Tank mixing/loading

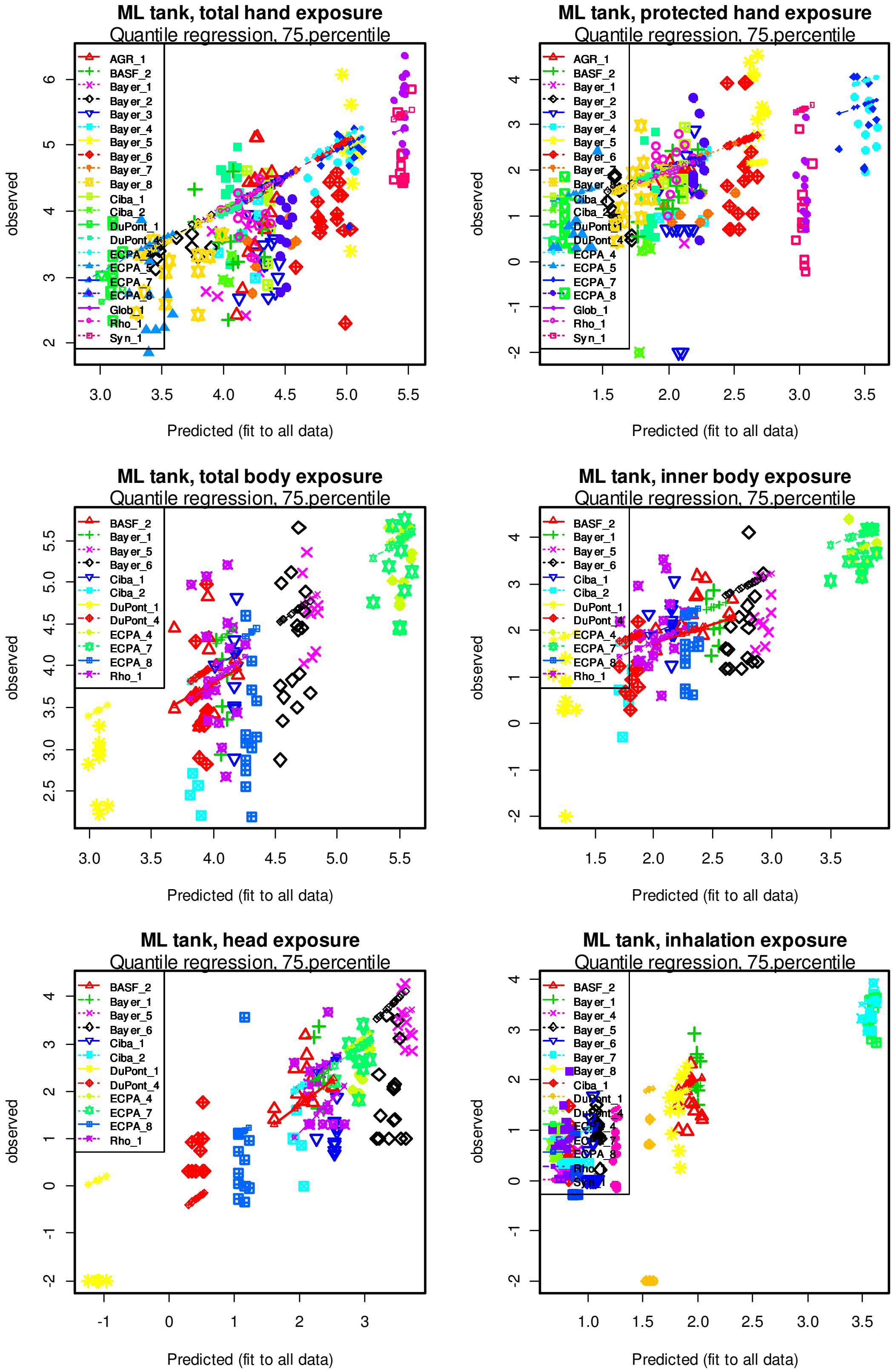

Figure A 13: Cross validation by study of the tank mixing/loading model; shown are the measurements from the studies (in different colours) together with the model prediction (same colour line) of the reduced datasets.

A 6.2 LCTM application

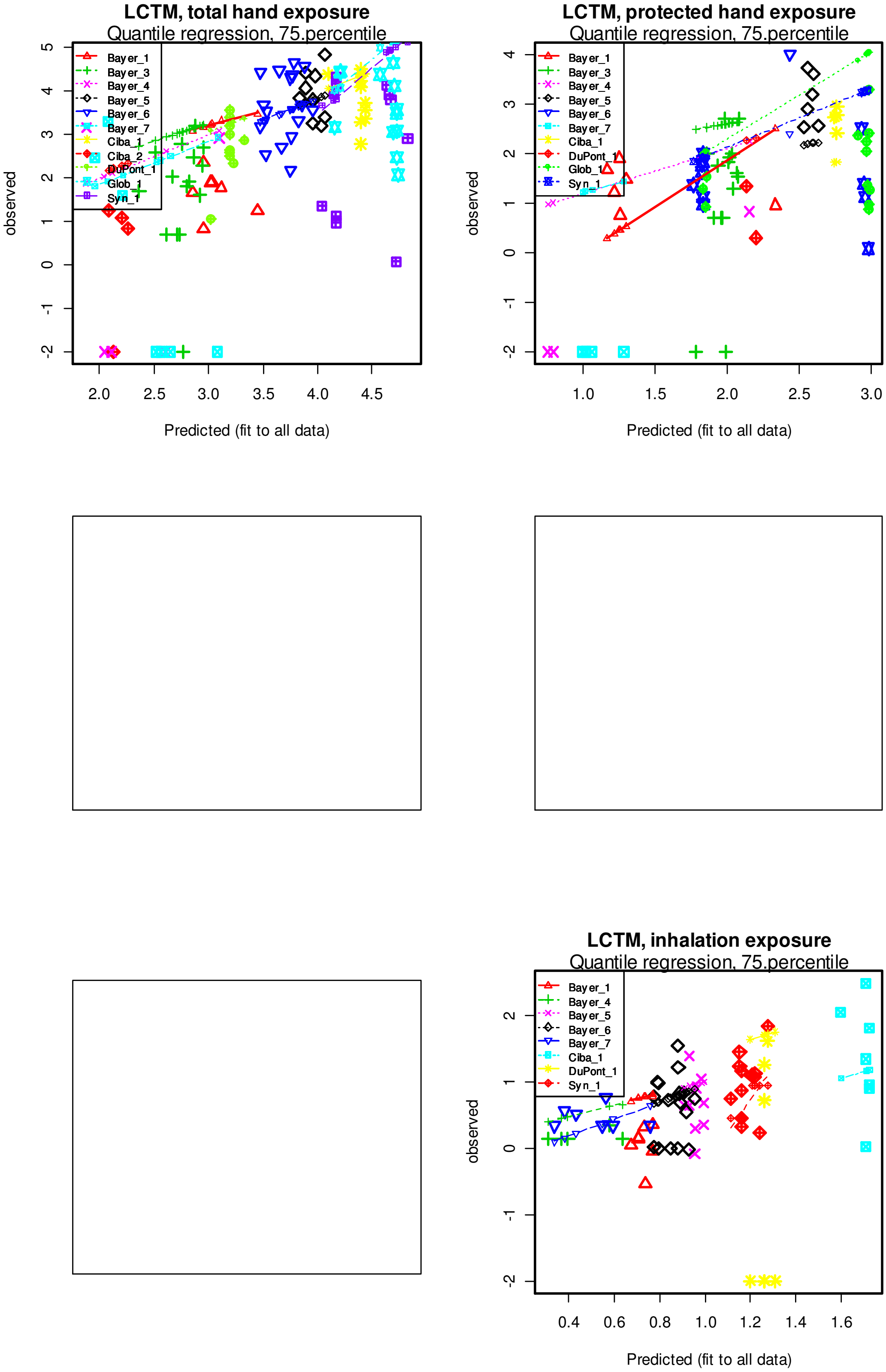

Figure A 14: Cross validation by study of the tank mixing/loading model; shown are the measurements from the studies (in different colours) together with the model prediction (same colour line) of the reduced datasets. Empty diagrams indicate poor coverage of some combination of factor levels.

A 6.3 HCTM application

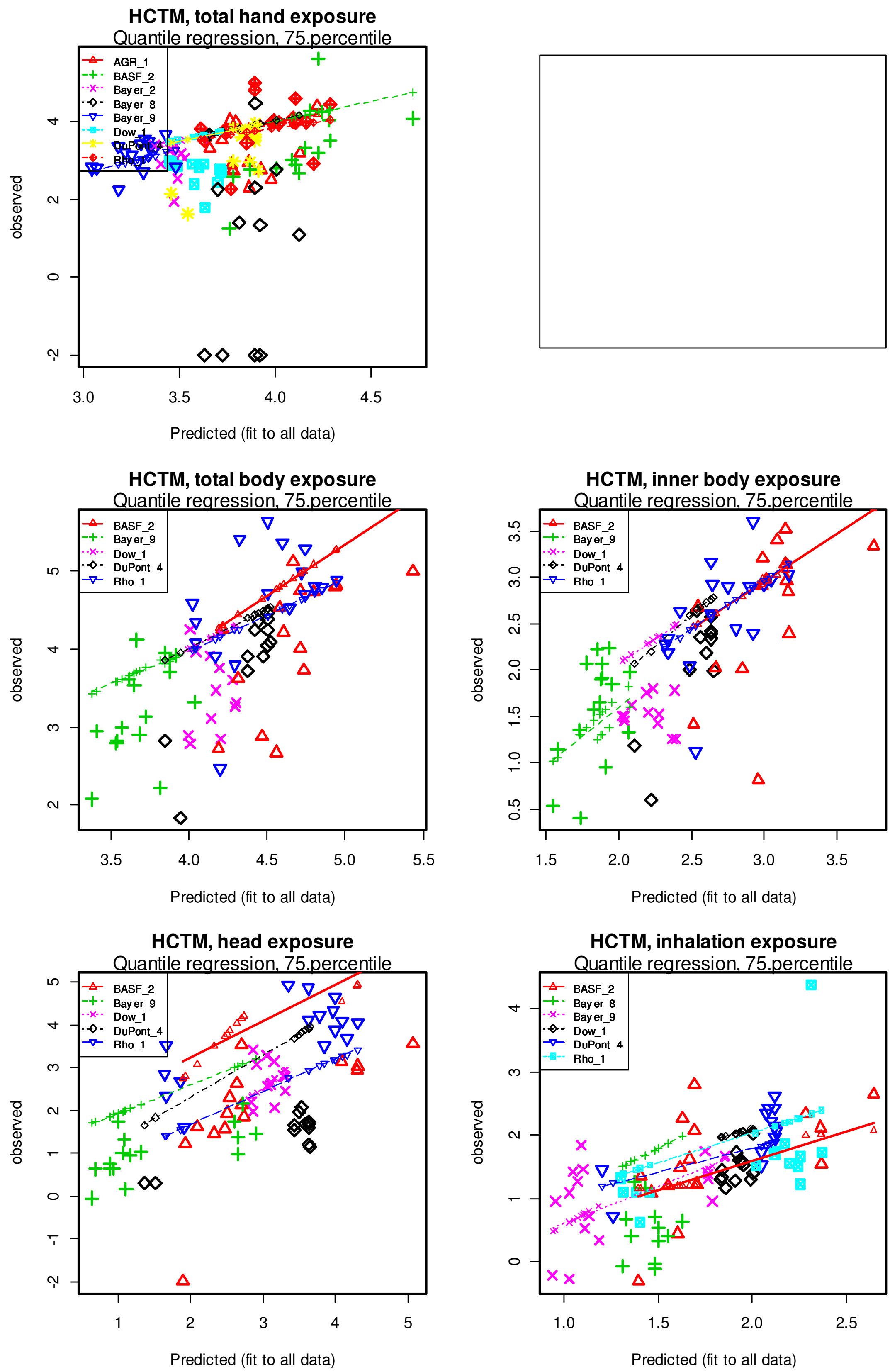

Figure A 15: Cross validation by study of the tank mixing/loading model; shown are the measurements from the studies (in different colours) together with the model prediction (same colour line) of the reduced datasets. Empty diagrams indicate poor coverage of some combination of factor levels.

A 6.4 HCHH application

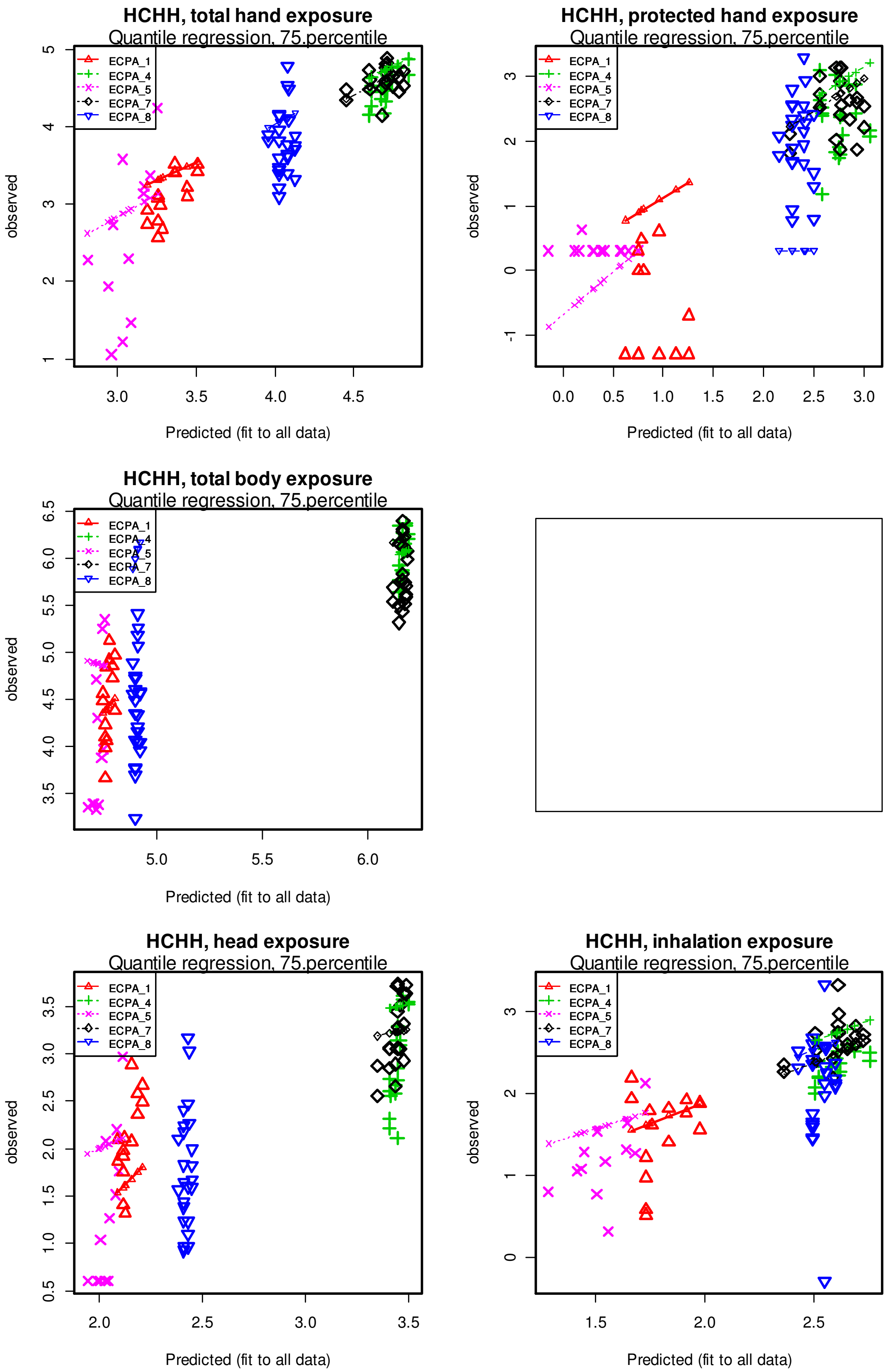

Figure A 16: Cross validation by study of the tank mixing/loading model; shown are the measurements from the studies (in different colours) together with the model prediction (same colour line) of the reduced datasets. Empty diagrams indicate poor coverage of some combination of factor levels.

Appendix 7 User Guidance to the Agricultural Operator Exposure Model

Purpose

The Agricultural Operator Exposure Model has been developed for estimating the exposure of professional operators to pesticides during mixing/loading and application. It is based on empirical data from various exposure studies conducted between 1994 and 2009 and covers the main outdoor scenarios for low crops and high crops considering modern application equipment. The model is applicable for conditions in Europe and is intended e.g. to be used for assessing operator exposure as part of the (zonal) authorisation of plant protection products within the EU.

Scenarios

The following outdoor application scenarios can be chosen by the user: Application with tractor-mounted/-trailed equipment in low crops (LCTM), application with tractor-mounted/-trailed equipment in high crops (HCTM), application with hand-held equipment in low crops (LCHH) and application with hand-held equipment in high crops (HCHH). For estimating the exposure for mixing and loading the plant protection product two scenarios are possible: Tank mixing/loading and knapsack mixing/loading. If tractor-mounted/-trailed equipment is selected tank mixing/loading is automatically taken into account; if hand-held equipment is selected two separate scenarios either including tank mixing/loading or knapsack mixing/loading are automatically considered and calculated.

For several of these scenarios a specification is possible by choosing different subsets. In case of LCTM application the droplet size (‘coarse’ instead of ‘normal’ if drift reducing nozzles are used) and the equipment type (‘small’ instead of ‘normal’ if the equipment used is suitable for the treatment of small areas/high crops) can be specified. The cabin status can be changed for the HCTM scenario from ‘no cabin’ to ‘cabin’ and the culture type (‘dense culture’ instead of ‘normal culture’ if direct contact with sprayed crop cannot be avoided by the operator while applying the plant protection product) can be refined for the HCHH scenario.

Additionally, the formulation type has an impact on the modelled exposure for tank mixing/loading. Therefore, powder formulations (WP), granular formulations (WG) and liquid formulations are distinguished. Apart from this no difference is made between mixing/loading a tank for LCTM, HCTM, LCHH or HCHH application. The exposure estimates for knapsack mixing/loading are identical for LCHH and HCHH.

Cleaning of the spray equipment is considered as a separate task but included in the exposure for the application.

Model data

The exposure predictions for the different scenarios are mainly based on statistical models and depend largely on the total amount of active substance used per day. The number of data available for knapsack mixing/loading and LCHH application was, however, not sufficient for modelling; instead the 75th percentile was calculated. This value is valid up to a total amount of 1.5 kg active substance (a.s.); above 1.5 kg a.s. linear extrapolation is performed (considered to be an overestimation since the dependency of exposure on the total amount of active substance used is generally sub-linear).

Work rate/area treated

The model gives the exposure for a typical working day. The corresponding area treated per day is based on available datasets (roughly the 75^{th} percentile) and ranges from 50 ha for the LCTM scenario to 1 ha for all hand-held scenarios with knapsack sprayers as well as for HCHH application in dense culture.

Operator

The model is only suitable for calculating the exposure of professional operators. An average body weight of 60 kg is assumed (precautionary principle). The exposure by inhalation is based on a default breathing rate of 1.25 m^3/h. If other default values are agreed on EU-level, these values could be adapted accordingly.

Personal protective equipment (PPE)

The exposure is calculated for a professional operator wearing at least one layer of work clothes and sturdy footwear during mixing/loading and application. Additional PPE can be selected from a list if the estimated systemic exposure exceeds the AOEL. Multiple PPE can be selected if their combination is logical. The PPE can be chosen separately for mixing/loading (m/l) and application (a). The risk mitigation factors applied are either based on data used for the model ('acc. model') or can be chosen from other sources.

Operating instructions

1. Select the sheet 'Data entry' and fill out the orange boxes on the active substance and the product. Orange boxes generally indicate information which should be inserted or selected. For each active substance a separate excel sheet has to be filled out.

2. Choose the formulation type of the product from the pull-down menu: 'WG' for water soluble or dispersible granules, 'WP' for wettable powder and 'Liquid' for all liquid formulations (either based on water or organic solvents).

3. Enter the value for the systemic AOEL (in mg/kg bw/d) and the value for the dermal absorption (in %) of the active substance in the undiluted product (for mixing/loading) as well as in the ready-to-use/diluted product (for application). Give the formulation which was used to assess the dermal absorption. Use default values (e.g. 25 % or 75 %, acc. EFSA guidance on dermal absorption[2]) if no appropriate data on the dermal absorption exist.

The absorption via inhalation is assumed to be 100 % if no other information is available; the average body weight of the operator is defined to be 60 kg. Both values can be changed if a different body weight or inhalation absorption value is required appropriate.

4. Choose all relevant application scenarios for the product by placing a check mark in the white boxes behind (click on the box). Enter the amount of active substance applied per hectare (in kg a.s./ha) and the intended use.

5. Select the sheet for the respective application scenario. Refine the scenario if necessary by choosing a subset from the pull-down menu (orange box on top of the sheet). Choose appropriate PPE (with the respective reduction factor) if necessary by placing a check mark in the white box behind it (click on the box). Workwear and sturdy footwear for mixing/loading and application are automatically pre-selected but can be replaced by a protective suit against chemicals. Respiratory protection and head protection with respective reduction factors can be defined according to individual requirements. Reduction factors in orange boxes can be changed.

[2] EFSA (European Food Safety Authority): Guidance on dermal absorption; EFSA Journal 10(4):2665, 2012

6. The resulting total systemic exposure (in mg/kg bw and % of the AOEL) is given in a summary box. In addition to the exposure when using workwear (and/or PPE) the potential exposure without any workwear and PPE is also listed. All calculations and parameters are shown in the tables below.

In case a different value is required for the treated area per day the default value in the parameter box (cell B45) can be changed.

7. For an overall summary of all scenarios select the sheet ‘Summary’. In the top box information on the product is given (generated from the information entered in the ‘Data entry’ sheet). The box below shows the results for the potential exposure and the exposure with workwear (and PPE if necessary). Only the scenarios selected in the ‘Data entry’ sheet are presented.

Notes

- LCTM: Nozzles are assumed to produce a ‘coarse’ droplet spectrum when they are classified for at least 50 % drift reduction (according to the definition developed by the Julius Kühn Institut).
- LCTM: The combination of the parameters ‘coarse droplets’ and ‘small area equipment’ is not covered by data.
- HCTM: The modelled exposure for the protected hand (application) is independent from the cabin status.
- HCHH: The modelled exposure for the protected body (application) is independent from the total amount of active substance.
- LCHH/HCHH: The head exposure for knapsack mixing/loading is based on data from operators wearing a face shield. The exposure when choosing hood and face shield for mixing/loading is therefore the same as the exposure when choosing no head protection.

14 Abbildungsverzeichnis

15 Tabellenverzeichnis

16 Supplementary information on the new Agricultural Operator Exposure Model

2013-01-29

17 Raw data used for the model

17.1 Mixing/loading

Study code	Op.#	ML type	TA (kg a.s.)	Form. type	Face shield ML	Glove wash ML	Total Hand ML (µg)	Prot. hand ML (µg)	Total body ML (µg)	Inner body ML (µg)	Head ML (µg)	Inhalation ML (µg)
LCTM_1	A	tank	25.1	WG	no	yes	4963.9	290.5	11900.7	716.5	2358.9	338.1
LCTM_1	B	tank	25.1	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	C	tank	28.2	WG	no		3537.9	36.1	2289.6	46.6	41.2	31.4
LCTM_1	D	tank	28.2	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	E	tank	28.5	WG	no	yes	501.6	64.8	7664.7	114.5	148.9	63.1
LCTM_1	F	tank	28.5	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	G	tank	21.3	WG	no	yes	612.9	104.4	20359.8	494.0	1409.8	824.9
LCTM_1	H	tank	21.3	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	I	tank	25.0	WG	no		5743.9	45.6	3277.1	107.3	144.2	280.2
LCTM_1	J	tank	25.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	K	tank	24.0	WG	no		256.1	2.5	879.1	29.1	43.9	73.1
LCTM_1	L	tank	24.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_1	M	tank	33.0	WG	no		1196.8	31.1	2791.2	167.9	152.6	235.3
LCTM_1	N	tank	33.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_2	1	tank	9.0	liquid	no		584.7	5.0	NA	NA	NA	NA
LCTM_2	2	tank	6.3	liquid	no		7205.0	5.0	NA	NA	NA	NA
LCTM_2	3	tank	6.8	liquid	no		3076.9	0.0	NA	NA	NA	NA
LCTM_2	4	tank	10.0	liquid	no		1605.0	5.0	NA	NA	NA	NA
LCTM_2	5	tank	8.8	liquid	no		3805.0	5.0	NA	NA	NA	NA
LCTM_2	6	tank	7.3	liquid	no		1625.0	125.0	NA	NA	NA	NA
LCTM_2	7	tank	4.9	liquid	no		8828.5	5.0	NA	NA	NA	NA
LCTM_2	8	tank	10.3	liquid	no		30151.8	740.0	NA	NA	NA	NA
LCTM_2	9	tank	7.5	liquid	no		480.0	0.0	NA	NA	NA	NA
LCTM_2	10	tank	3.8	liquid	no		472.8	32.8	NA	NA	NA	NA
LCTM_2	11	tank	5.8	liquid	no		2368.6	5.0	NA	NA	NA	NA
LCTM_2	12	tank	7.0	liquid	no		1550.5	5.0	NA	NA	NA	NA
LCTM_2	13	tank	7.9	liquid	no		5265.6	65.6	NA	NA	NA	NA
LCTM_2	14	tank	8.3	liquid	no		3324.2	213.1	NA	NA	NA	NA
LCTM_2	15	tank	9.6	liquid	no		970.0	40.0	NA	NA	NA	NA
LCTM_3	WM	tank	7.5	liquid	no		15960.8	70.8	5693.1	85.1	4.8	2.7

Study code	Op.#	ML type	TA (kg a.s.)	Form. type	Face shield ML	Glove wash ML	Total Hand ML (µg)	Prot. hand ML (µg)	Total body ML (µg)	Inner body ML (µg)	Head ML (µg)	Inhalation ML (µg)
LCTM_3	JT	tank	7.5	liquid	no		21317.8	77.8	14761.0	135.0	7.4	30.1
LCTM_3	HM	tank	7.5	liquid	no		25450.0	30.0	20391.0	162.0	21.0	2.5
LCTM_3	JK	tank	7.5	liquid	no		37604.6	44.6	3281.7	17.7	5.7	1.6
LCTM_3	RV	tank	4.5	liquid	no		40960.0	50.0	10139.0	227.0	10.0	3.8
LCTM_3	YB	tank	8.0	liquid	no		25545.0	375.0	9948.0	123.0	17.1	4.0
LCTM_3	JM	tank	8.0	liquid	no		14381.8	121.8	65484.9	84.9	14.3	12.2
LCTM_3	JD	tank	8.0	liquid	no		5514.0	869.0	14970.0	1170.0	76.2	2.5
LCTM_3	JB	tank	7.5	liquid	no		762.1	24.1	3063.0	289.0	8.5	1.6
LCTM_3	EG	tank	7.5	liquid	no		1595.0	35.0	781.0	358.0	22.8	1.0
LCTM_4	SH	tank	2.5	liquid	no		918.6	1.7	518.0	0.5	39.6	NA
LCTM_4	SC	tank	2.5	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_4	TS	tank	2.3	liquid	no		4760.8	0.0	281.6	5.3	10.0	NA
LCTM_4	THR	tank	2.3	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_4	SC	tank	3.1	liquid	no		2135.1	1.9	161.8	14.7	1.0	NA
LCTM_4	SH	tank	3.1	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_4	THR	tank	2.9	liquid	no		832.4	2.6	376.0	2.9	7.2	NA
LCTM_4	TS	tank	2.9	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_5	1	tank	200.0	liquid	no		26226.8	0.8	NA	NA	NA	0.8
LCTM_5	2	tank	200.0	liquid	no		29608.1	1.1	NA	NA	NA	0.7
LCTM_5	3	tank	192.0	liquid	no		70644.6	28.6	NA	NA	NA	9.6
LCTM_5	4	tank	160.0	liquid	no		29736.9	2.9	NA	NA	NA	2.5
LCTM_5	5	tank	192.0	liquid	no		278054.4	5.4	NA	NA	NA	4.5
LCTM_5	6	tank	192.0	liquid	no		49842.3	15.3	NA	NA	NA	7.3
LCTM_5	7	tank	208.0	liquid	no		31823.6	0.6	NA	NA	NA	4.9
LCTM_5	8	tank	188.0	liquid	no		36485.1	7.1	NA	NA	NA	18.7
LCTM_5	9	tank	200.0	liquid	no		73918.8	20.8	NA	NA	NA	3.5
LCTM_5	10	tank	200.0	liquid	no		28449.4	6.4	NA	NA	NA	0.8
LCTM_5	11	tank	179.0	liquid	no		315833.0	802.0	NA	NA	NA	0.8
LCTM_5	12	tank	250.0	liquid	no		717897.0	141.0	NA	NA	NA	19.1
LCTM_6	1	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	2	tank	1.0	WG	yes		6056.2	30.2	963.8	25.1	0.0	16.5
LCTM_6	3	tank	0.7	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	4	tank	0.7	WG	yes		1036.7	2.7	670.2	11.4	0.0	0.0
LCTM_6	5	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA

Study code	Op.#	ML type	TA (kg a.s.)	Form. type	Face shield ML	Glove wash ML	Total Hand ML (µg)	Prot. hand ML (µg)	Total body ML (µg)	Inner body ML (µg)	Head ML (µg)	Inhalation ML (µg)
LCTM_6	6	tank	1.0	WG	yes		1270.4	4.4	992.6	2.0	0.0	0.0
LCTM_6	7	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	8	tank	1.0	WG	yes		218.7	0.2	827.4	0.0	0.0	0.0
LCTM_6	9	tank	1.2	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	10	tank	1.2	WG	yes		2367.6	2.0	211.5	2.0	0.0	0.0
LCTM_6	11	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	12	tank	1.0	WG	yes		968.1	71.6	169.8	3.0	0.0	0.0
LCTM_6	13	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	14	tank	0.9	WG	yes		587.7	2.5	214.0	2.0	0.0	5.2
LCTM_6	15	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	16	tank	1.0	WG	yes		2085.3	14.3	1897.8	8.2	0.0	5.2
LCTM_6	17	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	18	tank	1.0	WG	yes		858.6	5.5	864.0	8.2	0.0	5.2
LCTM_6	19	tank	1.0	WG	no		NA	NA	NA	NA	NA	NA
LCTM_6	20	tank	1.0	WG	yes		6875.8	9.8	1200.1	7.6	0.0	0.0
LCTM_7	A	tank	14.0	liquid	no	yes	14865.5	264.5	NA	NA	NA	3.9
LCTM_7	B	tank	4.0	liquid	no		4273.2	9.2	NA	NA	NA	1.4
LCTM_7	C1	tank	6.0	liquid	no		8673.6	10.8	NA	NA	NA	1.4
LCTM_7	D	tank	13.1	liquid	no	yes	969.7	7.8	NA	NA	NA	1.4
LCTM_7	E	tank	5.3	liquid	no	yes	2294.3	10.8	NA	NA	NA	1.4
LCTM_8	1	tank	56.4	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	2	tank	56.4	liquid	no		2489.0	1268.0	NA	NA	751.5	13.4
LCTM_8	4	tank	47.3	liquid	no		87332.2	271.9	10604.7	38.8	1365.9	23.9
LCTM_8	5	tank	58.6	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	6	tank	58.6	liquid	no		26363.6	602.0	12563.9	46.3	2847.0	7.6
LCTM_8	7	tank	51.0	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	8	tank	51.0	liquid	no		80216.7	13219.0	46118.9	152.3	4555.6	10.5
LCTM_8	9	tank	68.0	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	10	tank	68.0	liquid	no		75609.2	1805.2	43837.2	239.3	1478.0	6.9
LCTM_8	11	tank	45.9	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	12	tank	45.9	liquid	no		1183456.6	23262.0	130025.8	186.1	2381.5	14.8
LCTM_8	13	tank	51.0	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	14	tank	51.0	liquid	no		128537.3	11486.1	225719.4	1429.5	14512.5	31.5
LCTM_8	15	tank	68.0	liquid	no		NA	NA	NA	NA	NA	NA

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LCTM_8	16	tank	68.0	liquid	no		93558.5	2005.8	52561.3	604.9	713.1	1.7
LCTM_8	17	tank	56.7	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_8	18	tank	56.7	liquid	no		412829.8	33747.5	41524.4	136.4	19050.5	11.5
LCTM_8	19	tank	64.3	liquid	no		88213.0	2383.3	14854.6	94.3	1695.3	7.8
LCTM_8	20	tank	64.3	liquid	no		NA	NA	NA	NA	NA	NA
LCTM_9	1	tank	33.5	liquid	no		28011.0	11.0	132198.0	198.0	4000.0	17.8
LCTM_9	2	tank	40.7	liquid	no		9070.0	8600.0	26727.0	117.0	122.0	48.5
LCTM_9	3	tank	40.0	liquid	no		39120.0	120.0	30546.0	346.0	24.0	1.0
LCTM_9	4	tank	27.5	liquid	no		5805.0	5.0	4220.0	120.0	30.0	4.0
LCTM_9	5	tank	42.3	liquid	no		27140.0	140.0	7959.0	179.0	26.0	5.3
LCTM_9	6	tank	26.4	liquid	no		4705.0	5.0	96559.0	39.0	220.0	1.0
LCTM_9	7	tank	40.0	liquid	no		7458.0	58.0	3146.0	26.0	112.0	1.0
LCTM_9	8	tank	50.0	liquid	no		201.0	11.0	78021.0	21.0	10.0	0.9
LCTM_9	9	tank	35.0	liquid	no	yes	1405.0	5.0	6715.0	15.0	10.0	1.0
LCTM_9	10	tank	56.5	liquid	no		5372.0	72.0	4777.0	1697.0	10.0	1.0
LCTM_9	11	tank	45.0	liquid	no		17073.0	73.0	28521.0	21.0	3200.0	11.0
LCTM_9	12	tank	47.5	liquid	no		5050.0	250.0	45552.0	552.0	1320.0	1.0
LCTM_9	13	tank	27.0	liquid	no		7216.0	16.0	2182.0	15.0	10.0	1.0
LCTM_9	14	tank	25.0	liquid	no		8250.0	8200.0	5742.0	42.0	10.0	1.0
LCTM_9	15	tank	25.0	liquid	no		14045.0	45.0	749.0	15.0	10.0	1.0
LCTM_9	16	tank	41.4	liquid	no		17000.0	8200.0	455259.0	13069.0	140.0	5.9
LCTM_10	A	tank	4.6	liquid	no		3542.6	16.3	NA	NA	NA	2.2
LCTM_10	B	tank	12.8	liquid	no		7977.7	30.9	NA	NA	NA	2.2
LCTM_10	C	tank	31.3	liquid	no	yes	3088.1	32.3	NA	NA	NA	2.2
LCTM_10	D	tank	12.0	liquid	no	yes	567.4	7.2	NA	NA	NA	2.2
LCTM_10	E	tank	5.6	liquid	no		1454.0	7.4	NA	NA	NA	2.2
LCTM_10	F	tank	7.1	liquid	no		6246.7	10.7	NA	NA	NA	2.2
LCTM_10	H	tank	15.0	liquid	no		3513.3	11.1	NA	NA	NA	2.2
LCTM_11	1	tank	203.8	liquid	no		732729.9	44.1	NA	NA	NA	NA
LCTM_11	2	tank	195.8	liquid	no		107414.1	12.9	NA	NA	NA	NA
LCTM_11	3	tank	213.6	liquid	no		79471.7	10.9	NA	NA	NA	NA
LCTM_11	4	tank	211.8	liquid	no		800722.6	10.9	NA	NA	NA	NA
LCTM_11	6	tank	209.5	liquid	no		266503.4	7.6	NA	NA	NA	NA
LCTM_11	7	tank	212.1	liquid	no		2346735.6	4.9	NA	NA	NA	NA

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LCTM_11	8	tank	211.6	liquid	no		597012.0	151.7	NA	NA	NA	NA
LCTM_11	9	tank	213.4	liquid	no		1227499.0	21.2	NA	NA	NA	NA
LCTM_11	11	tank	199.0	liquid	no		1060416.4	65.7	NA	NA	NA	NA
LCTM_11	12	tank	199.3	liquid	no		635008.7	167.2	NA	NA	NA	NA
LCTM_11	13	tank	211.8	liquid	no		186082.7	1493.4	NA	NA	NA	NA
LCTM_11	14	tank	162.3	liquid	no		487103.2	78.2	NA	NA	NA	NA
HCTM_1	1	tank	1.4	liquid	yes		1996.7	36.7	NA	NA	NA	NA
HCTM_1	2	tank	1.2	liquid	yes		2769.9	9.9	NA	NA	NA	NA
HCTM_1	3	tank	1.2	liquid	yes		4489.8	79.8	NA	NA	NA	NA
HCTM_1	4	tank	1.3	liquid	yes	yes	3159.8	9.8	NA	NA	NA	NA
HCTM_1	5	tank	1.0	liquid	yes	yes	2510.8	20.8	NA	NA	NA	NA
HCTM_1	6	tank	1.2	liquid	yes	yes	1332.7	12.7	NA	NA	NA	NA
HCTM_1	7	tank	1.9	liquid	yes		2763.7	3.7	NA	NA	NA	NA
HCTM_1	8	tank	1.9	liquid	yes	yes	4002.9	2.9	NA	NA	NA	NA
HCTM_1	9	tank	1.2	liquid	yes	yes	1931.2	71.2	NA	NA	NA	NA
HCTM_1	10	tank	1.3	liquid	yes	yes	2487.6	7.6	NA	NA	NA	NA
HCTM_2	1	tank	5.8	liquid	no		131119.5	102.5	NA	NA	NA	NA
HCTM_2	2	tank	8.3	liquid	no		38595.5	102.5	NA	NA	NA	NA
HCTM_2	3	tank	9.3	liquid	no		15559.5	102.5	NA	NA	NA	NA
HCTM_2	4	tank	6.9	liquid	no		5271.5	102.5	NA	NA	NA	NA
HCTM_2	5	tank	6.9	liquid	no		6927.5	102.5	NA	NA	NA	NA
HCTM_2	6	tank	5.4	liquid	no		30250.5	102.5	NA	NA	NA	NA
HCTM_2	7	tank	3.6	liquid	no		267.4	51.3	NA	NA	NA	NA
HCTM_2	8	tank	5.5	liquid	no		127643.5	102.5	NA	NA	NA	NA
HCTM_2	10	tank	5.3	liquid	no		27793.8	153.8	NA	NA	NA	NA
HCTM_2	11	tank	4.7	liquid	no		2320.5	102.5	NA	NA	NA	NA
HCTM_2	12	tank	6.6	liquid	no		34946.5	102.5	NA	NA	NA	NA
HCTM_2	13	tank	4.8	liquid	no		27365.5	102.5	NA	NA	NA	NA
HCTM_2	14	tank	8.0	liquid	no		9457.5	102.5	NA	NA	NA	NA
HCTM_2	15	tank	5.5	liquid	no		2971.5	102.5	NA	NA	NA	NA
HCTM_2	17	tank	4.0	liquid	no		663.0	102.5	NA	NA	NA	NA
HCTM_3	1	tank	2.7	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	2	tank	2.7	liquid	yes		18004.0	4.0	4397.7	4.7	2.0	5.2
HCTM_3	3	tank	2.4	liquid	no		NA	NA	NA	NA	NA	NA

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HCTM_3	4	tank	2.4	liquid	yes		42026.0	26.0	4066.8	16.8	2.0	5.2
HCTM_3	5	tank	2.7	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	6	tank	2.7	liquid	yes		32450.0	450.0	19475.0	55.0	8.2	5.2
HCTM_3	7	tank	3.0	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	8	tank	3.0	liquid	yes		1503.9	3.9	797.0	2.0	2.0	5.2
HCTM_3	9	tank	3.4	liquid	yes		12006.8	6.8	1945.4	15.4	5.6	5.2
HCTM_3	10	tank	3.4	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	11	tank	3.6	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	12	tank	3.6	liquid	yes		46090.0	90.0	2885.3	14.3	10.2	5.2
HCTM_3	13	tank	3.6	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	14	tank	3.6	liquid	yes		3903.4	3.4	664.3	6.3	2.0	5.2
HCTM_3	15	tank	3.6	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	16	tank	3.6	liquid	yes		32037.0	37.0	94341.0	21.0	2.0	5.2
HCTM_3	17	tank	3.2	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	18	tank	3.2	liquid	yes		49008.9	8.9	2097.9	8.9	10.0	5.2
HCTM_3	19	tank	3.6	liquid	yes		96670.0	670.0	5092.0	152.0	58.0	5.2
HCTM_3	20	tank	3.6	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	21	tank	3.0	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	22	tank	3.0	liquid	yes		22005.9	5.9	1943.0	4.0	2.0	10.4
HCTM_3	23	tank	3.8	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_3	24	tank	3.8	liquid	yes		19021.0	21.0	2976.7	76.7	2.0	10.4
HCTM_4	1	tank	2.2	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	2	tank	1.7	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	3	tank	1.5	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	4	tank	1.8	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	5	tank	1.6	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	7	tank	2.2	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	8	tank	1.3	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	9	tank	1.8	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	10	tank	2.3	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	11	tank	1.2	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	12	tank	1.1	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_4	13	tank	1.2	liquid	no		NA	NA	NA	NA	NA	NA
HCTM_5	1A	tank	18.4	WG	no		NA	NA	NA	NA	NA	NA

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HCTM_5	1B	tank	15.8	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	1M	tank	35.5	WG	no		5392.2	285.7	11928.8	230.4	125.0	19.4
HCTM_5	2A	tank	7.1	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	2B	tank	30.7	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	2M	tank	37.8	WG	no		1997.0	35.7	7853.7	465.2	116.7	16.3
HCTM_5	3A	tank	17.5	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	3M	tank	17.5	WG	no		40938.8	267.9	21752.0	1491.3	583.3	89.8
HCTM_5	4A	tank	12.3	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	4M	tank	12.3	WG	no		3396.0	125.0	4709.1	130.4	304.2	61.5
HCTM_5	5A	tank	17.5	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	5M	tank	17.5	WG	no		1536.9	14.3	15796.8	580.4	300.0	105.0
HCTM_5	6A	tank	5.3	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	6M	tank	7.0	WG	no		21055.2	3.6	28284.7	104.3	41.7	32.2
HCTM_5	7A	tank	10.0	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	7M	tank	13.5	WG	no		3885.3	14.3	1842.1	104.3	87.5	9.6
HCTM_5	8A	tank	13.7	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	8M	tank	15.8	WG	no		224.7	21.4	2691.7	213.0	62.5	34.7
HCTM_5	9A	tank	5.5	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	9B	tank	9.8	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	9M	tank	21.0	WG	no		4313.9	26.8	9850.8	1306.5	58.3	23.9
HCTM_5	10A	tank	7.0	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	10M	tank	7.0	WG	no		6926.5	7.1	3061.5	37.0	25.0	10.4
HCTM_5	11A	tank	10.0	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	11M	tank	19.8	WG	no		1672.2	46.4	2639.5	80.4	166.7	33.4
HCTM_5	14A	tank	12.9	WG	no		NA	NA	NA	NA	NA	NA
HCTM_5	14M	tank	16.8	WG	no		3403.3	67.9	67310.8	530.4	1504.2	211.8
HCTM_6	1	tank	4.5	liquid	no		8670.0	170.0	5077.4	17.4	160.0	1.0
HCTM_6	2	tank	3.6	liquid	no		7810.0	210.0	118602.2	912.2	140.0	1.0
HCTM_6	3	tank	3.6	liquid	no		11640.0	340.0	22295.9	75.9	80.0	6.3
HCTM_6	4	tank	5.0	liquid	no		2010.0	10.0	10152.3	82.3	240.0	31.3
HCTM_6	5	tank	2.4	liquid	no		10290.0	90.0	92883.7	153.7	400.0	10.4
HCTM_6	6	tank	7.2	liquid	no		9030.0	NA	28592.3	372.3	20.0	NA
HCTM_6	7	tank	8.0	liquid	no		6560.0	360.0	2761.3	41.3	520.0	145.8
HCTM_6	8	tank	6.3	liquid	no		30960.0	60.0	162413.2	3403.2	4640.0	4.2

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HCTM_6	9	tank	6.7	liquid	no	yes	10910.0	610.0	16395.9	2205.9	NA	1.3
HCTM_6	10	tank	10.0	liquid	no		28480.0	180.0	17999.8	249.8	20.0	10.4
HCTM_6	11	tank	6.3	liquid	no		19650.0	250.0	32460.1	160.1	40.0	14.6
HCTM_6	12	tank	6.0	liquid	no		5900.0	100.0	473.9	3.9	360.0	12.5
HCTM_6	13	tank	3.8	liquid	no		4190.0	90.0	6533.9	83.9	260.0	1.0
HCTM_6	14	tank	5.0	liquid	no		6590.0	90.0	2088.4	28.4	300.0	31.3
HCTM_6	15	tank	3.6	liquid	no		18630.0	130.0	4562.4	22.4	20.0	1.0
HCTM_6	16	tank	5.4	liquid	no		1930.0	30.0	1046.9	46.9	20.0	10.4
HCTM_6	17	tank	3.8	liquid	no		10590.0	NA	2231.9	21.9	20.0	4.2
HCTM_7	A	tank	4.0	WG	no	yes	285.7	2.7	NA	NA	NA	24.6
HCTM_7	B	tank	8.0	WG	no	yes	389.7	64.0	NA	NA	NA	1.8
HCTM_7	C	tank	7.5	WG	no		1218.1	9.1	NA	NA	NA	42.7
HCTM_7	D	tank	4.5	WG	no	yes	2157.2	15.2	NA	NA	NA	8.3
HCTM_7	E	tank	7.5	WG	no		2152.1	948.1	NA	NA	NA	24.8
HCTM_7	F	tank	8.0	WG	no	yes	1176.6	146.6	NA	NA	NA	106.3
HCTM_7	G	tank	13.5	WG	no		4355.6	98.6	NA	NA	NA	187.5
HCTM_7	H	tank	10.0	WG	no		2045.6	23.6	NA	NA	NA	132.3
HCTM_7	I	tank	7.5	WG	no		267.3	23.6	NA	NA	NA	3.9
HCTM_7	J	tank	3.8	WG	no		1763.3	6.3	NA	NA	NA	44.9
HCTM_7	K	tank	6.0	WG	no	yes	3608.8	85.8	NA	NA	NA	63.6
HCTM_7	L	tank	4.8	WG	no	yes	590.1	7.5	NA	NA	NA	45.1
HCTM_8	1	tank	1.6	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	2	tank	1.3	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	3	tank	1.5	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	4	tank	1.6	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	5	tank	1.2	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	6	tank	0.8	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	7	tank	0.9	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	8	tank	0.9	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	9	tank	1.4	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	10	tank	0.8	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	11	tank	1.2	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	12	tank	0.9	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	13	tank	2.2	WG	no		NA	NA	NA	NA	NA	NA

Study code	Op.#	ML type	TA (kg a.s.)	Form. type	Face shield ML	Glove wash ML	Total Hand ML (µg)	Prot. hand ML (µg)	Total body ML (µg)	Inner body ML (µg)	Head ML (µg)	Inhalation ML (µg)
HCTM_8	14	tank	1.8	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	15	tank	1.2	WG	no		NA	NA	NA	NA	NA	NA
HCTM_8	16	tank	0.9	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	1	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	2	knapsack	0.1	WG	no		520.7	2.0	33.6	2.0	4.0	5.2
LCHH_1	3	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	4	knapsack	0.1	WG	no		165.6	0.0	92.7	38.5	0.0	0.0
LCHH_1	5	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	6	knapsack	0.1	WG	no		643.6	6.1	163.4	0.0	4.0	0.0
LCHH_1	8	knapsack	0.1	WG	no		597.1	2.0	70.7	0.0	4.0	0.0
LCHH_1	9	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	10	knapsack	0.1	WG	no		356.3	6.5	367.6	1.0	4.0	0.0
LCHH_1	11	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	12	knapsack	0.1	WG	no		3616.4	18.4	914.2	9.5	4.0	5.2
LCHH_1	13	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	14	knapsack	0.1	WG	no		450.8	2.0	861.2	6.2	0.0	0.0
LCHH_1	15	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	16	knapsack	0.1	WG	no		202.7	9.1	1083.5	0.0	0.0	0.0
LCHH_1	17	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	18	knapsack	0.1	WG	no		725.8	5.2	52.3	6.3	0.0	5.2
LCHH_1	19	knapsack	0.1	WG	no		NA	NA	NA	NA	NA	NA
LCHH_1	20	knapsack	0.1	WG	no		2768.9	130.9	9087.9	168.6	4.0	0.0
LCHH_2	AA	knapsack	1.5	liquid	no		633.5	2.5	NA	NA	NA	NA
LCHH_2	AB	knapsack	1.5	liquid	no		875.5	2.5	NA	NA	NA	NA
LCHH_2	AC	knapsack	1.5	liquid	no		9495.0	5.0	NA	NA	NA	NA
LCHH_2	AD	knapsack	1.5	liquid	no		270.5	2.5	NA	NA	NA	NA
LCHH_2	AE	knapsack	1.5	liquid	no		2897.0	5.0	NA	NA	NA	NA
LCHH_2	AF	knapsack	1.5	liquid	no		1027.0	48.0	NA	NA	NA	NA
LCHH_2	AH	knapsack	1.2	liquid	no		889.5	2.5	NA	NA	NA	NA
LCHH_2	AI	knapsack	1.4	liquid	no		1118.0	8.0	NA	NA	NA	NA
LCHH_2	AJ	knapsack	1.2	liquid	no		720.0	5.0	NA	NA	NA	NA
LCHH_3	2	knapsack	0.2	liquid	yes		5176.5	2.5	360.2	81.9	5.0	26.0
LCHH_3	3	knapsack	0.2	liquid	yes		5146.8	21.8	830.3	59.4	5.0	26.0
LCHH_3	4	knapsack	0.2	liquid	yes		11260.4	150.4	234.4	24.9	5.0	26.0

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LCHH_3	5	knapsack	0.2	liquid	yes		5720.7	163.7	634.4	12.4	15.0	26.0
LCHH_3	7	knapsack	0.2	liquid	yes		6361.5	139.5	542.7	11.7	5.0	25.4
LCHH_3	8	knapsack	0.2	liquid	yes		13652.5	2.5	2786.9	29.3	5.0	23.7
LCHH_3	9	knapsack	0.2	liquid	yes		9388.6	144.6	378.6	13.2	19.0	26.7
LCHH_3	10	knapsack	0.2	liquid	yes		3960.5	123.5	120.4	10.2	5.0	26.0
LCHH_3	11	knapsack	0.2	liquid	yes		7325.4	340.4	399.0	22.8	11.4	25.4
LCHH_3	12	knapsack	0.2	liquid	yes		2506.0	165.0	148.9	51.8	5.0	26.0
LCHH_3	13	knapsack	0.2	liquid	yes		3852.0	5.0	31.0	16.0	5.0	26.0
LCHH_3	14	knapsack	0.2	liquid	yes		3737.7	45.7	865.2	12.2	5.0	26.0
LCHH_3	15	knapsack	0.2	liquid	yes		2687.5	2.5	342.6	102.6	5.0	24.2
LCHH_3	16	knapsack	0.2	liquid	yes		10031.6	122.6	720.6	16.9	5.0	26.0
LCHH_3	17	knapsack	0.2	liquid	yes		25482.5	2.5	974.1	60.7	5.0	23.7
LCHH_3	19	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	20	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	21	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	22	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	23	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	24	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	25	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	26	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	27	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	28	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	29	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	30	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	31	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	32	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_3	33	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	1	knapsack	0.2	liquid	yes		4813.7	3.7	144.7	39.8	5.0	2.6
LCHH_4	4	knapsack	0.2	liquid	yes		12115.0	5.0	606.8	119.9	5.0	2.6
LCHH_4	5	knapsack	0.2	liquid	yes		19435.0	5.0	248.0	6.0	5.0	2.6
LCHH_4	6	knapsack	0.2	liquid	yes		46641.8	11.8	496.5	24.6	5.0	2.6
LCHH_4	7	knapsack	0.2	liquid	yes		13582.3	2.3	802.9	5.2	5.0	2.6
LCHH_4	8	knapsack	0.2	liquid	yes		4800.0	3.0	410.1	3.5	5.0	2.6
LCHH_4	9	knapsack	0.2	liquid	yes		2924.3	1.3	243.5	1.7	5.0	2.6

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LCHH_4	10	knapsack	0.2	liquid	yes		9073.4	1.4	1094.0	11.9	5.0	2.6
LCHH_4	11	knapsack	0.2	liquid	yes		9317.6	5.6	261.0	2.4	5.0	8.0
LCHH_4	12	knapsack	0.2	liquid	yes		54768.3	8.3	17478.5	23.2	5.0	8.3
LCHH_4	13	knapsack	0.2	liquid	yes		14791.6	1.6	365.2	15.0	5.0	2.5
LCHH_4	14	knapsack	0.2	liquid	yes		9934.3	0.3	296.5	4.3	5.0	2.4
LCHH_4	15	knapsack	0.2	liquid	yes		6786.9	2.9	128.5	2.6	5.0	10.3
LCHH_4	17	knapsack	0.2	liquid	yes		12871.9	1.9	459.8	1.5	5.0	2.6
LCHH_4	18	knapsack	0.2	liquid	yes		9042.3	0.3	94.4	2.4	5.0	2.6
LCHH_4	19	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	20	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	21	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	23	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	24	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	25	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	26	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	27	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	28	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	30	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	31	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	33	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	34	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	35	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
LCHH_4	36	knapsack	0.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	1	tank	0.2	liquid	yes	yes	559.5	2.0	NA	NA	NA	NA
HCHH_1	2	tank	0.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	3	tank	0.3	liquid	yes		560.7	2.0	NA	NA	NA	NA
HCHH_1	4	tank	0.3	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	7	tank	0.4	liquid	yes		71.5	7.3	NA	NA	NA	NA
HCHH_1	8	tank	0.4	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	9	tank	0.8	liquid	yes		274.3	266.3	NA	NA	NA	NA
HCHH_1	10	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	11	tank	0.5	liquid	yes		156.9	4.0	NA	NA	NA	NA
HCHH_1	12	tank	0.5	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	13	tank	0.3	liquid	yes		7388.6	6.0	NA	NA	NA	NA

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HCHH_1	14	tank	0.3	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	15	tank	0.5	liquid	yes		2720.0	21.4	NA	NA	NA	NA
HCHH_1	16	tank	0.5	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	17	tank	0.4	liquid	yes		1726.6	2.0	NA	NA	NA	NA
HCHH_1	18	tank	0.3	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	19	tank	0.6	liquid	yes		171.1	2.0	NA	NA	NA	NA
HCHH_1	20	tank	0.3	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	21	tank	0.7	liquid	yes		541.1	2.0	NA	NA	NA	NA
HCHH_1	22	tank	0.5	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	23	tank	0.4	liquid	yes		158.1	4.0	NA	NA	NA	NA
HCHH_1	24	tank	0.3	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_1	25	tank	0.4	liquid	yes		538.7	8.0	NA	NA	NA	NA
HCHH_1	26	tank	0.4	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_2	1	tank	7.7	WP	no		96519.0	3389.0	346161.0	13231.0	1028.8	3978.3
HCHH_2	4	tank	5.6	WP	no	yes	32709.0	1069.0	105490.9	3438.9	105.0	1217.9
HCHH_2	9	tank	5.1	WP	no		56479.0	4179.0	450080.7	24890.7	705.8	1411.2
HCHH_2	10	tank	6.8	WP	no		85903.1	283.1	52183.8	2189.8	69.5	665.2
HCHH_2	13	tank	6.8	WP	no	yes	19554.2	614.2	65332.5	1333.5	90.5	1697.4
HCHH_2	16	tank	9.4	WP	no	yes	72156.0	916.0	222560.5	7686.5	823.8	559.4
HCHH_2	22	tank	7.5	WP	no		41597.0	2997.0	100002.8	2779.8	180.3	2801.3
HCHH_2	25	tank	7.7	WP	no	yes	79590.0	2200.0	441555.3	15105.3	954.2	4982.5
HCHH_2	26	tank	6.8	WP	no		58774.6	94.6	55904.5	2265.5	224.8	897.9
HCHH_2	30	tank	9.2	WP	no		133149.7	349.7	192730.9	5212.9	728.6	4272.0
HCHH_2	2	tank	3.8	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	3	tank	3.8	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	5	tank	2.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	6	tank	2.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	7	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	8	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	11	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	12	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	14	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	15	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	17	tank	4.2	WP	no		NA	NA	NA	NA	NA	NA

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HCHH_2	18	tank	4.2	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	19	tank	3.3	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	27	tank	3.3	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	20	tank	3.1	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	21	tank	3.1	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	23	tank	3.5	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	24	tank	3.5	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	28	tank	5.1	WP	no		NA	NA	NA	NA	NA	NA
HCHH_2	29	tank	5.1	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	3	tank	5.1	WP	no		145710.0	11210.0	155522.1	3124.1	1014.6	964.6
HCHH_3	6	tank	7.7	WP	no		179582.0	8082.0	568452.2	15222.2	2610.0	8504.4
HCHH_3	7	tank	3.4	WP	no		48739.6	289.6	57510.6	1172.6	161.5	1684.7
HCHH_3	10	tank	5.6	WP	no		129010.0	11310.0	471664.7	4332.7	599.2	2284.9
HCHH_3	18	tank	7.0	WP	no		95915.0	9265.0	239521.8	5981.8	423.8	1857.3
HCHH_3	21	tank	6.8	WP	no		48815.3	115.3	29301.0	1450.0	403.2	958.8
HCHH_3	24	tank	6.8	WP	no		5844.7	104.7	27859.6	2128.6	65.8	1765.6
HCHH_3	30	tank	8.5	WP	no		92805.0	2225.0	423989.5	15059.5	1477.0	4861.8
HCHH_3	33	tank	9.4	WP	no		81532.0	1292.0	133966.9	4630.9	462.2	3528.1
HCHH_3	34	tank	7.7	WP	no		64649.6	969.6	79508.6	3035.6	300.2	5132.7
HCHH_3	1	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	2	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	4	tank	3.8	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	5	tank	3.8	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	8	tank	1.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	9	tank	1.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	12	tank	2.6	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	16	tank	3.2	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	17	tank	3.2	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	19	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	20	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	22	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	23	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	26	tank	4.3	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	27	tank	4.3	WP	no		NA	NA	NA	NA	NA	NA

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HCHH_3	29	tank	4.3	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	31	tank	4.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	32	tank	4.7	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	35	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_3	36	tank	3.4	WP	no		NA	NA	NA	NA	NA	NA
HCHH_4	3	tank	10.1	liquid	yes		2072.5	62.5	1192.9	29.1	13.2	0.5
HCHH_4	6	tank	12.1	liquid	yes		6407.1	143.1	1056.3	45.3	1.0	1.2
HCHH_4	9	tank	10.1	liquid	yes		3783.1	71.1	564.0	49.6	0.5	0.5
HCHH_4	12	tank	11.8	liquid	yes		707.0	29.7	157.5	4.1	0.5	0.5
HCHH_4	15	tank	11.8	liquid	yes		11431.0	1774.0	11298.4	243.9	3.5	1.6
HCHH_4	18	tank	10.1	liquid	yes	yes	15229.7	149.7	1473.6	19.9	1.1	0.5
HCHH_4	21	tank	13.5	liquid	yes		8233.5	413.5	3763.6	46.6	0.9	0.5
HCHH_4	24	tank	10.1	liquid	yes		14843.0	3903.0	39868.2	215.2	5.4	0.5
HCHH_4	27	tank	13.5	liquid	yes		14912.1	102.1	1410.5	57.8	9.1	1.6
HCHH_4	30	tank	10.1	liquid	yes		7481.4	80.4	355.4	5.6	1.9	0.5
HCHH_4	33	tank	11.8	liquid	yes		3319.9	2.9	5180.8	119.1	3632.0	0.5
HCHH_4	36	tank	10.1	liquid	yes		593.8	50.1	740.2	4.5	12.2	0.5
HCHH_4	1	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	2	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	4	tank	6.0	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	5	tank	6.0	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	7	tank	4.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	8	tank	4.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	10	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	11	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	13	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	14	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	16	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	17	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	19	tank	6.8	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	20	tank	6.8	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	22	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	23	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	25	tank	6.8	liquid	no		NA	NA	NA	NA	NA	NA

Study code	Op.#	ML type	TA (kg a.s.)	Form. type	Face shield ML	Glove wash ML	Total Hand ML (µg)	Prot. hand ML (µg)	Total body ML (µg)	Inner body ML (µg)	Head ML (µg)	Inhalation ML (µg)
HCHH_4	26	tank	6.8	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	28	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	29	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	31	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	32	tank	5.9	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	34	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_4	35	tank	5.1	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	3	tank	0.8	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	4	tank	0.8	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	5	tank	1.0	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	6	tank	1.0	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	7	tank	1.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	8	tank	1.2	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	9	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	10	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	11	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	12	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	13	tank	0.6	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	14	tank	0.7	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	15	tank	0.5	liquid	no		NA	NA	NA	NA	NA	NA
HCHH_5	16	tank	0.5	liquid	no		NA	NA	NA	NA	NA	NA

17.2 Application

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCTM_1	A	LCTM	25.1	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	B	LCTM	25.1	cabin	coarse	normal	NA	225.8	16.5	159.0	12.6	12.9	1.4
LCTM_1	C	LCTM	28.2	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	D	LCTM	28.2	cabin	coarse	normal	NA	79.5	79.3	279.8	12.1	9.6	2.1
LCTM_1	E	LCTM	28.5	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	F	LCTM	28.5	cabin	coarse	normal	NA	80.2	5.6	87.9	12.9	12.9	0.3
LCTM_1	G	LCTM	21.3	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	H	LCTM	21.3	cabin	coarse	normal	NA	46.1	46.1	172.6	8.2	23.4	1.1
LCTM_1	I	LCTM	25.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	J	LCTM	25.0	cabin	coarse	normal	NA	6.7	NA	327.5	7.3	4.2	1.4
LCTM_1	K	LCTM	24.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	L	LCTM	24.0	cabin	other	normal	NA	17.5	8.9	235.1	2.5	2.4	2.3
LCTM_1	M	LCTM	33.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_1	N	LCTM	33.0	cabin	coarse	normal	NA	58.7	30.2	425.4	6.0	5.3	0.9
LCTM_2	1	LCTM	9.0	cabin	other	normal	NA	1613.4	19.2	NA	NA	NA	NA
LCTM_2	2	LCTM	6.3	cabin	other	normal	NA	105.6	55.6	NA	NA	NA	NA
LCTM_2	3	LCTM	6.8	cabin	other	normal	NA	5.0	5.0	NA	NA	NA	NA
LCTM_2	4	LCTM	10.0	cabin	other	normal	NA	193.9	33.9	NA	NA	NA	NA
LCTM_2	5	LCTM	8.8	cabin	other	normal	NA	308.4	98.4	NA	NA	NA	NA
LCTM_2	6	LCTM	7.3	cabin	other	normal	NA	610.0	500.0	NA	NA	NA	NA
LCTM_2	7	LCTM	4.9	cabin	other	normal	NA	390.0	100.0	NA	NA	NA	NA
LCTM_2	8	LCTM	10.3	cabin	other	normal	NA	500.0	500.0	NA	NA	NA	NA
LCTM_2	9	LCTM	7.5	cabin	other	normal	NA	0.0	0.0	NA	NA	NA	NA
LCTM_2	10	LCTM	3.8	cabin	other	normal	NA	50.0	0.0	NA	NA	NA	NA
LCTM_2	11	LCTM	5.8	cabin	other	normal	NA	5.0	5.0	NA	NA	NA	NA
LCTM_2	12	LCTM	7.0	cabin	other	normal	NA	5.0	5.0	NA	NA	NA	NA
LCTM_2	13	LCTM	7.9	cabin	other	normal	NA	65.6	65.6	NA	NA	NA	NA
LCTM_2	14	LCTM	8.3	cabin	other	normal	NA	82.0	82.0	NA	NA	NA	NA
LCTM_2	15	LCTM	9.6	cabin	other	normal	NA	40.0	40.0	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCTM_3	WM	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	JT	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	HM	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	JK	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	RV	LCTM	4.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	YB	LCTM	8.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	JM	LCTM	8.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	JD	LCTM	8.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	JB	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_3	EG	LCTM	7.5	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_4	SH	LCTM	2.5	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_4	SC	LCTM	2.5	cabin	other	normal	NA	0.0	NA	0.0	0.0	0.0	NA
LCTM_4	TS	LCTM	2.3	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_4	THR	LCTM	2.3	cabin	other	normal	NA	17.9	NA	26.2	0.5	0.0	NA
LCTM_4	SC	LCTM	3.1	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_4	SH	LCTM	3.1	cabin	other	normal	NA	6.8	NA	8.3	2.0	0.0	NA
LCTM_4	THR	LCTM	2.9	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_4	TS	LCTM	2.9	cabin	other	normal	NA	12.3	NA	9.3	0.0	0.0	NA
LCTM_5	1	LCTM	200.0	cabin	coarse	normal	NA	14822.7	99.7	NA	NA	NA	2.8
LCTM_5	2	LCTM	200.0	cabin	coarse	normal	NA	13.2	13.2	NA	NA	NA	2.1
LCTM_5	3	LCTM	192.0	cabin	coarse	normal	NA	8441.9	41.9	NA	NA	NA	27.9
LCTM_5	4	LCTM	160.0	cabin	coarse	normal	NA	22.9	22.9	NA	NA	NA	5.6
LCTM_5	5	LCTM	192.0	cabin	other	normal	NA	6386.0	13.0	NA	NA	NA	13.2
LCTM_5	6	LCTM	192.0	cabin	coarse	normal	NA	9991.5	57.5	NA	NA	NA	17.3
LCTM_5	7	LCTM	208.0	cabin	other	normal	NA	1.2	1.2	NA	NA	NA	1.7
LCTM_5	8	LCTM	188.0	cabin	other	normal	NA	8125.2	24.2	NA	NA	NA	12.0
LCTM_5	9	LCTM	200.0	cabin	coarse	normal	NA	20934.3	68.3	NA	NA	NA	14.5
LCTM_5	10	LCTM	200.0	cabin	coarse	normal	NA	9.4	9.4	NA	NA	NA	7.5
LCTM_5	11	LCTM	179.0	cabin	other	normal	NA	13716.0	313.0	NA	NA	NA	12.5
LCTM_5	12	LCTM	250.0	cabin	other	normal	NA	819.0	NA	NA	NA	NA	69.7
LCTM_6	1	LCTM	1.0	cabin	other	small area	NA	2485.3	21.3	2134.2	29.0	0.0	0.0

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCTM_6	2	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	3	LCTM	0.7	no cabin	other	small area	NA	11.2	NA	454.7	0.0	0.0	0.0
LCTM_6	4	LCTM	0.7	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	5	LCTM	1.0	cabin	other	small area	NA	1555.5	NA	2704.4	6.3	150.0	0.0
LCTM_6	6	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	7	LCTM	1.0	no cabin	other	small area	NA	321.9	NA	2342.2	24.7	12.8	18.3
LCTM_6	8	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	9	LCTM	1.2	cabin	other	small area	NA	752.3	2.0	750.7	2.0	4.0	0.0
LCTM_6	10	LCTM	1.2	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	11	LCTM	1.0	cabin	other	small area	NA	426.2	NA	1696.8	26.7	4.0	0.0
LCTM_6	12	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	13	LCTM	1.0	no cabin	other	small area	NA	219.4	NA	844.5	15.1	4.0	40.9
LCTM_6	14	LCTM	0.9	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	15	LCTM	1.0	no cabin	other	small area	NA	3637.7	NA	903.5	11.8	12.9	5.2
LCTM_6	16	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	17	LCTM	1.0	cabin	other	small area	NA	392.4	NA	896.3	31.5	4.0	5.2
LCTM_6	18	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_6	19	LCTM	1.0	cabin	other	small area	NA	980.7	NA	800.4	8.3	0.0	0.0
LCTM_6	20	LCTM	1.0	NA	other	small area	NA	NA	NA	NA	NA	NA	NA
LCTM_7	A	LCTM	14.0	cabin	coarse	normal	NA	0.0	NA	NA	NA	NA	2.2
LCTM_7	B	LCTM	4.0	cabin	coarse	normal	NA	1440.9	NA	NA	NA	NA	1.4
LCTM_7	C1	LCTM	6.0	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	1.4
LCTM_7	D	LCTM	13.1	cabin	other	normal	NA	831.7	6.7	NA	NA	NA	1.4
LCTM_7	E	LCTM	5.3	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	1.4
LCTM_8	1	LCTM	56.4	cabin	other	normal	NA	6264.0	1537.0	NA	NA	469.5	0.8
LCTM_8	2	LCTM	56.4	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	4	LCTM	47.3	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	5	LCTM	58.6	cabin	other	normal	NA	22448.4	3963.9	4859.9	35.1	61.1	7.8
LCTM_8	6	LCTM	58.6	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	7	LCTM	51.0	cabin	other	normal	NA	11846.2	780.5	7460.4	28.3	92.5	4.5
LCTM_8	8	LCTM	51.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCTM_8	9	LCTM	68.0	cabin	other	normal	NA	70746.8	NA	21204.9	359.0	266.5	4.7
LCTM_8	10	LCTM	68.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	11	LCTM	45.9	cabin	other	normal	NA	6808.1	338.5	3241.4	9.4	41.3	4.5
LCTM_8	12	LCTM	45.9	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	13	LCTM	51.0	cabin	other	normal	NA	26205.7	5271.8	8378.9	79.3	85.9	24.5
LCTM_8	14	LCTM	51.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	15	LCTM	68.0	cabin	other	normal	NA	2432.2	NA	1024.2	21.6	63.9	2.2
LCTM_8	16	LCTM	68.0	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	17	LCTM	56.7	cabin	other	normal	NA	1811.3	NA	755.5	44.8	42.5	2.0
LCTM_8	18	LCTM	56.7	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	19	LCTM	64.3	NA	other	normal	NA	NA	NA	NA	NA	NA	NA
LCTM_8	20	LCTM	64.3	cabin	other	normal	NA	1568.4	365.5	5284.2	38.2	210.2	11.1
LCTM_9	1	LCTM	33.5	cabin	other	normal	NA	30000.0	10000.0	706.0	157.0	4600.0	5.4
LCTM_9	2	LCTM	40.7	cabin	other	normal	NA	890.0	NA	1159.0	29.0	34.0	16.4
LCTM_9	3	LCTM	40.0	cabin	other	normal	NA	20500.0	NA	26091.0	91.0	74.0	35.3
LCTM_9	4	LCTM	27.5	cabin	other	normal	NA	3405.0	NA	675.0	15.0	30.0	1.0
LCTM_9	5	LCTM	42.3	cabin	other	normal	NA	45520.0	NA	3195.0	525.0	500.0	4.9
LCTM_9	6	LCTM	26.4	cabin	other	normal	NA	4760.0	NA	7924.0	134.0	118.0	10.0
LCTM_9	7	LCTM	40.0	cabin	other	normal	NA	150.0	NA	204.0	32.0	10.0	1.0
LCTM_9	8	LCTM	50.0	cabin	other	normal	NA	37210.0	NA	235.0	35.0	20.0	0.9
LCTM_9	9	LCTM	35.0	cabin	other	normal	NA	520.0	NA	358.0	53.0	10.0	1.0
LCTM_9	10	LCTM	56.5	cabin	other	normal	NA	3700.0	NA	2802.0	162.0	174.0	5.5
LCTM_9	11	LCTM	45.0	cabin	other	normal	NA	2100.0	NA	2967.0	47.0	198.0	6.8
LCTM_9	12	LCTM	47.5	cabin	other	normal	NA	4850.0	NA	2596.0	116.0	34.0	3.6
LCTM_9	13	LCTM	27.0	cabin	other	normal	NA	350.0	NA	876.0	26.0	110.0	9.5
LCTM_9	14	LCTM	25.0	cabin	other	normal	NA	1500.0	NA	1014.0	46.0	10.0	1.0
LCTM_9	15	LCTM	25.0	cabin	other	normal	NA	27600.0	NA	10688.0	48.0	32.0	6.0
LCTM_9	16	LCTM	41.4	cabin	other	normal	NA	23200.0	NA	6791.0	231.0	400.0	6.7
LCTM_10	A	LCTM	4.6	cabin	coarse	normal	NA	288.7	NA	NA	NA	NA	2.2
LCTM_10	B	LCTM	12.8	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	5.8
LCTM_10	C	LCTM	31.3	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	2.2

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCTM_10	D	LCTM	12.0	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	2.2
LCTM_10	E	LCTM	5.6	cabin	coarse	normal	NA	1980.9	NA	NA	NA	NA	3.6
LCTM_10	F	LCTM	7.1	cabin	coarse	normal	NA	40.5	NA	NA	NA	NA	3.2
LCTM_10	H	LCTM	15.0	cabin	coarse	normal	NA	0.0	0.0	NA	NA	NA	2.2
LCTM_11	1	LCTM	203.8	cabin	other	normal	NA	13092.6	23.2	NA	NA	NA	NA
LCTM_11	2	LCTM	195.8	cabin	coarse	normal	NA	1460.7	19.5	NA	NA	NA	NA
LCTM_11	3	LCTM	213.6	cabin	other	normal	NA	118.0	18.6	NA	NA	NA	NA
LCTM_11	4	LCTM	211.8	cabin	other	normal	NA	296.3	9.3	NA	NA	NA	NA
LCTM_11	6	LCTM	209.5	cabin	other	normal	NA	3083.4	7.4	NA	NA	NA	NA
LCTM_11	7	LCTM	212.1	cabin	coarse	normal	NA	26422.2	8.3	NA	NA	NA	NA
LCTM_11	8	LCTM	211.6	cabin	other	normal	NA	1207.0	252.7	NA	NA	NA	NA
LCTM_11	9	LCTM	213.4	cabin	coarse	normal	NA	28496.3	34.0	NA	NA	NA	NA
LCTM_11	11	LCTM	199.0	cabin	other	normal	NA	1130.8	109.0	NA	NA	NA	NA
LCTM_11	12	LCTM	199.3	cabin	other	normal	NA	44963.5	177.5	NA	NA	NA	NA
LCTM_11	13	LCTM	211.8	cabin	other	normal	NA	3711.9	1910.5	NA	NA	NA	NA
LCTM_11	14	LCTM	162.3	cabin	other	normal	NA	24231.7	231.0	NA	NA	NA	NA
HCTM_1	1	HCTM	1.4	no cabin	other	NA	NA	1173.7	33.7	NA	NA	NA	NA
HCTM_1	2	HCTM	1.2	no cabin	other	NA	NA	1369.2	9.2	NA	NA	NA	NA
HCTM_1	3	HCTM	1.2	no cabin	other	NA	NA	2757.8	57.8	NA	NA	NA	NA
HCTM_1	4	HCTM	1.3	no cabin	other	NA	NA	1513.2	53.2	NA	NA	NA	NA
HCTM_1	5	HCTM	1.0	no cabin	other	NA	NA	815.5	12.5	NA	NA	NA	NA
HCTM_1	6	HCTM	1.2	no cabin	other	NA	NA	1890.6	20.6	NA	NA	NA	NA
HCTM_1	7	HCTM	1.9	cabin	other	NA	NA	2586.8	6.8	NA	NA	NA	NA
HCTM_1	8	HCTM	1.9	no cabin	other	NA	NA	3047.8	17.8	NA	NA	NA	NA
HCTM_1	9	HCTM	1.2	no cabin	other	NA	NA	89.5	33.8	NA	NA	NA	NA
HCTM_1	10	HCTM	1.3	no cabin	other	NA	NA	333.9	34.9	NA	NA	NA	NA
HCTM_2	1	HCTM	5.8	cabin	other	NA	NA	9810.5	102.5	NA	NA	NA	NA
HCTM_2	2	HCTM	8.3	no cabin	other	NA	NA	24557.5	102.5	NA	NA	NA	NA
HCTM_2	3	HCTM	9.3	cabin	other	NA	NA	316.0	102.5	NA	NA	NA	NA
HCTM_2	4	HCTM	6.9	cabin	other	NA	NA	904.9	102.5	NA	NA	NA	NA
HCTM_2	5	HCTM	6.9	cabin	other	NA	NA	205.0	102.5	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
HCTM_2	6	HCTM	5.4	cabin	other	NA	NA	778.4	102.5	NA	NA	NA	NA
HCTM_2	7	HCTM	3.6	no cabin	other	NA	NA	7018.3	51.3	NA	NA	NA	NA
HCTM_2	8	HCTM	5.5	cabin	other	NA	NA	550.1	102.5	NA	NA	NA	NA
HCTM_2	10	HCTM	5.3	cabin	other	NA	NA	10863.8	153.8	NA	NA	NA	NA
HCTM_2	11	HCTM	4.7	no cabin	other	NA	NA	10652.5	102.5	NA	NA	NA	NA
HCTM_2	12	HCTM	6.6	no cabin	other	NA	NA	1539.5	102.5	NA	NA	NA	NA
HCTM_2	13	HCTM	4.8	cabin	other	NA	NA	3335.5	102.5	NA	NA	NA	NA
HCTM_2	14	HCTM	8.0	cabin	other	NA	NA	584.4	102.5	NA	NA	NA	NA
HCTM_2	15	HCTM	5.5	cabin	other	NA	NA	597.7	102.5	NA	NA	NA	NA
HCTM_2	17	HCTM	4.0	cabin	other	NA	NA	2083.5	102.5	NA	NA	NA	NA
HCTM_3	1	HCTM	2.7	no cabin	other	NA	NA	940.0	NA	5252.0	102.0	46.0	54.2
HCTM_3	2	HCTM	2.7	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	3	HCTM	2.4	cabin	other	NA	NA	142.0	NA	679.2	15.2	2.0	28.1
HCTM_3	4	HCTM	2.4	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	5	HCTM	2.7	no cabin	other	NA	NA	6810.0	NA	8110.0	100.0	34.0	33.3
HCTM_3	6	HCTM	2.7	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	7	HCTM	3.0	cabin	other	NA	NA	43.0	NA	68.0	4.0	2.0	5.2
HCTM_3	8	HCTM	3.0	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	9	HCTM	3.4	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	10	HCTM	3.4	no cabin	other	NA	NA	920.0	NA	8154.0	154.0	48.4	166.7
HCTM_3	11	HCTM	3.6	no cabin	other	NA	NA	3900.0	NA	24217.0	217.0	56.0	270.8
HCTM_3	12	HCTM	3.6	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	13	HCTM	3.6	no cabin	other	NA	NA	3180.0	NA	17562.0	262.0	48.0	93.8
HCTM_3	14	HCTM	3.6	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	15	HCTM	3.6	no cabin	other	NA	NA	4700.0	NA	29479.0	379.0	40.0	416.7
HCTM_3	16	HCTM	3.6	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	17	HCTM	3.2	no cabin	other	NA	NA	5710.0	NA	23079.0	229.0	116.0	260.4
HCTM_3	18	HCTM	3.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	19	HCTM	3.6	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	20	HCTM	3.6	no cabin	other	NA	NA	9020.0	NA	11206.0	246.0	16.4	135.4
HCTM_3	21	HCTM	3.0	no cabin	other	NA	NA	4160.0	NA	17640.0	440.0	94.0	218.8

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
HCTM_3	22	HCTM	3.0	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_3	23	HCTM	3.8	no cabin	other	NA	NA	558.0	NA	12448.0	98.0	14.0	114.6
HCTM_3	24	HCTM	3.8	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_4	1	HCTM	2.2	no cabin	other	NA	NA	582.2	23.0	1862.1	60.6	289.2	106.3
HCTM_4	2	HCTM	1.7	no cabin	other	NA	NA	647.7	4.0	2985.1	63.2	407.9	39.6
HCTM_4	3	HCTM	1.5	no cabin	other	NA	NA	801.9	10.2	8318.8	57.2	1943.4	18.8
HCTM_4	4	HCTM	1.8	no cabin	other	NA	NA	794.0	8.8	5714.6	26.4	1412.4	38.5
HCTM_4	5	HCTM	1.6	no cabin	other	NA	NA	250.5	8.6	1279.8	34.5	368.6	53.1
HCTM_4	7	HCTM	2.2	no cabin	other	NA	NA	283.6	7.4	4002.8	18.1	646.8	19.8
HCTM_4	8	HCTM	1.3	no cabin	other	NA	NA	727.7	16.4	9308.8	42.0	1218.5	14.6
HCTM_4	9	HCTM	1.8	no cabin	other	NA	NA	63.6	5.5	704.1	33.3	113.9	34.4
HCTM_4	10	HCTM	2.3	no cabin	other	NA	NA	509.9	5.0	2060.3	18.0	639.8	25.0
HCTM_4	11	HCTM	1.2	no cabin	other	NA	NA	757.1	12.9	620.6	31.4	95.4	21.9
HCTM_4	12	HCTM	1.1	no cabin	other	NA	NA	963.9	4.7	783.3	31.7	154.2	19.8
HCTM_4	13	HCTM	1.2	no cabin	other	NA	NA	908.9	4.0	18065.0	28.1	2649.9	28.1
HCTM_5	1A	HCTM	18.4	cabin	other	NA	NA	17522.5	416.1	5352.7	247.8	70.8	16.8
HCTM_5	1B	HCTM	15.8	cabin	other	NA	NA	19725.0	NA	131572.0	2532.6	433.3	41.8
HCTM_5	1M	HCTM	35.5	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	2A	HCTM	7.1	no cabin	other	NA	NA	2176.8	NA	54291.2	1604.3	1358.3	219.6
HCTM_5	2B	HCTM	30.7	no cabin	other	NA	NA	12080.4	NA	99905.6	2182.6	3637.5	441.6
HCTM_5	2M	HCTM	37.8	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	3A	HCTM	17.5	cabin	other	NA	NA	1546.5	914.3	10242.7	1393.5	133.3	117.4
HCTM_5	3M	HCTM	17.5	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	4A	HCTM	12.3	cabin	other	NA	NA	1014.7	NA	468.8	6.5	37.5	2.8
HCTM_5	4M	HCTM	12.3	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	5A	HCTM	17.5	cabin	other	NA	NA	423687.9	NA	56283.1	3291.3	3358.3	626.6
HCTM_5	5M	HCTM	17.5	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	6A	HCTM	5.3	cabin	other	NA	NA	17.9	NA	539.2	26.1	0.0	0.5
HCTM_5	6M	HCTM	7.0	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	7A	HCTM	10.0	no cabin	other	NA	NA	3248.2	NA	65833.3	708.7	1087.5	34.8
HCTM_5	7M	HCTM	13.5	NA	other	NA	NA	NA	NA	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
HCTM_5	8A	HCTM	13.7	cabin	other	NA	NA	485.7	NA	16484.0	928.3	204.2	182.0
HCTM_5	8M	HCTM	15.8	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	9A	HCTM	5.5	cabin	other	NA	NA	382.5	269.6	18006.7	480.4	16.7	22.1
HCTM_5	9B	HCTM	9.8	no cabin	other	NA	NA	11103.8	NA	62876.9	926.1	879.2	131.2
HCTM_5	9M	HCTM	21.0	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	10A	HCTM	7.0	cabin	other	NA	NA	573.4	325.0	4218.0	106.5	41.7	12.2
HCTM_5	10M	HCTM	7.0	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	11A	HCTM	10.0	cabin	other	NA	NA	630.2	62.5	757.9	102.2	29.2	15.6
HCTM_5	11M	HCTM	19.8	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_5	14A	HCTM	12.9	cabin	other	NA	NA	767.7	616.1	33981.4	810.9	87.5	30.3
HCTM_5	14M	HCTM	16.8	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
HCTM_6	1	HCTM	4.5	no cabin	other	NA	NA	9660.0	NA	231372.6	792.6	16560.0	72.9
HCTM_6	2	HCTM	3.6	no cabin	other	NA	NA	97980.0	9080.0	51717.8	397.8	13180.0	50.0
HCTM_6	3	HCTM	3.6	no cabin	other	NA	NA	66920.0	NA	432944.1	1474.1	72640.0	56.3
HCTM_6	4	HCTM	5.0	no cabin	other	NA	NA	9450.0	3850.0	34237.7	277.7	3240.0	35.4
HCTM_6	5	HCTM	2.4	no cabin	other	NA	NA	6260.0	NA	257516.3	426.3	87860.0	33.3
HCTM_6	6	HCTM	7.2	no cabin	other	NA	NA	9820.0	6620.0	63577.7	827.7	12280.0	NA
HCTM_6	7	HCTM	8.0	no cabin	other	NA	NA	820.0	220.0	62158.7	928.7	4820.0	23614.6
HCTM_6	8	HCTM	6.3	no cabin	other	NA	NA	38980.0	180.0	191696.8	4016.8	44420.0	45.8
HCTM_6	9	HCTM	6.7	cabin	other	NA	NA	2910.0	NA	6274.1	844.1	NA	12.5
HCTM_6	10	HCTM	10.0	no cabin	other	NA	NA	28240.0	NA	77100.2	1070.2	11580.0	54.2
HCTM_6	11	HCTM	6.3	no cabin	other	NA	NA	9730.0	3530.0	50649.9	249.9	7580.0	16.7
HCTM_6	12	HCTM	6.0	no cabin	other	NA	NA	12360.0	260.0	96226.1	796.1	21320.0	31.3
HCTM_6	13	HCTM	3.8	cabin	other	NA	NA	4560.0	2860.0	12146.1	156.1	3400.0	12.5
HCTM_6	14	HCTM	5.0	cabin	other	NA	NA	5580.0	380.0	8211.6	111.6	480.0	12.5
HCTM_6	15	HCTM	3.6	cabin	other	NA	NA	6800.0	6800.0	38287.6	187.6	700.0	20.8
HCTM_6	16	HCTM	5.4	cabin	other	NA	NA	190.0	190.0	293.1	13.1	40.0	4.2
HCTM_6	17	HCTM	3.8	cabin	other	NA	NA	3300.0	NA	22178.1	218.1	220.0	12.5
HCTM_7	A	HCTM	4.0	cabin	other	NA	NA	4518.0	43.0	NA	NA	NA	4.8
HCTM_7	B	HCTM	8.0	cabin	other	NA	NA	0.0	0.0	NA	NA	NA	3.4
HCTM_7	C	HCTM	7.5	cabin	other	NA	NA	29931.6	222.4	NA	NA	NA	5.1

code			(kg a.s.)	status	type	type	type	A (µg)	hand A (µg)	A (µg)	body A (µg)	A (µg)	A (µg)
HCTM_7	D	HCTM	4.5	cabin	other	NA	NA	181.4	1.3	NA	NA	NA	2.5
HCTM_7	E	HCTM	7.5	cabin	other	NA	NA	0.0	0.0	NA	NA	NA	0.9
HCTM_7	F	HCTM	8.0	cabin	other	NA	NA	21.6	2.7	NA	NA	NA	2.2
HCTM_7	G	HCTM	13.5	cabin	other	NA	NA	12.8	NA	NA	NA	NA	4.4
HCTM_7	H	HCTM	10.0	cabin	other	NA	NA	574.4	6.6	NA	NA	NA	2.5
HCTM_7	I	HCTM	7.5	cabin	other	NA	NA	205.6	18.1	NA	NA	NA	0.8
HCTM_7	J	HCTM	3.8	cabin	other	NA	NA	0.0	0.0	NA	NA	NA	0.9
HCTM_7	K	HCTM	6.0	cabin	other	NA	NA	25.1	NA	NA	NA	NA	14.5
HCTM_7	L	HCTM	4.8	cabin	other	NA	NA	0.0	NA	NA	NA	NA	18.1
HCTM_8	1	HCTM	1.6	cabin	other	NA	NA	2653.0	373.0	13081.1	116.9	21.2	29.1
HCTM_8	2	HCTM	1.3	cabin	other	NA	NA	1655.4	NA	985.2	118.7	4.5	26.7
HCTM_8	3	HCTM	1.5	cabin	other	NA	NA	857.4	NA	3455.6	45.1	10.2	69.1
HCTM_8	4	HCTM	1.6	cabin	other	NA	NA	509.3	32.4	812.1	9.0	1.4	3.4
HCTM_8	5	HCTM	1.2	cabin	other	NA	NA	2367.2	NA	624.0	22.4	5.6	12.3
HCTM_8	6	HCTM	0.8	cabin	other	NA	NA	678.1	11.5	119.7	3.4	0.9	0.6
HCTM_8	7	HCTM	0.9	no cabin	other	NA	NA	2973.0	NA	7489.9	78.9	23.2	20.9
HCTM_8	8	HCTM	0.9	no cabin	other	NA	NA	2283.0	NA	8280.4	173.4	141.2	9.1
HCTM_8	9	HCTM	1.4	cabin	other	NA	NA	1371.2	NA	4123.0	38.1	54.3	18.4
HCTM_8	10	HCTM	0.8	no cabin	other	NA	NA	3555.0	NA	8928.0	169.4	53.5	56.4
HCTM_8	11	HCTM	1.2	cabin	other	NA	NA	180.4	NA	679.0	2.5	4.4	0.5
HCTM_8	12	HCTM	0.9	cabin	other	NA	NA	661.3	NA	892.6	14.0	4.2	9.0
HCTM_8	13	HCTM	2.2	cabin	other	NA	NA	4614.0	NA	165.3	21.0	10.5	2.2
HCTM_8	14	HCTM	1.8	cabin	other	NA	NA	2174.6	188.6	1365.4	70.1	8.8	5.2
HCTM_8	15	HCTM	1.2	no cabin	other	NA	NA	694.2	NA	2086.1	94.1	28.0	46.3
HCTM_8	16	HCTM	0.9	no cabin	other	NA	NA	2261.2	NA	5009.5	82.4	9.7	23.8
LCHH_1	1	LCHH	0.1	NA	other	NA	NA	157.7	2.0	5316.5	9.7	4.0	0.0
LCHH_1	2	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	3	LCHH	0.1	NA	other	NA	NA	0.0	0.0	266.4	35.7	0.0	0.0
LCHH_1	4	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	5	LCHH	0.1	NA	other	NA	NA	149.2	0.0	3323.6	3.4	4.0	0.0
LCHH_1	6	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA

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LCHH_1	8	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	9	LCHH	0.1	NA	other	NA	NA	119.6	0.0	4115.2	13.1	4.0	0.0
LCHH_1	10	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	11	LCHH	0.1	NA	other	NA	NA	1783.2	22.2	12667.1	71.2	4.0	5.2
LCHH_1	12	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	13	LCHH	0.1	NA	other	NA	NA	185.5	4.1	6607.5	75.2	4.0	0.0
LCHH_1	14	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	15	LCHH	0.1	NA	other	NA	NA	944.2	2.0	4486.5	88.5	0.0	5.2
LCHH_1	16	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	17	LCHH	0.1	NA	other	NA	NA	218.4	0.0	73220.3	232.9	4.0	5.2
LCHH_1	18	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_1	19	LCHH	0.1	NA	other	NA	NA	503.1	12.2	14063.5	259.7	16.5	0.0
LCHH_1	20	LCHH	0.1	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_2	AA	LCHH	1.5	NA	other	NA	NA	105.0	2.5	NA	NA	NA	NA
LCHH_2	AB	LCHH	1.5	NA	other	NA	NA	215.0	2.5	NA	NA	NA	NA
LCHH_2	AC	LCHH	1.5	NA	other	NA	NA	374.0	6.0	NA	NA	NA	NA
LCHH_2	AD	LCHH	1.5	NA	other	NA	NA	217.0	2.5	NA	NA	NA	NA
LCHH_2	AE	LCHH	1.5	NA	other	NA	NA	647.5	5.0	NA	NA	NA	NA
LCHH_2	AF	LCHH	1.5	NA	other	NA	NA	439.0	5.0	NA	NA	NA	NA
LCHH_2	AH	LCHH	1.2	NA	other	NA	NA	106.5	2.5	NA	NA	NA	NA
LCHH_2	AI	LCHH	1.4	NA	other	NA	NA	105.0	5.0	NA	NA	NA	NA
LCHH_2	AJ	LCHH	1.2	NA	other	NA	NA	110.0	10.0	NA	NA	NA	NA
LCHH_3	2	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	3	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	4	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	5	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	7	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	8	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	9	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	10	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	11	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA

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LCHH_3	12	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	13	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	14	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	15	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	16	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	17	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_3	19	LCHH	0.2	NA	other	NA	NA	2496.5	2.5	72399.4	2340.6	5.0	26.0
LCHH_3	20	LCHH	0.2	NA	other	NA	NA	4213.1	111.1	29433.0	1243.8	5.0	26.0
LCHH_3	21	LCHH	0.2	NA	other	NA	NA	480.4	NA	103712.8	40254.3	5.0	24.8
LCHH_3	22	LCHH	0.2	NA	other	NA	NA	1258.6	NA	43336.4	974.0	5.0	26.7
LCHH_3	23	LCHH	0.2	NA	other	NA	NA	2396.7	NA	137007.0	62630.4	5.0	26.0
LCHH_3	24	LCHH	0.2	NA	other	NA	NA	1105.9	NA	112577.2	37405.5	5.0	26.0
LCHH_3	25	LCHH	0.2	NA	other	NA	NA	859.3	NA	162862.1	70260.1	5.0	26.0
LCHH_3	26	LCHH	0.2	NA	other	NA	NA	228.4	NA	33444.5	1695.2	5.0	26.0
LCHH_3	27	LCHH	0.2	NA	other	NA	NA	520.0	NA	97221.0	17159.2	5.0	26.0
LCHH_3	28	LCHH	0.2	NA	other	NA	NA	2013.1	NA	20178.9	879.4	5.0	23.7
LCHH_3	29	LCHH	0.2	NA	other	NA	NA	362.4	NA	72764.4	7326.1	5.0	26.0
LCHH_3	30	LCHH	0.2	NA	other	NA	NA	1544.0	NA	52829.8	5491.1	5.0	26.0
LCHH_3	31	LCHH	0.2	NA	other	NA	NA	301.6	NA	41754.0	1425.0	5.0	24.8
LCHH_3	32	LCHH	0.2	NA	other	NA	NA	410.2	NA	38059.4	1845.6	5.0	26.0
LCHH_3	33	LCHH	0.2	NA	other	NA	NA	404.9	NA	120986.3	24404.3	5.0	26.0
LCHH_4	1	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	4	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	5	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	6	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	7	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	8	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	9	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	10	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	11	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	12	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
LCHH_4	13	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	14	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	15	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	17	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	18	LCHH	0.2	NA	other	NA	NA	NA	NA	NA	NA	NA	NA
LCHH_4	19	LCHH	0.2	NA	other	NA	NA	1197.7	NA	88868.4	8516.3	48.1	6.9
LCHH_4	20	LCHH	0.2	NA	other	NA	NA	3230.8	NA	75215.8	8902.8	34.5	9.4
LCHH_4	21	LCHH	0.2	NA	other	NA	NA	4812.8	NA	119849.3	24321.3	85.0	2.6
LCHH_4	23	LCHH	0.2	NA	other	NA	NA	3256.4	NA	43587.4	620.3	27.8	12.5
LCHH_4	24	LCHH	0.2	NA	other	NA	NA	2610.3	NA	40115.4	917.3	5.0	10.2
LCHH_4	25	LCHH	0.2	NA	other	NA	NA	311.5	NA	45087.2	1735.3	11.9	8.0
LCHH_4	26	LCHH	0.2	NA	other	NA	NA	1793.8	NA	95575.0	25260.2	21.1	7.3
LCHH_4	27	LCHH	0.2	NA	other	NA	NA	4635.9	NA	45839.9	1250.7	224.4	7.5
LCHH_4	28	LCHH	0.2	NA	other	NA	NA	879.0	NA	34815.8	1661.3	5.0	12.7
LCHH_4	30	LCHH	0.2	NA	other	NA	NA	493.3	NA	24009.5	625.5	5.0	14.6
LCHH_4	31	LCHH	0.2	NA	other	NA	NA	928.2	NA	35453.4	5672.5	15.0	9.8
LCHH_4	33	LCHH	0.2	NA	other	NA	NA	899.2	NA	106397.3	35806.0	5.0	8.6
LCHH_4	34	LCHH	0.2	NA	other	NA	NA	166.0	NA	40211.1	1525.0	5.0	8.6
LCHH_4	35	LCHH	0.2	NA	other	NA	NA	2088.7	NA	16957.0	517.9	35.4	7.1
LCHH_4	36	LCHH	0.2	NA	other	NA	NA	186.2	NA	20806.4	764.7	5.0	12.5
HCHH_1	1	HCHH	0.2	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	2	HCHH	0.2	NA	other	NA	normal	190.0	2.0	2269.2	6.0	4.0	6.5
HCHH_1	3	HCHH	0.3	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	4	HCHH	0.3	NA	other	NA	normal	86.8	2.0	2455.4	27.1	4.0	11.4
HCHH_1	7	HCHH	0.4	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	8	HCHH	0.4	NA	other	NA	normal	29.6	2.0	2387.5	18.7	18.4	2.1
HCHH_1	9	HCHH	0.8	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	10	HCHH	0.6	NA	other	NA	normal	17479.6	2.0	220190.2	1938.2	919.2	135.6
HCHH_1	11	HCHH	0.5	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	12	HCHH	0.5	NA	other	NA	normal	1713.6	2.0	177535.1	8980.1	157.9	44.1
HCHH_1	13	HCHH	0.3	NA	other	NA	normal	NA	NA	NA	NA	NA	NA

Study code	Op.#	A type	TA (kg a.s.)	Cabin status	Droplet type	Equipment type	Culture type	Total hand A (µg)	Prot. hand A (µg)	Total body A (µg)	Inner body A (µg)	Head A (µg)	Inhalation A (µg)
HCHH_1	14	HCHH	0.3	NA	other	NA	normal	3785.6	2.0	51719.3	561.3	119.1	34.4
HCHH_1	15	HCHH	0.5	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	16	HCHH	0.5	NA	other	NA	normal	1382.0	2.0	7612.6	50.2	32.6	20.8
HCHH_1	17	HCHH	0.4	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	18	HCHH	0.3	NA	other	NA	normal	542.1	4.2	2484.3	20.8	10.9	19.6
HCHH_1	19	HCHH	0.6	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	20	HCHH	0.3	NA	other	NA	normal	11.4	2.0	2475.2	14.7	4.0	12.0
HCHH_1	21	HCHH	0.7	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	22	HCHH	0.5	NA	other	NA	normal	2352.7	2.0	9330.0	75.1	58.1	18.8
HCHH_1	23	HCHH	0.4	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	24	HCHH	0.3	NA	other	NA	normal	16.6	2.0	2129.3	10.4	4.0	5.9
HCHH_1	25	HCHH	0.4	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_1	26	HCHH	0.4	NA	other	NA	normal	194.8	2.0	19771.6	104.7	4.0	14.9
HCHH_2	1	HCHH	7.7	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	4	HCHH	5.6	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	9	HCHH	5.1	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	10	HCHH	6.8	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	13	HCHH	6.8	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	16	HCHH	9.4	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	22	HCHH	7.5	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	25	HCHH	7.7	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	26	HCHH	6.8	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	30	HCHH	9.2	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_2	2	HCHH	3.8	NA	other	NA	dense	37620.3	710.3	1396912.5	23312.5	1377.8	385.7
HCHH_2	3	HCHH	3.8	NA	other	NA	dense	47461.0	741.0	1182691.1	10531.1	1219.4	389.3
HCHH_2	5	HCHH	2.7	NA	other	NA	dense	44048.7	268.7	1538183.2	39583.2	403.8	252.4
HCHH_2	6	HCHH	2.7	NA	other	NA	dense	33725.0	335.0	2186007.2	40507.2	361.2	421.7
HCHH_2	7	HCHH	2.6	NA	other	NA	dense	14370.6	430.6	588835.7	23145.7	534.8	121.1
HCHH_2	8	HCHH	2.6	NA	other	NA	dense	14067.0	1257.0	428364.9	6294.9	164.5	101.5
HCHH_2	11	HCHH	3.4	NA	other	NA	dense	32178.7	238.7	1855320.0	217320.0	530.0	333.2
HCHH_2	12	HCHH	3.4	NA	other	NA	dense	21332.4	62.4	686729.0	77549.0	129.7	168.1

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HCHH_2	14	HCHH	2.6	NA	other	NA	dense	28730.8	250.8	840102.6	8532.6	208.0	155.8
HCHH_2	15	HCHH	2.6	NA	other	NA	dense	18115.0	15.0	553056.6	12466.6	402.0	161.4
HCHH_2	17	HCHH	4.2	NA	other	NA	dense	60345.6	265.6	2346040.0	305040.0	3764.0	364.4
HCHH_2	18	HCHH	4.2	NA	other	NA	dense	57473.0	763.0	2218137.0	188037.0	4048.0	328.7
HCHH_2	19	HCHH	3.3	NA	other	NA	dense	15030.9	80.9	746416.2	8216.2	1361.0	270.6
HCHH_2	27	HCHH	3.3	NA	other	NA	dense	29395.7	55.7	686657.8	14507.8	1694.0	237.7
HCHH_2	20	HCHH	3.1	NA	other	NA	dense	28546.6	66.6	741366.5	11566.5	379.0	230.9
HCHH_2	21	HCHH	3.1	NA	other	NA	dense	22803.0	1043.0	436281.8	5731.8	470.0	214.4
HCHH_2	23	HCHH	3.5	NA	other	NA	dense	30796.1	126.1	1140427.0	30327.0	703.6	185.0
HCHH_2	24	HCHH	3.5	NA	other	NA	dense	28844.0	254.0	1348956.7	52056.7	1967.8	234.0
HCHH_2	28	HCHH	5.1	NA	other	NA	dense	45899.0	119.0	1605165.0	66565.0	3496.0	255.5
HCHH_2	29	HCHH	5.1	NA	other	NA	dense	73704.6	144.6	1785824.0	103924.0	3280.0	313.5
HCHH_3	3	HCHH	5.1	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	6	HCHH	7.7	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	7	HCHH	3.4	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	10	HCHH	5.6	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	18	HCHH	7.0	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	21	HCHH	6.8	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	24	HCHH	6.8	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	30	HCHH	8.5	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	33	HCHH	9.4	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	34	HCHH	7.7	NA	other	NA	dense	NA	NA	NA	NA	NA	NA
HCHH_3	1	HCHH	2.6	NA	other	NA	dense	30248.2	338.2	205029.9	2389.9	1117.2	345.3
HCHH_3	2	HCHH	2.6	NA	other	NA	dense	40007.1	537.1	309541.0	4411.0	709.0	249.2
HCHH_3	4	HCHH	3.8	NA	other	NA	dense	33286.2	436.2	320400.4	4290.4	1129.8	397.0
HCHH_3	5	HCHH	3.8	NA	other	NA	dense	44837.7	217.7	551992.2	8092.2	3214.0	355.6
HCHH_3	8	HCHH	1.7	NA	other	NA	dense	21715.9	65.9	341465.5	10105.5	357.2	185.5
HCHH_3	9	HCHH	1.7	NA	other	NA	dense	29877.8	127.8	482533.9	8553.9	740.2	229.1
HCHH_3	12	HCHH	2.6	NA	other	NA	dense	53495.0	1025.0	1398261.1	71781.1	1139.0	540.5
HCHH_3	16	HCHH	3.2	NA	other	NA	dense	31097.0	1357.0	575811.3	6161.3	776.8	266.1
HCHH_3	17	HCHH	3.2	NA	other	NA	dense	14012.5	102.5	267811.1	3901.1	452.6	156.3

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HCHH_3	19	HCHH	3.4	NA	other	NA	dense	36834.0	254.0	669147.2	6727.2	1136.4	2136.3
HCHH_3	20	HCHH	3.4	NA	other	NA	dense	58171.0	1381.0	1891400.0	41000.0	5176.0	551.4
HCHH_3	22	HCHH	3.4	NA	other	NA	dense	64775.9	835.9	1996593.0	51393.0	2788.0	562.2
HCHH_3	23	HCHH	3.4	NA	other	NA	dense	50385.3	75.3	587522.8	3422.8	1136.4	692.4
HCHH_3	26	HCHH	4.3	NA	other	NA	dense	28532.7	72.7	380362.0	3642.0	2048.0	399.0
HCHH_3	27	HCHH	4.3	NA	other	NA	dense	28672.9	462.9	409798.9	3038.9	4282.0	503.7
HCHH_3	29	HCHH	4.3	NA	other	NA	dense	44019.9	389.9	501508.7	4888.7	848.2	675.4
HCHH_3	31	HCHH	4.7	NA	other	NA	dense	51673.3	163.3	967294.5	4834.5	5274.0	528.4
HCHH_3	32	HCHH	4.7	NA	other	NA	dense	34154.9	344.9	1195969.0	11669.0	4248.0	449.9
HCHH_3	35	HCHH	3.4	NA	other	NA	dense	78038.0	1368.0	2470393.0	136393.0	5394.0	949.1
HCHH_3	36	HCHH	3.4	NA	other	NA	dense	66785.8	355.8	1323720.0	44920.0	1893.8	392.8
HCHH_4	3	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	6	HCHH	12.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	9	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	12	HCHH	11.8	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	15	HCHH	11.8	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	18	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	21	HCHH	13.5	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	24	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	27	HCHH	13.5	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	30	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	33	HCHH	11.8	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	36	HCHH	10.1	NA	other	NA	normal	NA	NA	NA	NA	NA	NA
HCHH_4	1	HCHH	5.1	NA	other	NA	normal	1245.9	5.9	5824.0	88.4	8.4	44.6
HCHH_4	2	HCHH	5.1	NA	other	NA	normal	1640.7	8.7	4920.2	42.1	9.3	57.6
HCHH_4	4	HCHH	6.0	NA	other	NA	normal	30547.5	877.5	181782.1	1033.1	1055.8	359.4
HCHH_4	5	HCHH	6.0	NA	other	NA	normal	12242.0	192.0	116092.6	673.6	184.4	177.6
HCHH_4	7	HCHH	4.2	NA	other	NA	normal	7852.2	121.2	77026.3	303.3	126.8	334.0
HCHH_4	8	HCHH	4.2	NA	other	NA	normal	6539.9	59.9	35664.0	351.0	36.5	207.5
HCHH_4	10	HCHH	5.9	NA	other	NA	normal	5969.0	1958.0	21599.9	241.9	17.1	214.1
HCHH_4	11	HCHH	5.9	NA	other	NA	normal	4341.3	353.3	14393.3	123.3	40.0	134.9

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HCHH_4	13	HCHH	5.9	NA	other	NA	normal	34301.5	141.5	152194.2	1732.2	295.6	378.5
HCHH_4	14	HCHH	5.9	NA	other	NA	normal	60542.4	252.4	254373.0	1113.0	1471.6	2165.6
HCHH_4	16	HCHH	5.1	NA	other	NA	normal	9034.3	213.3	55710.8	365.8	174.4	28.0
HCHH_4	17	HCHH	5.1	NA	other	NA	normal	6543.1	365.1	52851.0	411.0	256.6	29.2
HCHH_4	19	HCHH	6.8	NA	other	NA	normal	5579.6	32.6	36232.0	201.1	98.9	238.0
HCHH_4	20	HCHH	6.8	NA	other	NA	normal	2112.3	6.3	10973.6	171.5	66.5	154.3
HCHH_4	22	HCHH	5.1	NA	other	NA	normal	13889.4	629.4	39838.1	658.1	17.4	257.4
HCHH_4	23	HCHH	5.1	NA	other	NA	normal	2472.9	349.9	11528.1	200.6	27.1	229.8
HCHH_4	25	HCHH	6.8	NA	other	NA	normal	5174.8	19.8	9015.8	139.0	38.6	132.5
HCHH_4	26	HCHH	6.8	NA	other	NA	normal	7626.2	264.2	37474.7	200.2	46.7	123.9
HCHH_4	28	HCHH	5.1	NA	other	NA	normal	2810.2	79.2	31240.6	268.6	149.0	42.3
HCHH_4	29	HCHH	5.1	NA	other	NA	normal	14297.3	177.3	22283.4	241.4	67.2	38.9
HCHH_4	31	HCHH	5.9	NA	other	NA	normal	4092.7	44.7	16036.4	637.6	12.5	95.6
HCHH_4	32	HCHH	5.9	NA	other	NA	normal	2529.7	86.7	11128.8	199.5	9.3	0.5
HCHH_4	34	HCHH	5.1	NA	other	NA	normal	3905.6	47.6	5969.7	530.2	44.5	480.2
HCHH_4	35	HCHH	5.1	NA	other	NA	normal	2994.9	46.9	1739.6	204.4	24.1	400.2
HCHH_5	3	HCHH	0.8	NA	other	NA	normal	3309.1	0.1	132803.6	2833.6	769.0	66.9
HCHH_5	4	HCHH	0.8	NA	other	NA	normal	2547.0	4.0	81714.1	1704.1	118.7	25.6
HCHH_5	5	HCHH	1.0	NA	other	NA	normal	1256.1	0.1	71351.4	1472.4	382.0	58.1
HCHH_5	6	HCHH	1.0	NA	other	NA	normal	1633.1	0.1	53381.4	1496.4	227.4	83.8
HCHH_5	7	HCHH	1.2	NA	other	NA	normal	3213.1	0.1	93188.3	1523.3	466.6	77.1
HCHH_5	8	HCHH	1.2	NA	other	NA	normal	2642.2	0.2	24009.3	789.3	309.0	36.5
HCHH_5	9	HCHH	0.6	NA	other	NA	normal	1271.1	0.1	17113.0	766.0	94.9	9.4
HCHH_5	10	HCHH	0.6	NA	other	NA	normal	1214.0	2.0	9745.9	229.8	56.6	16.9
HCHH_5	11	HCHH	0.6	NA	other	NA	normal	373.0	1.0	4595.7	70.8	25.7	3.3
HCHH_5	12	HCHH	0.6	NA	other	NA	normal	596.8	0.1	12581.7	240.2	83.0	3.9
HCHH_5	13	HCHH	0.6	NA	other	NA	normal	975.8	3.0	70383.1	1720.1	129.6	62.5
HCHH_5	14	HCHH	0.7	NA	other	NA	normal	476.4	1.0	11400.7	126.2	20.6	41.3
HCHH_5	15	HCHH	0.5	NA	other	NA	normal	834.2	0.1	36706.6	1880.6	122.7	87.3
HCHH_5	16	HCHH	0.5	NA	other	NA	normal	547.3	0.1	30433.2	1644.2	72.6	157.3

NA: not available

18 Tables of empirical percentiles

18.1 ML tank

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	41	10.7	227.8	894.4	2172.2	3007.9	7162.3
WP	20	859.5	10661.1	13904.6	23044.3	23729.6	28570.6
liquid	169	4.0	1068.3	2842.4	5652.6	11636.4	26852.8
all	230	4.0	996.5	3110.0	8737.9	14076.9	28570.6

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	41	0.1	2.8	8.1	15.3	31.5	126.4
WP	20	13.9	164.4	537.1	1397.9	2025.1	2198.0
liquid	167	0.0	6.1	18.9	62.2	194.5	595.2
all	228	0.0	7.0	22.1	130.2	313.9	2198.0

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	29	36.6	437.4	955.9	1395.5	3194.7	4040.7
WP	20	4097.0	19899.4	46407.6	75284.3	84284.5	88251.1
liquid	80	13.3	661.3	1895.5	5293.6	11746.1	38701.6
all	129	13.3	861.9	3971.1	21556.4	36966.8	88251.1

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	29	0.0	7.9	15.8	31.9	50.6	85.2
WP	20	196.1	590.2	1076.1	1976.1	2134.4	4880.5
liquid	80	0.2	4.8	20.5	48.0	151.6	544.5
all	129	0.0	8.6	38.5	416.5	802.2	4880.5

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	29	0.0	3.5	6.5	39.9	80.2	94.0
WP	20	9.7	60.0	127.2	176.3	206.1	341.2
liquid	80	0.0	2.8	23.3	69.5	172.6	742.4
all	129	0.0	4.0	38.9	96.5	170.9	742.4

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
WG	41	0.0	4.6	9.4	13.3	13.9	38.7
WP	20	59.8	325.6	501.6	653.3	693.0	1111.7
liquid	100	0.0	0.2	0.9	1.9	3.5	18.2
all	161	0.0	0.5	5.4	141.0	377.3	1111.7

18.2 ML knapsack

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	49	180.3	21394.0	41727.2	64839.0	102504.5	243414.5

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	49	0.2	20.8	63.3	647.9	730.9	1512.8

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	40	137.6	1737.6	3530.8	7533.7	15553.4	77682.1

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	40	0.1	54.5	115.6	373.4	639.5	1405.3

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	40	0.1	22.2	23.3	41.7	51.3	84.7

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	40	0.1	36.1	112.9	115.7	115.7	118.7

18.3 Application LCTM

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	80	0.0	71.1	447.8	1155.6	2626.0	5451.1
coarse droplets *	27	0.0	2.8	57.4	128.2	287.7	360.2
normal equip.	87	0.0	19.4	103.4	369.4	689.1	1104.0
small equip.	20	15.6	646.9	2336.2	3828.0	4239.8	5451.1
all	107	0.0	46.7	273.2	1029.1	2072.8	5451.1

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	43	0.0	3.4	21.4	70.8	100.3	298.5
coarse droplets *	21	0.0	0.1	0.3	0.9	2.2	2.8
normal equip.	58	0.0	0.6	5.3	22.6	67.8	298.5
small equip.	6	1.7	52.0	72.0	91.1	100.5	109.9
all	64	0.0	0.8	8.9	62.0	72.1	298.5

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	49	0.0	164.0	827.9	1858.6	2666.1	4298.8
coarse droplets *	6	3.1	9.0	12.1	13.0	13.0	13.1
normal equip.	35	0.0	24.5	78.9	245.8	346.5	652.3
small equip.	20	99.0	937.4	1881.4	2949.0	4144.4	4298.8
all	55	0.0	82.9	667.6	1695.7	2553.0	4298.8

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	49	0.0	2.4	14.5	32.3	45.7	56.7
coarse droplets *	6	0.2	0.4	0.4	0.5	0.5	0.5
normal equip.	35	0.0	0.7	1.9	4.9	5.4	12.4
small equip.	20	0.0	18.6	32.3	49.9	52.5	56.7
all	55	0.0	1.8	12.4	31.4	42.7	56.7

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	50	0.0	2.5	8.3	24.9	147.7	362.7
coarse droplets *	6	0.2	0.4	0.5	0.8	1.0	1.1
normal equip.	36	0.0	0.9	3.1	6.4	10.2	137.3
small equip.	20	0.0	6.7	16.5	159.2	194.6	362.7
all	56	0.0	1.7	6.1	17.8	142.0	362.7

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal droplets	49	0.0	0.1	0.4	5.9	22.3	40.8
coarse droplets *	24	0.0	0.1	0.2	0.5	0.5	0.7
normal equip.	56	0.0	0.1	0.2	0.4	0.5	0.9
small equip.	17	0.0	1.1	8.0	30.7	40.2	40.8
all	73	0.0	0.1	0.4	2.6	12.4	40.8

* nozzles are assumed to produce a ‘coarse’ droplet spectrum when they are classified for at least 50 % drift reduction
(according to definition by Julius Kühn Institut)

18.4 Application HCTM

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	55	34.9	1136.3	2216.9	2903.3	4970.1	27216.7
cabin	54	0.0	137.4	1126.1	1831.2	2051.8	24210.7
all	109	0.0	699.3	1644.0	2539.4	3793.6	27216.7

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	32	2.2	13.7	28.4	513.1	837.3	2522.2
cabin	35	0.0	18.6	40.8	93.4	394.2	1888.9
all	67	0.0	17.7	32.4	157.5	767.8	2522.2

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	42	386.9	6517.1	8655.9	15998.0	50378.9	120262.2
cabin	30	22.7	765.7	2862.0	6151.2	8322.6	10635.5
all	72	22.7	3157.1	7630.4	11070.0	22622.9	120262.2

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	42	7.9	71.1	113.8	184.5	224.0	642.7
cabin	30	0.5	24.7	66.7	96.3	145.2	188.1
all	72	0.5	48.9	95.2	174.6	198.4	642.7

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	42	3.7	144.3	1110.3	3650.3	6935.8	36608.3
cabin	29	0.0	4.9	15.0	115.2	193.4	906.7
all	71	0.0	36.8	262.0	1705.6	3670.6	36608.3

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
no cabin	41	2.7	18.9	33.7	72.9	82.7	2951.8
cabin	42	0.1	2.0	5.3	13.3	20.8	45.4
all	83	0.1	10.4	21.3	43.8	72.6	2951.8

18.5 Application LCHH

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	48	0.2	2114.1	7139.8	14393.2	17372.2	21390.3

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	20	0.1	3.5	15.6	110.0	200.3	493.9

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	39	4440.1	192606.4	409874.2	533674.2	583893.8	723831.6

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	39	34.9	6777.6	38709.1	160559.6	181348.0	312267.1

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	39	0.1	22.2	47.2	154.3	230.2	997.3

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
all	39	0.1	52.0	115.7	115.7	115.7	118.7

18.6 Application HCHH

Total hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	42.3	1261.0	2516.7	4471.0	8232.1	28749.4
dense crop	40	4392.6	10595.6	14509.9	17722.8	19492.7	22685.5
all	90	42.3	4399.2	10324.9	14900.1	18387.3	28749.4

Protected hand exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	0.0	5.8	21.8	60.6	100.7	330.7
dense crop	40	5.7	83.5	184.1	398.1	407.1	492.9
all	90	0.0	24.2	87.6	196.5	368.0	492.9

Total body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	343.1	11868.3	39750.4	101233.8	159723.5	367567.5
dense crop	40	80089.8	233322.3	385370.5	564948.3	593778.4	824286.3
all	90	343.1	81872.6	229477.8	401624.2	560133.6	824286.3

Inner body exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	8.3	107.0	583.7	2737.7	3363.0	18592.3
dense crop	40	715.0	4553.8	14928.7	29299.4	46085.5	73238.9
all	90	8.3	1186.6	3685.0	15131.5	25746.0	73238.9

Head exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	1.6	32.8	153.1	330.1	378.9	1511.8
dense crop	40	38.2	348.4	659.2	975.5	1146.7	1568.0
all	90	1.6	152.4	371.5	845.6	991.5	1568.0

Inhalation exposure (µg/kg a.s.)

	n	min	50th perc.	75th perc.	90th perc.	95th perc.	max
normal crop	50	0.1	38.6	68.4	98.2	199.7	365.8
dense crop	40	39.8	95.7	122.6	169.2	215.2	628.3
all	90	0.1	63.6	97.9	162.5	218.1	628.3

19 Model computations (75^{th} percentile)

ML – tank

Model: log total hands ML/TA ~ form + glove.wash.ML

```
Table of measured values:
         n        min       50%       75%        90%         95%         max
WG      41  218.70000  1997.005  3885.253   6056.21    6926.498    40938.82
WP      20 5844.70000 75873.000 96066.000 134405.73  147403.600   179582.00
liquid 169   71.49891  8250.000 30250.500 127822.26  553048.508  2346735.63

Table of predicted values ( 75 th percentile):
   TA   form glove.wash.ML lTA        LS.75        QR.75
1   1     WP                 0   29670.1581   14335.1765
2  10     WP                 1  296701.5812  143351.7647
3 100     WP                 2 2967015.8123 1433517.6471
4   1     WG                 0     826.2926     989.4997
5  10     WG                 1    8262.9260    9894.9967
6 100     WG                 2   82629.2599   98949.9671
7   1 liquid                 0    2730.3876    3144.0000
8  10 liquid                 1   27303.8760   31440.0000
9 100 liquid                 2  273038.7604  314400.0000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.39441 -0.43021  0.01458  0.47816  1.43035

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)        2.4752     0.1049  23.589  < 2e-16 ***
formWP             1.5498     0.1761   8.799 3.62e-16 ***
formliquid         0.5235     0.1137   4.603 6.96e-06 ***
glove.wash.MLyes  -0.2752     0.1321  -2.084   0.0383 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6457 on 226 degrees of freedom
  (273 observations deleted due to missingness)
Multiple R-squared: 0.2676,     Adjusted R-squared: 0.2579
F-statistic: 27.53 on 3 and 226 DF,  p-value: 3.275e-15

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands ML/TA ~ form + glove.wash.ML

N: 230      tau: 0.75      AIC: 487.015245897035

                 coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)         2.9954157  2.7220722  3.1789693  0.1752578 17.091485
0.000000000000
formWP              1.1609874  1.0630038  1.3975553  0.2342417  4.956365
0.000001408633
formliquid          0.5020669  0.3037828  0.7832727  0.1774336  2.829604
0.005079946194
glove.wash.MLyes   -0.2162037 -0.3174291 -0.1421132  0.1279344 -1.689958
0.092414890107
```

```
Formula for mean (based on LS-estimate):
log(total hands ML) = log(TA) + 2.475  + 1.55 formWP + 0.523 formliquid + -0.275
glove.wash.MLyes
Formula for 75th percentile (based on quantile regression):
log(total hands ML) = log(TA) + 2.995  + 1.161 formWP + 0.502 formliquid + -0.216
glove.wash.MLyes

==================================================================================
```

Model: log total hands ML ~ logTA + form + glove.wash.ML

```
Table of measured values:
         n        min       50%       75%       90%         95%         max
WG      41  218.70000  1997.005  3885.253   6056.21   6926.498   40938.82
WP      20 5844.70000 75873.000 96066.000 134405.73 147403.600  179582.00
liquid 169   71.49891  8250.000 30250.500 127822.26 553048.508 2346735.63

Table of predicted values ( 75 th percentile):
   TA   form glove.wash.ML lTA       LS.75      QR.75
1   1     WP                 0   50768.092  24160.752
2  10     WP                 1  261444.210 142214.928
3 100     WP                 2 1358732.619 837104.971
4   1     WG                 0    1416.019   1310.937
5  10     WG                 1    7291.778   7716.433
6 100     WG                 2   37897.700  45420.440
7   1 liquid                 0    5191.412   4856.967
8  10 liquid                 1   26693.708  28589.062
9 100 liquid                 2  138544.100 168280.830

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.20324 -0.42676  0.01194  0.40950  1.59322

Coefficients:
                 Estimate Std. Error t value    Pr(>|t|)
(Intercept)       2.72681    0.11377  23.968     < 2e-16 ***
lTA               0.71328    0.06106  11.682     < 2e-16 ***
formWP            1.54937    0.16846   9.197     < 2e-16 ***
formliquid        0.56778    0.10919   5.200 0.000000447 ***
glove.wash.MLyes -0.33484    0.12698  -2.637     0.00895 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6176 on 225 degrees of freedom
  (273 observations deleted due to missingness)
Multiple R-squared: 0.5191,      Adjusted R-squared: 0.5105
F-statistic: 60.71 on 4 and 225 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands ML ~ logTA + form + glove.wash.ML

N: 230      tau: 0.75      AIC: 469.946267705629

                 coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)         3.1175819  2.8754018  3.2851596 0.17488598 17.826368
0.00000000000000
lTA                 0.7698347  0.6051726  0.8928660 0.08008650  9.612540
0.00000000000000
formWP              1.2655286  1.1441228  1.5906277 0.21947736  5.766101
0.0000002659407
```

```
formliquid          0.5687833  0.4339356  0.8596325 0.15934428  3.569525
0.00043712533823
glove.wash.MLyes   -0.2865531 -0.4339894 -0.2724298 0.09230508 -3.104413
0.00215121712002


Formula for mean (based on LS-estimate):
log(total hands ML) =  2.727  + 0.713 log(TA) + 1.549 formWP + 0.568 formliquid + -
0.335 glove.wash.MLyes
Formula for 75th percentile (based on quantile regression):
log(total hands ML) =  3.118  + 0.77 log(TA) + 1.266 formWP + 0.569 formliquid + -
0.287 glove.wash.MLyes

==================================================================================
```

Model: log protected hands ML/TA ~ form

```
Table of measured values:
         n   min        50%        75%       90%        95%      max
WG      41  0.20   23.57881   67.85714  146.6098   285.7143   948.10
WP      20 94.60 1180.50000 3586.50000 9459.5000 11215.0000 11310.00
liquid 167  0.01   44.11000  127.50000  698.0000  2270.0844 33747.49

Table of predicted values ( 75 th percentile):
   TA   form lTA       LS.75        QR.75
1   1     WP   0   918.07622   443.006536
2  10     WP   1  9180.76221  4430.065359
3 100     WP   2 91807.62212 44300.653595
4   1     WG   0    16.42872     8.050558
5  10     WG   1   164.28718    80.505575
6 100     WG   2  1642.87182   805.055750
7   1 liquid   0    18.59977    18.889693
8  10 liquid   1   185.99771   188.896929
9 100 liquid   2  1859.97713  1888.969286

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.4465 -0.5423  0.1350  0.6738  2.2032

Coefficients:
            Estimate Std. Error t value      Pr(>|t|)
(Intercept)  0.51120    0.16089   3.177       0.00169 **
formWP       1.73852    0.28098   6.187 0.00000000286 ***
formliquid   0.06026    0.17955   0.336       0.73748
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.03 on 225 degrees of freedom
  (275 observations deleted due to missingness)
Multiple R-squared: 0.1795,      Adjusted R-squared: 0.1722
F-statistic: 24.61 on 2 and 225 DF,  p-value: 2.157e-10

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands ML/TA ~ form

N: 228      tau: 0.75      AIC: 650.151037692079

            coefficients  lower bd  upper bd Std. Error  t value          Pr(>|t|)
(Intercept)    0.9058260 0.7019279 1.1615873  0.1486089 6.095369 0.000000004696293
formWP         1.7405842 1.4216869 2.2430219  0.3278408 5.309235 0.000000263703363
formliquid     0.3703989 0.1133886 0.6456845  0.1671939 2.215386 0.027735803395846
```

```
Formula for mean (based on LS-estimate):
log(protected hands ML) = log(TA) + 0.511  + 1.739 formWP + 0.06 formliquid
Formula for 75th percentile (based on quantile regression):
log(protected hands ML) = log(TA) + 0.906  + 1.741 formWP + 0.37 formliquid

=====================================================================================
```

Model: log protected hands ML ~ logTA + form

```
Table of measured values:
         n   min        50%        75%       90%        95%      max
WG      41  0.20   23.57881   67.85714  146.6098   285.7143   948.10
WP      20 94.60 1180.50000 3586.50000 9459.5000 11215.0000 11310.00
liquid 167  0.01   44.11000  127.50000  698.0000  2270.0844 33747.49

Table of predicted values ( 75 th percentile):
   TA   form lTA       LS.75       QR.75
1   1     WP   0  2617.69487   901.39898
2  10     WP   1  6345.57685  4034.53616
3 100     WP   2 15597.25659 18058.02126
4   1     WG   0    46.74768    16.53407
5  10     WG   1   113.31914    74.00421
6 100     WG   2   278.57739   331.23253
7   1 liquid   0    69.01694    34.42993
8  10 liquid   1   166.85567   154.10358
9 100 liquid   2   409.15076   689.74614

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5338 -0.6104 -0.0085  0.5460  2.6548

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.02157    0.16664   6.130 3.91e-09 ***
lTA          0.38657    0.09305   4.155 4.64e-05 ***
formWP       1.74015    0.25771   6.752 1.23e-10 ***
formliquid   0.17395    0.16559   1.051    0.295
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9449 on 224 degrees of freedom
  (275 observations deleted due to missingness)
Multiple R-squared: 0.2334,     Adjusted R-squared: 0.2231
F-statistic: 22.73 on 3 and 224 DF,  p-value: 6.916e-13

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands ~ logTA + form

N: 228      tau: 0.75      AIC: 640.949581294589

            coefficients   lower bd  upper bd Std. Error  t value     Pr(>|t|)
(Intercept)    1.2183799 0.93262259 1.6186306 0.15100214 8.068627 4.307665e-14
lTA            0.6508765 0.25209209 0.9370533 0.09434751 6.898715 5.307998e-11
formWP         1.7365372 1.34585508 2.2625254 0.31896416 5.444302 1.362472e-07
formliquid     0.3185563 0.06098777 0.5744334 0.16234052 1.962272 5.096899e-02


Formula for mean (based on LS-estimate):
log(protected hands ML) =  1.022  + 0.387 log(TA) + 1.74 formWP + 0.174 formliquid
```

```
Formula for 75th percentile (based on quantile regression):
log(protected hands ML) =  1.218  + 0.651 log(TA) + 1.737 formWP + 0.319 formliquid
```

==

Model: log total body ML/TA ~ form

```
Table of measured values:
        n        min        50%         75%        90%        95%        max
WG     29   169.8190   2691.732   9850.784  20638.24  25671.59  67310.76
WP     20 27859.6000 144744.500 365618.125 452239.10 476504.08 568452.20
liquid 80   157.4779   5717.550  28538.814  93029.47 130134.43 455259.00

Table of predicted values ( 75 th percentile):
   TA   form lTA       LS.75       QR.75
1   1     WP   0   59215.639   45249.8039
2  10     WP   1  592156.392  452498.0392
3 100     WP   2 5921563.921 4524980.3922
4   1     WG   0    1195.379     955.8595
5  10     WG   1   11953.787    9558.5948
6 100     WG   2  119537.867   95585.9484
7   1 liquid   0    1834.777    1968.1333
8  10 liquid   1   18347.767   19681.3333
9 100 liquid   2  183477.669  196813.3333

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.69538 -0.46898  0.00179  0.40943  1.76812

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.6287     0.1211  21.703  < 2e-16 ***
formWP        1.6916     0.1896   8.922  4.5e-15 ***
formliquid    0.1909     0.1414   1.350    0.179
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6523 on 126 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.4361,     Adjusted R-squared: 0.4271
F-statistic: 48.72 on 2 and 126 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body ML/TA ~ form

N: 129      tau: 0.75      AIC: 283.575261648587

            coefficients  lower bd  upper bd Std. Error   t value   Pr(>|t|)
(Intercept)    2.9803941 2.9520942 3.0959954 0.04876137 61.122032 0.00000000
formWP         1.6752226 1.4464152 1.8743363 0.14883266 11.255746 0.00000000
formliquid     0.3136605 0.1343803 0.4136578 0.13020191  2.409031 0.01744181


Formula for mean (based on LS-estimate):
log(total body ML) = log(TA) + 2.629  + 1.692 formWP + 0.191 formliquid
Formula for 75th percentile (based on quantile regression):
log(total body ML) = log(TA) + 2.98  + 1.675 formWP + 0.314 formliquid
```

==

Model: log total body ML ~ logTA + form

```
Table of measured values:
        n        min         50%         75%       90%       95%       max
WG     29   169.8190   2691.732   9850.784  20638.24  25671.59  67310.76
WP     20 27859.6000 144744.500 365618.125 452239.10 476504.08 568452.20
liquid 80   157.4779   5717.550  28538.814  93029.47 130134.43 455259.00

Table of predicted values ( 75 th percentile):
   TA   form lTA       LS.75       QR.75
1   1     WP   0  102138.185   82817.453
2  10     WP   1  520609.776  417884.775
3 100     WP   2 2742854.212 2108585.556
4   1     WG   0    2065.124    1235.077
5  10     WG   1   10524.616    6232.019
6 100     WG   2   55454.708   31445.857
7   1 liquid   0    3602.302    3567.253
8  10 liquid   1   18243.548   17999.840
9 100 liquid   2   95561.440   90824.565

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.68026 -0.40599  0.02671  0.40490  1.58382

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.8696     0.1548  18.538  < 2e-16 ***
lTA           0.7121     0.1186   6.006 1.92e-08 ***
formWP        1.6910     0.1860   9.091 1.87e-15 ***
formliquid    0.2438     0.1404   1.736    0.085 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.64 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5019,     Adjusted R-squared: 0.4899
F-statistic: 41.98 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body ML ~ logTA + form

N: 129      tau: 0.75      AIC: 281.164941358761

            coefficients  lower bd  upper bd Std. Error   t value     Pr(>|t|)
(Intercept)    3.0916941 2.9737693 3.4791115  0.1658509 18.641406 0.000000e+00
lTA            0.7029347 0.5206110 0.9770069  0.1478848  4.753257 5.408988e-06
formWP         1.8264278 1.4055338 2.1365026  0.1960941  9.314038 4.440892e-16
formliquid     0.4606399 0.1537582 0.6904007  0.1646189  2.798220 5.953184e-03


Formula for mean (based on LS-estimate):
log(total body ML) =  2.87  + 0.712 log(TA) + 1.691 formWP + 0.244 formliquid
Formula for 75th percentile (based on quantile regression):
log(total body ML) =  3.092  + 0.703 log(TA) + 1.826 formWP + 0.461 formliquid

==================================================================================
```

Model: log inner body ML/TA ~ form

```
Table of measured values:
        n     min       50%       75%        90%       95%       max
WG     29    0.01  104.34783  230.4348   607.6532  1070.524  1491.304
```

```
WP     20 1172.62 3885.80000 9072.6250 15116.9900 15705.625 24890.700
liquid 80    0.50   56.38165  180.7781   557.2857  1442.907 13069.000

Table of predicted values ( 75 th percentile):
   TA   form lTA        LS.75       QR.75
1   1     WP   0   2015.03013   858.22095
2  10     WP   1  20150.30131  8582.20947
3 100     WP   2 201503.01308 85822.09469
4   1     WG   0     20.44845    15.80833
5  10     WG   1    204.48454   158.08333
6 100     WG   2   2044.84536  1580.83333
7   1 liquid   0     17.43670    20.61462
8  10 liquid   1    174.36701   206.14624
9 100 liquid   2   1743.67014  2061.46238

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.81139 -0.38382 -0.03199  0.47632  1.97094

Coefficients:
            Estimate Std. Error t value      Pr(>|t|)
(Intercept)  0.82912    0.12997   6.379 0.00000000308 ***
formWP       1.99002    0.20343   9.782       < 2e-16 ***
formliquid  -0.06405    0.15171  -0.422         0.674
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6999 on 126 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5322,     Adjusted R-squared: 0.5247
F-statistic: 71.66 on 2 and 126 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body ML/TA ~ form

N: 129      tau: 0.75      AIC: 296.741656712858

            coefficients   lower bd upper bd Std. Error   t value     Pr(>|t|)
(Intercept)    1.1988861  1.0827137 1.482428  0.1432624 8.3684648 9.459100e-14
formWP         1.7347130  1.4587825 2.146617  0.2061261 8.4157854 7.305268e-14
formliquid     0.1152893 -0.2424625 0.239787  0.1900452 0.6066415 5.451803e-01


Formula for mean (based on LS-estimate):
log(inner body ML) = log(TA) + 0.829  + 1.99 formWP + -0.064 formliquid
Formula for 75th percentile (based on quantile regression):
log(inner body ML) = log(TA) + 1.199  + 1.735 formWP + 0.115 formliquid

==================================================================================
```

Model: log inner body ML ~ logTA + form

```
Table of measured values:
        n     min        50%       75%        90%       95%       max
WG     29    0.01  104.34783  230.4348   607.6532  1070.524  1491.304
WP     20 1172.62 3885.80000 9072.6250 15116.9900 15705.625 24890.700
liquid 80    0.50   56.38165  180.7781   557.2857  1442.907 13069.000

Table of predicted values ( 75 th percentile):
   TA   form lTA        LS.75       QR.75
1   1     WP   0   2272.61613  1070.07660
```

```
2  10     WP   1  19823.08521  8237.31732
3 100     WP   2 179299.93565 63409.84965
4   1     WG   0     23.07097    18.59572
5  10     WG   1    201.20592   143.14758
6 100     WG   2   1820.10098  1101.93233
7   1 liquid   0     20.25718    23.76790
8  10 liquid   1    175.45152   182.96232
9 100 liquid   2   1576.89992  1408.42132

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.85758 -0.37844 -0.03886  0.47897  1.95879

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.87435    0.16985   5.148 9.95e-07 ***
lTA          0.94594    0.13010   7.271 3.42e-11 ***
formWP       1.98992    0.20410   9.750  < 2e-16 ***
formliquid  -0.05411    0.15408  -0.351    0.726
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7022 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5864,      Adjusted R-squared: 0.5765
F-statistic: 59.07 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body ML ~ logTA + form

N: 129      tau: 0.75      AIC: 298.500218309388

            coefficients   lower bd  upper bd Std. Error   t value     Pr(>|t|)
(Intercept)    1.2694131  0.9491635 2.0551478  0.2617355 4.8499848 3.597983e-06
lTA            0.8863709  0.6802906 1.2349656  0.1923795 4.6074079 9.905306e-06
formWP         1.7600018  1.4516838 2.1379769  0.2234322 7.8771190 1.397105e-12
formliquid     0.1065777 -0.3371854 0.1986804  0.2009334 0.5304129 5.967667e-01


Formula for mean (based on LS-estimate):
log(inner body ML) =  0.874  + 0.946 log(TA) + 1.99 formWP + -0.054 formliquid
Formula for 75th percentile (based on quantile regression):
log(inner body ML) =  1.269  + 0.886 log(TA) + 1.76 formWP + 0.107 formliquid

=================================================================================
```

Model: log head ML/TA ~ form + face.shield.ML

```
Table of measured values:
        n   min       50%     75%       90%      95%       max
WG     29  0.01  58.33333 152.622  748.6179 1466.402  2358.922
WP     20 65.76 443.00000 856.400 1073.6200 1533.650  2610.000
liquid 80  0.45  20.00000 245.000 2428.0764 4027.780 19050.450

Table of predicted values ( 75 th percentile):
   TA   form face.shield.ML lTA       LS.75       QR.75
1   1     WP             no   0   219.04983   124.732026
2  10     WP             no   1  2190.49835  1247.320261
3 100     WP             no   2 21904.98346 12473.202614
4   1     WG             no   0    10.78158     6.493506
5  10     WG             no   1   107.81575    64.935065
```

```
6 100     WG             no   2  1078.15752   649.350649
7   1 liquid             no   0    37.92948    51.885229
8  10 liquid             no   1   379.29478   518.852288
9 100 liquid             no   2  3792.94781  5188.522876

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.75616 -0.65556  0.03817  0.48372  3.00737

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       -1.0730     0.1938  -5.536 1.74e-07 ***
formWP             1.3050     0.2523   5.173 8.92e-07 ***
formliquid         0.5528     0.1829   3.023  0.00304 **
face.shield.MLno   1.5243     0.1744   8.738 1.31e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8429 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5152,      Adjusted R-squared: 0.5036
F-statistic: 44.29 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head ML/TA ~ form + face.shield.ML

N: 129      tau: 0.75      AIC: 343.897100923684

                 coefficients   lower bd    upper bd Std. Error   t value
Pr(>|t|)
(Intercept)        -0.9817457 -1.2491246 0.006850153  0.3393912 -2.892667
4.507360e-03
formWP              1.2834987  0.6797631 1.432409758  0.3043390  4.217332
4.704993e-05
formliquid          0.9025645  0.1673691 1.083707118  0.2976351  3.032453
2.950162e-03
face.shield.MLno    1.7942250  1.3733840 1.988838624  0.2510616  7.146552
6.522383e-11


Formula for mean (based on LS-estimate):
log(head ML) = log(TA) + -1.073  + 1.305 formWP + 0.553 formliquid + 1.524
face.shield.MLno
Formula for 75th percentile (based on quantile regression):
log(head ML) = log(TA) + -0.982  + 1.283 formWP + 0.903 formliquid + 1.794
face.shield.MLno

================================================================================
```

Model: log head ML ~ logTA + form + face.shield.ML

```
Table of measured values:
        n   min       50%     75%       90%      95%       max
WG     29  0.01  58.33333 152.622  748.6179 1466.402  2358.922
WP     20 65.76 443.00000 856.400 1073.6200 1533.650  2610.000
liquid 80  0.45  20.00000 245.000 2428.0764 4027.780 19050.450

Table of predicted values ( 75 th percentile):
   TA   form face.shield.ML lTA        LS.75        QR.75
1   1     WP             no   0   125.237212    76.704849
2  10     WP             no   1  2435.312101  1329.773388
```

```
3 100     WP            no   2 50378.924527 23053.265539
4   1     WG            no   0     5.371002     3.738957
5  10     WG            no   1   103.023506    64.819442
6 100     WG            no   2  2103.128963  1123.725155
7   1 liquid            no   0    17.056123    28.634814
8  10 liquid            no   1   323.688399   496.419907
9 100 liquid            no   2  6540.867567  8606.052761

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.9142 -0.6371  0.0174  0.5035  2.8635

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       -1.1990     0.2080  -5.763 6.15e-08 ***
lTA                1.2979     0.1859   6.981 1.56e-10 ***
formWP             1.3704     0.2540   5.395 3.34e-07 ***
formliquid         0.5030     0.1844   2.728  0.00729 **
face.shield.MLno   1.3362     0.2094   6.382 3.16e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8377 on 124 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.6771,     Adjusted R-squared: 0.6667
F-statistic:    65 on 4 and 124 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: lhd.ML ~ lTA + form + face.shield.ML

N: 129      tau: 0.75      AIC: 344.13316899082

                 coefficients   lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)        -1.0541785 -1.6499671 0.1398584  0.3576879 -2.947202
0.0038321514649
lTA                 1.2389548  0.8893727 1.7172198  0.2334025  5.308233
0.0000004931497
formWP              1.3120723  0.7211551 1.6108772  0.3108296  4.221195
0.0000465717697
formliquid          0.8841439  0.2246836 1.2392333  0.3017006  2.930534
0.0040295315885
face.shield.MLno    1.6269289  1.2743508 1.9460320  0.2879880  5.649295
0.0000001045863


Formula for mean (based on LS-estimate):
log(head ML) =  -1.199  + 1.298 log(TA) + 1.37 formWP + 0.503 formliquid + 1.336
face.shield.MLno
Formula for 75th percentile (based on quantile regression):
log(head ML) =  -1.054  + 1.239 log(TA) + 1.312 formWP + 0.884 formliquid + 1.627
face.shield.MLno

===============================================================================
```

Model: log inhalation ML/ML ~ form

```
Table of measured values:
        n         min         50%         75%        90%       95%       max
WG     41   0.0100000   31.437500   73.125000  211.75130  280.2083  824.8958
WP     20 559.4298246 1811.458333 4051.741372 4997.47807 5301.2610 8504.3860
```

```
liquid 100   0.5208333    3.096413    7.677895   15.10592   30.1828  145.8333

Table of predicted values ( 75 th percentile):
   TA   form lTA          LS.75        QR.75
1   1     WP   0   1117.3126493   495.495495
2  10     WP   1  11173.1264930  4954.954955
3 100     WP   2 111731.2649298 49549.549550
4   1     WG   0      6.0025047     9.396701
5  10     WG   1     60.0250474    93.967014
6 100     WG   2    600.2504742   939.670139
7   1 liquid   0      0.7415128     1.041667
8  10 liquid   1      7.4151277    10.416667
9 100 liquid   2     74.1512771   104.166667

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-2.2969 -0.4902  0.0638  0.5603  1.9473 

Coefficients:
            Estimate Std. Error t value     Pr(>|t|)    
(Intercept)   0.2178     0.1279   1.702       0.0907 .  
formWP        2.2629     0.2234  10.127      < 2e-16 ***
formliquid   -0.9043     0.1519  -5.952 0.0000000165 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8193 on 158 degrees of freedom
  (342 observations deleted due to missingness)
Multiple R-squared: 0.6179,     Adjusted R-squared: 0.6131 
F-statistic: 127.8 on 2 and 158 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation ML/TA ~ form

N: 161      tau: 0.75      AIC: 396.41224307945

            coefficients  lower bd   upper bd Std. Error   t value         Pr(>|t|)
(Intercept)    0.9729754  0.764994  1.1076091  0.1000743  9.722533 0.00000000000000
formWP         1.7220643  1.545980  2.0159344  0.1279940 13.454261 0.00000000000000
formliquid    -0.9552467 -1.370573 -0.6159043  0.1702491 -5.610876 0.00000008811108


Formula for mean (based on LS-estimate):
log(inhalation ML) = log(TA) + 0.218  + 2.263 formWP + -0.904 formliquid
Formula for 75th percentile (based on quantile regression):
log(inhalation ML) = log(TA) + 0.973  + 1.722 formWP + -0.955 formliquid

==============================================================================
```

Model: log inhalation ML ~ logTA + form

```
Table of measured values:
         n         min         50%         75%        90%       95%       max
WG      41   0.0100000   31.437500   73.125000  211.75130  280.2083  824.8958
WP      20 559.4298246 1811.458333 4051.741372 4997.47807 5301.2610 8504.3860
liquid 100   0.5208333    3.096413    7.677895   15.10592   30.1828  145.8333

Table of predicted values ( 75 th percentile):
   TA   form lTA        LS.75       QR.75
1   1     WP   0  2620.235243 2171.296524
2  10     WP   1  8804.650411 4308.469902
```

```
3 100     WP   2 30360.878198 8549.229777
4   1     WG   0    14.047459   37.341272
5  10     WG   1    47.201219   74.095705
6 100     WG   2   162.808299  147.026955
7   1 liquid   0     2.604823    3.701686
8  10 liquid   1     8.668413    7.345198
9 100 liquid   2    29.617240   14.574963

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.65066 -0.33244  0.06755  0.54541  1.80872

Coefficients:
            Estimate Std. Error t value   Pr(>|t|)
(Intercept)   0.6087     0.1555   3.915   0.000135 ***
lTA           0.5301     0.1157   4.582 0.00000935 ***
formWP        2.2641     0.2132  10.618    < 2e-16 ***
formliquid   -0.7323     0.1510  -4.848 0.00000297 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7818 on 157 degrees of freedom
  (342 observations deleted due to missingness)
Multiple R-squared: 0.6001,      Adjusted R-squared: 0.5925
F-statistic: 78.53 on 3 and 157 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation ML ~ logTA + form

N: 161      tau: 0.75      AIC: 341.820187831289

            coefficients   lower bd   upper bd Std. Error   t value     Pr(>|t|)
(Intercept)    1.5721891  1.4380717  1.8824508  0.1718112  9.150678 2.220446e-16
lTA            0.2976039  0.1873417  0.3415566  0.1164563  2.555500 1.155349e-02
formWP         1.7645300  1.4785136  1.9618551  0.1743337 10.121564 0.000000e+00
formliquid    -1.0037895 -1.2723112 -0.8706971  0.1678691 -5.979598 1.455240e-08


Formula for mean (based on LS-estimate):
log(inhalation ML) =  0.609  + 0.53 log(TA) + 2.264 formWP + -0.732 formliquid
Formula for 75th percentile (based on quantile regression):
log(inhalation ML) =  1.572  + 0.298 log(TA) + 1.765 formWP + -1.004 formliquid

================================================================================
```

A - LCTM

Model: log total hands A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n  min      50%      75%      90%      95%      max
coarse 27 0.01   58.661 1720.779 17267.34 24775.81 28496.25
other  70 0.01 1055.710 5910.500 24429.13 33965.50 70746.80

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA         LS.75        QR.75
1    1   coarse         normal   0      8.178169     62.76085
2   10   coarse         normal   1     81.781688    627.60848
3  100   coarse         normal   2    817.816883   6276.08478
4    1    other         normal   0    216.943202    148.32399
5   10    other         normal   1   2169.432022   1483.23987
```

```
6  100    other         normal   2  21694.320218  14832.39869
7    1   coarse     small area   0    238.472112    685.61732
8   10   coarse     small area   1   2384.721125   6856.17316
9  100   coarse     small area   2  23847.211250  68561.73156
10   1    other     small area   0   6106.678572   1620.33333
11  10    other     small area   1  61066.785720  16203.33333
12 100    other     small area   2 610667.857202 162033.33333

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.1980 -0.6925  0.2305  0.8675  2.6674

Coefficients:
                      Estimate Std. Error t value  Pr(>|t|)
(Intercept)             1.2979     0.5819   2.230   0.02810 *
dropletsother           1.4338     0.3440   4.168 0.0000682 ***
LCTM.equipmentnormal   -1.4087     0.5070  -2.779   0.00659 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.484 on 94 degrees of freedom
  (95 observations deleted due to missingness)
Multiple R-squared: 0.2502,      Adjusted R-squared: 0.2342
F-statistic: 15.68 on 2 and 94 DF,  p-value: 0.000001327

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands A/TA ~ droplets + LCTM.equipment

N: 97      tau: 0.75      AIC: 335.014147161201

                      coefficients    lower bd  upper bd Std. Error    t value
Pr(>|t|)
(Intercept)              2.8360818  2.33624800  3.453735  0.4390596  6.4594464
0.000000004600125
dropletsother            0.3735226 -0.09799894  1.300570  0.3963927  0.9423045
0.348452253847874
LCTM.equipmentnormal   -1.0383930 -1.54072772 -0.606228  0.2562966 -4.0515285
0.000104692842625


Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 1.298  + 1.434 dropletsother + -1.409
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(total hands A) = log(TA) + 2.836  + 0.374 dropletsother + -1.038
LCTM.equipmentnormal

=============================================================================
```

Model: log total hands A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
        n  min      50%      75%      90%      95%      max
coarse 27 0.01   58.661 1720.779 17267.34 24775.81 28496.25
other  70 0.01 1055.710 5910.500 24429.13 33965.50 70746.80

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA           LS.75        QR.75
1    1   coarse         normal   0       0.9088747     15.30925
2   10   coarse         normal   1      35.4569267    303.82406
3  100   coarse         normal   2    1481.8540204   6029.62482
```

```
4    1    other         normal   0       25.6553864     46.65483
5   10    other         normal   1     1003.2614056    925.90142
6  100    other         normal   2    42063.7775292  18375.23379
7    1   coarse     small area   0      215.5051156    538.19427
8   10   coarse     small area   1     9325.2272770  10680.88387
9  100   coarse     small area   2   430092.6183876 211970.44668
10   1    other     small area   0     5900.8466846   1640.14277
11  10    other     small area   1   256316.4484252  32549.90886
12 100    other     small area   2 11880726.2647416 645978.25438

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.0687 -0.6639  0.2672  0.9163  3.2574

Coefficients:
                     Estimate Std. Error t value     Pr(>|t|)
(Intercept)            1.2806     0.5676   2.256     0.026393 *
lTA                    1.6226     0.2579   6.293 0.0000000101 ***
dropletsother          1.4623     0.3357   4.356 0.0000340243 ***
LCTM.equipmentnormal  -2.3563     0.6312  -3.733     0.000326 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.448 on 93 degrees of freedom
  (95 observations deleted due to missingness)
Multiple R-squared: 0.3806,     Adjusted R-squared: 0.3607
F-statistic: 19.05 on 3 and 93 DF,  p-value: 0.00000000103

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands A ~ logTA + droplets + LCTM.equipment

N: 97      tau: 0.75      AIC: 333.582643408078

                     coefficients    lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             2.7309391  1.72038048  3.4247683  0.3581786  7.624518
2.047273e-11
lTA                     1.2976681  0.96312849  2.1921733  0.2826829  4.590543
1.381722e-05
dropletsother           0.4839426  0.08650673  1.2908475  0.3058415  1.582331
1.169690e-01
LCTM.equipmentnormal   -1.5459850 -2.71179712 -0.6350416  0.6337058 -2.439594
1.660016e-02


Formula for mean (based on LS-estimate):
log(total hands A) =  1.281  + 1.623 log(TA) + 1.462 dropletsother + -2.356
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(total hands A) =  2.731  + 1.298 log(TA) + 0.484 dropletsother + -1.546
LCTM.equipmentnormal

================================================================================
```

Model: log protected hands A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n  min      50%    75%      90%      95%     max
coarse 21 0.01 16.45300  41.90   68.300   79.339    99.7
other  39 0.01 55.55556 325.75 1611.702 4094.715 10000.0
```

```
Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA        LS.75        QR.75
1    1   coarse         normal   0    0.3906018    0.3415000
2   10   coarse         normal   1    3.9060185    3.4150000
3  100   coarse         normal   2   39.0601846   34.1500000
4    1    other         normal   0   10.9526692    9.9354198
5   10    other         normal   1  109.5266923   99.3541977
6  100    other         normal   2 1095.2669226  993.5419771
7    1   coarse     small area   0    2.5342606    0.7615541
8   10   coarse     small area   1   25.3426058    7.6155407
9  100   coarse     small area   2  253.4260583   76.1554071
10   1    other     small area   0   68.3095852   22.1562500
11  10    other     small area   1  683.0958523  221.5625000
12 100    other     small area   2 6830.9585234 2215.6250000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.0451 -0.7160  0.2216  0.8217  2.3049 

Coefficients:
                     Estimate Std. Error t value  Pr(>|t|)    
(Intercept)           -0.6728     0.9581  -0.702     0.485    
dropletsother          1.4565     0.3453   4.218 0.0000893 ***
LCTM.equipmentnormal  -0.6137     0.9176  -0.669     0.506    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.264 on 57 degrees of freedom
  (132 observations deleted due to missingness)
Multiple R-squared: 0.2536,     Adjusted R-squared: 0.2274 
F-statistic: 9.682 on 2 and 57 DF,  p-value: 0.0002399

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log rotected hands A/TA ~ droplets + LCTM.equipment

N: 60      tau: 0.75      AIC: 199.08881393109

                     coefficients       lower bd      upper bd Std. Error    t 
value     Pr(>|t|)
(Intercept)            -0.1182993  -1.318964e+00 1.797693e+308  0.3813710 -
0.3101947 0.7575442743
dropletsother           1.4637955   1.016440e+00  1.948735e+00  0.3813710  
3.8382453 0.0003129333
LCTM.equipmentnormal   -0.3483100 -1.797693e+308  4.503777e-01  0.2526824 -
1.3784498 0.1734509897


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + -0.673  + 1.456 dropletsother + -0.614 
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(protected hands A) = log(TA) + -0.118  + 1.464 dropletsother + -0.348 
LCTM.equipmentnormal

=============================================================================
```

Model: log protected hands A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
        n  min      50%    75%      90%      95%     max
coarse 21 0.01 16.45300  41.90   68.300   79.339    99.7
```

```
other  39 0.01 55.55556 325.75 1611.702 4094.715 10000.0

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA        LS.75      QR.75
1    1   coarse         normal   0    0.4000359   3.309380
2   10   coarse         normal   1    3.8641138  11.555412
3  100   coarse         normal   2   40.6600617  40.348210
4    1    other         normal   0   11.0856121  42.376964
5   10    other         normal   1  108.6529559 147.968298
6  100    other         normal   2 1162.5333082 516.663190
7    1   coarse     small area   0    2.5547616   1.698289
8   10   coarse     small area   1   28.0158841   5.929943
9  100   coarse     small area   2  329.7051836  20.705672
10   1    other     small area   0   69.6430098  21.746777
11  10    other     small area   1  774.8131686  75.933557
12 100    other     small area   2 9256.3593017 265.138372

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0241 -0.7178  0.2222  0.8134  2.3056

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.6796     0.9684  -0.702 0.485709
lTA                    1.0312     0.2733   3.773 0.000391 ***
dropletsother          1.4623     0.3521   4.153 0.000113 ***
LCTM.equipmentnormal  -0.6609     1.0141  -0.652 0.517243
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.275 on 56 degrees of freedom
  (132 observations deleted due to missingness)
Multiple R-squared: 0.3311,     Adjusted R-squared: 0.2953
F-statistic: 9.241 on 3 and 56 DF,  p-value: 0.00004631

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands A ~ logTA + droplets + LCTM.equipment

N: 60      tau: 0.75      AIC: 198.020779388257

                     coefficients       lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             0.2300117  -1.022036e+00 1.797693e+308  0.3363632 0.6838194
0.496909200
lTA                     0.5430388  -1.402333e-01  1.247271e+00  0.2589134 2.0973760
0.040487120
dropletsother           1.1073832   5.644328e-01  1.837555e+00  0.3370646 3.2853737
0.001760425
LCTM.equipmentnormal    0.2897349 -1.797693e+308  1.906963e+00  0.5174021 0.5599802
0.577726175


Formula for mean (based on LS-estimate):
log(protected hands A) =  -0.68  + 1.031 log(TA) + 1.462 dropletsother + -0.661
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(protected hands A) =  0.23  + 0.543 log(TA) + 1.107 dropletsother + 0.29
LCTM.equipmentnormal

=================================================================================
```

Model: log total body A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n    min       50%       75%       90%        95%       max
coarse  6 87.897  226.2195  315.5865  376.4275   400.8892   425.351
other  39  0.010 1024.1643 3218.1916 8014.9882 11739.6877 26091.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA        LS.75        QR.75
1    1   coarse         normal   0     31.67679     12.88942
2   10   coarse         normal   1    316.76787    128.89424
3  100   coarse         normal   2   3167.67874   1288.94242
4    1    other         normal   0    105.50568     82.93354
5   10    other         normal   1   1055.05685    829.33538
6  100    other         normal   2  10550.56849   8293.35375
7    1   coarse     small area   0   1425.66906    345.52107
8   10   coarse     small area   1  14256.69065   3455.21070
9  100   coarse     small area   2 142566.90649  34552.10699
10   1    other     small area   0   4577.37847   2223.16250
11  10    other     small area   1  45773.78467  22231.62500
12 100    other     small area   2 457737.84671 222316.25000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.8627 -0.2834  0.0499  0.3687  1.3531 

Coefficients:
                     Estimate Std. Error t value   Pr(>|t|)    
(Intercept)            2.5237     0.4457   5.663 0.00000121 ***
dropletsother          0.5574     0.3642   1.530      0.133    
LCTM.equipmentnormal  -1.6198     0.2978  -5.439 0.00000253 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.8121 on 42 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.4686,     Adjusted R-squared: 0.4433 
F-statistic: 18.52 on 2 and 42 DF,  p-value: 0.000001711 

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body A/TA ~ droplets + LCTM.equipment

N: 45      tau: 0.75      AIC: 91.4566336845678

                     coefficients       lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             2.5384745   2.063462e+00  2.5889507  0.2625157  9.669801
3.027800e-12
dropletsother           0.8084967 -1.797693e+308  1.2328140  0.1980425  4.082440
1.954018e-04
LCTM.equipmentnormal   -1.4282410  -1.546558e+00 -0.8550629  0.2563946 -5.570480
1.643488e-06


Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 2.524  + 0.557 dropletsother + -1.62 
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(total body A) = log(TA) + 2.538  + 0.808 dropletsother + -1.428 
LCTM.equipmentnormal
```

```
================================================================================

Model: log total body A ~ logTA + droplets + LCTM.equipment

Table of measured values:
        n    min       50%       75%       90%        95%       max
coarse  6 87.897  226.2195  315.5865  376.4275   400.8892   425.351
other  39  0.010 1024.1643 3218.1916 8014.9882 11739.6877 26091.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA            LS.75            QR.75
1    1   coarse         normal   0        0.2839690        0.6980422
2   10   coarse         normal   1       61.6524308       47.6237073
3  100   coarse         normal   2    15722.8996312     3249.1124980
4    1    other         normal   0        0.8884225        5.5103729
5   10    other         normal   1      190.5714464      375.9434637
6  100    other         normal   2    48381.9072489    25648.6249219
7    1   coarse     small area   0     1233.4257078      291.3779112
8   10   coarse     small area   1   338647.9825377    19879.1666242
9  100   coarse     small area   2 105956572.9273142  1356249.9092967
10   1    other     small area   0     3690.2641667     2300.1489669
11  10    other     small area   1   1015417.7265585   156926.9419918
12 100    other     small area   2 321011125.3926291 10706291.4088140

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.38770 -0.20025  0.05726  0.30601  1.24847

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            2.5898     0.3546   7.304 6.16e-09 ***
lTA                    2.4010     0.2778   8.643 8.82e-11 ***
dropletsother          0.5164     0.2897   1.782   0.0821 .
LCTM.equipmentnormal  -3.6823     0.4725  -7.793 1.28e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6457 on 41 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.6611,     Adjusted R-squared: 0.6363
F-statistic: 26.65 on 3 and 41 DF,  p-value: 9.979e-10

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body A ~ logTA + droplets + LCTM.equipment

N: 45      tau: 0.75      AIC: 82.3514498075204

                     coefficients       lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             2.4644566   2.303608e+00 2.8807472  0.2818583  8.743603
6.470091e-11
lTA                     1.8339415  -6.595997e-01 2.4397702  0.3669664  4.997574
1.130405e-05
dropletsother           0.8972993 -1.797693e+308 0.9849692  0.2251100  3.986048
2.696675e-04
LCTM.equipmentnormal   -2.6205750  -3.601294e+00 1.5713177  0.5388277 -4.863475
1.738273e-05


Formula for mean (based on LS-estimate):
```

```
log(total body A) =  2.59  + 2.401 log(TA) + 0.516 dropletsother + -3.682
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(total body A) =  2.464  + 1.834 log(TA) + 0.897 dropletsother + -2.621
LCTM.equipmentnormal
```

===

Model: log inner body A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n   min    50%      75%     90%      95%     max
coarse  6 5.955 10.149 12.45875  12.729  12.8040  12.879
other  39 0.010 29.036 50.50000 158.000 243.7996 525.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA       LS.75        QR.75
1    1   coarse         normal   0    1.386636    0.4518947
2   10   coarse         normal   1   13.866359    4.5189474
3  100   coarse         normal   2  138.663585   45.1894737
4    1    other         normal   0    2.786106    2.2750000
5   10    other         normal   1   27.861061   22.7500000
6  100    other         normal   2  278.610612  227.5000000
7    1   coarse     small area   0   12.933548    5.5224682
8   10   coarse     small area   1  129.335478   55.2246819
9  100   coarse     small area   2 1293.354781  552.2468190
10   1    other     small area   0   25.055983   27.8020833
11  10    other     small area   1  250.559834  278.0208333
12 100    other     small area   2 2505.598344 2780.2083333

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.68019 -0.11277  0.09724  0.47062  1.20745

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            0.4852     0.4430   1.095   0.2796
dropletsother          0.3377     0.3621   0.933   0.3564
LCTM.equipmentnormal  -0.9365     0.2960  -3.163   0.0029 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8073 on 42 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.2318,     Adjusted R-squared: 0.1952
F-statistic: 6.335 on 2 and 42 DF,  p-value: 0.003939

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A/TA ~ droplets + LCTM.equipment

N: 45      tau: 0.75      AIC: 86.1675527830627

                     coefficients       lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             0.7421332   6.336129e-01  0.8803569  0.2018088  3.677407
0.000663743613
dropletsother           0.7019441 -1.797693e+308  0.8327705  0.1578401  4.447185
0.000062646678
LCTM.equipmentnormal   -1.0870959  -1.239119e+00 -0.7966023  0.1993288 -5.453783
0.000002413731
```

```
Formula for mean (based on LS-estimate):
log(inner body A) = log(TA) + 0.485  + 0.338 dropletsother + -0.936
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(inner body A) = log(TA) + 0.742  + 0.702 dropletsother + -1.087
LCTM.equipmentnormal
```

==

Model: log inner body A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
        n   min    50%      75%     90%      95%     max
coarse  6 5.955 10.149 12.45875  12.729  12.8040  12.879
other  39 0.010 29.036 50.50000 158.000 243.7996 525.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA          LS.75          QR.75
1    1   coarse         normal   0      0.02635330     0.07990643
2   10   coarse         normal   1      3.57524952     2.62898714
3  100   coarse         normal   2    576.20386029    86.49583384
4    1    other         normal   0      0.05021627     0.35587323
5   10    other         normal   1      6.72523898    11.70852127
6  100    other         normal   2   1078.65652915   385.21995652
7    1   coarse     small area   0     11.97478982     6.37577805
8   10   coarse     small area   1   2088.50463441   209.76832906
9  100   coarse     small area   2 418909.95438985  6901.55013858
10   1    other     small area   0     21.75275416    28.39532072
11  10    other     small area   1   3802.77155840   934.22934968
12 100    other     small area   2 771251.91925157 30736.91212889

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-2.5303 -0.3485  0.1148  0.4460  1.0738

Coefficients:
                     Estimate Std. Error t value      Pr(>|t|)
(Intercept)            0.5418     0.3794   1.428         0.161
lTA                    2.2013     0.2972   7.406 0.00000000443 ***
dropletsother          0.3025     0.3100   0.976         0.335
LCTM.equipmentnormal  -2.7050     0.5056  -5.350 0.00000361874 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6909 on 41 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.5936,     Adjusted R-squared: 0.5639
F-statistic: 19.96 on 3 and 41 DF,  p-value: 0.00000003916

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A ~ logTA + droplets + LCTM.equipment

N: 45      tau: 0.75      AIC: 80.3873590947363

                     coefficients       lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             0.8045332   7.600549e-01 0.9225802  0.2009722  4.003206
0.00025599764423
lTA                     1.5172067  -1.836949e+00 2.0075805  0.2277324  6.662236
0.00000004952021
```

```
dropletsother           0.6487136 -1.797693e+308 0.6810359  0.1537386  4.219588
0.00013200146074
LCTM.equipmentnormal   -1.9019515  -2.525700e+00 2.4057042  0.3246297 -5.858833
0.00000068693195


Formula for mean (based on LS-estimate):
log(inner body A) =  0.542  + 2.201 log(TA) + 0.303 dropletsother + -2.705
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(inner body A) =  0.805  + 1.517 log(TA) + 0.649 dropletsother + -1.902
LCTM.equipmentnormal

==================================================================================
```

Model: log head A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n   min    50%      75%      90%      95%      max
coarse  6 4.204 11.245  12.8935  18.1510  20.7735   23.396
other  40 0.010 33.000 112.0000 279.8842 471.0250 4600.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA      LS.75        QR.75
1    1   coarse         normal   0   2.494476    0.5141833
2   10   coarse         normal   1  24.944755    5.1418327
3  100   coarse         normal   2 249.447554   51.4183267
4    1    other         normal   0   4.647910    3.9196765
5   10    other         normal   1  46.479096   39.1967647
6  100    other         normal   2 464.790956  391.9676471
7    1   coarse     small area   0   4.570010    1.7460608
8   10   coarse     small area   1  45.700100   17.4606082
9  100   coarse     small area   2 457.000999  174.6060823
10   1    other     small area   0   8.104609   13.3104167
11  10    other     small area   1  81.046093  133.1041667
12 100    other     small area   2 810.460932 1331.0416667

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-2.3758 -0.3223  0.1525  0.6263  2.2560

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.2212     0.6223  -0.356    0.724
dropletsother          0.3194     0.5081   0.629    0.533
LCTM.equipmentnormal  -0.2165     0.4148  -0.522    0.604

Residual standard error: 1.136 on 43 degrees of freedom
  (146 observations deleted due to missingness)
Multiple R-squared: 0.01908,     Adjusted R-squared: -0.02654
F-statistic: 0.4183 on 2 and 43 DF,  p-value: 0.6608

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A/TA ~ droplets + LCTM.equipment

N: 46      tau: 0.75      AIC: 131.376093919198

                     coefficients       lower bd    upper bd Std. Error    t value
Pr(>|t|)
(Intercept)             0.2420594  -3.331101e-01 0.655232392  0.6353594  0.3809802
0.705093784
```

```
dropletsother          0.8821323 -1.797693e+308 1.080739257  0.2727340  3.2344052
0.002345475
LCTM.equipmentnormal   -0.5309414  -1.692161e+00 0.006734941  0.6087614 -0.8721668
0.387961491


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + -0.221  + 0.319 dropletsother + -0.217 LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(head A) = log(TA) + 0.242  + 0.882 dropletsother + -0.531 LCTM.equipmentnormal

=============================================================================
```

Model: log head A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
        n   min    50%      75%      90%      95%      max
coarse  6 4.204 11.245  12.8935  18.1510  20.7735   23.396
other  40 0.010 33.000 112.0000 279.8842 471.0250 4600.000

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA        LS.75        QR.75
1    1   coarse         normal   0 1.970193e-03 2.673215e-04
2   10   coarse         normal   1 2.050244e+00 5.934102e-01
3  100   coarse         normal   2 2.636990e+03 1.317274e+03
4    1    other         normal   0 3.194781e-03 5.814136e-04
5   10    other         normal   1 3.265539e+00 1.290644e+00
6  100    other         normal   2 4.165501e+03 2.865019e+03
7    1   coarse     small area   0 3.698235e+00 6.735002e+00
8   10   coarse     small area   1 5.252276e+03 1.495061e+04
9  100   coarse     small area   2 8.857247e+06 3.318792e+07
10   1    other     small area   0 5.641072e+00 1.464836e+01
11  10    other     small area   1 8.018415e+03 3.251698e+04
12 100    other     small area   2 1.368819e+07 7.218241e+07

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.08083 -0.44113 -0.05607  0.43842  2.12791

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.1013     0.4729  -0.214    0.831
lTA                    3.1020     0.3682   8.425 1.44e-10 ***
dropletsother          0.2371     0.3860   0.614    0.542
LCTM.equipmentnormal  -3.3317     0.6300  -5.288 4.16e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8626 on 42 degrees of freedom
  (146 observations deleted due to missingness)
Multiple R-squared: 0.6748,     Adjusted R-squared: 0.6515
F-statistic: 29.04 on 3 and 42 DF,  p-value: 2.493e-10

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A ~ logTA + droplets + LCTM.equipment

N: 46      tau: 0.75      AIC: 119.784983567789

                     coefficients       lower bd  upper bd Std. Error    t value
Pr(>|t|)
```

```
(Intercept)             0.8283377   1.640359e-01 1.3728284  0.6786008  1.2206554
0.229025437393304
lTA                     3.3463212  -1.250799e+00 3.4841618  0.4616793  7.2481514
0.000000006433505
dropletsother           0.3374513 -1.797693e+308 0.6059289  0.3615965  0.9332261
0.356037490015100
LCTM.equipmentnormal   -4.4013039  -4.560889e+00 3.6526031  0.9174153 -4.7975045
0.000020489114180


Formula for mean (based on LS-estimate):
log(head A) =  -0.101  + 3.102 log(TA) + 0.237 dropletsother + -3.332
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(head A) =  0.828  + 3.346 log(TA) + 0.337 dropletsother + -4.401
LCTM.equipmentnormal

=================================================================================
```

Model: log inhalation A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
        n       min      50%      75%      90%      95%      max
coarse 24 0.2916667 2.190625 4.144376 12.38739 16.89189 27.87162
other  42 0.0100000 4.787498 9.905196 18.06176 34.77029 69.67905

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA      LS.75       QR.75
1    1   coarse         normal   0  0.3159927   0.2292882
2   10   coarse         normal   1  3.1599269   2.2928819
3  100   coarse         normal   2 31.5992695  22.9288194
4    1    other         normal   0  0.3048900   0.1723102
5   10    other         normal   1  3.0488995   1.7231019
6  100    other         normal   2 30.4889954  17.2310194
7    1   coarse     small area   0  0.6598439   7.2193527
8   10   coarse     small area   1  6.5984386  72.1935274
9  100   coarse     small area   2 65.9843856 721.9352739
10   1    other     small area   0  0.6150635   5.4253472
11  10    other     small area   1  6.1506353  54.2534722
12 100    other     small area   2 61.5063531 542.5347222

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.32771 -0.42373 -0.01846  0.41085  2.35455

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.7386     0.3158  -2.339   0.0225 *
dropletsother         -0.0129     0.2051  -0.063   0.9501
LCTM.equipmentnormal  -0.2876     0.2752  -1.045   0.2999
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7595 on 63 degrees of freedom
  (126 observations deleted due to missingness)
Multiple R-squared: 0.0183,      Adjusted R-squared: -0.01286
F-statistic: 0.5872 on 2 and 63 DF,  p-value: 0.5589

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A/TA ~ droplets + LCTM.equipment
```

```
N: 66      tau: 0.75      AIC: 152.174586696982

                     coefficients   lower bd  upper bd Std. Error    t value
Pr(>|t|)
(Intercept)            0.8584983 -0.6196656 1.7636241  1.4352010  0.5981729
0.5518691
dropletsother         -0.1240707 -0.4716392 0.2323238  0.1875928 -0.6613831
0.5107784
LCTM.equipmentnormal   -1.4981166 -2.3936953 1.2129236  1.4291876 -1.0482294
0.2985377


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + -0.739  + -0.013 dropletsother + -0.288
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 0.858  + -0.124 dropletsother + -1.498
LCTM.equipmentnormal

==================================================================================

Model: log inhalation A ~ logTA + droplets + LCTM.equipment

Table of measured values:
        n       min      50%      75%      90%      95%      max
coarse 24 0.2916667 2.190625 4.144376 12.38739 16.89189 27.87162
other  42 0.0100000 4.787498 9.905196 18.06176 34.77029 69.67905

Table of predicted values ( 75 th percentile):
    TA droplets LCTM.equipment lTA      LS.75     QR.75
1    1   coarse         normal   0  2.0402489  1.019834
2   10   coarse         normal   1  5.3617037  3.232397
3  100   coarse         normal   2 15.4829386 10.245183
4    1    other         normal   0  2.8260848  1.035609
5   10    other         normal   1  7.2610598  3.282396
6  100    other         normal   2 20.4418081 10.403656
7    1   coarse     small area   0  0.4454778  5.234974
8   10   coarse     small area   1  1.3735425 16.592414
9  100   coarse     small area   2  4.5760787 52.590175
10   1    other     small area   0  0.5729611  5.315949
11  10    other     small area   1  1.7292726 16.849066
12 100    other     small area   2  5.6771019 53.403643

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2752 -0.3880  0.0428  0.3138  2.3689

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.8889     0.3094  -2.873  0.00555 **
lTA                    0.4586     0.2167   2.116  0.03838 *
dropletsother          0.1278     0.2049   0.623  0.53525
LCTM.equipmentnormal   0.6499     0.4591   1.416  0.16188
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7297 on 62 degrees of freedom
  (126 observations deleted due to missingness)
Multiple R-squared: 0.3581,      Adjusted R-squared: 0.327
F-statistic: 11.53 on 3 and 62 DF,  p-value: 0.00000421

Summary of RQ fit ( 75 th percentile):
```

```
Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A ~ logTA + droplets + LCTM.equipment

N: 66      tau: 0.75      AIC: 140.240062633317

                      coefficients    lower bd   upper bd Std. Error     t value
Pr(>|t|)
(Intercept)            0.718914533 -0.75503927  1.4921159  1.4685936  0.48952586
0.62619701
lTA                    0.500995042  0.28846780  0.6533667  0.2029621  2.46841621
0.01634254
dropletsother          0.006666262 -0.08609104  0.4849030  0.1976382  0.03372962
0.97320112
LCTM.equipmentnormal -0.710384882 -1.51094830 -0.1518216  1.5010104 -0.47327113
0.63768188


Formula for mean (based on LS-estimate):
log(inhalation A) =  -0.889  + 0.459 log(TA) + 0.128 dropletsother + 0.65
LCTM.equipmentnormal
Formula for 75th percentile (based on quantile regression):
log(inhalation A) =  0.719  + 0.501 log(TA) + 0.007 dropletsother + -0.71
LCTM.equipmentnormal

=====================================================================================
```

A – HCTM

Model: log total hands A/TA ~ cabin

```
Table of measured values:
          n   min       50%      75%      90%      95%      max
cabin    54  0.01  722.8822 2845.750  8907.35 18293.39 423687.9
no cabin 55 63.60 2283.0000 8019.125 12248.14 31462.00  97980.0

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA       LS.75      QR.75
1  1    cabin 0.00000    586.8352   1129.495
2 10    cabin 1.00000   5868.3523  11294.955
3 50    cabin 1.69897  29341.7613  56474.773
4  1 no cabin 0.00000   6046.9293   2287.171
5 10 no cabin 1.00000  60469.2928  22871.712
6 50 no cabin 1.69897 302346.4642 114358.561

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.8534 -0.3990  0.0938  0.6827  2.4337

Coefficients:
              Estimate Std. Error t value  Pr(>|t|)
(Intercept)     1.9503     0.1630  11.964   < 2e-16 ***
cabinno cabin   1.0132     0.2295   4.415 0.0000243 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.198 on 107 degrees of freedom
  (48 observations deleted due to missingness)
Multiple R-squared: 0.1541,     Adjusted R-squared: 0.1462
F-statistic: 19.49 on 1 and 107 DF,  p-value: 0.00002425

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
```

```
Formula: log total hands A/TA ~ cabin

N: 109      tau: 0.75      AIC: 283.746678011629

              coefficients  lower bd  upper bd Std. Error   t value  Pr(>|t|)
(Intercept)      3.0528845 2.9238344 3.1293128  0.1100186 27.748814 0.00000000
cabinno cabin    0.3064142 0.1737269 0.4544226  0.1223811  2.503771 0.01379777


Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 1.95  + 1.013 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(total hands A) = log(TA) + 3.053  + 0.306 cabinno cabin

=================================================================================
```

Model: log total hands A ~ logTA + cabin

```
Table of measured values:
          n   min       50%      75%      90%      95%      max
cabin    54  0.01  722.8822 2845.750  8907.35 18293.39 423687.9
no cabin 55 63.60 2283.0000 8019.125 12248.14 31462.00  97980.0

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA     LS.75     QR.75
1  1    cabin 0.00000  1319.357  1321.472
2 10    cabin 1.00000  4001.022 10181.795
3 50    cabin 1.69897  9424.682 42427.509
4  1 no cabin 0.00000  9999.209  2523.365
5 10 no cabin 1.00000 31374.791 19442.249
6 50 no cabin 1.69897 75578.673 81015.795

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.7383 -0.3698  0.1652  0.5563  2.7213

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     2.2936     0.2747   8.350 2.81e-13 ***
lTA             0.4924     0.3280   1.501 0.136267
cabinno cabin   0.8879     0.2419   3.670 0.000382 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.19 on 106 degrees of freedom
  (48 observations deleted due to missingness)
Multiple R-squared: 0.1134,     Adjusted R-squared: 0.09663
F-statistic: 6.776 on 2 and 106 DF,  p-value: 0.001701

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands A ~ logTA + cabin

N: 109      tau: 0.75      AIC: 284.506041441222

              coefficients  lower bd  upper bd Std. Error   t value        Pr(>|t|)
(Intercept)      3.1210578 2.9892568 3.1928774  0.1462035 21.347349 0.0000000000000
lTA              0.8867665 0.5906531 1.1008597  0.1606896  5.518507 0.0000002442601
cabinno cabin    0.2809222 0.2008339 0.4157297  0.1353510  2.075509 0.0403595661587


Formula for mean (based on LS-estimate):
```

```
log(total hands A) =  2.294  + 0.492 log(TA) + 0.888 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(total hands A) =  3.121  + 0.887 log(TA) + 0.281 cabinno cabin
```

==

Model: log protected hands A/TA ~ 1

```
Table of measured values:
      n  min  50%   75%      90%  95%  max
TRUE 67 0.01 62.5 189.3 735.3571 3754 9080

Table of predicted values ( 75 th percentile):
  TA     lTA      LS.75      QR.75
1  1 0.00000   77.07232   35.18519
2 10 1.00000  770.72316  351.85185
3 50 1.69897 3853.61582 1759.25926

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.0132 -0.3011  0.1385  0.3991  2.2916

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.1101     0.1389   7.993 2.72e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.137 on 66 degrees of freedom
  (90 observations deleted due to missingness)

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands A/TA ~ 1

N: 67      tau: 0.75      AIC: 189.152527410218

               [,1]              [,2]
Std. Error 1.54636 0.226660523877326
t value    1.54636 6.822360659356746
Pr(>|t|)   1.54636 0.000000003348474


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + 1.11
Formula for 75th percentile (based on quantile regression):
log(protected hands A) = log(TA) + 1.546
```

==

Model: log protected hands A ~ logTA

```
Table of measured values:
      n  min  50%   75%      90%  95%  max
TRUE 67 0.01 62.5 189.3 735.3571 3754 9080

Table of predicted values ( 75 th percentile):
  TA     lTA      LS.75      QR.75
1  1 0.00000   93.67653   26.50184
2 10 1.00000  708.05627  451.14882
3 50 1.69897 3302.95100 3271.76821
```

```
Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.9727 -0.3073  0.1115  0.4220  2.2919

Coefficients:
            Estimate Std. Error t value  Pr(>|t|)
(Intercept)   1.1747     0.2644   4.442 0.0000354 ***
lTA           0.8836     0.4047   2.183    0.0326 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.145 on 65 degrees of freedom
  (90 observations deleted due to missingness)
Multiple R-squared: 0.06833,     Adjusted R-squared: 0.054
F-statistic: 4.767 on 1 and 65 DF,  p-value: 0.03262

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands A ~ logTA

N: 67      tau: 0.75      AIC: 189.174852486929

            coefficients  lower bd upper bd Std. Error  t value     Pr(>|t|)
(Intercept)     1.423276 1.2136836 1.646346  0.1933376 7.361608 3.971954e-10
lTA             1.231044 0.8300814 1.528645  0.4985753 2.469123 1.618145e-02


Formula for mean (based on LS-estimate):
log(protected hands A) =  1.175  + 0.884 log(TA)
Formula for 75th percentile (based on quantile regression):
log(protected hands A) =  1.423  + 1.231 log(TA)

================================================================================
```

Model: log total body A/TA ~ cabin

```
Table of measured values:
         n   min     50%      75%      90%       95%      max
cabin    30  68.0  3789.3 12847.30 34411.99  48185.15 131572.0
no cabin 42 620.6 15005.0 60191.87 99537.61 229388.82 432944.1

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA      LS.75      QR.75
1  1    cabin 0.00000   1960.869   2936.609
2 10    cabin 1.00000  19608.693  29366.090
3 50    cabin 1.69897  98043.463 146830.449
4  1 no cabin 0.00000  14124.214   8811.600
5 10 no cabin 1.00000 141242.142  88116.000
6 50 no cabin 1.69897 706210.710 440580.000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.50148 -0.39690  0.07254  0.33688  1.36373

Coefficients:
              Estimate Std. Error t value    Pr(>|t|)
(Intercept)     2.8569     0.1154  24.759     < 2e-16 ***
```

```
cabinno cabin   0.8595     0.1511   5.689 0.000000274 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.632 on 70 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.3162,     Adjusted R-squared: 0.3064
F-statistic: 32.37 on 1 and 70 DF,  p-value: 0.0000002742

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body A/TA ~ cabin

N: 72      tau: 0.75      AIC: 145.090453236418

              coefficients  lower bd  upper bd Std. Error   t value   Pr(>|t|)
(Intercept)      3.4678461 3.1549120 3.6296310  0.2218090 15.634383 0.00000000
cabinno cabin    0.4772087 0.3793818 0.7828825  0.2563102  1.861841 0.06682364


Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 2.857  + 0.86 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(total body A) = log(TA) + 3.468  + 0.477 cabinno cabin

================================================================================
```

Model: log total body A ~ logTA + cabin

```
Table of measured values:
          n   min     50%      75%      90%       95%      max
cabin    30  68.0  3789.3 12847.30 34411.99  48185.15 131572.0
no cabin 42 620.6 15005.0 60191.87 99537.61 229388.82 432944.1

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA       LS.75      QR.75
1  1    cabin 0.00000    1516.785   2935.623
2 10    cabin 1.00000   23780.715  29423.173
3 50    cabin 1.69897  171734.800 147350.259
4  1 no cabin 0.00000   11501.102   8813.017
5 10 no cabin 1.00000  182393.644  88331.122
6 50 no cabin 1.69897 1327217.960 442359.280

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.47799 -0.40715  0.07089  0.35937  1.34654

Coefficients:
              Estimate Std. Error t value     Pr(>|t|)
(Intercept)     2.7384     0.1636  16.738      < 2e-16 ***
lTA             1.1991     0.1949   6.151 0.0000000442 ***
cabinno cabin   0.8844     0.1530   5.781 0.0000001968 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6318 on 69 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.4712,     Adjusted R-squared: 0.4558
F-statistic: 30.74 on 2 and 69 DF,  p-value: 2.847e-10

Summary of RQ fit ( 75 th percentile):
```

```
Call: rq(formula = frm, tau = TAU)
Formula: log total body A ~ logTA + cabin

N: 72      tau: 0.75      AIC: 147.087832553993

              coefficients  lower bd  upper bd Std. Error   t value     Pr(>|t|)
(Intercept)      3.4677004 3.0512121 3.6450659  0.2369142 14.636947 0.0000000000
lTA              1.0009892 0.8774469 1.4987240  0.2759931  3.626863 0.0005452442
cabinno cabin    0.4774242 0.3806906 0.9112588  0.2217922  2.152575 0.0348516563


Formula for mean (based on LS-estimate):
log(total body A) =  2.738  + 1.199 log(TA) + 0.884 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(total A) =  3.468  + 1.001 log(TA) + 0.477 cabinno cabin

==================================================================================
```

Model: log inner body A/TA ~ cabin

```
Table of measured values:
          n    min      50%      75%       90%      95%      max
cabin    30  2.513 104.3478 240.3834  974.7826 2020.000 3291.304
no cabin 42 18.000 195.2000 641.5217 1056.0182 1597.835 4016.803

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA      LS.75      QR.75
1  1    cabin 0.00000   46.20855   68.00446
2 10    cabin 1.00000  462.08546  680.04459
3 50    cabin 1.69897 2310.42732 3400.22297
4  1 no cabin 0.00000  146.31294  114.96464
5 10 no cabin 1.00000 1463.12937 1149.64640
6 50 no cabin 1.69897 7315.64687 5748.23201

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.57773 -0.33219  0.04825  0.37584  1.00428

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    1.30149    0.09622  13.526  < 2e-16 ***
cabinno cabin  0.50224    0.12598   3.987 0.000162 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.527 on 70 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.185,Adjusted R-squared: 0.1734
F-statistic: 15.89 on 1 and 70 DF,  p-value: 0.0001625

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A/TA ~ cabin

N: 72      tau: 0.75      AIC: 114.762236677029

              coefficients  lower bd  upper bd Std. Error   t value Pr(>|t|)
(Intercept)      1.8325374 1.6726848 1.9516426  0.1245534 14.712862 0.000000
cabinno cabin    0.2280269 0.1021839 0.4283918  0.1542446  1.478346 0.143801


Formula for mean (based on LS-estimate):
```

```
log(inner body  A) = log(TA) + 1.301  + 0.502 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(inner body A) = log(TA) + 1.833  + 0.228 cabinno cabin
```

==

Model: log inner body A ~ logTA + cabin

```
Table of measured values:
          n    min      50%      75%       90%      95%      max
cabin    30  2.513 104.3478 240.3834  974.7826 2020.000 3291.304
no cabin 42 18.000 195.2000 641.5217 1056.0182 1597.835 4016.803

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA       LS.75       QR.75
1  1    cabin 0.00000    28.25414    44.40084
2 10    cabin 1.00000   631.14039   710.33718
3 50    cabin 1.69897  5779.07254  4932.59819
4  1 no cabin 0.00000    98.54550    92.04603
5 10 no cabin 1.00000  2221.84370  1472.57859
6 50 no cabin 1.69897 20470.25049 10225.62061

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.75220 -0.31112  0.01928  0.36241  0.88951

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     1.0919     0.1328   8.224 7.78e-12 ***
lTA             1.3521     0.1582   8.546 2.00e-12 ***
cabinno cabin   0.5463     0.1242   4.400 3.85e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5127 on 69 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.5446,     Adjusted R-squared: 0.5314
F-statistic: 41.25 on 2 and 69 DF,  p-value: 1.643e-12

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A ~ logTA + cabin

N: 72      tau: 0.75      AIC: 112.6963078482

              coefficients  lower bd  upper bd Std. Error  t value     Pr(>|t|)
(Intercept)      1.6473911 1.3649053 1.8866263  0.1683707 9.784311 1.132427e-14
lTA              1.2040734 1.0599906 1.7371778  0.1918388 6.276484 2.649529e-08
cabinno cabin    0.3166139 0.1081182 0.5920687  0.1583272 1.999745 4.946644e-02


Formula for mean (based on LS-estimate):
log(inner body A) =  1.092  + 1.352 log(TA) + 0.546 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(inner body A) =  1.647  + 1.204 log(TA) + 0.317 cabinno cabin
```

==

Model: log head A/TA ~ cabin

```
Table of measured values:
          n   min       50%       75%   90%   95%   max
```

```
cabin    29 0.010  29.16667  133.3333   524  2295  3400
no cabin 42 9.706 523.80000 3538.1250 16222 43265 87860

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA       LS.75       QR.75
1  1    cabin 0.00000    32.13015    14.95726
2 10    cabin 1.00000   321.30146   149.57265
3 50    cabin 1.69897  1606.50729   747.86325
4  1 no cabin 0.00000   924.09599  1158.00000
5 10 no cabin 1.00000  9240.95990 11580.00000
6 50 no cabin 1.69897 46204.79950 57900.00000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5363 -0.5973 -0.1260  0.6652  2.2851

Coefficients:
              Estimate Std. Error t value     Pr(>|t|)
(Intercept)     0.8161     0.1860   4.388 0.0000402314 ***
cabinno cabin   1.4624     0.2418   6.047 0.0000000674 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.002 on 69 degrees of freedom
  (86 observations deleted due to missingness)
Multiple R-squared: 0.3464,     Adjusted R-squared: 0.3369
F-statistic: 36.57 on 1 and 69 DF,  p-value: 0.00000006745

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A/TA ~ cabin

N: 71      tau: 0.75      AIC: 220.326120739326

              coefficients  lower bd upper bd Std. Error  t value      Pr(>|t|)
(Intercept)       1.174852 0.8644907 1.904791  0.3589889 3.272670 0.00166612196
cabinno cabin     1.888856 1.0732378 2.353883  0.4333453 4.358779 0.00004463465


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + 0.816  + 1.462 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(head A) = log(TA) + 1.175  + 1.889 cabinno cabin

==================================================================================
```

Model: log head A ~ logTA + cabin

```
Table of measured values:
          n   min       50%       75%   90%   95%   max
cabin    29 0.010  29.16667  133.3333   524  2295  3400
no cabin 42 9.706 523.80000 3538.1250 16222 43265 87860

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA        LS.75         QR.75
1  1    cabin 0.00000     18.93465      6.028619
2 10    cabin 1.00000    473.65377    214.240817
3 50    cabin 1.69897   4891.35871   2598.867210
4  1 no cabin 0.00000    601.93757    575.103816
5 10 no cabin 1.00000  15315.53667  20437.634934
6 50 no cabin 1.69897 159963.65494 247920.541047
```

```
Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.5900 -0.5753 -0.0296  0.6225  2.3213 

Coefficients:
              Estimate Std. Error t value     Pr(>|t|)    
(Intercept)     0.5791     0.2589   2.237       0.0286 *  
lTA             1.4037     0.3083   4.553 0.0000224805 ***
cabinno cabin   1.5097     0.2433   6.205 0.0000000371 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.9965 on 68 degrees of freedom
  (86 observations deleted due to missingness)
Multiple R-squared: 0.4333,     Adjusted R-squared: 0.4166 
F-statistic:    26 on 2 and 68 DF,  p-value: 0.000000004113 

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A ~ logTA + cabin

N: 71      tau: 0.75      AIC: 219.05624673354

              coefficients  lower bd upper bd Std. Error  t value        Pr(>|t|)
(Intercept)      0.7802178 0.6497944 1.699527  0.3528133 2.211418 0.0303717434151
lTA              1.5506844 1.0202520 2.495199  0.4464379 3.473460 0.0008983307293
cabinno cabin    1.9795284 0.9345993 2.313762  0.3457341 5.725581 0.0000002547704


Formula for mean (based on LS-estimate):
log(head A) =  0.579  + 1.404 log(TA) + 1.51 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(head A) =  0.78  + 1.551 log(TA) + 1.98 cabinno cabin

=================================================================================
```

Model: log inhalation A/TA ~ cabin

```
Table of measured values:
          n       min      50%       75%       90%      95%        max
cabin    42 0.4882812 12.23041  20.21498  40.67383 114.9386   626.6276
no cabin 41 9.0679825 46.32143 114.58333 260.41667 416.6667 23614.5833

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA      LS.75       QR.75
1  1    cabin 0.00000    4.79766    5.787037
2 10    cabin 1.00000   47.97660   57.870370
3 50    cabin 1.69897  239.88299  289.351852
4  1 no cabin 0.00000   56.97570   33.730159
5 10 no cabin 1.00000  569.75700  337.301587
6 50 no cabin 1.69897 2848.78499 1686.507937

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.29458 -0.36355 -0.02158  0.28687  2.13246 

Coefficients:
```

```
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.26309    0.09407   2.797  0.00645 **
cabinno cabin  1.07454    0.13384   8.028 6.61e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6096 on 81 degrees of freedom
  (74 observations deleted due to missingness)
Multiple R-squared: 0.4431,     Adjusted R-squared: 0.4363
F-statistic: 64.45 on 1 and 81 DF,  p-value: 6.605e-12

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A/TA ~ cabin

N: 83      tau: 0.75      AIC: 172.692616768888

              coefficients  lower bd upper bd Std. Error  t value       Pr(>|t|)
(Intercept)      0.7624563 0.4557273 1.076942  0.1517406 5.024736 0.000002955432
cabinno cabin    0.7655621 0.4366039 1.153757  0.1858920 4.118316 0.000091421071


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + 0.263  + 1.075 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 0.762  + 0.766 cabinno cabin

==================================================================================
```

Model: log inhalation A ~ logTA + cabin

```
Table of measured values:
         n       min      50%       75%       90%      95%        max
cabin    42 0.4882812 12.23041  20.21498  40.67383 114.9386   626.6276
no cabin 41 9.0679825 46.32143 114.58333 260.41667 416.6667 23614.5833

Table of predicted values ( 75 th percentile):
  TA    cabin     lTA       LS.75     QR.75
1  1    cabin 0.00000    8.395456   9.76800
2 10    cabin 1.00000   35.442112  35.88884
3 50    cabin 1.69897  101.776594  89.12202
4  1 no cabin 0.00000   83.423846  63.80529
5 10 no cabin 1.00000  357.986062 234.42854
6 50 no cabin 1.69897 1038.975682 582.15153

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.27225 -0.37160 -0.05694  0.30073  2.29570

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.5064     0.1501   3.374 0.001145 **
lTA             0.6312     0.1795   3.517 0.000724 ***
cabinno cabin   1.0011     0.1360   7.359 1.44e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5979 on 80 degrees of freedom
  (74 observations deleted due to missingness)
Multiple R-squared: 0.4154,     Adjusted R-squared: 0.4008
F-statistic: 28.42 on 2 and 80 DF,  p-value: 4.721e-10
```

```
Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A ~ logTA + cabin

N: 83      tau: 0.75      AIC: 167.389586225296

              coefficients  lower bd  upper bd Std. Error  t value      Pr(>|t|)
(Intercept)      0.9898056 0.6189254 1.1445207  0.2204011 4.490928 0.00002357554
lTA              0.5651538 0.3172190 1.0047892  0.2747784 2.056762 0.04296834469
cabinno cabin    0.8150510 0.4314457 0.9744438  0.2052451 3.971112 0.00015542901


Formula for mean (based on LS-estimate):
log(inhalation A) =  0.506  + 0.631 log(TA) + 1.001 cabinno cabin
Formula for 75th percentile (based on quantile regression):
log(inhalation A) =  0.99  + 0.565 log(TA) + 0.815 cabinno cabin

==================================================================================
```

A – HCHH

Model: log total hands A/TA ~ HCHH.culture

```
Table of measured values:
               n         min      50%      75%      90%      95%     max
dense culture 40 14012.50000 33505.60 48192.07 60788.63 67131.74 78038.0
normal        50    11.42899  2538.35  5871.65 13930.19 24666.95 60542.4

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA       LS.75      QR.75
1 0.2 dense culture -0.69897   4075.2024  2897.7479
2 1.0 dense culture  0.00000  20376.0118 14488.7395
3 5.0 dense culture  0.69897 101880.0590 72443.6975
4 0.2        normal -0.69897    466.8722   526.7295
5 1.0        normal  0.00000   2334.3611  2633.6475
6 5.0        normal  0.69897  11671.8055 13168.2377

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.45276 -0.19272  0.01306  0.21206  1.37923

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         4.01965    0.06675   60.22   <2e-16 ***
HCHH.culturenormal -0.94024    0.08955  -10.50   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4222 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5561,     Adjusted R-squared: 0.551
F-statistic: 110.2 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 92.2304054589573

                   coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
```

```
(Intercept)            4.161031  4.1000863  4.2274697 0.04821723 86.297587
0.000000000000000
HCHH.culturenormal    -0.740473 -0.9078952 -0.6409805 0.11099436 -6.671267
0.000000002163713


Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 4.02  + -0.94 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(total hands A) = log(TA) + 4.161  + -0.74 HCHH.culturenormal

==================================================================================
```

Model: log total hands A ~ logTA + HCHH.culture

```
Table of measured values:
               n         min      50%      75%      90%      95%     max
dense culture 40 14012.50000 33505.60 48192.07 60788.63 67131.74 78038.0
normal        50    11.42899  2538.35  5871.65 13930.19 24666.95 60542.4

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA       LS.75      QR.75
1 0.2 dense culture -0.69897   3844.2915  4744.7676
2 1.0 dense culture  0.00000  19761.1423 18228.0345
3 5.0 dense culture  0.69897 103740.0328 70026.8736
4 0.2        normal -0.69897    444.7233   708.2275
5 1.0        normal  0.00000   2306.7763  2720.8067
6 5.0        normal  0.69897  12225.8957 10452.5579

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.42657 -0.20494  0.01478  0.21196  1.39359

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         4.00222    0.08839  45.280  < 2e-16 ***
lTA                 1.03355    0.11079   9.329 9.51e-15 ***
HCHH.culturenormal -0.92993    0.09624  -9.662 1.98e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4244 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.7624,     Adjusted R-squared: 0.7569
F-statistic: 139.6 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total hands A ~ logTA + HCHH.culture

N: 90      tau: 0.75      AIC: 91.783850155563

                   coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           4.2607398  4.0601172  4.3467143 0.09907554 43.004961
0.0000000000000
lTA                   0.8362661  0.5619509  1.1325130 0.17215730  4.857570
0.0000052041660
HCHH.culturenormal   -0.8260422 -0.9103580 -0.6399492 0.13932259 -5.928989
0.0000000600931
```

```
Formula for mean (based on LS-estimate):
log(total hands A) =  4.002  + 1.034 log(TA) + -0.93 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(total hands A) =  4.261  + 0.836 log(TA) + -0.826 HCHH.culturenormal

================================================================================
```

Model: log protected hands A/TA ~ HCHH.culture

```
Table of measured values:
               n   min    50%     75%     90%      95%  max
dense culture 40 14.96 267.15 580.400 1064.40 1357.550 1381
normal        50  0.05   4.12 112.575  350.24  510.465 1958

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA       LS.75      QR.75
1 0.2 dense culture -0.69897   57.848861  36.638655
2 1.0 dense culture  0.00000  289.244307 183.193277
3 5.0 dense culture  0.69897 1446.221537 915.966387
4 0.2        normal -0.69897    3.164249   4.780405
5 1.0        normal  0.00000   15.821246  23.902027
6 5.0        normal  0.69897   79.106229 119.510135

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-2.0303 -0.4054  0.0761  0.5027  1.8766 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)          1.9036     0.1286  14.802  < 2e-16 ***
HCHH.culturenormal  -1.2607     0.1725  -7.307 1.18e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.8133 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.3776,     Adjusted R-squared: 0.3705 
F-statistic: 53.39 on 1 and 88 DF,  p-value: 1.179e-10 

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 215.865596980336

                   coefficients  lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           2.2629095  2.076615  2.4624996  0.1344074 16.836203
0.0000000000
HCHH.culturenormal   -0.8844748 -1.210279 -0.5619251  0.2348540 -3.766062
0.0002990514


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + 1.904  + -1.261 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(protected hands A) = log(TA) + 2.263  + -0.884 HCHH.culturenormal

================================================================================
```

Model: log protected hands A ~ logTA + HCHH.culture

```
Table of measured values:
               n   min    50%     75%     90%      95%  max
dense culture 40 14.96 267.15 580.400 1064.40 1357.550 1381
normal        50  0.05   4.12 112.575  350.24  510.465 1958

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA        LS.75        QR.75
1 0.2 dense culture -0.69897    6.0065615    5.1395560
2 1.0 dense culture  0.00000  102.6241790   76.0307989
3 5.0 dense culture  0.69897 1819.8505679 1124.7435409
4 0.2        normal -0.69897    0.5616543    0.8693045
5 1.0        normal  0.00000    9.7504679   12.8598496
6 5.0        normal  0.69897  175.8469801  190.2391262

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.9307 -0.4726  0.1691  0.5092  1.4326

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          1.4920     0.1563   9.545 3.45e-15 ***
lTA                  1.7924     0.1959   9.148 2.23e-14 ***
HCHH.culturenormal  -1.0171     0.1702  -5.976 4.90e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7505 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.675,Adjusted R-squared: 0.6675
F-statistic: 90.34 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log protected hands A ~ logTA + HCHH.culture

N: 90      tau: 0.75      AIC: 193.393622557388

                   coefficients   lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           1.8809896  1.7899347  2.112410  0.1643803 11.442911
0.000000e+00
lTA                   1.6739831  1.4922738  1.845165  0.1944332  8.609553
2.828848e-13
HCHH.culturenormal   -0.7717537 -0.9929029 -0.605342  0.1774365 -4.349465
3.696362e-05


Formula for mean (based on LS-estimate):
log(protected hands A) =  1.492  + 1.792 log(TA) + -1.017 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(protected hands A) =  1.881  + 1.674 log(TA) + -0.772 HCHH.culturenormal

================================================================================
```

Model: log total body A/TA ~ HCHH.culture

```
Table of measured values:
               n        min       50%        75%       90%       95%     max
dense culture 40 205029.900 743891.35 1433241.63 2015534.4 2224532.1 2470393
normal        50   1739.584  21941.66   55128.48  134742.7  179870.9  254373

Table of predicted values ( 75 th percentile):
```

```
   TA  HCHH.culture      lTA       LS.75       QR.75
1 0.2 dense culture -0.69897  118738.745   76960.465
2 1.0 dense culture  0.00000  593693.727  384802.326
3 5.0 dense culture  0.69897 2968468.636 1924011.628
4 0.2        normal -0.69897    6134.736    8593.682
5 1.0        normal  0.00000   30673.678   42968.412
6 5.0        normal  0.69897  153368.388  214842.061

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.57788 -0.31279 -0.03126  0.33281  1.45202 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)         5.39920    0.08632   62.55   <2e-16 ***
HCHH.culturenormal -1.28588    0.11582  -11.10   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.546 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5835,     Adjusted R-squared: 0.5787 
F-statistic: 123.3 on 1 and 88 DF,  p-value: < 2.2e-16 

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log total body A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 161.39484076558

                   coefficients  lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           5.5852377  5.508614  5.742505 0.06162287 90.635786
0.0000000000000
HCHH.culturenormal   -0.9520884 -1.328522 -0.746140 0.17418488 -5.465965
0.0000004243098


Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 5.399  + -1.286 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(total body A) = log(TA) + 5.585  + -0.952 HCHH.culturenormal

================================================================================
```

Model: log total body A ~ logTA + HCHH.culture

```
Table of measured values:
               n        min       50%         75%       90%       95%     max
dense culture 40 205029.900 743891.35 1433241.63 2015534.4 2224532.1 2470393
normal        50   1739.584  21941.66   55128.48  134742.7  179870.9  254373

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75      QR.75
1 0.2 dense culture -0.69897  736899.83  938758.26
2 1.0 dense culture  0.00000 1199733.40 1207693.11
3 5.0 dense culture  0.69897 1999622.92 1553672.24
4 0.2        normal -0.69897   23190.05   47775.05
5 1.0        normal  0.00000   38137.10   61461.61
6 5.0        normal  0.69897   64243.17   79069.10

Summary of LS fit (mean):
```

```
Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.24318 -0.29821 -0.01523  0.31477  1.15490 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)         5.75181    0.09853   58.38   <2e-16 ***
lTA                 0.32106    0.12350    2.60    0.011 *  
HCHH.culturenormal -1.49453    0.10728  -13.93   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.473 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.7484,     Adjusted R-squared: 0.7427 
F-statistic: 129.4 on 2 and 87 DF,  p-value: < 2.2e-16 

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: logtotal body A ~ logTA + HCHH.culture

N: 90      tau: 0.75      AIC: 139.961403513638

                   coefficients   lower bd   upper bd Std. Error    t value
Pr(>|t|)
(Intercept)            6.081957  5.8033622  6.3503375  0.1512085 40.2223276
0.000000e+00
lTA                    0.156520 -0.3203005  0.6660829  0.2559031  0.6116379
5.423724e-01
HCHH.culturenormal    -1.293353 -1.5601880 -1.0322111  0.1598204 -8.0925371
3.209211e-12


Formula for mean (based on LS-estimate):
log(total body A) =  5.752  + 0.321 log(TA) + -1.495 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(total body A) =  6.082  + 0.157 log(TA) + -1.293 HCHH.culturenormal

===============================================================================
```

Model: log inner body A/TA ~ HCHH.culture

```
Table of measured values:
               n    min       50%       75%        90%        95%      max
dense culture 40 2389.9 11617.750 46538.250 107170.900 189501.150 305040.0
normal        50    6.0   255.251   972.135   1721.309   1912.291   8980.1

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75      QR.75
1 0.2 dense culture -0.69897  3086.1552  2985.1584
2 1.0 dense culture  0.00000 15430.7761 14925.7919
3 5.0 dense culture  0.69897 77153.8803 74628.9593
4 0.2        normal -0.69897   102.0456   129.3984
5 1.0        normal  0.00000   510.2280   646.9918
6 5.0        normal  0.69897  2551.1399  3234.9590

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
```

```
-1.3168 -0.5376 -0.1802  0.4585  2.0331

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)           3.7157     0.1090   34.09   <2e-16 ***
HCHH.culturenormal  -1.4795     0.1462  -10.12   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6894 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5377,      Adjusted R-squared: 0.5324
F-statistic: 102.3 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 229.807828692636

                    coefficients  lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)             4.173937  4.013135  4.3378198  0.1847551 22.591725
0.00000000000
HCHH.culturenormal    -1.363039 -1.819007 -0.9292632  0.3324126 -4.100442
0.00009168582


Formula for mean (based on LS-estimate):
log(inner body A) = log(TA) + 3.716  + -1.479 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(inner body A) = log(TA) + 4.174  + -1.363 HCHH.culturenormal

==================================================================================
```

Model: log inner body A ~ HCHH.culture

```
Table of measured values:
              n    min       50%       75%        90%        95%      max
dense culture 40 2389.9 11617.750 46538.250 107170.900 189501.150 305040.0
normal        50    6.0   255.251   972.135   1721.309   1912.291   8980.1

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75    QR.75
1 0.2 dense culture -0.69897 47386.8463 44920.00
2 1.0 dense culture  0.00000 47386.8463 44920.00
3 5.0 dense culture  0.69897 47386.8463 44920.00
4 0.2        normal -0.69897   772.3104  1033.07
5 1.0        normal  0.00000   772.3104  1033.07
6 5.0        normal  0.69897   772.3104  1033.07

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.67010 -0.43413 -0.07057  0.46915  1.50503

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)           4.2350     0.1016   41.68   <2e-16 ***
HCHH.culturenormal  -1.7868     0.1363  -13.11   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.6426 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.6613,     Adjusted R-squared: 0.6575
F-statistic: 171.8 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inner body A ~ HCHH.culture

N: 90      tau: 0.75      AIC: 198.181054848504

                   coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)             4.65244  4.533592  4.874557  0.1756244 26.49086 0.0000e+00
HCHH.culturenormal     -1.63831 -2.020595 -1.424602  0.2169680 -7.55093 3.7921e-11


Formula for mean (based on LS-estimate):
log(inner body A) =  4.235  + -1.787 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(inner body A) =  4.652  + -1.638 HCHH.culturenormal

==================================================================================
```

Model: log head A/TA ~ HCHH.culture

```
Table of measured values:
               n    min     50%     75%     90%     95%    max
dense culture 40 129.72 1136.40 2894.50 4251.40 5180.90 5394.0
normal        50   4.00   62.29  155.68  390.46  851.61 1471.6

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75      QR.75
1 0.2 dense culture -0.69897  183.23646  129.70835
2 1.0 dense culture  0.00000  916.18231  648.54177
3 5.0 dense culture  0.69897 4580.91157 3242.70885
4 0.2        normal -0.69897   19.05529   31.11475
5 1.0        normal  0.00000   95.27646  155.57377
6 5.0        normal  0.69897  476.38229  777.86885

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.35628 -0.38421 -0.00847  0.42494  1.62893

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         2.53252    0.09903  25.574  < 2e-16 ***
HCHH.culturenormal -0.98195    0.13286  -7.391 7.98e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6263 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.383,Adjusted R-squared: 0.376
F-statistic: 54.62 on 1 and 88 DF,  p-value: 7.983e-11

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 183.810933611642
```

```
                    coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)            2.8119380  2.6943462  2.9570867 0.08284337 33.942823
0.000000000
HCHH.culturenormal   -0.6200016 -0.8154153 -0.3671444 0.19327437 -3.207883
0.001865531


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + 2.533  + -0.982 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(head A) = log(TA) + 2.812  + -0.62 HCHH.culturenormal

==================================================================================
```

Model: log head A ~ logTA + HCHH.culture

```
Table of measured values:
               n    min     50%     75%     90%     95%    max
dense culture 40 129.72 1136.40 2894.50 4251.40 5180.90 5394.0
normal        50   4.00   62.29  155.68  390.46  851.61 1471.6

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75      QR.75
1 0.2 dense culture -0.69897 1108.15073 1121.86855
2 1.0 dense culture  0.00000 1853.82379 1881.59144
3 5.0 dense culture  0.69897 3189.99577 3155.79428
4 0.2        normal -0.69897   70.99248   90.81339
5 1.0        normal  0.00000  120.20909  152.31170
6 5.0        normal  0.69897  209.51282  255.45630

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.00654 -0.38986  0.00658  0.42513  1.34706

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          2.8745     0.1185  24.257  < 2e-16 ***
lTA                  0.3416     0.1485   2.300   0.0238 *
HCHH.culturenormal  -1.1843     0.1290  -9.178 1.94e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5689 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5785,     Adjusted R-squared: 0.5688
F-statistic: 59.71 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log head A ~ logTA + HCHH.culture

N: 90      tau: 0.75      AIC: 174.550492400507

                    coefficients    lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)            3.2745253  2.69544882  3.5046349  0.1610892 20.327409
0.00000000000
lTA                    0.3213061  0.03030095  1.0895270  0.2455845  1.308332
0.19420661943
HCHH.culturenormal   -1.0917921 -1.37936930 -0.4471906  0.2087528 -5.230072
0.00000115453
```

```
Formula for mean (based on LS-estimate):
log(head A) =  2.874  + 0.342 log(TA) + -1.184 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(head A) =  3.275  + 0.321 log(TA) + -1.092 HCHH.culturenormal

==================================================================================
```

Model: log inhalation A/TA ~ HCHH.culture

```
Table of measured values:
               n         min       50%      75%      90%      95%      max
dense culture 40 101.5315315 330.97728 428.7562 573.4975 705.2123 2136.261
normal        50   0.5208333  57.84375 156.5365 336.5000 390.4583 2165.625

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA      LS.75     QR.75
1 0.2 dense culture -0.69897   40.48203  23.70271
2 1.0 dense culture  0.00000  202.41015 118.51357
3 5.0 dense culture  0.69897 1012.05076 592.56784
4 0.2        normal -0.69897   13.15918  13.97321
5 1.0        normal  0.00000   65.79588  69.86607
6 5.0        normal  0.69897  328.97942 349.33036

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.55824 -0.20138  0.01866  0.22641  1.06065

Coefficients:
                   Estimate Std. Error t value   Pr(>|t|)
(Intercept)         1.98988    0.07295  27.278    < 2e-16 ***
HCHH.culturenormal -0.48726    0.09787  -4.979 0.00000316 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4614 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.2198,     Adjusted R-squared: 0.2109
F-statistic: 24.79 on 1 and 88 DF,  p-value: 0.000003159

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A/TA ~ HCHH.culture

N: 90      tau: 0.75      AIC: 96.9541298620591

                   coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           2.0737681  2.0256229  2.2061435 0.06892195 30.088643
0.00000000
HCHH.culturenormal   -0.2295017 -0.4055022 -0.1271319 0.10063017 -2.280645
0.02498486


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + 1.99  + -0.487 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 2.074  + -0.23 HCHH.culturenormal

==================================================================================
```

Model: log inhalation A ~ logTA + HCHH.culture

```
Table of measured values:
               n         min       50%      75%      90%      95%      max
dense culture 40 101.5315315 330.97728 428.7562 573.4975 705.2123 2136.261
normal        50   0.5208333  57.84375 156.5365 336.5000 390.4583 2165.625

Table of predicted values ( 75 th percentile):
   TA  HCHH.culture      lTA     LS.75     QR.75
1 0.2 dense culture -0.69897  85.62221  38.70512
2 1.0 dense culture  0.00000 273.81494 147.39514
3 5.0 dense culture  0.69897 895.47117 561.30378
4 0.2        normal -0.69897  22.80875  21.18048
5 1.0        normal  0.00000  73.64498  80.65859
6 5.0        normal  0.69897 243.30085 307.16054

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.41240 -0.16074 -0.00015  0.23767  1.20649

Coefficients:
                   Estimate Std. Error t value     Pr(>|t|)
(Intercept)         2.12507    0.09405  22.596      < 2e-16 ***
lTA                 0.73970    0.11788   6.275 0.0000000132 ***
HCHH.culturenormal -0.56726    0.10240  -5.539 0.0000003182 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4515 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5543,     Adjusted R-squared: 0.544
F-statistic:  54.1 on 2 and 87 DF,  p-value: 5.417e-16

Summary of RQ fit ( 75 th percentile):

Call: rq(formula = frm, tau = TAU)
Formula: log inhalation A ~ lTA + HCHH.culture

N: 90      tau: 0.75      AIC: 93.9953959079024

                   coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           2.1684832  2.0596035  2.3750716 0.09589396 22.613344
0.00000000000000
lTA                   0.8308151  0.6293360  1.0236831 0.13451506  6.176372
0.00000002039931
HCHH.culturenormal   -0.2618326 -0.4684561 -0.1752491 0.08930619 -2.931852
0.00430477702971


Formula for mean (based on LS-estimate):
log(inhalation A) =  2.125  + 0.74 log(TA) + -0.567 HCHH.culturenormal
Formula for 75th percentile (based on quantile regression):
log(inhalation A) =  2.168  + 0.831 log(TA) + -0.262 HCHH.culturenormal

==================================================================================
```

20 Model computations (95th percentile)

ML – tank

Model: log total hands ML/TA ~ form + glove.wash.ML

```
Table of measured values:
         n        min       50%       75%        95%        max
WG      41  218.70000  1997.005  3885.253   6926.498   40938.82
WP      20 5844.70000 75873.000 96066.000 147403.600  179582.00
liquid 169   71.49891  8250.000 30250.500 553048.508 2346735.63

Table of predicted values (95th percentile):
   TA   form glove.wash.ML lTA        LS.95       QR.95
1   1     WP                 0   131415.044   36940.235
2  10     WP                 1  1314150.437  369402.352
3 100     WP                 2 13141504.368 3694023.518
4   1     WG                 0     3594.576    3007.883
5  10     WG                 1    35945.761   30078.835
6 100     WG                 2   359457.614  300788.348
7   1 liquid                 0    11706.751   12018.519
8  10 liquid                 1   117067.507  120185.185
9 100 liquid                 2  1170675.074 1201851.852

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.39441 -0.43021  0.01458  0.47816  1.43035

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)        2.4752     0.1049  23.589  < 2e-16 ***
formWP             1.5498     0.1761   8.799 3.62e-16 ***
formliquid         0.5235     0.1137   4.603 6.96e-06 ***
glove.wash.MLyes  -0.2752     0.1321  -2.084   0.0383 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6457 on 226 degrees of freedom
  (273 observations deleted due to missingness)
Multiple R-squared: 0.2676,     Adjusted R-squared: 0.2579
F-statistic: 27.53 on 3 and 226 DF,  p-value: 3.275e-15

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total hands ML/TA ~ form + glove.wash.ML

N: 230      tau: 0.95      AIC: 574.934332011854

                 coefficients   lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)         3.4782610  3.3812566 1.797693e+308  0.3058971 11.370690
0.0000000000000
formWP              1.0892386  0.6135219 1.797693e+308  0.3499321  3.112714
0.0020929729294
formliquid          0.6015899  0.1046676  7.940540e-01  0.3419521  1.759281
0.0798829033719
glove.wash.MLyes   -0.6800388 -0.8003503 1.797693e+308  0.1243340 -5.469451
0.0000001192885


Formula for mean (based on LS-estimate):
```

```
log(total hands ML) = log(TA) + 2.475  + 1.55 formWP + 0.523 formliquid + -0.275
glove.wash.MLyes
Formula for 95th percentile (based on quantile regression):
log(total hands ML) = log(TA) + 3.478  + 1.089 formWP + 0.602 formliquid + -0.68
glove.wash.MLyes

==================================================================================
```

Model: log total hands ML ~ logTA + form + glove.wash.ML

```
Table of measured values:
         n        min       50%       75%        95%         max
WG      41  218.70000  1997.005  3885.253   6926.498   40938.82
WP      20 5844.70000 75873.000 96066.000 147403.600  179582.00
liquid 169   71.49891  8250.000 30250.500 553048.508 2346735.63

Table of predicted values (95th percentile):
   TA   form glove.wash.ML lTA       LS.95       QR.95
1   1     WP                 0  211829.082   88490.755
2  10     WP                 1 1085465.642  531567.071
3 100     WP                 2 5687802.843 3193142.055
4   1     WG                 0    5807.999    6251.808
5  10     WG                 1   29757.650   37554.828
6 100     WG                 2  155950.511  225593.172
7   1 liquid                 0   21042.671   17796.138
8  10 liquid                 1  107425.191  106902.025
9 100 liquid                 2  561082.546  642164.218

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.20324 -0.42676  0.01194  0.40950  1.59322

Coefficients:
                 Estimate Std. Error t value    Pr(>|t|)
(Intercept)       2.72681    0.11377  23.968     < 2e-16 ***
lTA               0.71328    0.06106  11.682     < 2e-16 ***
formWP            1.54937    0.16846   9.197     < 2e-16 ***
formliquid        0.56778    0.10919   5.200 0.000000447 ***
glove.wash.MLyes -0.33484    0.12698  -2.637     0.00895 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6176 on 225 degrees of freedom
  (273 observations deleted due to missingness)
Multiple R-squared: 0.5191,     Adjusted R-squared: 0.5105
F-statistic: 60.71 on 4 and 225 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total hands ML ~ logTA + form + glove.wash.ML

N: 230      tau: 0.95      AIC: 548.585657672922

                 coefficients   lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)         3.7960056  3.6249198  3.858266e+00 0.12228994 31.041030
0.000000e+00
lTA                 0.7786602  0.6581955  8.036805e-01 0.08840868  8.807508
4.440892e-16
formWP              1.1508923  0.7655981 1.797693e+308 0.16476918  6.984876
3.182898e-11
```

```
formliquid          0.4543202  0.3701585  6.513177e-01 0.11475598  3.959011
1.009693e-04
glove.wash.MLyes   -0.8445578 -0.8970980 1.797693e+308 0.09698032 -8.708548
6.661338e-16


Formula for mean (based on LS-estimate):
log(total hands ML) =  2.727  + 0.713 log(TA) + 1.549 formWP + 0.568 formliquid + -
0.335 glove.wash.MLyes
Formula for 95th percentile (based on quantile regression):
log(total hands ML) =  3.796  + 0.779 log(TA) + 1.151 formWP + 0.454 formliquid + -
0.845 glove.wash.MLyes

==================================================================================
```

Model: log protected hands ML/TA ~ form

```
Table of measured values:
         n   min        50%        75%        95%      max
WG      41  0.20   23.57881   67.85714   285.7143   948.10
WP      20 94.60 1180.50000 3586.50000 11215.0000 11310.00
liquid 167  0.01   44.11000  127.50000  2270.0844 33747.49

Table of predicted values (95th percentile):
   TA   form lTA       LS.95        QR.95
1   1     WP   0   9845.5941   2016.04278
2  10     WP   1  98455.9415  20160.42781
3 100     WP   2 984559.4150 201604.27807
4   1     WG   0    171.1291     31.46875
5  10     WG   1   1711.2911    314.68750
6 100     WG   2  17112.9113   3146.87500
7   1 liquid   0    189.6903    198.06763
8  10 liquid   1   1896.9033   1980.67633
9 100 liquid   2  18969.0332  19806.76329

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.4465 -0.5423  0.1350  0.6738  2.2032

Coefficients:
            Estimate Std. Error t value      Pr(>|t|)
(Intercept)  0.51120    0.16089   3.177       0.00169 **
formWP       1.73852    0.28098   6.187 0.00000000286 ***
formliquid   0.06026    0.17955   0.336       0.73748
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.03 on 225 degrees of freedom
  (275 observations deleted due to missingness)
Multiple R-squared: 0.1795,      Adjusted R-squared: 0.1722
F-statistic: 24.61 on 2 and 225 DF,  p-value: 2.157e-10

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log protected hands ML/TA ~ form

N: 228      tau: 0.95      AIC: 749.581628856977

            coefficients       lower bd      upper bd Std. Error  t value
Pr(>|t|)
(Intercept)     1.497879   1.235315e+00 1.797693e+308  0.4108617 3.645702
0.00033125141
```

```
formWP          1.806620   1.185979e+00 1.797693e+308  0.4117043 4.388150
0.00001757679
formliquid      0.798934 -1.797693e+308  1.112073e+00  0.4380121 1.824000
0.06947860284


Formula for mean (based on LS-estimate):
log(protected hands ML) = log(TA) + 0.511  + 1.739 formWP + 0.06 formliquid
Formula for 95th percentile (based on quantile regression):
log(protected hands ML) = log(TA) + 1.498  + 1.807 formWP + 0.799 formliquid
```

===

Model: log protected hands ML ~ logTA + form

```
Table of measured values:
         n   min        50%        75%        95%      max
WG      41  0.20   23.57881   67.85714   285.7143   948.10
WP      20 94.60 1180.50000 3586.50000 11215.0000 11310.00
liquid 167  0.01   44.11000  127.50000  2270.0844 33747.49

Table of predicted values (95th percentile):
   TA   form lTA       LS.95       QR.95
1   1     WP   0  23228.3155   1689.52798
2  10     WP   1  55931.1599  21390.43128
3 100     WP   2 139322.0976 270815.60985
4   1     WG   0    403.9063     31.60064
5  10     WG   1    972.5122    400.08294
6 100     WG   2   2423.3790   5065.28846
7   1 liquid   0    586.9531    150.54063
8  10 liquid   1   1404.0642   1905.93416
9 100 liquid   2   3477.1500  24130.26247

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5338 -0.6104 -0.0085  0.5460  2.6548

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.02157    0.16664   6.130 3.91e-09 ***
lTA          0.38657    0.09305   4.155 4.64e-05 ***
formWP       1.74015    0.25771   6.752 1.23e-10 ***
formliquid   0.17395    0.16559   1.051    0.295
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9449 on 224 degrees of freedom
  (275 observations deleted due to missingness)
Multiple R-squared: 0.2334,     Adjusted R-squared: 0.2231
F-statistic: 22.73 on 3 and 224 DF,  p-value: 6.916e-13

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log protected hands ML ~ logTA + form

N: 228      tau: 0.95      AIC: 748.956405920501

            coefficients       lower bd      upper bd Std. Error  t value
Pr(>|t|)
(Intercept)    1.4996959   1.175213e+00  2.053562e+00  0.4289192 3.496453
0.0005683700293
```

```
lTA           1.1024542   6.434132e-01  1.499053e+00  0.2070463 5.324674
0.0000002454625
formWP        1.7280695   1.142468e+00 1.797693e+308  0.4042927 4.274303
0.0000283717922
formliquid    0.6779579 -1.797693e+308  1.181122e+00  0.4362767 1.553963
0.1216049263326


Formula for mean (based on LS-estimate):
log(protected hands ML) =  1.022  + 0.387 log(TA) + 1.74 formWP + 0.174 formliquid
Formula for 95th percentile (based on quantile regression):
log(protected hands ML) =  1.5  + 1.102 log(TA) + 1.728 formWP + 0.678 formliquid

==================================================================================
```

Model: log total body ML/TA ~ form

```
Table of measured values:
        n        min        50%         75%        95%        max
WG     29   169.8190   2691.732   9850.784  25671.59  67310.76
WP     20 27859.6000 144744.500 365618.125 476504.08 568452.20
liquid 80   157.4779   5717.550  28538.814 130134.43 455259.00

Table of predicted values (95th percentile):
   TA   form lTA        LS.95       QR.95
1   1     WP   0   267819.993   84075.704
2  10     WP   1  2678199.931  840757.041
3 100     WP   2 26781999.311 8407570.410
4   1     WG   0     5346.273    4006.593
5  10     WG   1    53462.731   40065.930
6 100     WG   2   534627.314  400659.301
7   1 liquid   0     8075.691   25986.111
8  10 liquid   1    80756.910  259861.114
9 100 liquid   2   807569.099 2598611.144

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.69538 -0.46898  0.00179  0.40943  1.76812

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.6287     0.1211  21.703  < 2e-16 ***
formWP        1.6916     0.1896   8.922  4.5e-15 ***
formliquid    0.1909     0.1414   1.350    0.179
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6523 on 126 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.4361,     Adjusted R-squared: 0.4271
F-statistic: 48.72 on 2 and 126 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total body ML/TA ~ form

N: 129      tau: 0.95      AIC: 354.486892421103

            coefficients       lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)    3.6027752   3.217406e+00 1.797693e+308  0.1495698 24.087582
0.000000e+00
```

```
formWP          1.3218953   1.289313e+00 1.797693e+308  0.1500675  8.808674
8.437695e-15
formliquid      0.8119661 -1.797693e+308  1.173778e+00  0.2750485  2.952083
3.765769e-03


Formula for mean (based on LS-estimate):
log(total body ML) = log(TA) + 2.629  + 1.692 formWP + 0.191 formliquid
Formula for 95th percentile (based on quantile regression):
log(total body ML) = log(TA) + 3.603  + 1.322 formWP + 0.812 formliquid

===============================================================================
```

Model: log total body ML ~ logTA + form

```
Table of measured values:
        n        min        50%        75%       95%       max
WG     29   169.8190   2691.732   9850.784  25671.59  67310.76
WP     20 27859.6000 144744.500 365618.125 476504.08 568452.20
liquid 80   157.4779   5717.550  28538.814 130134.43 455259.00

Table of predicted values (95th percentile):
   TA   form lTA        LS.95      QR.95
1   1     WP   0   456626.075  285786.66
2  10     WP   1  2290292.199  557911.87
3 100     WP   2 12457026.311 1089153.87
4   1     WG   0     9133.499   16070.53
5  10     WG   1    45794.207   31372.84
6 100     WG   2   249135.929   61245.97
7   1 liquid   0    15817.348   72024.35
8  10 liquid   1    78093.847  140605.73
9 100 liquid   2   418768.757  274490.08

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.68026 -0.40599  0.02671  0.40490  1.58382

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.8696     0.1548  18.538  < 2e-16 ***
lTA           0.7121     0.1186   6.006 1.92e-08 ***
formWP        1.6910     0.1860   9.091 1.87e-15 ***
formliquid    0.2438     0.1404   1.736    0.085 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.64 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5019,     Adjusted R-squared: 0.4899
F-statistic: 41.98 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total body ML ~ logTA + form

N: 129      tau: 0.95      AIC: 336.128084718612

            coefficients       lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)    4.2060302   3.515313e+00 1.797693e+308  0.4119966 10.208896
0.00000000000
```

```
lTA             0.2905236   5.983216e-02  1.189557e+00  0.2850692  1.019134
0.31010797424
formWP          1.2500117   9.794553e-01 1.797693e+308  0.2891650  4.322832
0.00003114506
formliquid      0.6514491 -1.797693e+308  1.129022e+00  0.3172415  2.053480
0.04211174869


Formula for mean (based on LS-estimate):
log(total bpdy ML) =  2.87  + 0.712 log(TA) + 1.691 formWP + 0.244 formliquid
Formula for 95th percentile (based on quantile regression):
log(total body ML) =  4.206  + 0.291 log(TA) + 1.25 formWP + 0.651 formliquid

==================================================================================
```

Model: log inner body ML/TA ~ form

```
Table of measured values:
        n     min        50%       75%       95%       max
WG     29    0.01  104.34783  230.4348  1070.524  1491.304
WP     20 1172.62 3885.80000 9072.6250 15705.625 24890.700
liquid 80    0.50   56.38165  180.7781  1442.907 13069.000

Table of predicted values (95th percentile):
   TA   form lTA         LS.95        QR.95
1   1     WP   0   10175.38606   1989.83007
2  10     WP   1  101753.86058  19898.30065
3 100     WP   2 1017538.60585 198983.00654
4   1     WG   0     102.02672     62.21532
5  10     WG   1    1020.26716    622.15321
6 100     WG   2   10202.67159   6221.53209
7   1 liquid   0      85.51871    146.25000
8  10 liquid   1     855.18707   1462.50000
9 100 liquid   2    8551.87067  14625.00000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.81139 -0.38382 -0.03199  0.47632  1.97094

Coefficients:
            Estimate Std. Error t value      Pr(>|t|)
(Intercept)  0.82912    0.12997   6.379 0.00000000308 ***
formWP       1.99002    0.20343   9.782       < 2e-16 ***
formliquid  -0.06405    0.15171  -0.422         0.674
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6999 on 126 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5322,     Adjusted R-squared: 0.5247
F-statistic: 71.66 on 2 and 126 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inner body ML/TA ~ form

N: 129      tau: 0.95      AIC: 377.182868326582

            coefficients       lower bd      upper bd Std. Error  t value
Pr(>|t|)
(Intercept)    1.7938973   1.512269e+00 1.797693e+308  0.1974280 9.086335
1.776357e-15
```

```
formWP          1.5049186   1.366484e+00 1.797693e+308  0.3001189 5.014407
1.763693e-06
formliquid      0.3711985 -1.797693e+308  9.840475e-01  0.3588683 1.034359
3.029497e-01


Formula for mean (based on LS-estimate):
log(inner body ML) = log(TA) + 0.829  + 1.99 formWP + -0.064 formliquid
Formula for 95th percentile (based on quantile regression):
log(inner body ML) = log(TA) + 1.794  + 1.505 formWP + 0.371 formliquid

==================================================================================
```

Model: log inner body ML ~ logTA + form

```
Table of measured values:
        n     min        50%       75%       95%       max
WG     29    0.01  104.34783  230.4348  1070.524  1491.304
WP     20 1172.62 3885.80000 9072.6250 15705.625 24890.700
liquid 80    0.50   56.38165  180.7781  1442.907 13069.000

Table of predicted values (95th percentile):
   TA   form lTA       LS.95        QR.95
1   1     WP   0  11753.4349   1124.56181
2  10     WP   1 100724.6155  21450.84626
3 100     WP   2 943459.4181 409171.64369
4   1     WG   0    117.9146     26.48904
5  10     WG   1   1010.1048    505.27449
6 100     WG   2   9463.8167   9638.03428
7   1 liquid   0    102.7160    111.10570
8  10 liquid   1    865.1584   2119.32433
9 100 liquid   2   7978.4295  40425.79058

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.85758 -0.37844 -0.03886  0.47897  1.95879

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.87435    0.16985   5.148 9.95e-07 ***
lTA          0.94594    0.13010   7.271 3.42e-11 ***
formWP       1.98992    0.20410   9.750  < 2e-16 ***
formliquid  -0.05411    0.15408  -0.351    0.726
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7022 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5864,      Adjusted R-squared: 0.5765
F-statistic: 59.07 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inner body ML ~ logTA + form

N: 129      tau: 0.95      AIC: 377.573830363579

            coefficients       lower bd      upper bd Std. Error  t value
Pr(>|t|)
(Intercept)    1.4230663   1.327185e+00 1.797693e+308  0.3608720 3.943410
0.0001330071682
```

```
lTA            1.2804611  -1.706662e-01  1.482441e+00  0.3190572 4.013265
0.0001024993734
formWP         1.6279171   1.119118e+00 1.797693e+308  0.2880818 5.650884
0.0000001024896
formliquid     0.6226701 -1.797693e+308  9.416483e-01  0.3646865 1.707412
0.0902281421990


Formula for mean (based on LS-estimate):
log(inner body ML) =  0.874  + 0.946 log(TA) + 1.99 formWP + -0.054 formliquid
Formula for 95th percentile (based on quantile regression):
log(inner body ML) =  1.423  + 1.28 log(TA) + 1.628 formWP + 0.623 formliquid

===============================================================================
```

Model: log head ML/TA ~ form + face.shield.ML

```
Table of measured values:
        n   min       50%     75%      95%       max
WG     29  0.01  58.33333 152.622 1466.402  2358.922
WP     20 65.76 443.00000 856.400 1533.650  2610.000
liquid 80  0.45  20.00000 245.000 4027.780 19050.450

Table of predicted values (95th percentile):
   TA   form face.shield.ML lTA        LS.95       QR.95
1   1     WP             no   0   1540.34830   198.94118
2  10     WP             no   1  15403.48303  1989.41176
3 100     WP             no   2 154034.83029 19894.11765
4   1     WG             no   0     75.08315    89.53373
5  10     WG             no   1    750.83151   895.33730
6 100     WG             no   2   7508.31508  8953.37302
7   1 liquid             no   0    258.44649   284.55806
8  10 liquid             no   1   2584.46493  2845.58059
9 100 liquid             no   2  25844.64928 28455.80588

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.75616 -0.65556  0.03817  0.48372  3.00737

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       -1.0730     0.1938  -5.536 1.74e-07 ***
formWP             1.3050     0.2523   5.173 8.92e-07 ***
formliquid         0.5528     0.1829   3.023  0.00304 **
face.shield.MLno   1.5243     0.1744   8.738 1.31e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8429 on 125 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.5152,     Adjusted R-squared: 0.5036
F-statistic: 44.29 on 3 and 125 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log head ML/TA ~ form + face.shield.ML

N: 129      tau: 0.95      AIC: 417.287560639801

                 coefficients       lower bd      upper bd Std. Error   t value
Pr(>|t|)
```

```
(Intercept)         0.7049413  -5.756861e-01 1.797693e+308  0.7891821 0.8932555
0.37343689
formWP              0.3467380   2.986884e-01 1.797693e+308  0.1698111 2.0419037
0.04326501
formliquid          0.5021842 -1.797693e+308  1.095434e+00  0.2986862 1.6813102
0.09519961
face.shield.ML no    1.2470454 -1.797693e+308  2.377515e+00  0.7955561 1.5675141
0.11952263


Formula for mean (based on LS-estimate):
log(hd.ML) = log(TA) + -1.073  + 1.305 formWP + 0.553 formliquid + 1.524
face.shield.MLno
Formula for 95th percentile (based on quantile regression):
log(head ML) = log(TA) + 0.705  + 0.347 formWP + 0.502 formliquid + 1.247
face.shield.ML no

================================================================================
```

Model: log head ML ~ logTA + form + face.shield.ML

```
Table of measured values:
        n   min       50%     75%      95%       max
WG     29  0.01  58.33333 152.622 1466.402  2358.922
WP     20 65.76 443.00000 856.400 1533.650  2610.000
liquid 80  0.45  20.00000 245.000 4027.780 19050.450

Table of predicted values (95th percentile):
   TA   form face.shield.ML lTA        LS.95       QR.95
1   1     WP             no   0    897.97264   138.63024
2  10     WP             no   1  16942.65776  2309.70074
3 100     WP             no   2 371992.28580 38481.62960
4   1     WG             no   0     38.86211    45.99762
5  10     WG             no   1    709.07515   766.36047
6 100     WG             no   2  15070.31179 12768.23418
7   1 liquid             no   0    122.90985   137.26404
8  10 liquid             no   1   2184.73997  2286.93867
9 100 liquid             no   2  45289.57262 38102.39362

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.9142 -0.6371  0.0174  0.5035  2.8635

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       -1.1990     0.2080  -5.763 6.15e-08 ***
lTA                1.2979     0.1859   6.981 1.56e-10 ***
formWP             1.3704     0.2540   5.395 3.34e-07 ***
formliquid         0.5030     0.1844   2.728  0.00729 **
face.shield.MLno   1.3362     0.2094   6.382 3.16e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8377 on 124 degrees of freedom
  (374 observations deleted due to missingness)
Multiple R-squared: 0.6771,     Adjusted R-squared: 0.6667
F-statistic:    65 on 4 and 124 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log head ML ~ logTA + form + face.shield.ML
```

```
N: 129      tau: 0.95      AIC: 413.747209236552

                  coefficients       lower bd      upper bd Std. Error   t value
Pr(>|t|)
(Intercept)          0.6089731  -1.548457e+00 1.797693e+308  1.6470789 0.3697291
0.7122150
lTA                  1.2216977   6.014051e-01  3.234390e+00  0.7757631 1.5748335
0.1178429
formWP               0.4791226   3.956502e-01 1.797693e+308  0.5307039 0.9028059
0.3683793
formliquid           0.4748214 -1.797693e+308  1.911982e+00  0.6229477 0.7622171
0.4473778
face.shield.MLno     1.0537623  -1.859106e-01  2.485119e+00  0.9784825 1.0769353
0.2835999


Formula for mean (based on LS-estimate):
log(head ML) =  -1.199  + 1.298 log(TA) + 1.37 formWP + 0.503 formliquid + 1.336
face.shield.MLno
Formula for 95th percentile (based on quantile regression):
log(head ML) =  0.609  + 1.222 log(TA) + 0.479 formWP + 0.475 formliquid + 1.054
face.shield.MLno

=================================================================================
```

Model: log inhalation ML/TA ~ form

```
Table of measured values:
         n         min         50%         75%       95%       max
WG      41   0.0100000   31.437500   73.125000  280.2083  824.8958
WP      20 559.4298246 1811.458333 4051.741372 5301.2610 8504.3860
liquid 100   0.5208333    3.096413    7.677895   30.1828  145.8333

Table of predicted values (95th percentile):
   TA   form lTA         LS.95        QR.95
1   1     WP   0   7406.721622   670.937966
2  10     WP   1  74067.216221  6709.379658
3 100     WP   2 740672.162211 67093.796583
4   1     WG   0     38.878033    13.888889
5  10     WG   1    388.780326   138.888889
6 100     WG   2   3887.803261  1388.888889
7   1 liquid   0      4.739923     4.016885
8  10 liquid   1     47.399234    40.168845
9 100 liquid   2    473.992343   401.688453

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-2.2969 -0.4902  0.0638  0.5603  1.9473

Coefficients:
            Estimate Std. Error t value     Pr(>|t|)
(Intercept)   0.2178     0.1279   1.702       0.0907 .
formWP        2.2629     0.2234  10.127      < 2e-16 ***
formliquid   -0.9043     0.1519  -5.952 0.0000000165 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8193 on 158 degrees of freedom
  (342 observations deleted due to missingness)
Multiple R-squared: 0.6179,     Adjusted R-squared: 0.6131
F-statistic: 127.8 on 2 and 158 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):
```

```
Call: rq(formula = frm, tau = 0.95)
Formula: log inhalation ML/TA ~ form

N: 161      tau: 0.95      AIC: 430.886378321356

             coefficients  lower bd       upper bd Std. Error   t value     Pr(>|t|)
(Intercept)     1.1426675  1.127165  1.797693e+308  0.2000766  5.711151 5.421156e-08
formWP          1.6840149  1.476925  1.797693e+308  0.2424690  6.945280 9.287549e-11
formliquid     -0.5387782 -1.123763  -4.920402e-01  0.2376888 -2.266738 2.476288e-02


Formula for mean (based on LS-estimate):
log(inhalation ML) = log(TA) + 0.218  + 2.263 formWP + -0.904 formliquid
Formula for 95th percentile (based on quantile regression):
log(inhalation ML) = log(TA) + 1.143  + 1.684 formWP + -0.539 formliquid

==================================================================================
```

Model: log inhalation ML ~ logTA + form

```
Table of measured values:
         n         min         50%         75%        95%       max
WG      41   0.0100000   31.437500   73.125000  280.2083  824.8958
WP      20 559.4298246 1811.458333 4051.741372 5301.2610 8504.3860
liquid 100   0.5208333    3.096413    7.677895   30.1828  145.8333

Table of predicted values (95th percentile):
   TA   form lTA        LS.95      QR.95
1   1     WP   0  16142.89095 4889.82103
2  10     WP   1  53567.47217 5165.53435
3 100     WP   2 189368.11784 5456.79381
4   1     WG   0     84.65508  259.52483
5  10     WG   1    280.88771  274.15818
6 100     WG   2    993.65328  289.61663
7   1 liquid   0     15.72313   28.71472
8  10 liquid   1     50.95116   30.33381
9 100 liquid   2    176.10705   32.04418

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.65066 -0.33244  0.06755  0.54541  1.80872

Coefficients:
            Estimate Std. Error t value   Pr(>|t|)
(Intercept)   0.6087     0.1555   3.915   0.000135 ***
lTA           0.5301     0.1157   4.582 0.00000935 ***
formWP        2.2641     0.2132  10.618    < 2e-16 ***
formliquid   -0.7323     0.1510  -4.848 0.00000297 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7818 on 157 degrees of freedom
  (342 observations deleted due to missingness)
Multiple R-squared: 0.6001,     Adjusted R-squared: 0.5925
F-statistic: 78.53 on 3 and 157 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inhalation ML ~ logTA + form

N: 161      tau: 0.95      AIC: 409.612935251085
```

```
            coefficients   lower bd       upper bd Std. Error     t value
Pr(>|t|)
(Intercept)   2.41417891  1.3106630   3.086235e+00  0.6360971  3.79529962
0.000210176
lTA           0.02382229 -0.1266278   9.235126e-01  0.4429797  0.05377739
0.957180895
formWP        1.27511405  0.9741828  1.797693e+308  0.3946513  3.23098878
0.001503015
formliquid   -0.95607427 -1.6048096  -7.189633e-01  0.3864038 -2.47428827
0.014413990


Formula for mean (based on LS-estimate):
log(inhalation ML) =  0.609  + 0.53 log(TA) + 2.264 formWP + -0.732 formliquid
Formula for 95th percentile (based on quantile regression):
log(inhalation ML) =  2.414  + 0.024 log(TA) + 1.275 formWP + -0.956 formliquid

=================================================================================
```

A - LCTM

Model: log total hands A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n    min    50%      75%       95%      max
small area 10 11.219 589.24 1411.807  3119.117  3637.72
normal     87  0.010 819.00 6597.035 29548.875 70746.80

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA        LS.95       QR.95
1    1   coarse         normal   0      251.290    353.7335
2   10   coarse         normal   1     2512.900   3537.3346
3  100   coarse         normal   2    25128.996  35373.3459
4    1    other         normal   0     6444.409   1040.3941
5   10    other         normal   1    64444.091  10403.9407
6  100    other         normal   2   644440.908 104039.4074
7    1   coarse     small area   0     8838.937   1288.3573
8   10   coarse     small area   1    88389.375  12883.5725
9  100   coarse     small area   2   883893.745 128835.7251
10   1    other     small area   0   207881.383   3789.2917
11  10    other     small area   1  2078813.831  37892.9167
12 100    other     small area   2 20788138.315 378929.1667

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.1980 -0.6925  0.2305  0.8675  2.6674

Coefficients:
                     Estimate Std. Error t value  Pr(>|t|)
(Intercept)            1.2979     0.5819   2.230   0.02810 *
dropletsother          1.4338     0.3440   4.168 0.0000682 ***
LCTM.equipmentnormal  -1.4087     0.5070  -2.779   0.00659 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.484 on 94 degrees of freedom
  (95 observations deleted due to missingness)
Multiple R-squared: 0.2502,     Adjusted R-squared: 0.2342
F-statistic: 15.68 on 2 and 94 DF,  p-value: 0.000001327

Summary of RQ fit (95th percentile):
```

```
Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 1.298  + 1.434 dropletsother + -1.409
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(total hands A) = log(TA) + 3.11  + 0.469 dropletsother + -0.561
LCTM.equipmentnormal
```

==

Model: log total hands A ~ lTA + droplets + LCTM.equipment

```
Table of measured values:
            n    min    50%      75%       95%      max
small area 10 11.219 589.24 1411.807  3119.117  3637.72
normal     87  0.010 819.00 6597.035 29548.875 70746.80

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA           LS.95       QR.95
1    1   coarse         normal   0        28.96012    560.8890
2   10   coarse         normal   1      1017.01101   3028.9777
3  100   coarse         normal   2     42289.29779  16357.4349
4    1    other         normal   0       786.38558   2291.6552
5   10    other         normal   1     27778.49639  12375.6607
6  100    other         normal   2   1164189.30483  66832.4717
7    1   coarse     small area   0      7308.79876    917.3643
8   10   coarse     small area   1    330973.81219   4954.0566
9  100   coarse     small area   2  17526974.41248  26753.4682
10   1    other     small area   0    184183.32606   3748.1258
11  10    other     small area   1   8419215.26732  20241.0615
12 100    other     small area   2 451330141.46465 109308.1166

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.0687 -0.6639  0.2672  0.9163  3.2574

Coefficients:
                     Estimate Std. Error t value     Pr(>|t|)
(Intercept)            1.2806     0.5676   2.256     0.026393 *
lTA                    1.6226     0.2579   6.293 0.0000000101 ***
dropletsother          1.4623     0.3357   4.356 0.0000340243 ***
LCTM.equipmentnormal  -2.3563     0.6312  -3.733     0.000326 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.448 on 93 degrees of freedom
  (95 observations deleted due to missingness)
Multiple R-squared: 0.3806,      Adjusted R-squared: 0.3607
F-statistic: 19.05 on 3 and 93 DF,  p-value: 0.00000000103

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total hands A) =  1.281  + 1.623 log(TA) + 1.462 dropletsother + -2.356
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(total hands A) =  2.963  + 0.732 log(TA) + 0.611 dropletsother + -0.214
LCTM.equipmentnormal
```

==

Model: log ptotected hands A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n  min      50%      75%       95%      max
small area  2 2.00 11.63500  16.4525   20.3065    21.27
normal     58 0.01 32.04515 106.7800 2218.5234 10000.00

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA         LS.95         QR.95
1    1   coarse         normal   0      7.527131     2.1643192
2   10   coarse         normal   1     75.271308    21.6431925
3  100   coarse         normal   2    752.713084   216.4319249
4    1    other         normal   0    204.986147   103.3677255
5   10    other         normal   1   2049.861469  1033.6772549
6  100    other         normal   2  20498.614692 10336.7725490
7    1   coarse     small area   0     95.308199     0.4639088
8   10   coarse     small area   1    953.081993     4.6390881
9  100   coarse     small area   2   9530.819932    46.3908808
10   1    other     small area   0   2354.882774    22.1562500
11  10    other     small area   1  23548.827737   221.5625000
12 100    other     small area   2 235488.277366  2215.6250000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0451 -0.7160  0.2216  0.8217  2.3049

Coefficients:
                     Estimate Std. Error t value  Pr(>|t|)
(Intercept)           -0.6728     0.9581  -0.702     0.485
dropletsother          1.4565     0.3453   4.218 0.0000893 ***
LCTM.equipmentnormal  -0.6137     0.9176  -0.669     0.506
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.264 on 57 degrees of freedom
  (132 observations deleted due to missingness)
Multiple R-squared: 0.2536,      Adjusted R-squared: 0.2274
F-statistic: 9.682 on 2 and 57 DF,  p-value: 0.0002399

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + -0.673  + 1.456 dropletsother + -0.614
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(protected hands A) = log(TA) + -0.334  + 1.679 dropletsother + 0.669
LCTM.equipmentnormal

================================================================================
```

Model: log protected hands A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
            n  min      50%      75%       95%      max
small area  2 2.00 11.63500  16.4525   20.3065    21.27
normal     58 0.01 32.04515 106.7800 2218.5234 10000.00

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA         LS.95        QR.95
1    1   coarse         normal   0      9.588512   53.7495817
2   10   coarse         normal   1     79.255499   70.3046043
3  100   coarse         normal   2    808.857802   91.9586206
4    1    other         normal   0    248.670808 3333.0177951
```

```
5   10    other         normal   1   2130.588853 4359.5966697
6  100    other         normal   2  22656.507068 5702.3647310
7    1   coarse     small area   0     99.591887    0.3446452
8   10   coarse     small area   1   1125.261040    0.4507969
9  100   coarse     small area   2  15129.855016    0.5896437
10   1    other     small area   0   2480.408559   21.3714908
11  10    other     small area   1  29039.437403   27.9539702
12 100    other     small area   2 405169.412512   36.5638718

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0241 -0.7178  0.2222  0.8134  2.3056

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.6796     0.9684  -0.702 0.485709
lTA                    1.0312     0.2733   3.773 0.000391 ***
dropletsother          1.4623     0.3521   4.153 0.000113 ***
LCTM.equipmentnormal  -0.6609     1.0141  -0.652 0.517243
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.275 on 56 degrees of freedom
  (132 observations deleted due to missingness)
Multiple R-squared: 0.3311,     Adjusted R-squared: 0.2953
F-statistic: 9.241 on 3 and 56 DF,  p-value: 0.00004631

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(protected hands A) =  -0.68  + 1.031 log(TA) + 1.462 dropletsother + -0.661
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(protected hands A) =  -0.463  + 0.117 log(TA) + 1.792 dropletsother + 2.193
LCTM.equipmentnormal

=================================================================================
```

Model: log total body A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n    min      50%      75%       95%       max
small area 10 454.69 899.9205 2024.874  2541.393  2704.369
normal     35   0.01 876.0000 4050.644 13843.063 26091.000

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA        LS.95        QR.95
1    1   coarse         normal   0     239.5013     13.10016
2   10   coarse         normal   1    2395.0131    131.00160
3  100   coarse         normal   2   23950.1306   1310.01600
4    1    other         normal   0     708.8850    427.52000
5   10    other         normal   1    7088.8505   4275.20000
6  100    other         normal   2   70888.5046  42752.00000
7    1   coarse     small area   0   12073.7270     86.32069
8   10   coarse     small area   1  120737.2698    863.20685
9  100   coarse     small area   2 1207372.6983   8632.06853
10   1    other     small area   0   32637.1664   2817.05104
11  10    other     small area   1  326371.6642  28170.51042
12 100    other     small area   2 3263716.6422 281705.10417

Summary of LS fit (mean):
```

```
Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.8627 -0.2834  0.0499  0.3687  1.3531 

Coefficients:
                     Estimate Std. Error t value   Pr(>|t|)    
(Intercept)            2.5237     0.4457   5.663 0.00000121 ***
dropletsother          0.5574     0.3642   1.530      0.133    
LCTM.equipmentnormal  -1.6198     0.2978  -5.439 0.00000253 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.8121 on 42 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.4686,     Adjusted R-squared: 0.4433 
F-statistic: 18.52 on 2 and 42 DF,  p-value: 0.000001711 

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 2.524  + 0.557 dropletsother + -1.62 
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(total body A) = log(TA) + 1.936  + 1.514 dropletsother + -0.819 
LCTM.equipmentnormal

=============================================================================
```

Model: log total body A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
            n    min      50%      75%       95%       max
small area 10 454.69 899.9205 2024.874  2541.393  2704.369
normal     35   0.01 876.0000 4050.644 13843.063 26091.000

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA             LS.95            QR.95
1    1   coarse         normal   0          1.807590        0.1304745
2   10   coarse         normal   1        315.484740       35.2740033
3  100   coarse         normal   2      81982.678570     9536.3850185
4    1    other         normal   0          5.265868        3.3143207
5   10    other         normal   1        892.046916      896.0320758
6  100    other         normal   2     229240.435804   242243.7508436
7    1   coarse     small area   0       6753.195877      117.5742579
8   10   coarse     small area   1    2106289.024292    31786.3947198
9  100   coarse     small area   2  907507307.291877  8593504.2845758
10   1    other     small area   0      17615.469146     2986.6274472
11  10    other     small area   1    5524036.432433   807439.6606024
12 100    other     small area   2 2441781583.404030 218292645.1423756

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-2.38770 -0.20025  0.05726  0.30601  1.24847 

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)    
(Intercept)            2.5898     0.3546   7.304 6.16e-09 ***
lTA                    2.4010     0.2778   8.643 8.82e-11 ***
dropletsother          0.5164     0.2897   1.782   0.0821 .  
```

```
LCTM.equipmentnormal  -3.6823     0.4725  -7.793 1.28e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6457 on 41 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.6611,     Adjusted R-squared: 0.6363
F-statistic: 26.65 on 3 and 41 DF,  p-value: 9.979e-10

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total body A) =  2.59  + 2.401 log(TA) + 0.516 dropletsother + -3.682
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(total body A) =  2.07  + 2.432 log(TA) + 1.405 dropletsother + -2.955
LCTM.equipmentnormal

==================================================================================
```

Model: log inner body A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n  min     50%      75%       95%     max
small area 10 0.01 13.4385 26.19250  30.41375  31.541
normal     35 0.01 32.0000 66.17458 269.39884 525.000

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA       LS.95        QR.95
1    1   coarse         normal   0    10.35814    0.5011554
2   10   coarse         normal   1   103.58135    5.0115538
3  100   coarse         normal   2  1035.81354   50.1155378
4    1    other         normal   0    18.50786    5.5797101
5   10    other         normal   1   185.07861   55.7971014
6  100    other         normal   2  1850.78606  557.9710145
7    1   coarse     small area   0   108.14302    2.9509713
8   10   coarse     small area   1  1081.43021   29.5097128
9  100   coarse     small area   2 10814.30210  295.0971276
10   1    other     small area   0   176.56784   32.8552083
11  10    other     small area   1  1765.67844  328.5520833
12 100    other     small area   2 17656.78440 3285.5208333

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.68019 -0.11277  0.09724  0.47062  1.20745

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)            0.4852     0.4430   1.095   0.2796
dropletsother          0.3377     0.3621   0.933   0.3564
LCTM.equipmentnormal  -0.9365     0.2960  -3.163   0.0029 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8073 on 42 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.2318,     Adjusted R-squared: 0.1952
F-statistic: 6.335 on 2 and 42 DF,  p-value: 0.003939

Summary of RQ fit (95th percentile):
```

```
Formula for mean (based on LS-estimate):
log(inner body A) = log(TA) + 0.485  + 0.338 dropletsother + -0.936
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(inner body A) = log(TA) + 0.47  + 1.047 dropletsother + -0.77
LCTM.equipmentnormal

==================================================================================
```

Model: log inner body A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
            n  min     50%      75%       95%     max
small area 10 0.01 13.4385 26.19250  30.41375  31.541
normal     35 0.01 32.0000 66.17458 269.39884 525.000

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA           LS.95           QR.95
1    1   coarse         normal   0       0.1909661      0.02206981
2   10   coarse         normal   1      20.5110454      2.05456549
3  100   coarse         normal   2    3372.7989047    191.26757447
4    1    other         normal   0       0.3371457      0.21285236
5   10    other         normal   1      35.0736392     19.81526208
6  100    other         normal   2    5699.0741167   1844.68060612
7    1   coarse     small area   0      73.8540291      3.54406905
8   10   coarse     small area   1   14763.6126204    329.93131348
9  100   coarse     small area   2 4170244.3665726  30714.60234628
10   1    other     small area   0     115.8483868     34.18078294
11  10    other     small area   1   23293.0828068   3182.02338792
12 100    other     small area   2 6762270.6612796 296227.06006907

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-2.5303 -0.3485  0.1148  0.4460  1.0738

Coefficients:
                     Estimate Std. Error t value      Pr(>|t|)
(Intercept)            0.5418     0.3794   1.428         0.161
lTA                    2.2013     0.2972   7.406 0.00000000443 ***
dropletsother          0.3025     0.3100   0.976         0.335
LCTM.equipmentnormal  -2.7050     0.5056  -5.350 0.00000361874 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6909 on 41 degrees of freedom
  (147 observations deleted due to missingness)
Multiple R-squared: 0.5936,     Adjusted R-squared: 0.5639
F-statistic: 19.96 on 3 and 41 DF,  p-value: 0.00000003916

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inner body A) =  0.542  + 2.201 log(TA) + 0.303 dropletsother + -2.705
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(inner body A) =  0.55  + 1.969 log(TA) + 0.984 dropletsother + -2.206
LCTM.equipmentnormal

==================================================================================
```

Model: log head A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n  min 50%      75%      95%  max
small area 10 0.01   4  10.5835  88.3266  150
normal     36 0.01  34 112.0000 477.1250 4600

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA        LS.95         QR.95
1    1   coarse         normal   0    42.18142     1.098404
2   10   coarse         normal   1   421.81419    10.984038
3  100   coarse         normal   2  4218.14192   109.840376
4    1    other         normal   0    66.54133    11.820331
5   10    other         normal   1   665.41327   118.203310
6  100    other         normal   2  6654.13271  1182.033097
7    1   coarse     small area   0    90.43582    14.519525
8   10   coarse     small area   1   904.35823   145.195246
9  100   coarse     small area   2  9043.58229  1451.952465
10   1    other     small area   0   126.26068   156.250000
11  10    other     small area   1  1262.60677  1562.500000
12 100    other     small area   2 12626.06774 15625.000000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-2.3758 -0.3223  0.1525  0.6263  2.2560 

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.2212     0.6223  -0.356    0.724
dropletsother          0.3194     0.5081   0.629    0.533
LCTM.equipmentnormal  -0.2165     0.4148  -0.522    0.604

Residual standard error: 1.136 on 43 degrees of freedom
  (146 observations deleted due to missingness)
Multiple R-squared: 0.01908,     Adjusted R-squared: -0.02654 
F-statistic: 0.4183 on 2 and 43 DF,  p-value: 0.6608

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + -0.221  + 0.319 dropletsother + -0.217 LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(head A) = log(TA) + 1.162  + 1.032 dropletsother + -1.121 LCTM.equipmentnormal

==============================================================================
```

Model: log head A ~ logTA + droplets + LCTM.equipment

```
Table of measured values:
            n  min 50%      75%      95%  max
small area 10 0.01   4  10.5835  88.3266  150
normal     36 0.01  34 112.0000 477.1250 4600

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA        LS.95        QR.95
1    1   coarse         normal   0 2.319798e-02 1.695891e-04
2   10   coarse         normal   1 1.811477e+01 1.254818e+00
3  100   coarse         normal   2 2.388161e+04 9.284613e+03
4    1    other         normal   0 3.430464e-02 3.727660e-04
5   10    other         normal   1 2.562686e+01 2.758159e+00
6  100    other         normal   2 3.310167e+04 2.040808e+04
7    1   coarse     small area   0 3.574882e+01 7.991875e+01
8   10   coarse     small area   1 6.021658e+04 5.913324e+05
9  100   coarse     small area   2 1.550901e+08 4.375368e+09
```

```
10   1    other     small area   0 4.544572e+01 1.756658e+02
11  10    other     small area   1 7.671346e+04 1.299781e+06
12 100    other     small area   2 2.036375e+08 9.617298e+09

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.08083 -0.44113 -0.05607  0.43842  2.12791

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.1013     0.4729  -0.214    0.831
lTA                    3.1020     0.3682   8.425 1.44e-10 ***
dropletsother          0.2371     0.3860   0.614    0.542
LCTM.equipmentnormal  -3.3317     0.6300  -5.288 4.16e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8626 on 42 degrees of freedom
  (146 observations deleted due to missingness)
Multiple R-squared: 0.6748,      Adjusted R-squared: 0.6515
F-statistic: 29.04 on 3 and 42 DF,  p-value: 2.493e-10

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(head A) =  -0.101  + 3.102 log(TA) + 0.237 dropletsother + -3.332
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(head A) =  1.903  + 3.869 log(TA) + 0.342 dropletsother + -5.673
LCTM.equipmentnormal

================================================================================
```

Model: log inhalation A/TA ~ droplets + LCTM.equipment

```
Table of measured values:
            n       min      50%      75%      95%      max
small area 10 0.0100000 0.010000 5.208333 30.70521 40.89583
normal     56 0.2916667 3.399313 7.548564 25.34423 69.67905

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA      LS.95        QR.95
1    1   coarse         normal   0   1.852881    0.4762228
2   10   coarse         normal   1  18.528815    4.7622283
3  100   coarse         normal   2 185.288147   47.6222826
4    1    other         normal   0   1.771998    0.4804267
5   10    other         normal   1  17.719979    4.8042672
6  100    other         normal   2 177.199792   48.0426725
7    1   coarse     small area   0   4.310932   39.7431184
8   10   coarse     small area   1  43.109320  397.4311839
9  100   coarse     small area   2 431.093200 3974.3118386
10   1    other     small area   0   3.787097   40.0939542
11  10    other     small area   1  37.870965  400.9395425
12 100    other     small area   2 378.709652 4009.3954248

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
```

```
-1.32771 -0.42373 -0.01846  0.41085  2.35455

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.7386     0.3158  -2.339   0.0225 *
dropletsother         -0.0129     0.2051  -0.063   0.9501
LCTM.equipmentnormal  -0.2876     0.2752  -1.045   0.2999
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7595 on 63 degrees of freedom
  (126 observations deleted due to missingness)
Multiple R-squared: 0.0183,     Adjusted R-squared: -0.01286
F-statistic: 0.5872 on 2 and 63 DF,  p-value: 0.5589

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + -0.739  + -0.013 dropletsother + -0.288
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 1.599  + 0.004 dropletsother + -1.921
LCTM.equipmentnormal

==========================================================================
```

Model:log inhalation A ~ lTA + droplets + LCTM.equipment

```
Table of measured values:
            n       min      50%      75%      95%      max
small area 10 0.0100000 0.010000 5.208333 30.70521 40.89583
normal     56 0.2916667 3.399313 7.548564 25.34423 69.67905

Table of predicted values (95th percentile):
    TA droplets LCTM.equipment lTA      LS.95      QR.95
1    1   coarse         normal   0  12.924097   1.354606
2   10   coarse         normal   1  29.789409   5.093432
3  100   coarse         normal   2  86.588531  19.151733
4    1    other         normal   0  18.747855   2.909464
5   10    other         normal   1  40.877300  10.939831
6  100    other         normal   2 111.617199  41.134681
7    1   coarse     small area   0   2.720041  18.824879
8   10   coarse     small area   1   9.290334  70.783126
9  100   coarse     small area   2  38.394466 266.150493
10   1    other     small area   0   3.287538  40.432655
11  10    other     small area   1  10.653514 152.030177
12 100    other     small area   2  42.462744 571.646224

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.2752 -0.3880  0.0428  0.3138  2.3689

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           -0.8889     0.3094  -2.873  0.00555 **
lTA                    0.4586     0.2167   2.116  0.03838 *
dropletsother          0.1278     0.2049   0.623  0.53525
LCTM.equipmentnormal   0.6499     0.4591   1.416  0.16188
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7297 on 62 degrees of freedom
```

```
  (126 observations deleted due to missingness)
Multiple R-squared: 0.3581,     Adjusted R-squared: 0.327
F-statistic: 11.53 on 3 and 62 DF,  p-value: 0.00000421

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inhalation A) =  -0.889  + 0.459 log(TA) + 0.128 dropletsother + 0.65
LCTM.equipmentnormal
Formula for 95th percentile (based on quantile regression):
log(inhalation A) =  1.275  + 0.575 log(TA) + 0.332 dropletsother + -1.143
LCTM.equipmentnormal

==================================================================================
```

A – HCTM

Model: log total hands A/TA ~ cabin

```
Table of measured values:
          n   min       50%      75%      95%      max
cabin    54  0.01  722.8822 2845.750 18293.39 423687.9
no cabin 55 63.60 2283.0000 8019.125 31462.00  97980.0

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95      QR.95
1  1    cabin 0.00000    9041.814   2075.574
2 10    cabin 1.00000   90418.140  20755.735
3 50    cabin 1.69897  452090.700 103778.677
4  1 no cabin 0.00000   93127.500   6236.800
5 10 no cabin 1.00000  931275.003  62368.000
6 50 no cabin 1.69897 4656375.016 311840.000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.8534 -0.3990  0.0938  0.6827  2.4337

Coefficients:
              Estimate Std. Error t value  Pr(>|t|)
(Intercept)     1.9503     0.1630  11.964   < 2e-16 ***
cabinno cabin   1.0132     0.2295   4.415 0.0000243 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.198 on 107 degrees of freedom
  (48 observations deleted due to missingness)
Multiple R-squared: 0.1541,     Adjusted R-squared: 0.1462
F-statistic: 19.49 on 1 and 107 DF,  p-value: 0.00002425

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 1.95  + 1.013 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(total hands A) = log(TA) + 3.317  + 0.478 cabinno cabin

==================================================================================
```

Model: log total hands ~ logTA + cabin

```
Table of measured values:
```

```
          n   min       50%      75%      95%      max
cabin    54  0.01  722.8822 2845.750 18293.39 423687.9
no cabin 55 63.60 2283.0000 8019.125 31462.00  97980.0

Table of predicted values (95th percentile):
  TA    cabin     lTA      LS.95       QR.95
1  1    cabin 0.00000   20918.63    1910.373
2 10    cabin 1.00000   61231.95   44335.446
3 50    cabin 1.69897  158350.16  399289.220
4  1 no cabin 0.00000  154197.17    4796.941
5 10 no cabin 1.00000  490707.37  111326.208
6 50 no cabin 1.69897 1340603.17 1002614.353

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-4.7383 -0.3698  0.1652  0.5563  2.7213

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     2.2936     0.2747   8.350 2.81e-13 ***
lTA             0.4924     0.3280   1.501 0.136267
cabinno cabin   0.8879     0.2419   3.670 0.000382 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.19 on 106 degrees of freedom
  (48 observations deleted due to missingness)
Multiple R-squared: 0.1134,      Adjusted R-squared: 0.09663
F-statistic: 6.776 on 2 and 106 DF,  p-value: 0.001701

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total hands A) =  2.294  + 0.492 log(TA) + 0.888 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(total hands A) =  3.281  + 1.366 log(TA) + 0.4 cabinno cabin

==================================================================================
```

Model: log protected hands A/TA ~ cabin

```
Table of measured values:
          n  min     50%      75%    95%  max
cabin    35 0.01 102.500 246.0452 1498.0 6800
no cabin 32 4.00  28.325 102.5000 5096.5 9080

Table of predicted values (95th percentile):
  TA    cabin     lTA      LS.95      QR.95
1  1    cabin 0.00000   718.9384   762.6667
2 10    cabin 1.00000  7189.3838  7626.6667
3 50    cabin 1.69897 35946.9191 38133.3333
4  1 no cabin 0.00000  1627.7753   919.4444
5 10 no cabin 1.00000 16277.7531  9194.4444
6 50 no cabin 1.69897 81388.7653 45972.2222

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
```

```
-3.8449 -0.4004  0.1514  0.4369  2.3344

Coefficients:
              Estimate Std. Error t value   Pr(>|t|)    
(Intercept)     0.9418     0.1913   4.924 0.00000611 ***
cabinno cabin   0.3524     0.2768   1.273      0.207    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.132 on 65 degrees of freedom
  (90 observations deleted due to missingness)
Multiple R-squared: 0.02434,     Adjusted R-squared: 0.009329 
F-statistic: 1.622 on 1 and 65 DF,  p-value: 0.2074

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + 0.942  + 0.352 cabinno cabin 
Formula for 95th percentile (based on quantile regression):
log(protected hands A) = log(TA) + 2.882  + 0.081 cabinno cabin 

===============================================================================
```

Model: log protected hands A ~ logTA + cabin

```
Table of measured values:
          n  min     50%      75%    95%  max
cabin    35 0.01 102.500 246.0452 1498.0 6800
no cabin 32 4.00  28.325 102.5000 5096.5 9080

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95         QR.95
1  1    cabin 0.00000    636.4986     127.20878
2 10    cabin 1.00000   8650.1137   28808.87811
3 50    cabin 1.69897  81874.2866 1275284.80527
4  1 no cabin 0.00000   1481.5123      86.97209
5 10 no cabin 1.00000  26120.5725   19696.50450
6 50 no cabin 1.69897 289668.5968  871906.66756

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.8810 -0.3344  0.1279  0.4731  2.3692 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)     0.7934     0.3930   2.019   0.0477 *
lTA             1.2043     0.4715   2.554   0.0130 *
cabinno cabin   0.4260     0.3262   1.306   0.1963  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.139 on 64 degrees of freedom
  (90 observations deleted due to missingness)
Multiple R-squared: 0.09251,     Adjusted R-squared: 0.06416 
F-statistic: 3.262 on 2 and 64 DF,  p-value: 0.04476

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(protected hands A) =  0.793  + 1.204 log(TA) + 0.426 cabinno cabin 
Formula for 95th percentile (based on quantile regression):
```

```
log(protected hands A) =  2.105  + 2.355 log(TA) + -0.165 cabinno cabin

==================================================================================
```

Model: log total body A/TA ~ cabin

```
Table of measured values:
          n   min     50%      75%       95%      max
cabin    30  68.0  3789.3 12847.30  48185.15 131572.0
no cabin 42 620.6 15005.0 60191.87 229388.82 432944.1

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95       QR.95
1  1    cabin 0.00000    8467.507    8353.775
2 10    cabin 1.00000   84675.074   83537.748
3 50    cabin 1.69897  423375.370  417688.740
4  1 no cabin 0.00000   60581.048   51416.135
5 10 no cabin 1.00000  605810.481  514161.348
6 50 no cabin 1.69897 3029052.403 2570806.739

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.50148 -0.39690  0.07254  0.33688  1.36373

Coefficients:
              Estimate Std. Error t value    Pr(>|t|)
(Intercept)     2.8569     0.1154  24.759     < 2e-16 ***
cabinno cabin   0.8595     0.1511   5.689 0.000000274 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.632 on 70 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.3162,     Adjusted R-squared: 0.3064
F-statistic: 32.37 on 1 and 70 DF,  p-value: 0.0000002742

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 2.857  + 0.86 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(total body A) = log(TA) + 3.922  + 0.789 cabinno cabin

==================================================================================
```

Model: log total body A ~ logTA + cabin

```
Table of measured values:
          n   min     50%      75%       95%      max
cabin    30  68.0  3789.3 12847.30  48185.15 131572.0
no cabin 42 620.6 15005.0 60191.87 229388.82 432944.1

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95       QR.95
1  1    cabin 0.00000    6706.461    8270.677
2 10    cabin 1.00000  103822.658   83400.253
3 50    cabin 1.69897  803261.916  419442.115
4  1 no cabin 0.00000   50067.183   51136.464
5 10 no cabin 1.00000  797205.678  515652.318
6 50 no cabin 1.69897 6284162.974 2593353.032

Summary of LS fit (mean):
```

```
Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.47799 -0.40715  0.07089  0.35937  1.34654

Coefficients:
               Estimate Std. Error t value     Pr(>|t|)
(Intercept)      2.7384     0.1636  16.738      < 2e-16 ***
lTA              1.1991     0.1949   6.151 0.0000000442 ***
cabinno cabin    0.8844     0.1530   5.781 0.0000001968 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6318 on 69 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.4712,     Adjusted R-squared: 0.4558
F-statistic: 30.74 on 2 and 69 DF,  p-value: 2.847e-10

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(total body A) =  2.738  + 1.199 log(TA) + 0.884 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(total body A) =  3.918  + 1.004 log(TA) + 0.791 cabinno cabin

===================================================================================
```

Model: log inner body A ~ cabin

```
Table of measured values:
          n    min      50%      75%      95%      max
cabin    30  2.513 104.3478 240.3834 2020.000 3291.304
no cabin 42 18.000 195.2000 641.5217 1597.835 4016.803

Table of predicted values (95th percentile):
  TA    cabin     lTA      LS.95      QR.95
1  1    cabin 0.00000   156.5004   160.8006
2 10    cabin 1.00000  1565.0035  1608.0055
3 50    cabin 1.69897  7825.0176  8040.0276
4  1 no cabin 0.00000   492.7523   224.6986
5 10 no cabin 1.00000  4927.5229  2246.9858
6 50 no cabin 1.69897 24637.6144 11234.9288

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.57773 -0.33219  0.04825  0.37584  1.00428

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    1.30149    0.09622  13.526  < 2e-16 ***
cabinno cabin  0.50224    0.12598   3.987 0.000162 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.527 on 70 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.185,Adjusted R-squared: 0.1734
F-statistic: 15.89 on 1 and 70 DF,  p-value: 0.0001625
```

```
Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inner body A) = log(TA) + 1.301  + 0.502 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(inner body A) = log(TA) + 2.206  + 0.145 cabinno cabin

================================================================================
```

Model: linner body A ~ logTA + cabin

```
Table of measured values:
          n    min      50%      75%      95%      max
cabin    30   2.513 104.3478 240.3834 2020.000 3291.304
no cabin 42 18.000 195.2000 641.5217 1597.835 4016.803

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95       QR.95
1  1    cabin 0.00000    94.40761    61.98984
2 10    cabin 1.00000  2087.30247  1513.86722
3 50    cabin 1.69897 20211.99416 14128.48204
4  1 no cabin 0.00000   325.14631   229.73278
5 10 no cabin 1.00000  7354.84246  5610.35399
6 50 no cabin 1.69897 72307.04735 52359.80039

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.75220 -0.31112  0.01928  0.36241  0.88951

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     1.0919     0.1328   8.224 7.78e-12 ***
lTA             1.3521     0.1582   8.546 2.00e-12 ***
cabinno cabin   0.5463     0.1242   4.400 3.85e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5127 on 69 degrees of freedom
  (85 observations deleted due to missingness)
Multiple R-squared: 0.5446,     Adjusted R-squared: 0.5314
F-statistic: 41.25 on 2 and 69 DF,  p-value: 1.643e-12

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inner body A) =  1.092  + 1.352 log(TA) + 0.546 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(inner body A) =  1.792  + 1.388 log(TA) + 0.569 cabinno cabin

================================================================================
```

Model: log head A/TA ~ cabin

```
Table of measured values:
          n   min       50%       75%   95%   max
cabin    29 0.010  29.16667  133.3333  2295  3400
no cabin 42 9.706 523.80000 3538.1250 43265 87860

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95       QR.95
1  1    cabin 0.00000    327.0796    194.4444
```

```
2 10    cabin 1.00000   3270.7956   1944.4444
3 50    cabin 1.69897  16353.9778   9722.2222
4  1 no cabin 0.00000   9294.9198   7107.2000
5 10 no cabin 1.00000  92949.1983  71072.0000
6 50 no cabin 1.69897 464745.9914 355360.0000

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5363 -0.5973 -0.1260  0.6652  2.2851

Coefficients:
              Estimate Std. Error t value     Pr(>|t|)
(Intercept)     0.8161     0.1860   4.388 0.0000402314 ***
cabinno cabin   1.4624     0.2418   6.047 0.0000000674 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.002 on 69 degrees of freedom
  (86 observations deleted due to missingness)
Multiple R-squared: 0.3464,     Adjusted R-squared: 0.3369
F-statistic: 36.57 on 1 and 69 DF,  p-value: 0.00000006745

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + 0.816  + 1.462 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(head A) = log(TA) + 2.289  + 1.563 cabinno cabin

===============================================================================
```

Model: log head A ~ logTA + cabin

```
Table of measured values:
         n   min       50%       75%   95%   max
cabin    29 0.010  29.16667  133.3333  2295  3400
no cabin 42 9.706 523.80000 3538.1250 43265 87860

Table of predicted values (95th percentile):
  TA    cabin     lTA        LS.95         QR.95
1  1    cabin 0.00000     197.6841      82.46489
2 10    cabin 1.00000    4854.9178    3854.04130
3 50    cabin 1.69897   55983.9688   56617.37545
4  1 no cabin 0.00000    6129.9418    2083.24163
5 10 no cabin 1.00000  156966.7471   97361.42659
6 50 no cabin 1.69897 1861186.2041 1430277.47075

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5900 -0.5753 -0.0296  0.6225  2.3213

Coefficients:
              Estimate Std. Error t value     Pr(>|t|)
(Intercept)     0.5791     0.2589   2.237       0.0286 *
lTA             1.4037     0.3083   4.553 0.0000224805 ***
cabinno cabin   1.5097     0.2433   6.205 0.0000000371 ***
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9965 on 68 degrees of freedom
  (86 observations deleted due to missingness)
Multiple R-squared: 0.4333,     Adjusted R-squared: 0.4166
F-statistic:    26 on 2 and 68 DF,  p-value: 0.000000004113

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(head A) =  0.579  + 1.404 log(TA) + 1.51 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(head A) =  1.916  + 1.67 log(TA) + 1.402 cabinno cabin

==================================================================================
```

Model: log inhalation A/TA ~ cabin

```
Table of measured values:
          n       min      50%       75%      95%        max
cabin    42 0.4882812 12.23041  20.21498 114.9386   626.6276
no cabin 41 9.0679825 46.32143 114.58333 416.6667 23614.5833

Table of predicted values (95th percentile):
  TA    cabin     lTA       LS.95      QR.95
1  1    cabin 0.00000    19.47447   20.93666
2 10    cabin 1.00000   194.74470  209.36657
3 50    cabin 1.69897   973.72348 1046.83285
4  1 no cabin 0.00000   231.36539   82.67196
5 10 no cabin 1.00000  2313.65391  826.71958
6 50 no cabin 1.69897 11568.26955 4133.59788

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.29458 -0.36355 -0.02158  0.28687  2.13246

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.26309    0.09407   2.797  0.00645 **
cabinno cabin  1.07454    0.13384   8.028 6.61e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6096 on 81 degrees of freedom
  (74 observations deleted due to missingness)
Multiple R-squared: 0.4431,     Adjusted R-squared: 0.4363
F-statistic: 64.45 on 1 and 81 DF,  p-value: 6.605e-12

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + 0.263  + 1.075 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 1.321  + 0.596 cabinno cabin

==================================================================================
```

Model: log inhalation A ~ logTA + cabin

```
Table of measured values:
          n       min      50%       75%      95%        max
```

```
cabin    42 0.4882812 12.23041  20.21498 114.9386   626.6276
no cabin 41 9.0679825 46.32143 114.58333 416.6667 23614.5833

Table of predicted values (95th percentile):
  TA    cabin     lTA     LS.95      QR.95
1  1    cabin 0.00000   34.0542   19.91302
2 10    cabin 1.00000  141.0456  319.26142
3 50    cabin 1.69897  428.7310 2220.30035
4  1 no cabin 0.00000  334.0465   73.42179
5 10 no cabin 1.00000 1440.2406 1177.15636
6 50 no cabin 1.69897 4493.5015 8186.52222

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.27225 -0.37160 -0.05694  0.30073  2.29570

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.5064     0.1501   3.374 0.001145 **
lTA             0.6312     0.1795   3.517 0.000724 ***
cabinno cabin   1.0011     0.1360   7.359 1.44e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5979 on 80 degrees of freedom
  (74 observations deleted due to missingness)
Multiple R-squared: 0.4154,     Adjusted R-squared: 0.4008
F-statistic: 28.42 on 2 and 80 DF,  p-value: 4.721e-10

Summary of RQ fit (95th percentile):


Formula for mean (based on LS-estimate):
log(inhalation A) =  0.506  + 0.631 log(TA) + 1.001 cabinno cabin
Formula for 95th percentile (based on quantile regression):
log(inhalation A) =  1.299  + 1.205 log(TA) + 0.567 cabinno cabin

==================================================================================
```

A - HCHH

Model: log total hands A/TA ~ HCHH.culture

```
Table of measured values:
               n         min      50%      75%      95%     max
dense culture 40 14012.50000 33505.60 48192.07 67131.74 78038.0
normal        50    11.42899  2538.35  5871.65 24666.95 60542.4

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95     QR.95
1 0.2 dense culture -0.69897  10744.014  3882.895
2 1.0 dense culture  0.00000  53720.071 19414.477
3 5.0 dense culture  0.69897 268600.356 97072.384
4 0.2        normal -0.69897   1227.969  2045.351
5 1.0        normal  0.00000   6139.844 10226.757
6 5.0        normal  0.69897  30699.218 51133.784

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
```

```
     Min       1Q   Median       3Q      Max 
-1.45276 -0.19272  0.01306  0.21206  1.37923 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)         4.01965    0.06675   60.22   <2e-16 ***
HCHH.culturenormal -0.94024    0.08955  -10.50   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.4222 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5561,     Adjusted R-squared: 0.551 
F-statistic: 110.2 on 1 and 88 DF,  p-value: < 2.2e-16 

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total hands A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 145.938392319042

                   coefficients   lower bd       upper bd Std. Error    t value
Pr(>|t|)
(Intercept)           4.2881257  4.2697255  1.797693e+308 0.02758175 155.469681
0.0000000
HCHH.culturenormal   -0.2783878 -0.6173111  -5.593555e-02 0.24712226  -1.126518
0.2630088


Formula for mean (based on LS-estimate):
log(total hands A) = log(TA) + 4.02  + -0.94 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(total hands A) = log(TA) + 4.288  + -0.278 HCHH.culturenormal

==================================================================================

Model: log total hands A ~ logTA + HCHH.culture

Table of measured values:
               n         min      50%      75%      95%     max
dense culture 40 14012.50000 33505.60 48192.07 67131.74 78038.0
normal        50    11.42899  2538.35  5871.65 24666.95 60542.4

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA     LS.95     QR.95
1 0.2 dense culture -0.69897  10678.12  7576.702
2 1.0 dense culture  0.00000  52828.93 25954.114
3 5.0 dense culture  0.69897 275220.46 88906.235
4 0.2        normal -0.69897   1207.50  2568.890
5 1.0        normal  0.00000   6107.82  8799.775
6 5.0        normal  0.69897  32573.12 30143.772

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.42657 -0.20494  0.01478  0.21196  1.39359 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)         4.00222    0.08839  45.280  < 2e-16 ***
lTA                 1.03355    0.11079   9.329 9.51e-15 ***
HCHH.culturenormal -0.92993    0.09624  -9.662 1.98e-15 ***
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4244 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.7624,     Adjusted R-squared: 0.7569
F-statistic: 139.6 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total hands A ~ logTA + HCHH.culture

N: 90      tau: 0.95      AIC: 142.862005667458

                   coefficients   lower bd    upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           4.4142062  4.3001110  4.73212120  0.1959222 22.530407
0.00000000
lTA                   0.7650200  0.2486867  1.32245313  0.3271734  2.338270
0.02166676
HCHH.culturenormal   -0.4697346 -0.5637189 -0.03111358  0.1423647 -3.299516
0.00140485


Formula for mean (based on LS-estimate):
log(total hnads A) =  4.002  + 1.034 log(TA) + -0.93 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(total hands A) =  4.414  + 0.765 log(TA) + -0.47 HCHH.culturenormal

==================================================================================
```

Model: log protected hands A/TA ~ HCHH.culture

```
Table of measured values:
               n   min    50%     75%      95%  max
dense culture 40 14.96 267.15 580.400 1357.550 1381
normal        50  0.05   4.12 112.575  510.465 1958

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95      QR.95
1 0.2 dense culture -0.69897  374.49410   81.23529
2 1.0 dense culture  0.00000 1872.47050  406.17647
3 5.0 dense culture  0.69897 9362.35248 2030.88235
4 0.2        normal -0.69897   20.39107   24.82840
5 1.0        normal  0.00000  101.95535  124.14201
6 5.0        normal  0.69897  509.77673  620.71006

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-2.0303 -0.4054  0.0761  0.5027  1.8766

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          1.9036     0.1286  14.802  < 2e-16 ***
HCHH.culturenormal  -1.2607     0.1725  -7.307 1.18e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.8133 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.3776,     Adjusted R-squared: 0.3705
F-statistic: 53.39 on 1 and 88 DF,  p-value: 1.179e-10
```

```
Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log protected hands A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 233.747352132785

                     coefficients   lower bd       upper bd Std. Error   t value
Pr(>|t|)
(Intercept)              2.608715  2.6028269  1.797693e+308 0.03223789 80.920763
0.00000000
HCHH.culturenormal    -0.514796 -0.8430704  -2.934116e-01 0.22378891 -2.300364
0.02379235


Formula for mean (based on LS-estimate):
log(protected hands A) = log(TA) + 1.904  + -1.261 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(protected hands A) = log(TA) + 2.609  + -0.515 HCHH.culturenormal
```

===

Model: log protected hands A ~ logTA + HCHH.culture

```
Table of measured values:
               n   min    50%     75%      95%  max
dense culture 40 14.96 267.15 580.400 1357.550 1381
normal        50  0.05   4.12 112.575  510.465 1958

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA        LS.95       QR.95
1 0.2 dense culture -0.69897    36.584931   12.657397
2 1.0 dense culture  0.00000   584.164209  203.674486
3 5.0 dense culture  0.69897 10219.736796 3277.395629
4 0.2        normal -0.69897     3.286021    2.445655
5 1.0        normal  0.00000    54.565714   39.353865
6 5.0        normal  0.69897   994.948873  633.256469

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.9307 -0.4726  0.1691  0.5092  1.4326

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          1.4920     0.1563   9.545 3.45e-15 ***
lTA                  1.7924     0.1959   9.148 2.23e-14 ***
HCHH.culturenormal  -1.0171     0.1702  -5.976 4.90e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7505 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.675,Adjusted R-squared: 0.6675
F-statistic: 90.34 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log protected hands A ~ logTA + HCHH.culture

N: 90      tau: 0.95      AIC: 206.195230951648
```

```
                   coefficients   lower bd   upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           2.3089366  2.2264449  2.4002113 0.09796646 23.568644
0.0000000000
lTA                   1.7262432  0.1989191  1.8929807 0.14927969 11.563818
0.0000000000
HCHH.culturenormal   -0.7139492 -0.8154612 -0.3405046 0.19484366 -3.664216
0.0004258183


Formula for mean (based on LS-estimate):
log(protected hands A) =  1.492  + 1.792 log(TA) + -1.017 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(protected hands A) =  2.309  + 1.726 log(TA) + -0.714 HCHH.culturenormal

==================================================================================
```

Model: log total body A/TA ~ HCHH.culture

```
Table of measured values:
               n        min       50%        75%       95%     max
dense culture 40 205029.900 743891.35 1433241.63 2224532.1 2470393
normal        50   1739.584  21941.66   55128.48  179870.9  254373

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA       LS.95      QR.95
1 0.2 dense culture -0.69897   415989.19  117446.65
2 1.0 dense culture  0.00000  2079945.95  587233.24
3 5.0 dense culture  0.69897 10399729.73 2936166.18
4 0.2        normal -0.69897    21426.72   32589.84
5 1.0        normal  0.00000   107133.62  162949.20
6 5.0        normal  0.69897   535668.11  814746.01

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.57788 -0.31279 -0.03126  0.33281  1.45202

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         5.39920    0.08632   62.55   <2e-16 ***
HCHH.culturenormal -1.28588    0.11582  -11.10   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.546 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5835,     Adjusted R-squared: 0.5787
F-statistic: 123.3 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total body A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 190.039417040803

                   coefficients   lower bd       upper bd Std. Error    t value
Pr(>|t|)
(Intercept)           5.7688106  5.7597297  1.797693e+308 0.05553349 103.879859
0.000000000
HCHH.culturenormal   -0.5567584 -0.7864454  -2.018612e-01 0.17934165  -3.104457
0.002564275
```

```
Formula for mean (based on LS-estimate):
log(total body A) = log(TA) + 5.399  + -1.286 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(total body A) = log(TA) + 5.769  + -0.557 HCHH.culturenormal

==================================================================================
```

Model: log total body A ~ logTA + HCHH.culture

```
Table of measured values:
               n        min       50%        75%       95%     max
dense culture 40 205029.900 743891.35 1433241.63 2224532.1 2470393
normal        50   1739.584  21941.66   55128.48  179870.9  254373

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95     QR.95
1 0.2 dense culture -0.69897 2301384.82 2156000.0
2 1.0 dense culture  0.00000 3590379.65 2188718.3
3 5.0 dense culture  0.69897 5933306.32 2221933.1
4 0.2        normal -0.69897   70610.29  176076.3
5 1.0        normal  0.00000  112913.22  178748.3
6 5.0        normal  0.69897  191527.68  181460.9

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.24318 -0.29821 -0.01523  0.31477  1.15490 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)         5.75181    0.09853   58.38   <2e-16 ***
lTA                 0.32106    0.12350    2.60    0.011 *  
HCHH.culturenormal -1.49453    0.10728  -13.93   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 

Residual standard error: 0.473 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.7484,     Adjusted R-squared: 0.7427 
F-statistic: 129.4 on 2 and 87 DF,  p-value: < 2.2e-16 

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log total body A ~ logTA + HCHH.culture

N: 90      tau: 0.95      AIC: 149.256397383259

                   coefficients   lower bd   upper bd Std. Error     t value
Pr(>|t|)
(Intercept)         6.340189868  6.1713694  6.4369540 0.06733459  94.1594825
0.000000
lTA                 0.009358227 -0.1401279  1.1022710 0.11784533   0.0794111
0.936888
HCHH.culturenormal -1.087947945 -1.1665282 -0.2460348 0.06393434 -17.0166445
0.000000


Formula for mean (based on LS-estimate):
log(total body A) =  5.752  + 0.321 log(TA) + -1.495 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(total body A) =  6.34  + 0.009 log(TA) + -1.088 HCHH.culturenormal
```

```
===================================================================================
```

Model: log inner body A ~ HCHH.culture

```
Table of measured values:
               n    min       50%       75%        95%      max
dense culture 40 2389.9 11617.750 46538.250 189501.150 305040.0
normal        50    6.0   255.251   972.135   1912.291   8980.1

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA       LS.95      QR.95
1 0.2 dense culture -0.69897  15029.4331   9029.388
2 1.0 dense culture  0.00000  75147.1656  45146.939
3 5.0 dense culture  0.69897 375735.8282 225734.694
4 0.2        normal -0.69897    495.0399    695.362
5 1.0        normal  0.00000   2475.1993   3476.810
6 5.0        normal  0.69897  12375.9964  17384.049

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
    Min      1Q  Median      3Q     Max
-1.3168 -0.5376 -0.1802  0.4585  2.0331

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)          3.7157     0.1090   34.09   <2e-16 ***
HCHH.culturenormal  -1.4795     0.1462  -10.12   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6894 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5377,     Adjusted R-squared: 0.5324
F-statistic: 102.3 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inner body A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 252.511603193986

                   coefficients  lower bd       upper bd Std. Error   t value
Pr(>|t|)
(Intercept)            4.654628  4.554884  1.797693e+308  0.0969588 48.006248
0.00000000000
HCHH.culturenormal    -1.113447 -1.358390  -7.393541e-01  0.2674025 -4.163938
0.00007275973


Formula for mean (based on LS-estimate):
log(inner body A) = log(TA) + 3.716  + -1.479 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(inner body A) = log(TA) + 4.655  + -1.113 HCHH.culturenormal
```

```
===================================================================================
```

Model: log inner body A ~ HCHH.culture

```
Table of measured values:
               n    min       50%       75%        95%      max
dense culture 40 2389.9 11617.750 46538.250 189501.150 305040.0
normal        50    6.0   255.251   972.135   1912.291   8980.1
```

```
Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95     QR.95
1 0.2 dense culture -0.69897 207255.648 188037.00
2 1.0 dense culture  0.00000 207255.648 188037.00
3 5.0 dense culture  0.69897 207255.648 188037.00
4 0.2        normal -0.69897   3365.701   1938.22
5 1.0        normal  0.00000   3365.701   1938.22
6 5.0        normal  0.69897   3365.701   1938.22

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.67010 -0.43413 -0.07057  0.46915  1.50503 

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)    
(Intercept)          4.2350     0.1016   41.68   <2e-16 ***
HCHH.culturenormal  -1.7868     0.1363  -13.11   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6426 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.6613,     Adjusted R-squared: 0.6575 
F-statistic: 171.8 on 1 and 88 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inner body A ~ HCHH.culture

N: 90      tau: 0.95      AIC: 222.008235452382

                   coefficients  lower bd       upper bd Std. Error   t value
Pr(>|t|)
(Intercept)            5.274243  5.100385  1.797693e+308  0.1271757 41.472096
0.000000e+00
HCHH.culturenormal    -1.986840 -2.224905  -1.474155e+00  0.2650627 -7.495738
4.902989e-11


Formula for mean (based on LS-estimate):
log(inner body A) =  4.235  + -1.787 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(inner body A) =  5.274  + -1.987 HCHH.culturenormal

=================================================================================
```

Model: log head A/TA ~ HCHH.culture

```
Table of measured values:
               n    min     50%     75%     95%    max
dense culture 40 129.72 1136.40 2894.50 5180.90 5394.0
normal        50   4.00   62.29  155.68  851.61 1471.6

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA       LS.95     QR.95
1 0.2 dense culture -0.69897   772.02822  225.3846
2 1.0 dense culture  0.00000  3860.14109 1126.9231
3 5.0 dense culture  0.69897 19300.70543 5634.6154
4 0.2        normal -0.69897    80.00397   76.4918
5 1.0        normal  0.00000   400.01986  382.4590
6 5.0        normal  0.69897  2000.09928 1912.2951
```

```
Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.35628 -0.38421 -0.00847  0.42494  1.62893

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         2.53252    0.09903  25.574  < 2e-16 ***
HCHH.culturenormal -0.98195    0.13286  -7.391 7.98e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6263 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.383,Adjusted R-squared: 0.376
F-statistic: 54.62 on 1 and 88 DF,  p-value: 7.983e-11

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log head A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 207.89745205755

                   coefficients  lower bd      upper bd Std. Error  t value
Pr(>|t|)
(Intercept)           3.0518943  2.998703 1.797693e+308  0.0698863 43.66942
0.00000000
HCHH.culturenormal   -0.4693094 -0.629691  5.664356e-02  0.2149896 -2.18294
0.03170261


Formula for mean (based on LS-estimate):
log(head A) = log(TA) + 2.533  + -0.982 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(head A) = log(TA) + 3.052  + -0.469 HCHH.culturenormal

=================================================================================
```

Model: log head A ~ logTA + HCHH.culture

```
Table of measured values:
               n    min     50%     75%     95%    max
dense culture 40 129.72 1136.40 2894.50 5180.90 5394.0
normal        50   4.00   62.29  155.68  851.61 1471.6

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95     QR.95
1 0.2 dense culture -0.69897  4359.4751 1879.2681
2 1.0 dense culture  0.00000  6928.2490 3182.4765
3 5.0 dense culture  0.69897 11800.1292 5389.4158
4 0.2        normal -0.69897   270.8947  485.5438
5 1.0        normal  0.00000   443.4959  822.2519
6 5.0        normal  0.69897   779.4351 1392.4557

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-1.00654 -0.38986  0.00658  0.42513  1.34706
```

```
Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)           2.8745     0.1185  24.257  < 2e-16 ***
lTA                   0.3416     0.1485   2.300   0.0238 *
HCHH.culturenormal  -1.1843     0.1290  -9.178 1.94e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5689 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5785,     Adjusted R-squared: 0.5688
F-statistic: 59.71 on 2 and 87 DF,  p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log head A ~ logTA + HCHH.culture

N: 90      tau: 0.95      AIC: 195.479163307029

                   coefficients   lower bd  upper bd Std. Error   t value
Pr(>|t|)
(Intercept)           3.5027652  2.8493417 3.6988423 0.14044555 24.940379
0.00000000000000
lTA                   0.3273051 -0.3353057 2.4347579 0.23408874  1.398210
0.16560442825750
HCHH.culturenormal   -0.5877603 -1.1151096 0.8211811 0.09401927 -6.251487
0.00000001464939


Formula for mean (based on LS-estimate):
log(head A) =  2.874  + 0.342 log(TA) + -1.184 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(head A) =  3.503  + 0.327 log(TA) + -0.588 HCHH.culturenormal

==================================================================================
```

Model: log inhalation A/TA ~ HCHH.culture

```
Table of measured values:
              n         min       50%      75%      95%      max
dense culture 40 101.5315315 330.97728 428.7562 705.2123 2136.261
normal        50   0.5208333  57.84375 156.5365 390.4583 2165.625

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95      QR.95
1 0.2 dense culture -0.69897  116.78287   42.39534
2 1.0 dense culture  0.00000  583.91437  211.97668
3 5.0 dense culture  0.69897 2919.57183 1059.88341
4 0.2        normal -0.69897   37.86361   44.61349
5 1.0        normal  0.00000  189.31804  223.06743
6 5.0        normal  0.69897  946.59018 1115.33717

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.55824 -0.20138  0.01866  0.22641  1.06065

Coefficients:
                   Estimate Std. Error t value   Pr(>|t|)
(Intercept)         1.98988    0.07295  27.278    < 2e-16 ***
HCHH.culturenormal -0.48726    0.09787  -4.979 0.00000316 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.4614 on 88 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.2198,     Adjusted R-squared: 0.2109
F-statistic: 24.79 on 1 and 88 DF,  p-value: 0.000003159

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = 0.95)
Formula: log inhalation A/TA ~ HCHH.culture

N: 90      tau: 0.95      AIC: 159.415483991196

                   coefficients   lower bd      upper bd Std. Error     t value
Pr(>|t|)
(Intercept)          2.32628809  2.2825014 1.797693e+308  0.1780171 13.06777750
0.0000000
HCHH.culturenormal   0.02214808 -0.6551251  2.110937e-01  0.2518236  0.08795078
0.9301156


Formula for mean (based on LS-estimate):
log(inhalation A) = log(TA) + 1.99  + -0.487 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(inhalation A) = log(TA) + 2.326  + 0.022 HCHH.culturenormal

=================================================================================

Model: log inhalation A ~ log TA + HCHH.culture

Table of measured values:
               n         min       50%      75%      95%      max
dense culture 40 101.5315315 330.97728 428.7562 705.2123 2136.261
normal        50   0.5208333  57.84375 156.5365 390.4583 2165.625

Table of predicted values (95th percentile):
   TA  HCHH.culture      lTA      LS.95     QR.95
1 0.2 dense culture -0.69897  253.90712 127.89291
2 1.0 dense culture  0.00000  779.58394 333.82387
3 5.0 dense culture  0.69897 2528.82618 871.34129
4 0.2        normal -0.69897   66.02013  69.90183
5 1.0        normal  0.00000  207.54022 182.45654
6 5.0        normal  0.69897  690.19760 476.24490

Summary of LS fit (mean):

Call:
lm(formula = frm)

Residuals:
     Min       1Q   Median       3Q      Max
-2.41240 -0.16074 -0.00015  0.23767  1.20649

Coefficients:
                   Estimate Std. Error t value     Pr(>|t|)
(Intercept)         2.12507    0.09405  22.596      < 2e-16 ***
lTA                 0.73970    0.11788   6.275 0.0000000132 ***
HCHH.culturenormal -0.56726    0.10240  -5.539 0.0000003182 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4515 on 87 degrees of freedom
  (44 observations deleted due to missingness)
Multiple R-squared: 0.5543,     Adjusted R-squared: 0.544
F-statistic:  54.1 on 2 and 87 DF,  p-value: 5.417e-16

Summary of RQ fit (95th percentile):
```

```
Call: rq(formula = frm, tau = 0.95)
Formula: linhalation A ~ logTA + HCHH.culture

N: 90      tau: 0.95      AIC: 158.884027565652

                   coefficients   lower bd upper bd Std. Error    t value
Pr(>|t|)
(Intercept)           2.5235174  2.1658532 3.088993  0.2224206 11.3456984
0.00000000
lTA                   0.5961213 -1.2403115 2.018214  0.2510519  2.3744941
0.01977204
HCHH.culturenormal   -0.2623580 -0.7886172 0.235646  0.2933158 -0.8944557
0.37354600


Formula for mean (based on LS-estimate):
log(inhalation A) =  2.125  + 0.74 log(TA) + -0.567 HCHH.culturenormal
Formula for 95th percentile (based on quantile regression):
log(inhalation A) =  2.524  + 0.596 log(TA) + -0.262 HCHH.culturenormal
```

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