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Update of the Greenhouse Agricultural Operator Exposure Model

Amendment to Project Report 01/2016

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Content

1 Summary

Several approaches are available in the EU to estimate the exposure of operators applying pesticides in greenhouses. The most recent is the Greenhouse AOEM for spray applications published in 2015 that was now subject to a revision. Three new exposure studies made available after the finalisation of the first model version were integrated to improve the model. Each of the new studies provided additional information.

The principal advantage of the updated model is its applicability to a broader range of spray application techniques. Besides spray lances and guns, the updated Greenhouse AOEM also covers knapsack and pulled trolley sprayers. While exposure with knapsack sprayers and spray guns was comparable, trolley sprayers can be considered as an exposure refinement option for application in high crops. Their use resulted in significantly lower exposure. Moreover, additional data for the mixing and loading step was considered. However, it was still not sufficient to establish an independent model. Therefore, the decision to combine data from outdoor and greenhouse applications was maintained. Updated models for tank and knapsack sprayers were generated for outdoor and greenhouse scenarios.

The structure of the model as well as the exposure factors, such as formulation type for mixing/loading did not change during the revision. In some cases, statistical models instead of percentiles could be established. For knapsack mixing/loading and application in low crops, fixed percentiles were still used since no correlation with the total amount of active substance handled per day was observed. Some new factors were introduced, such as application technique or use of a certified protective coverall. The latter can now be used as an alternative to workwear in high crops when the operator has intense and frequent contact with the treated crop and workwear does not provide a sufficient protection. Notably, the protection is less efficient than the protection provided by rain suits that had already been introduced as a refinement option in the previous version of the Greenhouse AOEM.

This update demonstrates that the integration of new data is a valuable and important procedure in exposure model improvement, which increases its acceptance.

2 Scope

A new greenhouse model for operator exposure to pesticides was developed and published in 2015. Studies sponsored by the European Crop Protection Association (ECPA) had been re-evaluated in order to obtain a transparent and valid model for typical conditions and practices in greenhouses in Europe. Statistical methods were applied to analyse data, identify factors that affect exposure and. to perform data modelling and model validation. Despite the relatively large data record, the model had some limitations. It was derived only on exposure data for hand-held lance sprayers or spray guns connected to a static tank and, therefore, was not applicable to other application equipment. Variation in other factors such as application rate was also low since in total only two different products were applied in all the studies. In addition, no information on body exposure during mixing and loading was available in the studies. For this reason, data from outdoor applications and indoor applications were combined to create one model for the mixing/loading task.

Due to these limitations, one of the recommendations of the project was to include further data when available and to revise the model in order to increase the applicability and statistical power of the model.

Since then, new greenhouse exposure data became available. The new data was published in three studies which were conducted in 2012 and 2016 in different EU member states, partly within the framework of the FP7 BROWSE project (Bystander, Resident, Operator & Worker Exposure models for plant protection products, www.browseproject.eu). On the basis of the amended data record, an updated model was established.

The new data as well as the revised model, including model development, is presented in this report.

3 Exposure data

3.1 Exposure studies

The original greenhouse data record contained seven exposure studies with a total of 70 entries for mixing/loading and 102 entries for application. In all studies, either lance sprayers or spray guns were used which were connected to a large static tank located at the edge of the greenhouse. Information on body exposure during mixing/loading of the tank was not available in the studies. In addition, there was no data for liquid formulations

Each of the three new studies provided additional information to the database. Two of the studies (from France and Spain) contained data for additional spray equipment typical for application in greenhouses, i.e. knapsack sprayers and trolley sprayers. The third study (from Greece) contained data for spray guns connected via hose to a static tank. In contrast to the old greenhouse studies, a liquid product was used and body exposure was also monitored during mixing and loading of the tank. The study in Greece has been conducted within the framework of the FP7 BROWSE project.

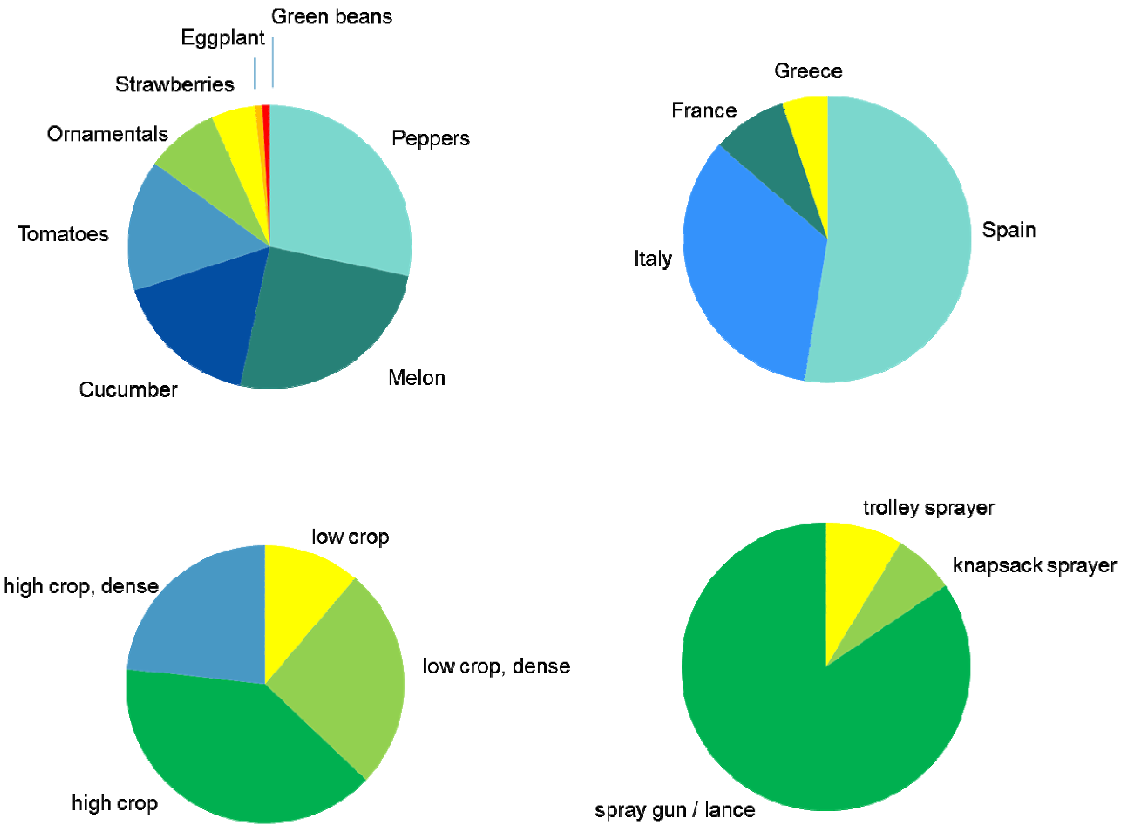

Figure 1: Overview of the study characteristics and different scenarios in the greenhouse database of both, old and new studies

The majority of the greenhouses where the exposure trials took place were similar to the greenhouses in the studies already included in the database. They consisted of large wooden or steel constructions covered with plastic. However, in some trials exposure was also monitored in plastic tunnels of approximately 4 to 5 m width. The structures were either fully closed or partly open, e.g. gaps between plastic sheets, covers or panels on the side or on the roof as well as tunnels with their ends fully opened. The greenhouses were located in the Almeria Region in Spain, in the south of France and Greece. The greenhouse studies from the initial database were either conducted in Italy or Spain.

The crops treated in the new studies were tomato, pepper, strawberry, green beans and eggplant. Data for tomato and pepper were already available in the previous database besides data for melon, cucumber and ornamentals. Strawberries were either grown on the ground or as hydroculture at head level. Depending on the space between crop rows and crop stage, the operators had more or less frequent contact with the treated crop. In case contact with the treated crop could not be avoided the crop growing condition was considered as "dense". In several trials from the old and the new studies frequent contact was observed.

Figure 1 provides an illustration of the study characteristics of the amended greenhouse database. A brief summary of the studies is presented in Appendix 1.

A major benefit of the new greenhouse data is that the exposure data covered a broader application rate, i.e. total amount of pesticide applied per day (see Figure 2). Low amounts of active substance down to 0.003 kg per day were applied in the new studies. This lead to an improved model fit in the lower application rate range.

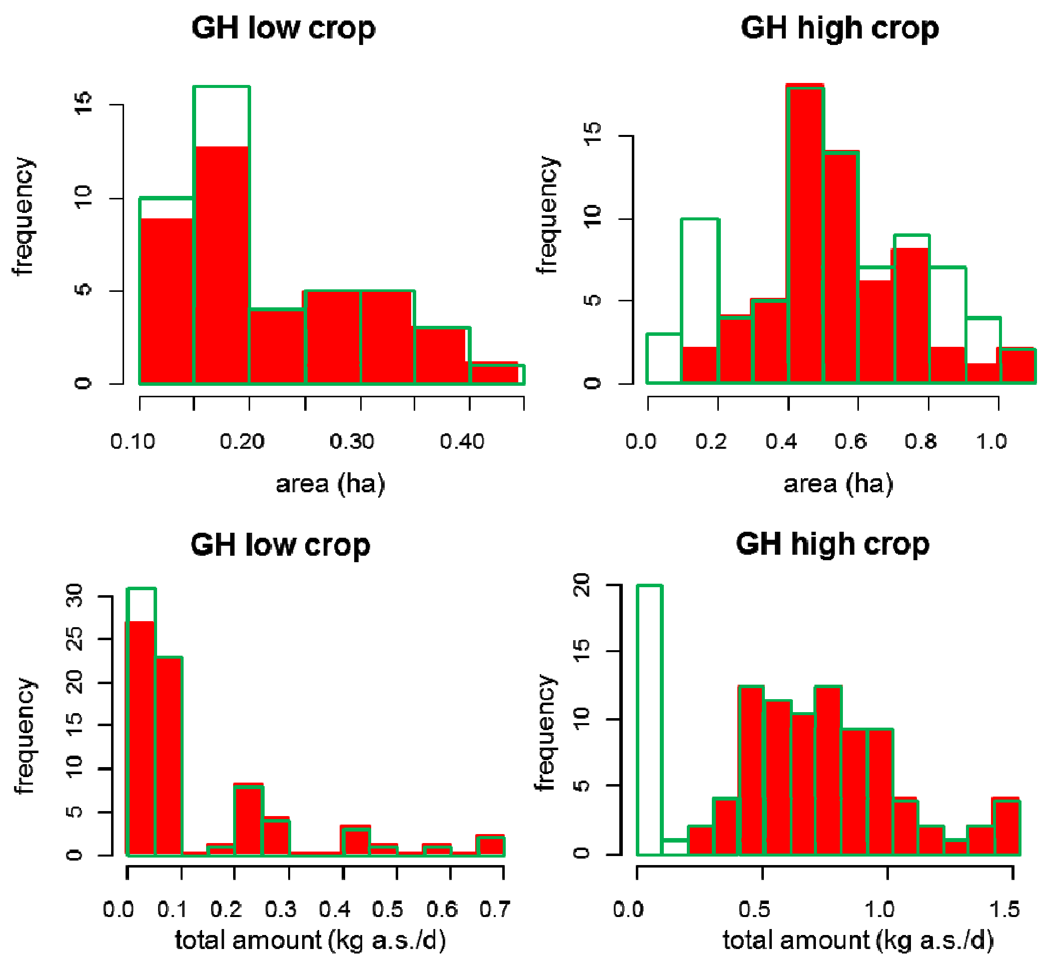

Figure 2: Distribution of the area treated and the total amount of active substance applied on one day in the old greenhouse studies (red columns) and in both the old and new greenhouse studies (green columns).

Exposure was monitored for a typical workday according to the statements made in the study report. The spraying duration in the new studies ranged from 8 to 206 min during which an area of 0.04 to 0.85 ha was treated. The duration of spraying correlated with the area treated and the amount of active substance handled. Over all studies, the application duration reached a maximum of 206 min (75^{th} perc. 128 min) and the largest area treated was 1.10 ha (75^{th} perc. 0.60 ha).

All new studies fulfilled the quality criteria that had been defined for the greenhouse project before, e.g. compliance with OECD Series No. 9 (OECD, 1997). Therefore, they were evaluated and all relevant data and information was included in the greenhouse database.

3.2 Sampling methodology

In all greenhouse studies, dermal exposure was monitored with whole body dosimetry while personal air samplers were employed for inhalation exposure.

The body dosimeters consisted of two layers of clothing – one layer of full-length underwear (100% cotton or 50% polyester/50% cotton) and usually one layer of workwear (100% cotton or 65% polyester/35% cotton). In some cases the operators did not wear workwear. In two of the old studies, rain coats, rain trousers or a protective coverall (Cat 3 Type 6) were used as outer dosimeters and in the new study from France the operators wore a Cat 3 Type 4 coverall (Tyvek). In the new studies, head exposure was monitored with either hoods, bandanas and caps or face/neck wipes combined with hoods. In the first studies, face/neck wipes were taken. In the majority of the studies, hand exposure was determined with hand washes usually taken whenever the operator wanted to wash his hands and at the end of the operation. In the new study from Spain, scheduled hand washes were taken every 20 to 25 minutes. Inner cotton gloves were used as dosimeter for hand exposure beneath protective gloves in the new study from Greece. Protective nitrile gloves were worn by all operators during mixing/loading and application and were analysed as well.

The personal air samplers consisted of a pump operating at a flow rate of approximately 2 L/min and an IOM sampling unit (named after the Institute of Occupational Medicine, Edinburgh, Scotland) with a glass fibre filter. Except for the Greek study, mixing/loading was not monitored in the newly included studies. Inhalation exposure was only monitored in the Spanish study. Cleaning, when conducted, was monitored as part of the application task in two of the new studies (France and Spain). In total cleaning was monitored for 8 out of 128 replicates performing the application task.

3.3 Data processing

Before modelling, data was prepared for evaluation. In one case, two data records for trolley sprayers (with tanks of 100 to 120 L capacity) from the French study were excluded from further consideration. The application scenario differed from that of the other trolley sprayer data where they (connected via a hose to a static tank) were pulled instead of pushed. Contact to treated foliage were also avoided in the Spanish study because the operator pushed the trolley to the end of each row where the trolley were switched on and the operator pulled it spraying towards the main corridor. At the main corridor, the operator switched off the trolley, turned around and started again. The two data sets were considered too small for a separate scenario to be modelled. In another case, where the operator treated low crops and high crops in the same trial, the data set was categorised as high crop since twice as many rows with high crops than with low crops were sprayed.

For the previous greenhouse model as well as for the AOEM, a threshold of 70% was used for correction of the exposure data for field recovery. For the updated model, according to current practice a threshold of 95% was used. This rule was also applied to the old greenhouse data and the outdoor mixing/loading data.

Values below the LOQ were considered as ½ LOQ for further evaluation. For values reported as "zero" (not detected) a value of 0.01 µg/sample was used instead to enable statistical analysis. Both decisions were not supposed to have a significant impact on the overall exposure outcome due to the selected modelling method, i.e. quantile regression.

To adjust inhalation, exposure a breathing rate of 1.25 m^3/h was considered. Head exposure was determined by using a correction factor of two for face/neck wipe data and for hood/cap data. No correction was necessary when head exposure was sampled with both, face/neck wipes and hats.

The final number of data suitable for modelling is presented in Table 1 (tables with the complete record of processed data and information used for modelling are available in Appendix 2). Data was grouped according to the different dosimeters that were used for monitoring. New data was highlighted in a different colour. Three different types of inner body exposure existed in the database: Body exposure beneath workwear (inner body I), body exposure beneath rain coats/rain trousers in dense crop (inner body II) and body exposure beneath a certified protective coverall in dense crop (inner body III). The last type was not considered during the first greenhouse project since the number of data was too small, at that time. Additional data was added to this group with the inclusion of the new studies.

Table 1: Number of data entries for mixing/loading and application from the updated greenhouse database; black: old greenhouse data for lance/spray gun equipment with large static tank, blue: new greenhouse data for lance/spray gun equipment with large static tank, green: new greenhouse data for trolley sprayer, red: new greenhouse data for knapsack sprayers

	Inhala tion	Outer body	Inner body I	Inner body II	Inner body III	Nitrile gloves	Prot. Hands	Bare hands	Head
Mixing/loading tank									
WG	50					49	50		30
WP	20					20	20		
liquid		6	6			6	6		6
Application									
High crop	30 10	30+6 10	30+6 10			20+6 10	22+6 10	8+6 10	29+6 10
High crop dense	32	10 5	10	22	6 5	5 5	18 5	14 5	31 5
Low crop	10	10 3	10		3	10 3	10 3		10 3
Low crop dense	29	20	20	10		30	30		30

4 Modelling approach

4.1 Exposure scenarios

In comparison to the first Greenhouse AOEM, additional equipment was included in the database. Exposure data for knapsack sprayers and trolley sprayers (connected via a hose to a static tank) became available in addition to spray lance/spray gun data. Nevertheless, the application scenarios remained the same:

- Indoor spray application in low crops
- Indoor spray application in high crops

An impact of the application equipment, if statistically confirmed, will be addressed by an additional factor in the respective models for indoor low crops and indoor high crops.

Data for indoor tank mixing/loading relevant for spray lance/spray gun equipment and trolley sprayers are still insufficient to derive an independent model. Therefore, data from outdoor and indoor tank mixing/loading was combined as it had been done for the first Greenhouse AOEM. Exposure using knapsack equipment was covered by the new Greenhouse AOEM as well. However, no data for indoor mixing/loading of knapsack sprayers was available at all. Therefore, data for outdoor knapsack mixing/loading was used, since no differences between the exposures for outside or indoor mixing/loading of knapsack tanks were expected. The knapsack mixing/loading model from the AOEM was revised using a higher threshold of 95% for the correction of field recovery. The following mixing/loading scenarios were derived:

- Tank mixing/loading (indoor + outdoor)
- Knapsack mixing/loading (indoor + outdoor)

All four scenarios were independently modelled and validated.

4.2 Variables

In analogy to the AOEM exposure variables were defined as below. For each variable of each scenario separate models were established.

Inhalation exposure: All residues which were found on air sampling filters or tubes normalised to a generic respiration rate of 1.25 m^3/h, which is considered representative of inhalation exposure

Head exposure: All residues which were found on head dosimeters including a correction factor of 2 for face/neck wipes – also termed potential head exposure

'Inner' body exposure: All residues which were found on an inner layer of clothing beneath an outer layer of clothing (head and hands excluded) – also termed actual body exposure

Total body exposure: All residues which 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 - also termed potential body exposure

Protected hand exposure: All residues which were found on the hands of operators wearing gloves - also termed actual hand exposure

Total hand exposure: All residues which were found on hands and gloves of the operator – also termed potential hand exposure

4.3 Form of the model and choice of factors

For the greenhouse model the same log linear model was chosen as for the AOEM model with X as the exposure variable and with A and F as factors that drive the exposure:

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

The respective non-logarithmic form of the model is given below:

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

The exponent α was set to be between 0 and 1 resulting in a sub linear or linear dependency from the major exposure factor A. An exponential increase in exposure with, e.g. increasing amounts of active substance applied per day is considered unlikely.

Based on the experience from the AOEM project, the total amount of active substance applied per day (TA) was chosen as the major factor for exposure. In addition to that, the extent of contact with treated foliage (dense or normal scenario) was considered relevant for both application scenarios due to very distinct exposure levels for dense and normal crop conditions. With respect to the limited number of data, a statistical analysis of a greater number of possible impact factors (e.g. the impact of the application equipment) as it was done for the AOEM data was not possible. However, it was decided to have a separate exposure factor for trolley sprayers as this is a very specific scenario suitable as a risk mitigation option for the authorisation of plant protection products. In addition, the use of a rain coat/rain trousers or a certified protective coverall was included as a factor. The previous model already contained a factor for rain clothing. For the updated model, enough data was available to consider the certified protective coverall separately.

In the case of mixing/loading, the existing tank model from the AOEM was adjusted by including the new greenhouse tank data. The same exposure factors were used as for the original tank mixing/loading model as the number of additional data was small. For knapsack mixing/loading no new data was added from the Greenhouse database. The outdoor models were not changed expect for applying a higher threshold of 95% for the correction of recovery.

4.4 Methods

Modelling was performed according to the procedure described in the previous project report on the greenhouse AOEM. Quantile regression, a non-parametric method, was used for the prediction of the 75th percentile (for longer-term exposure) and the 95th percentile (for acute exposure). As long as the percentile was well within the range of measured data, the resulting fit could be expected to be more robust than the one obtained from least squares regression. In particular, it did not depend on the actual choice of the value substituted for non-detects or assume the same standard deviation over the whole range.

For those exposure variables for which no statistical model could be derived the respective empirical percentiles were calculated with quantile regression.

5 Statistical evaluation

In the following, the results for each scenario are discussed. The model equations are given in Chapter 8. The model computations are presented in Appendix 4.

5.1 Mixing/loading – Tanks

Only limited information was available in the greenhouse database for exposure during mixing/loading. No mixing/loading data was generated for knapsack and trolley sprayers. For lance sprayers or spray guns connected to static tanks, data was available but in most of the cases only for hand exposure. On this basis, it was not possible to derive a separate mixing/loading model for the greenhouse. Instead, in line with the previous greenhouse model, mixing/loading data from indoor and outdoor was combined. This approach was justified by the outcome of modelling. The previous combined tank model did not differ substantially from the outdoor tank model. The additional data from the new greenhouse studies supported this decision (see Figure 3 and Figure 4). For the majority of the exposure variables, similar models for the combined indoor and outdoor data (green lines) were obtained in comparison to the previous model for the combined indoor and outdoor data (orange lines) and the original model for the outdoor data only (blue lines). However, for protected body exposure and protected hand exposure the changes were more obvious. This could be explained by a better fit for lower amounts of active substance since data for this range were included in the new database.

Exposure was mainly driven by the amount of active substance used and the formulation type. Highest exposure was estimated for powder, followed by liquid and granule formulations. In comparison to the outdoor model, an additional formulation type was introduced in the previous combined model: powder formulations packed in small sachets which resulted in similar exposure as powders. This formulation type has no relevance for commercial products and should therefore not used in the risk assessment for product authorisation. The same applies to glove wash which was identified in the initial outdoor model as a factor reducing total hand exposure. Rinsing gloves before their removal is not an available mitigation measure in the EU.

Inhalation exposure did not increase to the same extent as head exposure. This was probably due to the fact that head exposure resulted mainly from spillages and contact with contaminated hands.

The exposure models with the respective upper 95% confidence levels are presented in Appendix 3. The confidence of the models for the 75th percentile was usually better than that for the 95th percentile. At lower amounts of handled active substance, broader confidence intervals were observed due to fewer data records.

The quality of the models was tested by comparing the prediction for the 75th level and the 95th level. Ideally, the exposure at the 95th percentile should always be higher than at the 75th percentile. For this purpose, models were plotted together and checked for interceptions (see Figure A1 presented in Appendix 3). In the relevant range of total amount applied per day, interceptions occurred in only two cases: actual body and inhalation exposure with powder formulations. In the first case, the prediction for the 95th percentile was below the prediction of the 75th percentile only in the low range of active substance handled. In the second case, the prediction of the 95th percentile was already slightly below the prediction of the 75th percentile at a higher range. To avoid a lower prediction for the 95th percentile in comparison to the 75th percentile, the higher of the two values should be chosen.

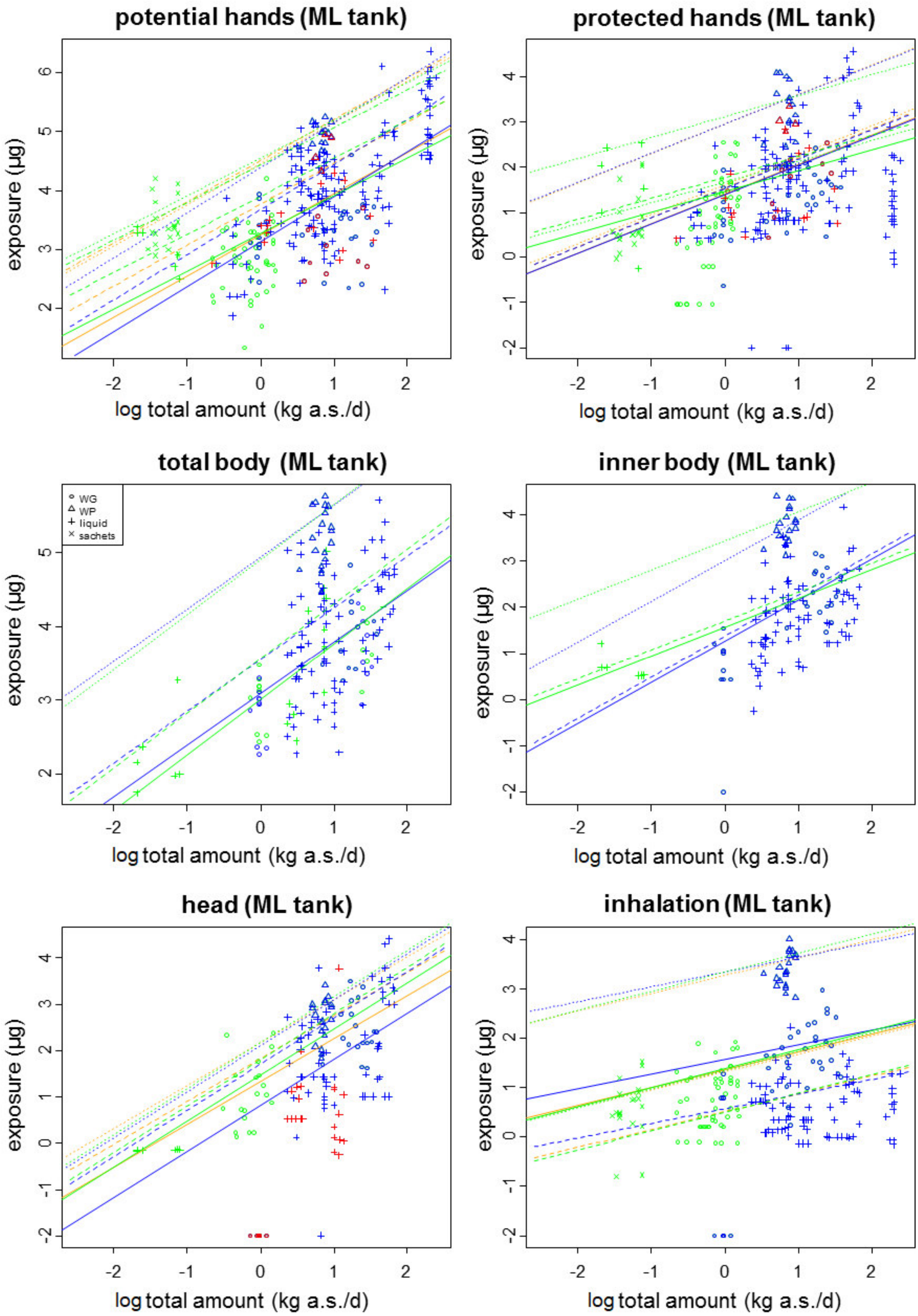

Figure 3: Comparison of the old tank mixing/loading model with outdoor data only (blue lines), the combined model with outdoor data and old greenhouse data (orange lines) and the new combined model with outdoor data and all available greenhouse data (green lines) – 75th percentile; dotted lines: WP formulation, broken/dotted lines: sachets (WP), broken lines: liquid formulations, solid lines: WG formulation; Δ: WP; x: sachets; o: WG; +: liquids, green: greenhouse data, blue/red: outdoor data

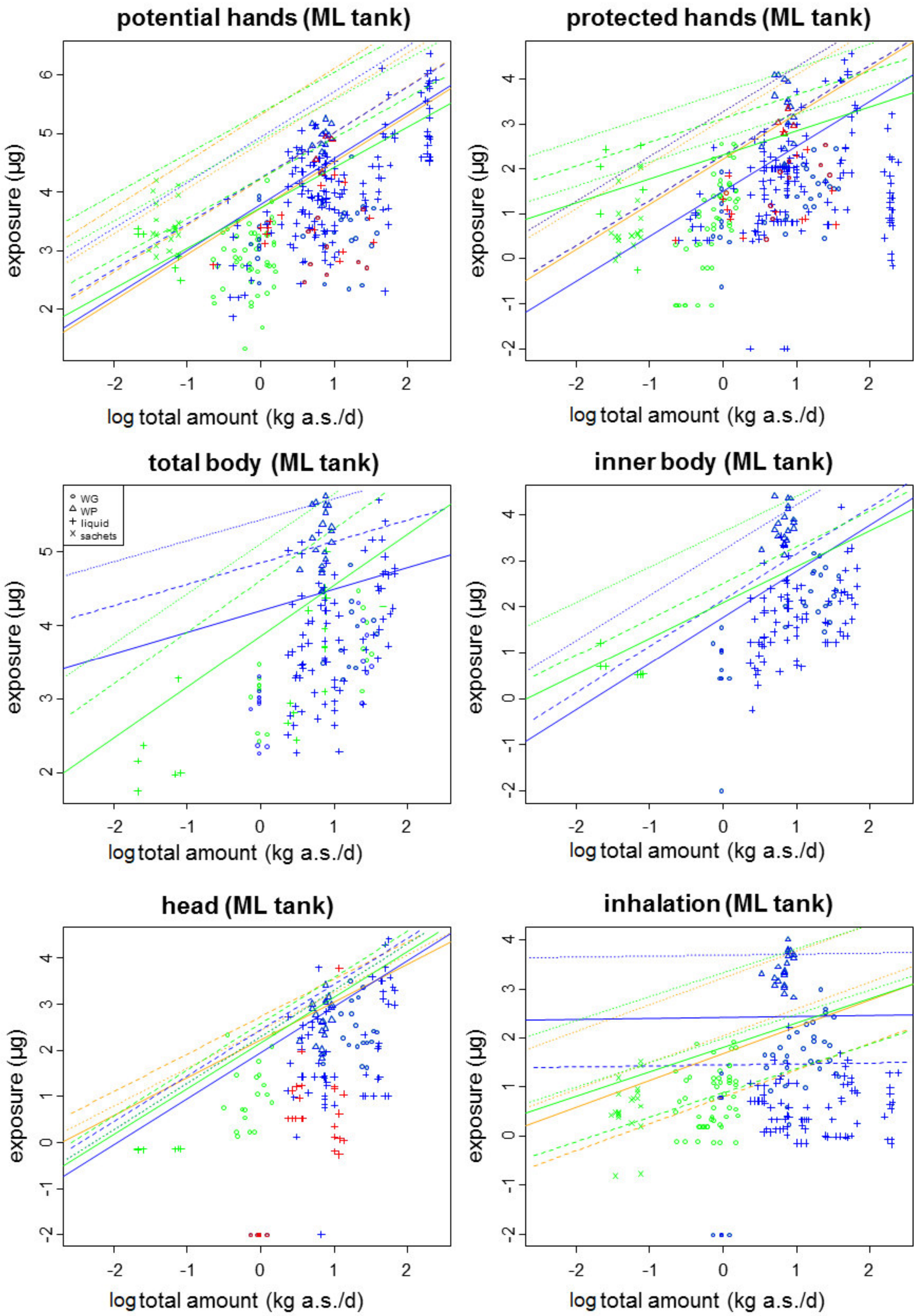

Figure 4: Comparison of the old tank mixing/loading model with outdoor data only (blue lines), the combined model with outdoor data and old greenhouse data (orange lines) and the new combined model with outdoor data and all available greenhouse data (green lines) – 95th percentile; dotted lines: WP formulation, broken/dotted lines: sachets (WP), broken lines: liquid formulations, solid lines: WG formulation; Δ: WP; x: sachets; o: WG; +: liquids, green: greenhouse data, blue/red: outdoor data

5.2 Mixing/loading – Knapsack sprayers

No data was available for exposure during mixing and loading in greenhouses using knapsack sprayers. Nevertheless, it was supposed that outdoor data can be applied to indoor uses as well.

The database remained the same but in comparison to the original outdoor mixing/loading knapsack model the threshold for the correction of recovery was increased from 70% to 95%. New percentiles were calculated from the revised data (Figures 5 and 6). The impact of the more conservative correction level on the results was low. The percentiles did not change significantly, except for inhalation which had a low effect on overall exposure.

In general, no exposure factors could be identified due to the number and distribution of data. Therefore, exposure was set at the 75^{th} and 95^{th} percentile for longer-term and acute exposure, respectively.

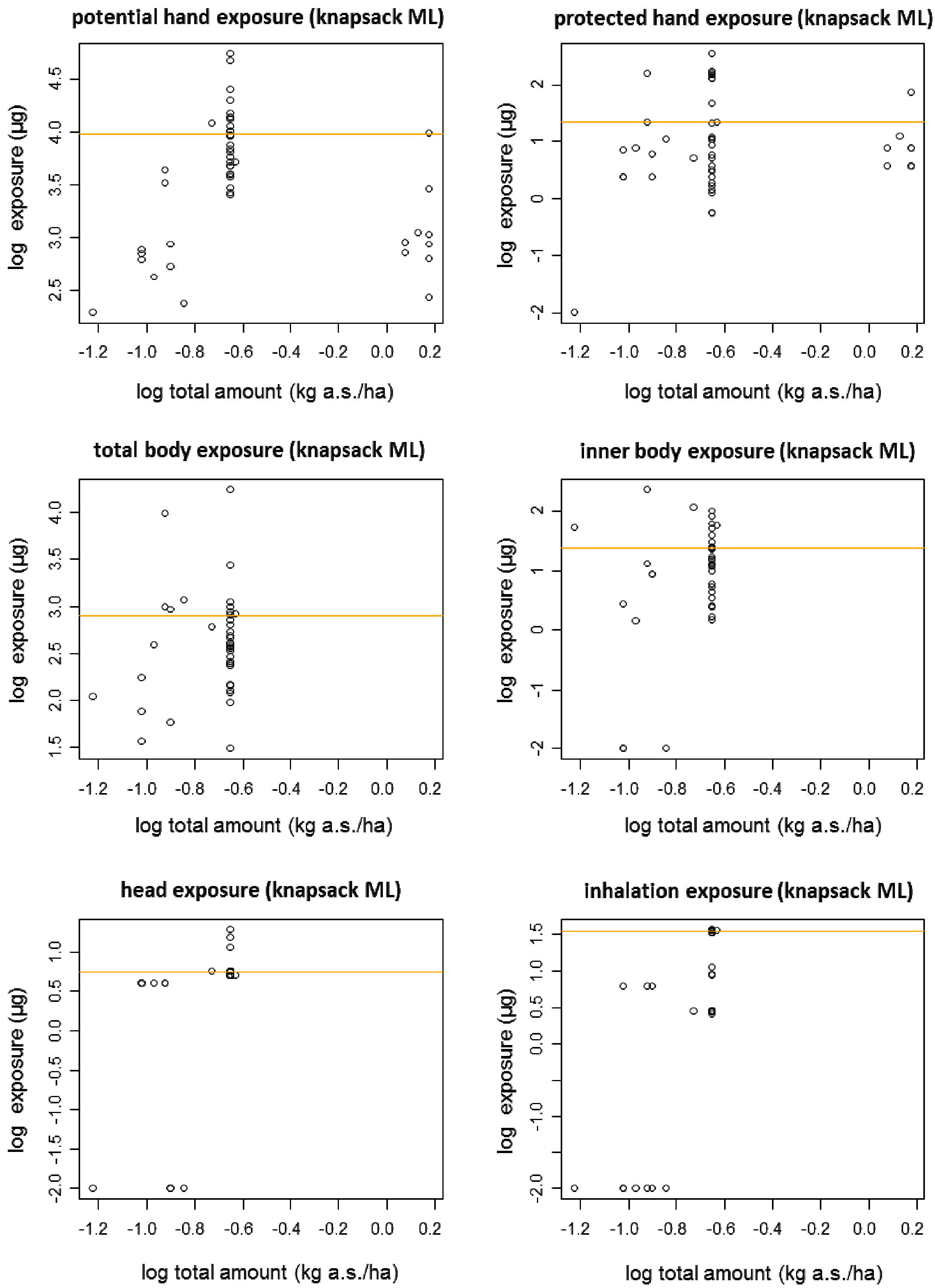

Figure 5: 75th percentile prediction with quantile regression for knapsack mixing/loading (orange line) together with the single data points

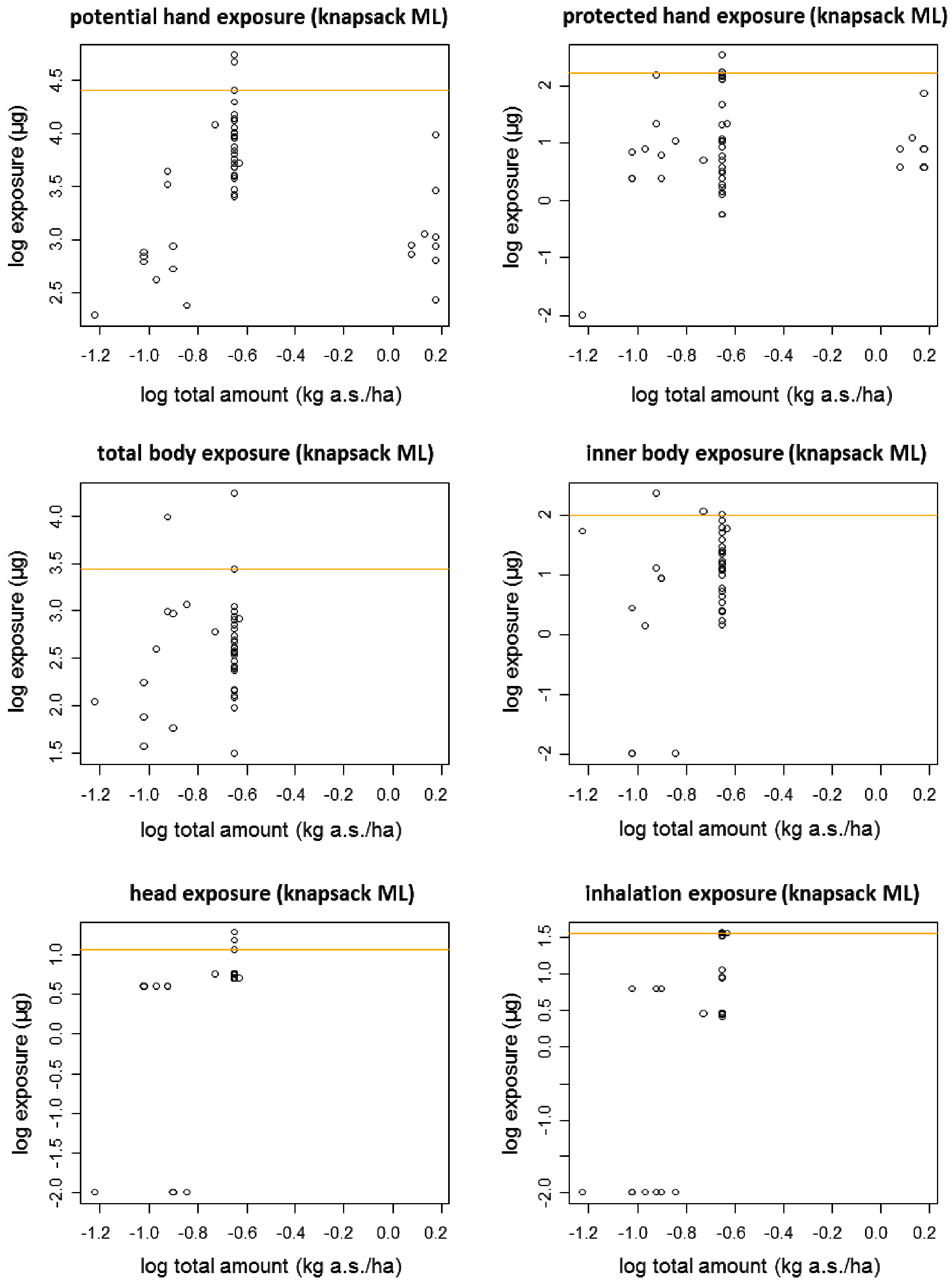

Figure 6: 95th percentile prediction with quantile regression for knapsack mixing/loading (orange line) together with the single data points

5.3 Application – HCHH greenhouse

A clear correlation between exposure and amount of active substance was observed for hand-held application in high crops (HCHH) in greenhouses. In contrast to the previous model, a correlation could be derived for protected hand exposure. Instead of percentiles, a statistical model was established for this factor.

Data for different application devices allowed considering additional spray equipment in the new model. Three sprayer types were used in the studies: spray lances, knapsack sprayers and pulled trolley sprayers. The distribution of the data showed that exposure for spray lances and knapsack sprayers were indistinguishable, which could be related to the low number of data records. However, trolley sprayers (pulled) resulted in lower hand and body exposure of the operator (Figures 4 and 5). Consequently, the impact of trolley sprayers was addressed in an additional exposure factor.

Another factor of exposure was related to foliar contact during application (dense scenario). Especially, body exposure was much higher under dense than under normal conditions. In case of a dense scenario, actual body exposure could be reduced to normal levels when rain suits instead of workwear were worn. This option already existed in the previous greenhouse AOEM model. Now, as an alternative to rain suits, certified protective coveralls can be chosen to reduce body exposure in dense crop conditions. However, protection was less effective than by rain suits with exposure levels above the normal scenario with workwear. Neither rain suits nor certified protective coverall were available for the normal scenario because data was not available for this combination.

Data for dense crop conditions were only available for lance and knapsack spray equipment yet not for trolley sprayers. Presumably, row width needs to be sufficiently large for treatment with trolley sprayers. Thus, dense conditions are not thought to occur in combination with trolley sprayers.

As already observed for mixing/loading, the increase in head exposure was different from the increase in inhalation exposure at higher application rates. Although spray drift should affect both exposure routes in the same way, inhalation exposure was more pronounced. This could be explained by the fact that some operators used face shields during application and that the face has a limited capability to collect spray droplets in comparison to inhalation.

Exposure levels from hand-held application in high crops indoors and outdoors were compared (Figure 7). Indoor exposure was higher than outdoor exposure. This outcome was expected since indoor crops are grown more narrowly with a higher potential for dermal contact to the treated crop. Moreover, the denser spray cloud is not expected to dilute as quickly in the air compared to outdoors. In consequence, outdoor and indoor application data should not be combined.

The models with the upper confidence level (95%) are presented in Appendix 3. No confidence intervals could be established for the 95th percentile models due to the small number of data records on which the models were based.

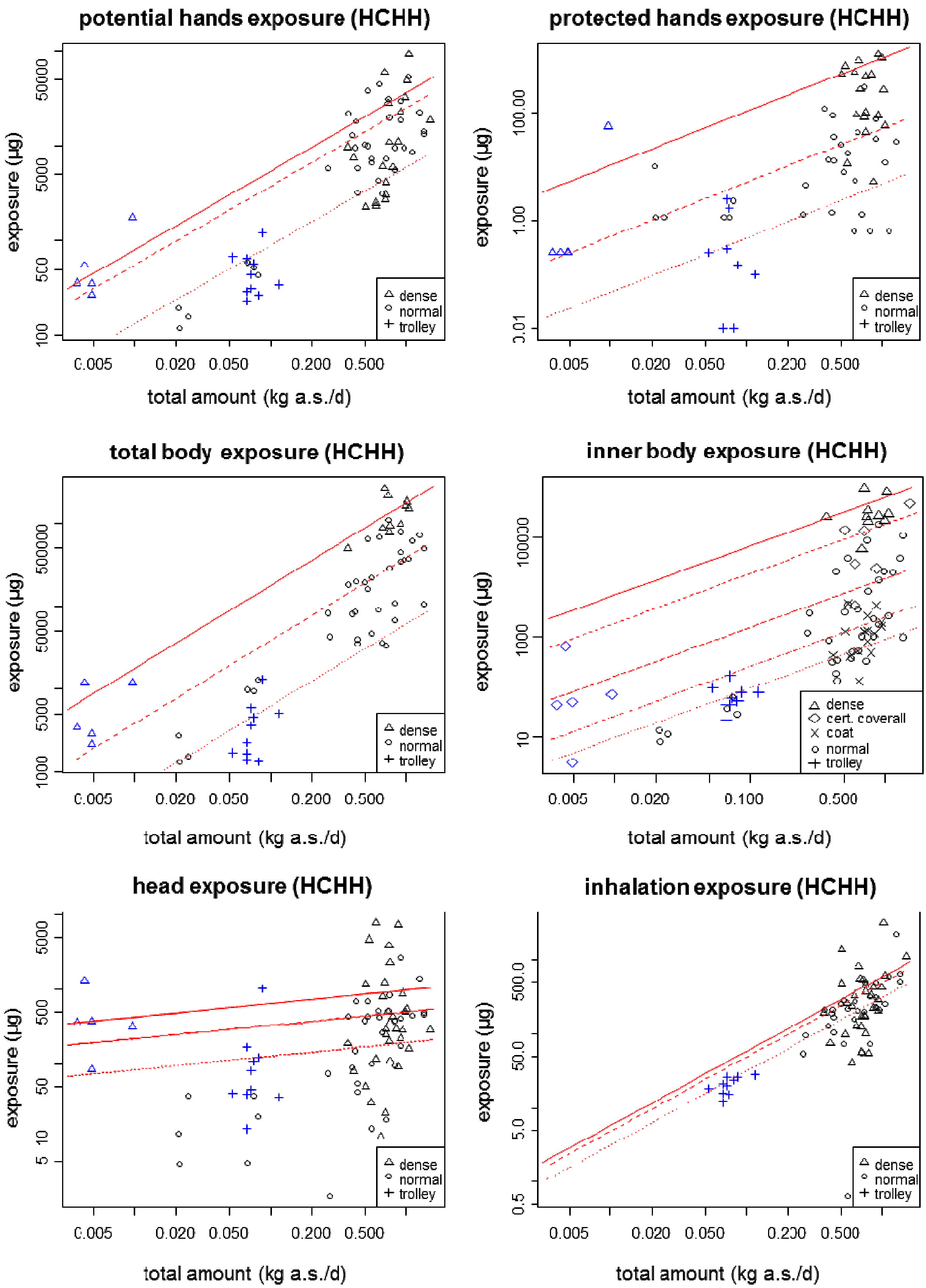

Figure 7: Predicted models for application in high crops in greenhouses – 75th percentile; solid line: dense scenario, broken line: normal scenario, dotted line: trolley sprayer, broken/dotted line: dense scenario with rain suits, small broken line: dense scenario with certified coverall; Δ : dense scenario; o : normal scenario; + : trolley sprayer; x : rain coat; ◊ certified coverall; blue: new data, black: old data

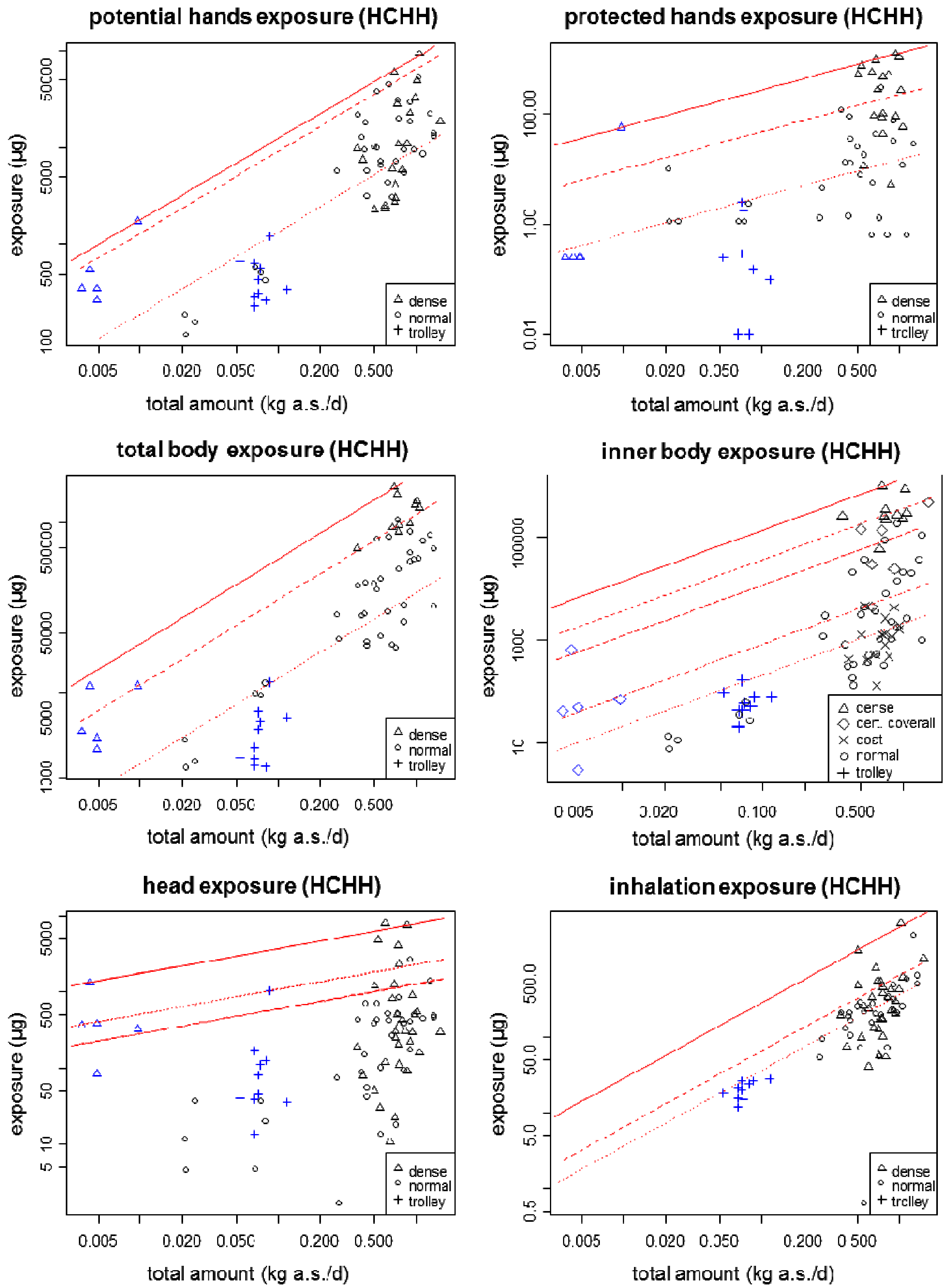

Figure 8: Predicted models for application in high crops in greenhouses – 95th percentile; solid line: dense scenario, broken line: normal scenario, dotted line: trolley sprayer, broken/dotted line: dense scenario with rain suits, small broken line: dense scenario with certified coverall; Δ : dense scenario; o : normal scenario; + : trolley sprayer; x : rain coat; ◊ certified coverall; blue: new data, black: old data

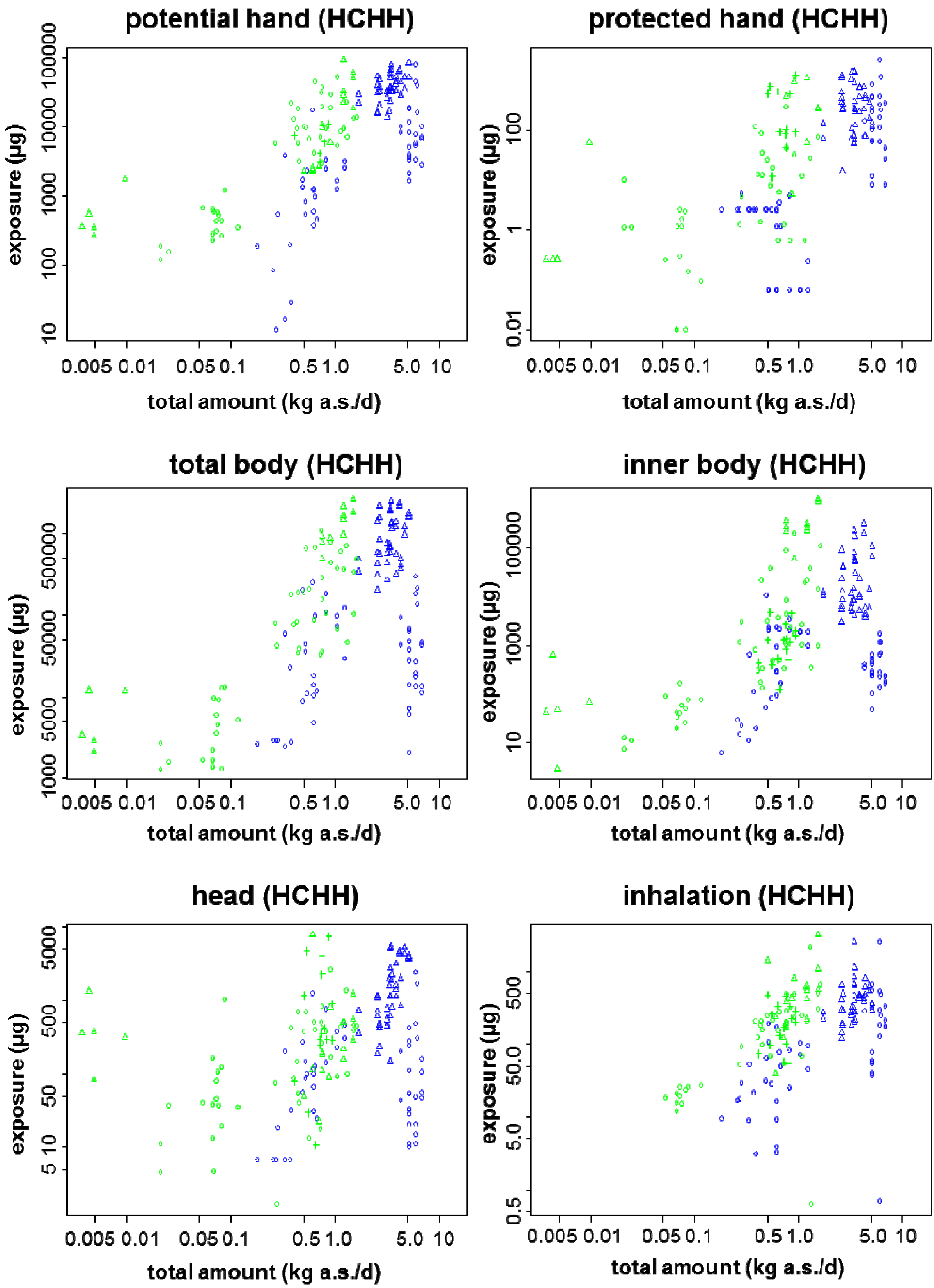

Figure 9: Comparison of outdoor data (blue) and greenhouse data (green) for hand-held application on high crops; o: normal, Δ: dense scenario, +: dense scenario with rain coats

The quality of the models was tested in the same way as described for the tank mixing/loading model. The predicted 95th percentile of exposure was always higher than the predicted 75th percentile of exposure in the observed range of active substance handled per day (see Figure A2 in Appendix 3).

5.4 Application – LCHH greenhouse

Only knapsack and lance spray equipment was relevant for low crop hand-held treatment (LCHH). The use of trolley sprayers was limited to applications in high crops.

The previous greenhouse model for applications in low crops consisted of percentiles of exposures instead of statistical models. No dependence of exposure on the total amount of active substance applied was observed. One reason for this outcome was the narrow range of active substance applied in the studies. From the three new greenhouse studies only three new data records for application in low crops were obtained.

Despite the additional information, no model could be fit. Exposure estimations remained based on the respective percentiles (Figures 8 and 9). All three newly introduced data records referred to operators who wore a certified protective coverall under normal crop conditions whereas previous data records featured operators wearing workwear. The penetration factors presented in Chapter 7 (Table 4) indicated that although the protective coverall was supposed to provide a better protection, penetration was higher compared to workwear. This result could be related to the small number of replicates (three replicates in comparison to ten replicates). Regardless, it justified that the inner body data for workwear and protective coverall in the case of application to low crops under normal conditions should be considered together in a combined scenario as exposure beneath workwear.

Comparison of the indoor and outdoor data for hand-held application in low crops revealed that even in combination both datasets indicated no correlation between exposure and the amount of active substance applied (Figure 12). Therefore, both datasets and scenarios remained separated.

Likewise, data for the normal and dense scenario were considered separately. However, no consistent difference in exposure was observed. In comparison to the normal scenario, exposure to the body, head and protected hand was higher in the dense scenario, whereas exposure to the unprotected hand and via inhalation was lower. A higher body exposure in the dense scenario was attributed to more frequent body contact with the treated crop. For hand exposure, no clear conclusion could be drawn from the data. Hence, data for normal and dense scenario were combined in case of hand (protected and potential), head and inhalation exposure (combined percentiles not shown in Figures 10 and 11).

No new data was available for exposure under dense conditions. From the previous greenhouse data it was concluded that the in case of dense crop conditions actual body exposure could be reduced to normal levels when rain trousers were worn. For normal crop conditions - as for high crops, rain trousers were not included as an option since no data existed for this combination.

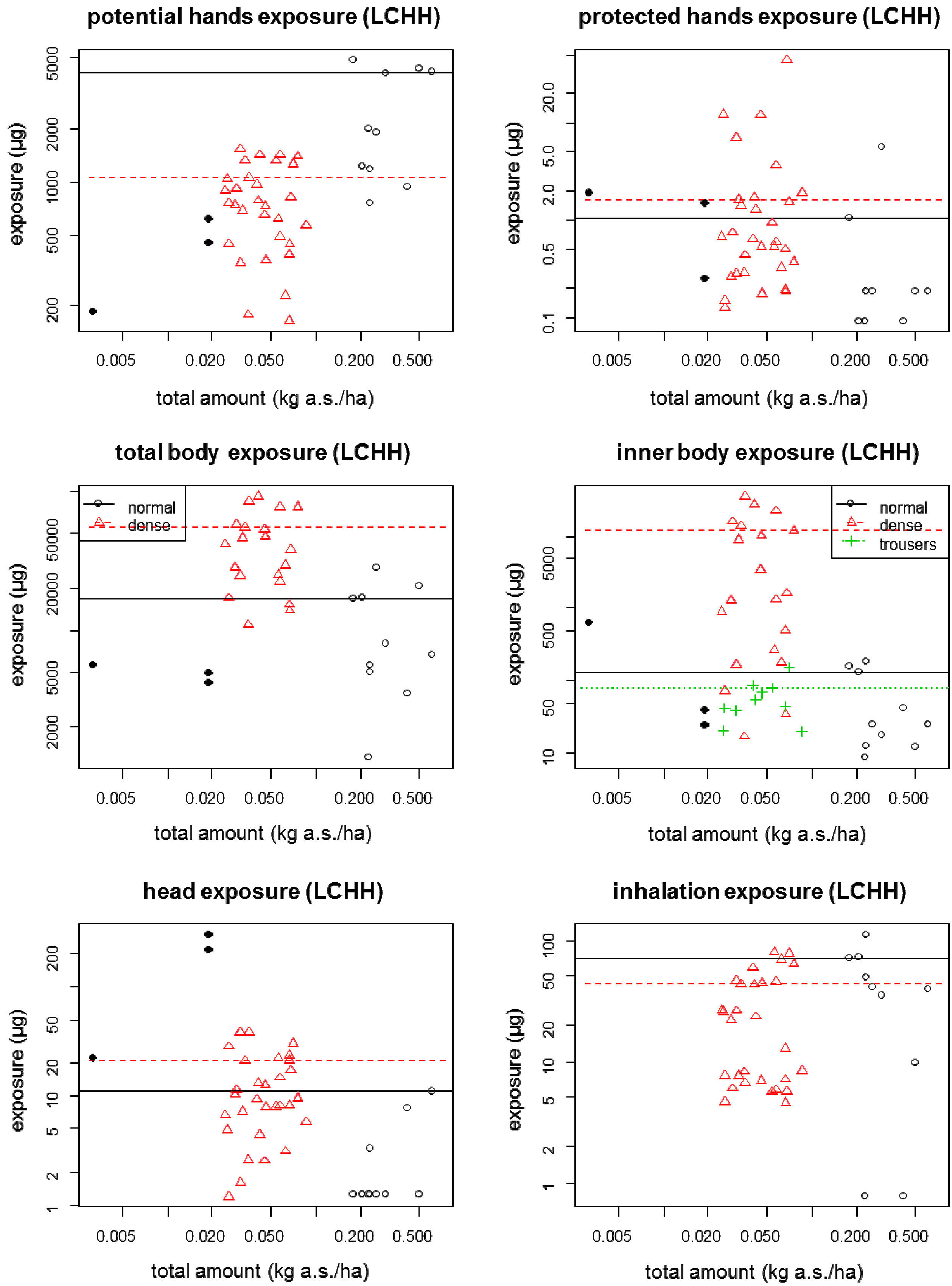

Figure 10: 75th percentile prediction with quantile regression for greenhouse application on low crops; solid line: normal scenario, broken line: dense scenario, dotted line: dense scenario with rain trousers; o: normal; Δ: dense, + : rain trousers, filled symbols: new data, empty symbols: old data

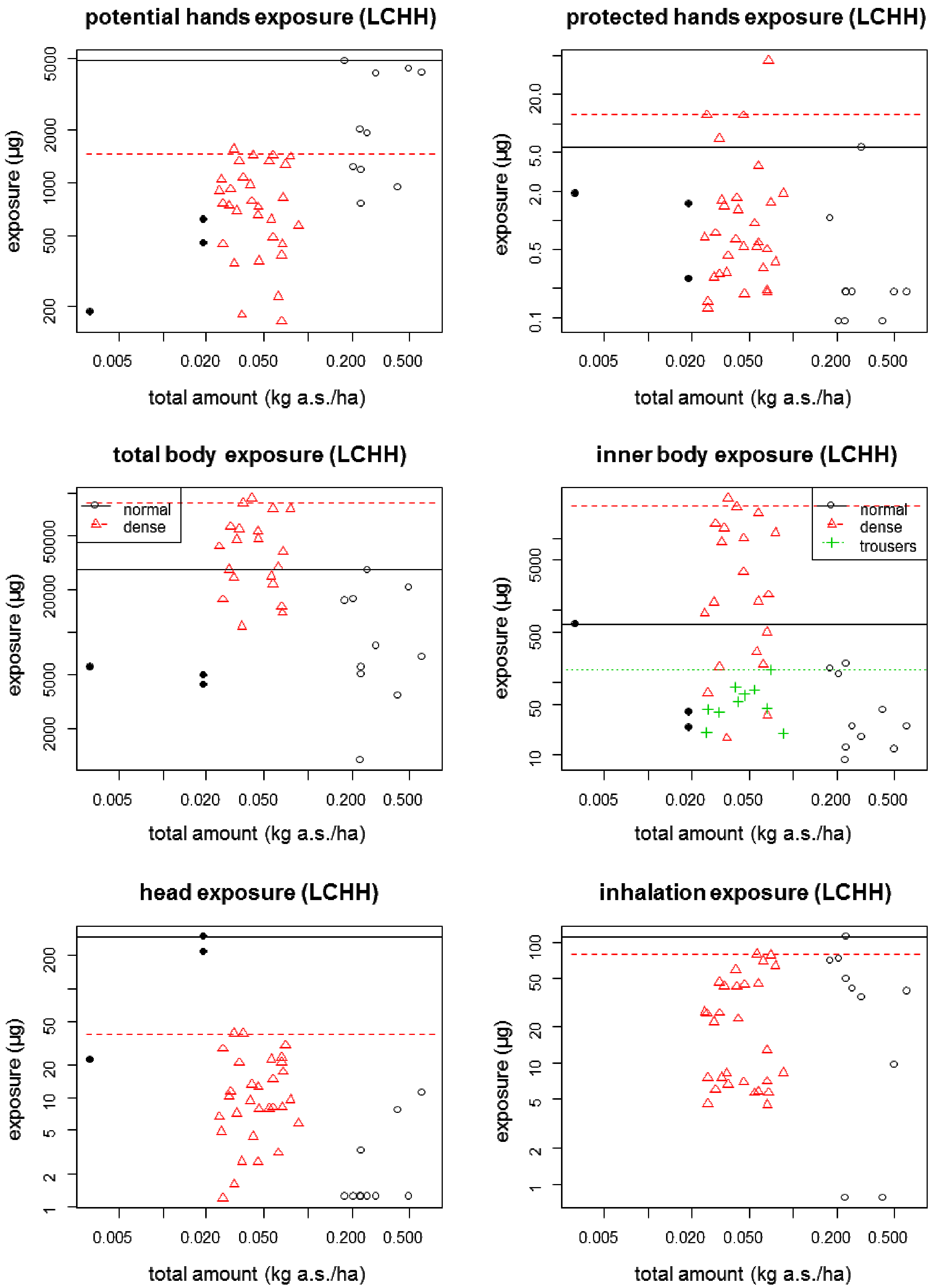

Figure 11: 95th percentile prediction with quantile regression for greenhouse application on low crops; solid line: normal scenario, broken line: dense scenario, dotted line: dense scenario with rain trousers; o: normal; Δ: dense, + : rain trousers, filled symbols: new data, empty symbols: old data

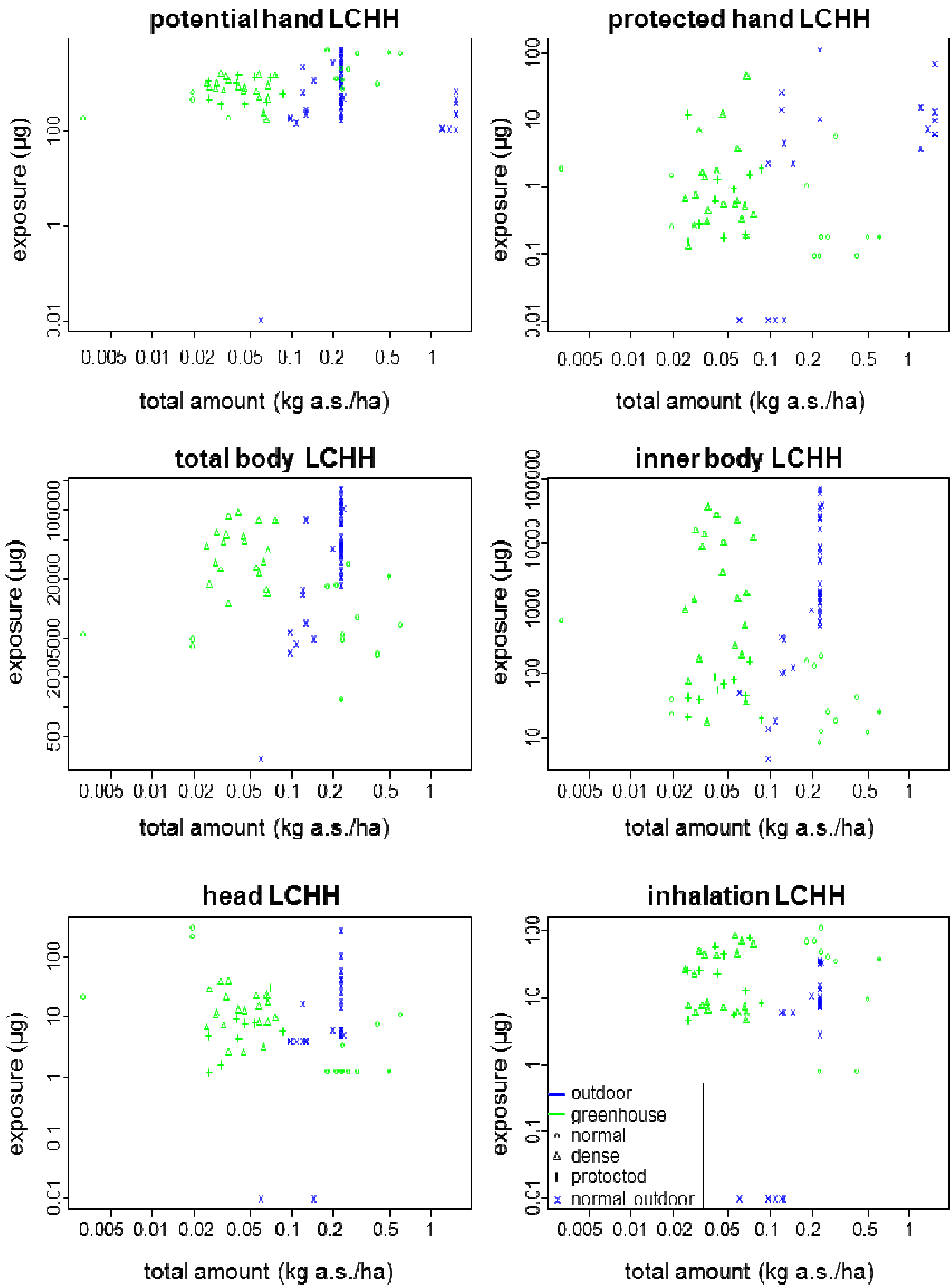

Figure 12: Comparison of indoor and outdoor data for hand-held application in low crops; green: greenhouse data, blue: outdoor data

6 Validation

The robustness of the statistical models for tank mixing/loading and GH HCHH was examined with cross validation. The approach of this method is to repeatedly remove a portion of the data from the database and to compare the models obtained with the reduced databases (see AOEM project report for more details). Similarity of models for the reduced databases to the whole model indicates robustness. This approach was already applied to validate the AOEM and the previous version of the Greenhouse AOEM.

The results are presented in Appendix 3. The diagrams each show ten random data subsets together with the respective model (in the same colour). The tank mixing/loading model as well as the GH HCHH model proved to be robust to the exclusion of data as the different models for the different subsets were highly similar.

7 Uncertainty Analysis

Models are generally subject to limitations in their applicability domain as well as uncertainty arising from gaps in data and knowledge on relevant parameters. Therefore, this section identifies and discusses model uncertainty based on the EFSA Guidance on Uncertainty Analysis in Scientific Assessments (EFSA Journal 2018;16(1):5123).

The model was developed to provide a conservative yet realistic exposure estimation of plant protection product application by operators. It shall apply to hand-held and semi-automated spray application in greenhouses in the European Union.

Automated application and non-spraying scenarios, such as dusting, fogging, drip irrigation and watering, were not taken into account. Likewise, combined exposure, for example after the sequential application of products, was outside the scope of this model.

All relevant exposure pathways, i.e. dermal and inhalation, were considered. Appropriate model parameters were statistically derived by log linear regression. Subsequently, exposure was modelled using the more robust quantile regression approach. Having been conducted according to Good Agricultural Practice, the included studies comply with highest quality standards. Sampling and chemical analysis was in agreement with Good Laboratory Practice.

Table 2 summarises relevant sources of uncertainty and makes assumptions about their potential for conservative (protective) and underprotective exposure predictions. Their overall impact on exposure assessment is characterised. Recommendations for impact reduction are provided, where applicable.

Table 2: Sources and impact of potentially protective and underprotective influences on exposure assessment

Source of uncertainty	Potential to be protective	Potential to be underprotective	Impact on exposure assessment
Database			
Cultivation systems (high and low crops) are not well characterised[1]	Crops between 0.6 and 1.1 m height are considered as high crops	Crops between 0.6 and 1.1 m height are considered as low crops	*High* Crops above 0.6 m height should be considered as high crops, leading to sufficiently conservative exposure estimation
Normal and dense scenarios are not well characterised	Dense scenario is calculated as worst-case	Normal scenario is falsely applied to dense scenarios	*High* Unless dense scenario can be excluded (e.g. trolley sprayer application), it should be used as a worst-case

[1] Low crops in the greenhouse database had a height of up to 0.6 m. The height of the high crops ranged from 1.1 to 2.4 m.

Continuation Table 3: Sources and impact of potentially protective and underprotective influences on exposure assessment

Source of uncertainty	Potential to be protective	Potential to be underprotective	Impact on exposure assessment
Application techniques in this model are limited to spray lance/gun as well as knapsack and trolley sprayers	Hand-held data provides a worst-case exposure estimation for operators in greenhouses	Other greenhouse application techniques result in higher operator exposure	*High* Other application techniques than those included in the evaluated studies could have a relevant impact on exposure assessment. However, such techniques would either be considered outside the applicability domain of the model or covered by comparably conservative hand-held application techniques.
Variability of products and active substances applied	The tested formulations (application) adequately predict exposure for all formulation types and active substances	The tested formulations (application) are insufficient to adequately predict exposure for all formulation types and active substances	*Moderate* Variability between formulation types and different active substances is unknown due to the limited database. However, the impact of formulation type during application is low. Moreover, volatile active substances should be considered outside the applicability domain of the model.
Use of rain suit/trousers as protective equipment	Rain suits/trousers are similarly or more protective than protective coveralls	Rain suits/trousers result in higher exposure than protective coveralls	*Low* Although rain suits/trousers are not validated as protective equipment for plant protection products, data indicates a higher protection factor than protective coveralls and workwear. However, the available data is limited. Therefore, some uncertainty remains regarding the generalisation of protection by rain clothing.
Studies conducted in Southern Europe (F, GR, ES, IT)	Application practices in Europe are similar or, alternatively, application in Southern Europe is worst-case	Application practices in Central and Northern Europe differ/lead to higher operator exposure	*Low* Differences in area treated, application duration, rate and practices as well as climatic conditions are unknown/ uncharacterised. Since they may be considered worst-case, e.g. application area of 1 ha per operator and day, uncertainty is deemed low.

Continuation Table 4: Sources and impact of potentially protective and underprotective influences on exposure assessment

Source of uncertainty	Potential to be protective	Potential to be underprotective	Impact on exposure assessment
Variability of greenhouses	Wood and steel constructions covered with plastic foil or glass provide a conservative scenario for other types of greenhouses	Application in other types of greenhouses leads to higher exposure	*Low* Uncertainty by the type of greenhouse is considered low in comparison to other relevant factors, such as application technique or cultivation system
Variability of crop types	The studied crop types adequately predict exposure for all relevant crops in greenhouses	The studied crop types are insufficient to adequately predict exposure for all relevant crops in greenhouses	*Low* Crop type has a lower impact on exposure assessment than the cultivation system used for the crop, i.e. high or low crop
Model			
Model robustness	The database is sufficient to produce a robust model	The database does not provide a sufficiently robust model	*Moderate* Model robustness has been supported by cross validation. Especially for application in low crops, it is affected by the limited database with regard to application rates and resulting extrapolation beyond the rates used in the studies.
Combination of indoor and outdoor data for mixing/loading	Exposure during mixing/loading is comparable with regard to indoor and outdoor application scenarios	Mixing/loading for indoor application leads to higher operator exposure	*Low* The use of similar equipment for indoor and outdoor application leads to comparable mixing/loading scenarios. This was confirmed by statistical analysis.
Extrapolation of head exposure data (in case only face/neck wipe or hood/cap data)	Correction factor of 2 sufficient to account for missing exposure data	Correction factor of 2 not sufficient to account for missing exposure data	*Low* Head exposure is generally low and the overall impact on total exposure is marginal
Operator variability	Body weight normalisation to 60 kg is conservative for lower body weights	Dermal exposure of operators with high body surface areas, e.g. tall persons, is underestimated	*Low* In general, operators weighed more than 60 kg. The normalisation to lower body weights while using dermal exposure data as measured is reasonably conservative.
Correction of data with insufficient recovery	The correction of low recovery data (<95%) is sufficiently conservative	N/A	*Low* Data correction is sufficiently conservative

Continuation Table 5: Sources and impact of potentially protective and underprotective influences on exposure assessment

Source of uncertainty	Potential to be protective	Potential to be underprotective	Impact on exposure assessment
Choice of regression model	Quantile regression is adequate to describe exposure	Quantile regression underestimates exposure	*Low* Quantile regression is robust since it is non-parametric and thus independent of non-detects and heterogeneous standard deviation. The quantiles used are the current general agreement for longer-term (75th percentile) and acute (95th percentile) exposure.
Combination of 75th percentiles (long-term) and 95th percentile (acute) for different body parts modelled	The selected percentiles are sufficiently protective to estimate total exposure	The selected percentiles underestimate total exposure in a relevant number of cases	*Low* The addition of the selected percentiles is considered conservative and thus sufficiently protective

Overall, most sources of uncertainty have a low impact on exposure assessment by the presented greenhouse model. Relevant sources with a moderate to high impact include the cultivation and application system as well as database limitations, e.g. with regard to the range of application rates in the low crop model. Hence, further data on low crop application could reduce uncertainty. Additional studies on modern application techniques, e.g. automated application, could broaden the scope of the model. In the meantime, hand-held application may be regarded to cause highest potential exposure, thus providing a worst-case for automated and semi-automated application techniques.

8 Exposure models

8.1 Use and applicability

Updated exposure models have been developed for greenhouse applications in low crops and high crops as well as for tank mixing/loading and knapsack mixing/loading. The updated exposure models are presented in Tables 3 and 4. The models are suitable to estimate exposure from spray applications. Dust applications, fogging, drip irrigation and watering were not addressed as these types of application were out of the scope of this project.

The new Greenhouse AOEM covers spray applications with lance sprayers/spray guns, knapsack sprayers and trolley sprayers whereas in the previous version only lance and spray gun equipment had been included. No discrimination was made between exposure using lance sprayers and knapsack sprayers due to the small number of data records for knapsack sprayers. Trolley sprayers were considered as a specific scenario for refinement since this equipment combined with the specific application procedure resulted in lower exposure. Attention should be payed to the fact that the trolley sprayers were pulled along the rows and switched off at the end of each row to turn around which minimised exposure. If this application type is chosen for exposure calculation, information should be provided to the operator how to use the trolley sprayers, accordingly.

The normal scenario for crop cultivation should be selected as basic scenario. In case frequent contact of the operator with the treated crop during application cannot be ruled out (e.g. due to an early application when plants have not yet developed full foliage) the dense scenario should be calculated, as a worst-case. However, the dense scenario is not relevant for trolley sprayers as this type of equipment requires a certain distance between the rows.

Potential exposure can be reduced by choosing protected hand exposure which corresponds to the use of protective gloves and protected body exposure which corresponds to wearing workwear. In case of a dense crop scenario a rain coat/rain trousers or a certified protective coverall can be chosen instead of workwear. Additionally, face shields are available for head exposure during tank mixing/loading.

Use of either the high crop model or low crop model should be based on the target height rather than the crop height itself since they might substantially differ (e.g. ornamentals in pots placed on tables or strawberries in hydroculture). Low crops in the greenhouse database had a height of up to 0.6 m. The height of the high crops ranged from 1.1 to 2.4 m.

Table 6: Exposure models predicting the 75th percentile; in case no model could be derived the 75th percentile was calculated (normal scenario/dense scenario/dense scenario with rain trousers); exposure is given in µg/person, * with or without face mask

Tank ML		log exp = α log TA + [formulation type] + constant
	total hands	log $D_{ML(H)}$ = 0.64 log TA + 0.64 [liquid] + 1.28 [WP] + 1.17 [WP_S] - 0.47 [glove wash] + 3.27
	prot. hands	log $D_{ML(Hp)}$ = 0.46 log TA + 0.32 [liquid] + 1.66 [WP] + 0.20 [WP_S] + 1.46
	total body	log $D_{ML(B)}$ = 0.74 log TA + 0.52 [liquid] + 1.85 [WP] + 3.04
	inner body	log $D_{ML(Bp)}$ = 0.62 log TA + 0.12 [liquid] + 1.84 [WP] + 1.58
	head	log $D_{ML(C)}$ = log TA + 0.34 [liquid] + 0.70 [WP] - 1.67 [face shield] + 1.46
	inhalation	log I_{ML} = 0.38 log TA - 0.87 [liquid] + 1.96 [WP] - 0.03 [WP_S] + 1.38
Knapsack ML		75^{th} percentile (above 1.5 kg linear extrapolation)
	total hands	9497
	prot. hands	21
	total body	803
	inner body	25
	head	5.5
	inhalation	35
GH HCHH		log exp = α log TA + [dense] + constant
	total hands	log $D_{A(H)}$ = 0.83 log TA + 0.17 [dense] – 0.62 [trolley] + 4.40
	prot. hands	log $D_{A(Hp)}$ = log TA + 1.32 [dense] – 1.04 [trolley] + 1.71
	total body	log $D_{A(B)}$ = log TA + 0.67 [dense] - 0.81 [trolley] + 5.59
	inner body[2]	log $D_{A(Bp)}$ = log TA + 1.64 [dense] – 2.42 [dense with rain suit] – 0.54 [dense with protective coverall] - 1.23 [trolley] + 4.19
	head*	log $D_{A(C)}$ = 0.18 log TA + 0.29 [dense] – 0.41 [trolley] + 2.70
	inhalation	log I_A = log TA + 0.08 [dense] – 0.19 [trolley] + 2.69
GH LCHH		75^{th} percentile (above 0.60 kg a.s./ 0.075 kg a.s. / 0.086 kg a.s. linear extrapolation)
	total hands	1323
	prot. hands	1.5
	total body	16797 (normal) / 55521 (dense)
	inner body	132 (normal) / 12180 (dense) / 80 (dense with rain trousers)
	head*	21
	inhalation	47

[2] Rain suit and protective coverall are only applicable to exposure in dense foliage. In that case, either ‘dense with rain suit’ or ‘dense with protective coverall’ may be selected.

Table 7: Exposure models predicting the 95th percentile; in case no model could be derived the 95th percentile was calculated (normal scenario/dense scenario/with rain trousers); exposure is given in µg/person, * with or without face mask

Tank ML		log exp = α log TA + [formulation type] + constant
	total hands	log $D_{ML(H)}$ = 0.69 log TA + 0.71 [liquid] + 1.21 [WP] + 1.30 [WP_S] – 0.72 [glove wash] + 3.74
	prot. hands	log $D_{ML(Hp)}$ = 0.53 log TA + 0.83 [liquid] + 1.39 [WP] + 0.38 [WP_S] + 2.29
	total body	log $D_{ML(B)}$ = 0.69 log TA + 0.72 [liquid] + 1.29 [WP] + 3.87
	inner body	log $D_{ML(Bp)}$ = 0.78 log TA + 0.44 [liquid] + 1.58 [WP] + 2.09
	head	log $D_{ML(C)}$ = log TA + 0.39 [liquid] + 0.11 [WP] – 1.16 [face shield] + 2.19
	inhalation	log I_{ML} = 0.49 log TA – 0.92 [liquid] + 1.54 [WP] + 0.19 [WP_S] + 1.81
Knapsack ML		95th percentile (above 1.5 kg linear extrapolation)
	total hands	25490
	prot. hands	164
	total body	2787
	inner body	103
	head	11
	inhalation	36
GH HCHH		log exp = α log TA + [dense] + constant
	total hands	log $D_{A(H)}$ = 0.84 log TA + 0.14 [dense] – 0.82 [trolley] + 4.81
	prot. hands	log $D_{A(Hp)}$ = 0.67 log TA + 0.76 [dense] – 1.19 [trolley] + 2.36
	total body	log $D_{A(B)}$ = log TA + 0.48 [dense] – 0.92 [trolley] + 6.10
	inner body[3]	log $D_{A(Bp)}$ = log TA + 1.07 [dense] – 2.20[dense with rain suit] – 0.64 [dense with protective coverall] – 1.71 [trolley] + 5.07
	head*	log $D_{A(C)}$ = 0.33 log TA + 0.79 [dense] + 0.25 [trolley] + 3.10
	inhalation	log I_A = log TA + 0.63 [dense] – 0.26 [trolley] + 2.82
GH LCHH		95th percentile (above 0.60 kg a.s./ 0.075 kg a.s. / 0.086 kg a.s. linear extrapolation)
	total hands	4159
	prot. hands	12
	total body	28082 (normal) / 85382 (dense)
	inner body	640 (normal) / 27958 (dense) / 154 (dense with rain trousers)
	head*	39
	inhalation	80

[3] Rain suit and protective coverall are only applicable to exposure in dense foliage. In that case, either 'dense with rain suit' or 'dense with protective coverall' may be selected.

The revised tank mixing/loading and knapsack mixing/loading models apply to both indoor and outdoor tanks. They will also replace the mixing/loading models of the outdoor AOEM. Trolley sprayers are either available with small tanks or connected to static tanks via a hose, but both can be considered as large tanks in comparison to knapsack tanks with 10 to 20 L capacity. The factors ‘glove wash‘ and ‘water soluble granules packed in small sachets‘ are not suggested to be used for regulatory purposes.

According to the study data, the treatment of 1 ha is a realistic assumption for a typical day’s work. The actual time of application was in the range of only 8 to 206 min with an average of only 92 min. The actual area that was treated in that time varied between 0.04 ha to 1.1 ha.
The greenhouse model has a limited applicability range. In the ultra-low range of total amount applied (i.e. < 0.003 kg a.s./d, as might be the case when calculating exposure to impurities or metabolites) the model has a low accuracy. Especially when choosing the hand-held scenario in low crops or knapsack mixing/loading the model is likely to overestimate exposure.

8.2 Protection factors

The operators wore at least one layer of work clothes which consisted of polyester/cotton or cotton coverall. In some cases rain suits/rain trousers or certified coveralls (Category III Type 6 or Type 4) were used. Most of the operators also used protective gloves during their entire working time. The protection provided by this clothing or personal protective equipment (PPE) was accounted for by establishing separate models for protected hand and inner body exposure.

The data showed that the use of workwear, certified protective coverall or rain clothing resulted in different exposure levels which corresponded to different respective protection levels. Rain clothing possessed the highest resistance to liquids followed by certified protective clothing. Workwear consisting of a polyester/cotton fabric was more permeable for liquids.

Table 5 provides penetration factors for gloves, workwear and certified coverall to give an indication of PPE efficiency in the studies. The values represent mean values or 75th percentiles of the ratios of protected and potential body or hand exposure, respectively. No factor could be calculated for Category III Type 6 coveralls because exposure on the coveralls was not determined.

The factors vary depending on crop conditions and are highest for the dense scenario in high crops. The penetration of Category III Type 4 coveralls in low crops is unexpectedly high. This could result from the low number of replicates of which one had a high contamination of the inner body dosimeter in the torso region resulting in a penetration factor of 11.5%. For the other two replicates a penetration of less than 1% was observed (0.93% and 0.49%). Notably, only knapsack sprayers were used in low crop dense application scenarios, while all operators in low crop normal scenarios used hand-held sprayers connected to a static tank.

8.3 Future perspectives

The new greenhouse model is based on the most recent data suitable for the purpose of exposure modelling. Nevertheless, more data is needed to identify further impact factors and to constantly improve the model. Especially, representative data for greenhouse application to low crops is missing. In addition, data for other scenarios, such as fogging or watering is required to enhance the applicability of the model. It is intended to provide further updates of the model whenever new data becomes available.

Table 8: Penetration factors in % derived from PPE and clothing worn by the operators during application in the greenhouse (n: number of replicates).

	Protective gloves			Work clothes			Category III Type 4 coverall		
	n	mean	75th perc.	n	mean	75th perc.	n	mean	75th perc.
	all crops								
all	113	0.68	0.45	96	7.3	6.5	8	2.8	2.6
	high crops								
normal	52	0.62	0.74	46	3.2	3.7		-	-
dense	11	2.8	3.3	10	27.6	41.5	5	1.8	1.7
	low crops								
normal	20	0.09	0.03	10	0.84	0.91	3	4.3	6.2
dense	30	0.41	0.23	30	9.1	14.0		-	-

9 Conclusion

The Greenhouse AOEM had been developed for use in the risk assessment of active substances in plant protection products. It underwent a first update after new experimental field data became available. On the basis of the expanded greenhouse database, new models were established. Some gaps that were identified during the first model development could be addressed with the updated version. Now, the Greenhouse AOEM includes a broader range of application techniques, such as knapsack sprayers and trolley sprayers and contains data for a lower application range. Moreover, a certified protective coverall has become available as an alternative to workwear and rain coats during application in dense high crops. In addition, the combined indoor and outdoor models for mixing/loading were revised. The tank model was improved for lower amounts of active substance handled per day whereas the knapsack model did not change significantly since no new data was available for this scenario.

10 List of figures

11 List of tables

12 Appendix 1 Additional exposure studies

GH 1
Active substance: Spinosad (480 g/L)
Formulation type: Suspension concentrate
Pesticide function: Insecticide
Crop: Strawberries, pepper, eggplant, tomatoes, green beans

Setting:
The dermal exposure of 8 male and 2 female operators was monitored during application with backpack or trolley sprayers to obtain exposure data as well as protection factors for the protective equipment provided. The field part of the study was conducted in greenhouses in the south of France between June and July 2016. The product was applied on various crops, either low (pepper, eggplant, green beans, strawberries; 25 to 50 cm) or high (hanged strawberries, tomatoes; 80 to 180 cm). Each operator sprayed over one or several types of crops under one or several greenhouses. Repeated contact with the treated crop foliage and with the spray mist were observed. The greenhouses consisted of either high technology multi-span plastic structures or plastic film over a metallic structure. The application rate was in the range of 0.02 to 0.11 kg a.s./ha. During a spraying duration of 8 to 38 min an area of 0.04 to 0.23 ha was treated. Two operators used wheelbarrow (trolley) sprayers with a tank capacity of 100 to 120 L and with a vertical boom on each side (flat fan nozzles) or with cone nozzles around a circle. All other operators used knapsack motorised mist-blower/hydraulic power sprayers with a tank capacity of 10 to 20 L. Cleaning as part of the application task was included in the monitoring of four operators who rinsed the sprayer directly after application. Exposure during mixing and loading as well as inhalation exposure was not monitored as this was out of the scope of the study.

The results of the study were published in 2018[4].

Exposure assessment:
Body exposure was determined with two layers of clothing. The outer layer consisted of a Category III Type 4 coverall (Tyvek Classic Plus). Beneath the coverall the operators wore full-length cotton undergarment. Both layers were collected after work. The exposure of the hands was monitored by taking hand washes and collecting the protective nitrile gloves (EN 374-3) that were worn throughout spraying. Residues on the coverall hood or bandana were analysed to determine head exposure. All samples were stored frozen until analysis. Field recoveries were performed for all matrices at each sampling day.
Spinosad residues were extracted from the samples, dissolved in acetonitrile/ultra-pure water (30/70, v/v) and quantified by LC-MS/MS.

Results:
The exposure of the single operators is presented in the table below. Correction for field recovery was made in case recovery was < 95%. All results for hand wash (recovery: 31-43%) and gloves (recovery: 55-84%) needed to be corrected. The results for the coverall (recovery: 92-102%) were corrected when below 223.6 µg/specimen and the results for the undergarment (recovery: 88-123%) were corrected when higher than 11.2 µg/specimen. Values below the LOQ were considered as ½ of the LOQ. Values below the LOD were considered as LOD.

[4] Mercier, T., Großkopf, C. and Martin, S.: Potential operator dermal exposure during foliar indoor application: a comparison between knapsack, trolley sprayer and lance equipment; Journal of Consumer Protection and Food Safety, 2018;https://doi.org/10.1007/s00003-018-1194-5

Application

Operator	TA a.s. [kg]	Exposure time [min]	Inhalation	Hands [µg]	Gloves [µg]	$Body_{inner}$ [µg]	$Body_{outer}$ [µg]	Cap/ Hood [µg]
1 ^{LC} (K)	0.0032	13		1.90	183	640	4914	11.2
2 ^{LC} (T)	0.0047	8		0.15*	173	1.2	932	3.6
3 ^{HC} (T)	0.0254	18		43.0	530	309	11661	2083
4 ^{HC} (K)	0.0096	20		57.5	1705	71	11771	160
5 ^{HC} (K)	0.0043	35		0.25**	555	657	11290	883
6 ^{HC} (K)	0.0037	37		0.25**	359	43.6	3402	240
7 ^{HC} (K)	0.0048	28		0.25**	355	3.0	2158	251
8 $^{LC/HC}$ (K)	0.0048	38		0.25**	268	48.6	2874	55.6
9 ^{LC} (K)	0.0192	26		0.25**	455	39.3	4164	143
10 ^{LC} (K)	0.0192	25		1.5	610	23.8	4873	200

* LOD ** ½ LOQ K: knapsack sprayer T: trolley sprayer HC: high crop LC: low crop

GH 2

Active substance: Methoxyfenozide (240 g/L)
Formulation type: Soluble concentrate
Pesticide function: Insecticide
Crop: Peppers

Setting:
The study was conducted in 2012 with 10 test subjects in greenhouses in Almeria, Spain. Dermal and inhalation exposure was determined for applying methoxyfenozide to indoor peppers using trolley sprayers. The trolleys were pulled along the rows and switched off at the end before the trolleys were moved to the next row and turned on again. The product was applied to an area of 0.64 to 0.98 ha using 53 to 115 g of active substance diluted in 650 to 1280 L water per hectare. Cleaning was monitored when it was routinely done at the end of the day. This was the case for operator 2 and 10. Mixing and loading was not monitored.
Exposure assessment:

The operators wore standardised clothing consisting of coveralls with hood, long undergarments and nitrile gloves. Coverall, undergarment and gloves were collected at the end of the work. In addition, hand washes were taken every 20 to 25 min throughout application. Face/neck wipes were taken at the end of the application or during application if required by the operator. Personal air samplers were attachted to each operator during application to determine inhalation exposure. The air filter as well as all other samples were wrapped and stored in a freezer until analysis. Residues in/on the samples were determined by UPLC-MS/MS. Extraction from the samples was performed with methanol.

Results:
The field recovery for the sample matrices ranged from 85 to 107%. No correction of the results was necessary since the recovery at residue level was > 95% for all matrices. The results are presented below. Inhalation exposure was adjusted to a breathing rate of 1.25 m^3/h.

Application

Operator	TA a.s. [kg]	Exposure time [min]	Inhalation	Hands [µg]	Gloves [µg]	Body$_{inner}$ [µg]	Body$_{outer}$ [µg]	Face/neck wipe + cap [µg]
1	0.067	150	1.14	0*	647.2	20.2	1366	168.2
2	0.072	183	2.62	0.30	436.5	163.9	5745	45.6
3	0.053	200	1.76	0.25	667.2	94.6	1608	40.5
4	0.072	133	1.91	2.54	315.1	42.1	3596	81.1
5	0.115	206	2.82	0.10	345.2	78.5	5048	35.1
6	0.067	120	1.56	0*	293.4	43.1	2220	38.5
7	0.074	169	1.48	1.70	571.3	59.5	4442	109.1
8	0.086	179	2.53	0.15	1225.0	78.4	12998	1024
9	0.082	167	2.41	0*	264.7	51.6	1286	123.2
10	0.067	168	2.03	0*	230.6	20.7	1640	13.6

* not detected, < LOD

GH 3

Active substance:	Bupirimate (250 g/L) / tebufenozide (240 g/L)
Formulation type:	Emulsifiable concentrate / suspension concentrate
Pesticide function:	Fungicide
Crop:	Tomatoes

Setting:
The study was conducted as part of the BROWSE project[5] to obtain mechanistic data on the contribution of transfer of existing deposits of pesticides from the crop and application equipment to the total dermal exposure during mixing/loading and application. The field phase took place in October 2012 on Crete in Southern Greece. Two different pesticides, the first one containing bupiramate and the second one tebufenozide, were applied sequentially on tomatoes and three operators each were monitored on both occasions. The operators used spray guns that were connected via a hose to a tank. Areas of 0.13 ha were treated with 0.02 to 0.08 kg a.s. diluted in 200 L in each trial. Mixing/loading and application was performed by the same operator. Only one mixing/loading task was performed. Spraying was finished within 36 to 47 min. Cleaning was not monitored.

Exposure assessment:
The dermal exposure during mixing/loading and during application was determined separately. Body exposure was sampled with a cotton jacket and cotton trousers as outer layer and a long-sleeved cotton shirt and cotton pants as inner layer. In addition, each operator wore cotton gloves beneath protective nitrile gloves to monitor potential and actual hand exposure. A baseball cap was worn for the head exposure. Residues of bupiramate and tebufenozide were extracted from the samples with methanol and subjected to LC/MS analysis.

Results:
All exposure values had to be corrected for field recovery which was in a range of 79 to 93% for bupiramate and of 82 to 90% for tebufenozide. The results are presented in the following table.

[5] **BROWSE Report of the Reserve fund experiments conducted in Greece**; “Collation of data on dermal transfer and efficiency of (protective) clothing and gloves for use in WP1-3 models”; FP7 BROWSE project (Bystander, Resident, Operator & Worker Exposure models for plant protection products). www.browseproject.eu

Mixing/loading

Operator	TA a.s. [kg]	Exposure time [min]	Inhalation	Hands [µg]	Gloves [µg]	$Body_{inner}$ [µg]	$Body_{outer}$ [µg]	Cap [µg]
1	0.068			0.6*	504	3.41*	91.7	0.35*
2	0.075			337.5	454	3.41*	1877	0.37*
3	0.081			34.5	276	3.45*	95.0	0.36*
1	0.021			10.0	1936	5.00**	138.6**	0.34*
2	0.025			268.5	1665	5.06**	228.0	0.34*
3	0.021			112.2	2285	16.7	39.3	0.34*

* ½ LOQ ** contains values with ½ LOQ

Application

Operator	TA a.s. [kg]	Exposure time [min]	Inhalation	Hands [µg]	Gloves [µg]	Bodyin-ner [µg]	Bodyoute r [µg]	Cap [µg]
1	0.068	36		1.1	587.3	35.2	9704	2.4
2	0.075	43		1.1	522.8	60.2	9168	18.5
3	0.081	47		2.3	430.4	27.6	12713	9.6
1	0.021	36		1.1	119.2	7.8	1302	2.3
2	0.025	47		1.1	156.4	11.2	1541	18.4
3	0.021	39		10.0	180.8	13.3	2676	5.7

13 Appendix 2 Raw data used for modelling

Mixing/loading

Study code	Operator	ML type	TA (kg a.s.)	Form. type	Face mask	Glove wash	Total hands (µg)	Prot. hands (µg)	Total body (µg)	Inner body (µg)	Head (µg)	Inhalation (µg)
LCTM_1	A	tank	25.10	WG	no	yes	5007	334	11901	717	2359	384
LCTM_1	C	tank	28.20	WG	no		3543	41.5	2290	46.6	41.2	35.7
LCTM_1	E	tank	28.50	WG	no	yes	511	74.5	7665	114	149	71.7
LCTM_1	G	tank	21.30	WG	no	yes	629	120	20360	494	1410	937
LCTM_1	I	tank	25.00	WG	no		5751	52.4	3277	107	144	318
LCTM_1	K	tank	24.00	WG	no		256	2.85	879	29.1	43.9	83.1
LCTM_1	M	tank	33.00	WG	no		1201	35.7	2791	168	153	267
LCTM_2	1	tank	9.00	liquid	no		570	6.49	NA	NA	NA	NA
LCTM_2	2	tank	6.25	liquid	no		8681	6.49	NA	NA	NA	NA
LCTM_2	3	tank	6.75	liquid	no		2817	0.01	NA	NA	NA	NA
LCTM_2	4	tank	10.00	liquid	no		2260	6.49	NA	NA	NA	NA
LCTM_2	5	tank	8.75	liquid	no		5359	6.49	NA	NA	NA	NA
LCTM_2	6	tank	7.25	liquid	no		2217	104	NA	NA	NA	NA
LCTM_2	7	tank	4.86	liquid	no		8457	6.49	NA	NA	NA	NA
LCTM_2	8	tank	10.25	liquid	no		25057	961	NA	NA	NA	NA
LCTM_2	9	tank	7.50	liquid	no		676	0.01	NA	NA	NA	NA
LCTM_2	10	tank	3.75	liquid	no		646	26.0	NA	NA	NA	NA
LCTM_2	11	tank	5.75	liquid	no		1837	6.49	NA	NA	NA	NA
LCTM_2	12	tank	7.00	liquid	no		1204	6.49	NA	NA	NA	NA
LCTM_2	13	tank	7.87	liquid	no		7376	51.9	NA	NA	NA	NA
LCTM_2	14	tank	8.25	liquid	no		2141	169	NA	NA	NA	NA
LCTM_2	15	tank	9.63	liquid	no		1362	51.9	NA	NA	NA	NA
LCTM_3	WM	tank	7.50	liquid	no		19222	77.0	6188	92.5	5.67	2.67
LCTM_3	JT	tank	7.50	liquid	no		25675	84.6	16045	147	8.74	30.1

LCTM_3	HM	tank	7.50	liquid	no		30659	32.6	22164	176	24.8	2.49
LCTM_3	JK	tank	7.50	liquid	no		45301	48.5	3567	19	6.76	1.58
LCTM_3	RV	tank	4.50	liquid	no		49344	54.3	11021	247	11.8	3.79
LCTM_3	YB	tank	8.00	liquid	no		30733	408	10813	134	20.2	3.99
LCTM_3	JM	tank	8.00	liquid	no		17313	132	71179	92.3	16.8	12.2
LCTM_3	JD	tank	8.00	liquid	no		6541	945	16272	1272	90.0	2.52
LCTM_3	JB	tank	7.50	liquid	no		915	26.2	3329	314	10.1	1.58
LCTM_3	EG	tank	7.50	liquid	no		1918	38.0	849	389	26.9	1.05
LCTM_4	SH	tank	2.52	liquid	no		1258	2.46	595	0.57	52.3	NA
LCTM_4	TS	tank	2.34	liquid	no		6522	0.01	324	6.09	13.2	NA
LCTM_4	SC	tank	3.12	liquid	no		2925	2.75	186	16.9	1.32	NA
LCTM_4	THR	tank	2.88	liquid	no		1140	3.77	432	3.33	9.51	NA
LCTM_5	1	tank	200.00	liquid	no		34969	0.92	NA	NA	NA	0.84
LCTM_5	2	tank	200.00	liquid	no		39477	1.26	NA	NA	NA	0.70
LCTM_5	3	tank	192.00	liquid	no		91738	28.6	NA	NA	NA	9.57
LCTM_5	4	tank	160.00	liquid	no		38618	2.90	NA	NA	NA	2.53
LCTM_5	5	tank	192.00	liquid	no		347567	6.21	NA	NA	NA	4.50
LCTM_5	6	tank	192.00	liquid	no		62301	17.6	NA	NA	NA	7.32
LCTM_5	7	tank	208.00	liquid	no		39779	0.69	NA	NA	NA	4.93
LCTM_5	8	tank	188.00	liquid	no		45606	8.16	NA	NA	NA	18.7
LCTM_5	9	tank	200.00	liquid	no		86961	22.6	NA	NA	NA	3.52
LCTM_5	10	tank	200.00	liquid	no		33469	6.96	NA	NA	NA	0.84
LCTM_5	11	tank	179.00	liquid	no		367117	802	NA	NA	NA	0.84
LCTM_5	12	tank	250.00	liquid	no		834741	141	NA	NA	NA	19.1
LCTM_6	2	tank	0.96	WG	yes		7568	35.5	1034	35.4	0.01	19.4
LCTM_6	4	tank	0.72	WG	yes		1296	3.14	717	16.0	0.01	0.01
LCTM_6	6	tank	0.96	WG	yes		1588	5.15	1057	2.82	0.01	0.01
LCTM_6	8	tank	0.96	WG	yes		273	0.24	880	0.01	0.01	0.01

LCTM_6	10	tank	1.20	WG	yes		2959	2.35	226	2.82	0.01	0.01
LCTM_6	12	tank	0.96	WG	yes		1205	84.2	182	4.25	0.01	0.01
LCTM_6	14	tank	0.90	WG	yes		734	2.96	228	2.82	0.01	6.13
LCTM_6	16	tank	0.96	WG	yes		2606	16.9	2022	11.6	0.01	6.13
LCTM_6	18	tank	0.96	WG	yes		1073	6.48	922	11.5	0.01	6.13
LCTM_6	20	tank	0.96	WG	yes		8594	11.6	1279	10.7	0.01	0.01
LCTM_7	A	tank	14.00	liquid	no	yes	14865	264	NA	NA	NA	3.94
LCTM_7	B	tank	4.00	liquid	no		4273	9.16	NA	NA	NA	1.38
LCTM_7	C1	tank	6.00	liquid	no		8674	10.8	NA	NA	NA	1.38
LCTM_7	D	tank	13.10	liquid	no	yes	970	7.76	NA	NA	NA	1.38
LCTM_7	E	tank	5.30	liquid	no	yes	2294	10.8	NA	NA	NA	1.38
LCTM_8	2	tank	56.40	liquid	no		2735	1393	NA	NA	1016	14.9
LCTM_8	4	tank	47.30	liquid	no		95969	299	12331	44.5	1847	26.6
LCTM_8	6	tank	58.60	liquid	no		28971	662	14609	53.2	3849	8.50
LCTM_8	8	tank	51.00	liquid	no		88150	14526	53625	175	6160	11.6
LCTM_8	10	tank	68.00	liquid	no		83087	1984	50970	275	1998	7.63
LCTM_8	12	tank	45.90	liquid	no		1300502	25563	151190	214	3220	16.4
LCTM_8	14	tank	51.00	liquid	no		141250	12622	262445	1643	19622	35.0
LCTM_8	16	tank	68.00	liquid	no		102812	2204	61110	695	964	1.83
LCTM_8	18	tank	56.70	liquid	no		453659	37085	48282	157	25758	12.8
LCTM_8	19	tank	64.30	liquid	no		96937	2619	17272	108	2292	8.63
LCTM_9	1	tank	33.50	liquid	no		28012	12.4	148537	222	4000	17.8
LCTM_9	2	tank	40.70	liquid	no		10133	9663	30030	131	122	48.5
LCTM_9	3	tank	40.00	liquid	no		39135	135	34321	389	24.0	0.98
LCTM_9	4	tank	27.50	liquid	no		5806	5.62	4742	135	30.0	4.01
LCTM_9	5	tank	42.30	liquid	no		27157	157	8943	201	26.0	5.26
LCTM_9	6	tank	26.40	liquid	no		4706	5.62	108493	43.8	220	0.98
LCTM_9	7	tank	40.00	liquid	no		7465	65.2	3535	29.2	112	0.98

LCTM_9	8	tank	50.00	liquid	no		202	12.4	87664	23.6	10.0	0.94
LCTM_9	9	tank	35.00	liquid	no	yes	1406	5.62	7545	16.9	10.0	0.98
LCTM_9	10	tank	56.50	liquid	no		5381	80.9	5367	1907	10.0	1.02
LCTM_9	11	tank	45.00	liquid	no		17082	82.0	32046	23.6	3200	11.0
LCTM_9	12	tank	47.50	liquid	no		5081	281	51182	620	1320	0.99
LCTM_9	13	tank	27.00	liquid	no		7218	18.0	2452	16.9	10.0	0.95
LCTM_9	14	tank	25.00	liquid	no		9263	9213	6452	47.2	10.0	1.04
LCTM_9	15	tank	25.00	liquid	no		14051	50.6	842	16.9	10.0	1.00
LCTM_9	16	tank	41.40	liquid	no		18013	9213	511527	14684	140	5.86
LCTM_10	A	tank	4.60	liquid	no		4165	16.3	NA	NA	NA	2.19
LCTM_10	B	tank	12.80	liquid	no		9380	30.9	NA	NA	NA	2.19
LCTM_10	C	tank	31.30	liquid	no	yes	3627	32.3	NA	NA	NA	2.19
LCTM_10	D	tank	12.00	liquid	no	yes	666	7.21	NA	NA	NA	2.19
LCTM_10	E	tank	5.60	liquid	no		1709	7.42	NA	NA	NA	2.19
LCTM_10	F	tank	7.10	liquid	no		7347	10.7	NA	NA	NA	2.19
LCTM_10	H	tank	15.00	liquid	no		4131	11.1	NA	NA	NA	2.19
LCTM_11	1	tank	197.44	liquid	no		732734	47.9	NA	NA	NA	NA
LCTM_11	2	tank	189.76	liquid	no		107415	14.0	NA	NA	NA	NA
LCTM_11	3	tank	207.02	liquid	no		79473	11.9	NA	NA	NA	NA
LCTM_11	4	tank	205.25	liquid	no		800724	11.9	NA	NA	NA	NA
LCTM_11	6	tank	202.99	liquid	no		266504	8.25	NA	NA	NA	NA
LCTM_11	7	tank	205.54	liquid	no		2346736	5.33	NA	NA	NA	NA
LCTM_11	8	tank	205.00	liquid	no		597025	165	NA	NA	NA	NA
LCTM_11	9	tank	206.76	liquid	no		1227501	23.0	NA	NA	NA	NA
LCTM_11	11	tank	192.78	liquid	no		1060422	71.4	NA	NA	NA	NA
LCTM_11	12	tank	193.10	liquid	no		635023	182	NA	NA	NA	NA
LCTM_11	13	tank	205.20	liquid	no		186213	1623	NA	NA	NA	NA
LCTM_11	14	tank	157.23	liquid	no		487110	85.0	NA	NA	NA	NA

HCTM_1	1	tank	1.39	liquid	yes		1997	36.7	NA	NA	NA	NA
HCTM_1	2	tank	1.20	liquid	yes		2770	9.92	NA	NA	NA	NA
HCTM_1	3	tank	1.20	liquid	yes		4490	79.8	NA	NA	NA	NA
HCTM_1	4	tank	1.32	liquid	yes	yes	3160	9.76	NA	NA	NA	NA
HCTM_1	5	tank	1.00	liquid	yes	yes	2511	20.8	NA	NA	NA	NA
HCTM_1	6	tank	1.15	liquid	yes	yes	1333	12.7	NA	NA	NA	NA
HCTM_1	7	tank	1.90	liquid	yes		2764	3.72	NA	NA	NA	NA
HCTM_1	8	tank	1.90	liquid	yes	yes	4003	2.86	NA	NA	NA	NA
HCTM_1	9	tank	1.20	liquid	yes	yes	1931	71.2	NA	NA	NA	NA
HCTM_1	10	tank	1.25	liquid	yes	yes	2488	7.64	NA	NA	NA	NA
HCTM_2	1	tank	5.67	liquid	no		139482	103	NA	NA	NA	NA
HCTM_2	2	tank	8.15	liquid	no		41053	103	NA	NA	NA	NA
HCTM_2	3	tank	9.10	liquid	no		16546	103	NA	NA	NA	NA
HCTM_2	4	tank	6.76	liquid	no		5601	103	NA	NA	NA	NA
HCTM_2	5	tank	6.77	liquid	no		7363	103	NA	NA	NA	NA
HCTM_2	6	tank	5.33	liquid	no		32175	103	NA	NA	NA	NA
HCTM_2	7	tank	3.48	liquid	no		267	51.3	NA	NA	NA	NA
HCTM_2	8	tank	5.44	liquid	no		135784	103	NA	NA	NA	NA
HCTM_2	10	tank	5.23	liquid	no		29558	154	NA	NA	NA	NA
HCTM_2	11	tank	4.57	liquid	no		2462	103	NA	NA	NA	NA
HCTM_2	12	tank	6.48	liquid	no		37171	103	NA	NA	NA	NA
HCTM_2	13	tank	4.68	liquid	no		29106	103	NA	NA	NA	NA
HCTM_2	14	tank	7.88	liquid	no		10055	103	NA	NA	NA	NA
HCTM_2	15	tank	5.42	liquid	no		3155	103	NA	NA	NA	NA
HCTM_2	17	tank	3.96	liquid	no		663	103	NA	NA	NA	NA
HCTM_3	2	tank	2.70	liquid	yes		20934	4.00	4398	4.70	3.29	5.21
HCTM_3	4	tank	2.40	liquid	yes		48863	26.0	4067	16.8	3.29	5.21
HCTM_3	6	tank	2.70	liquid	yes		37659	450	19475	55.00	13.5	5.21

HCTM_3	8	tank	3.00	liquid	yes		1748	3.90	797	2.00	3.29	5.21
HCTM_3	9	tank	3.38	liquid	yes		13960	6.80	1945	15.4	9.20	5.21
HCTM_3	12	tank	3.60	liquid	yes		53578	90.0	2885	14.3	16.8	5.21
HCTM_3	14	tank	3.60	liquid	yes		4538	3.40	664	6.30	3.29	5.21
HCTM_3	16	tank	3.60	liquid	yes		37246	37.0	94341	21.00	3.29	5.21
HCTM_3	18	tank	3.15	liquid	yes		56986	8.90	2098	8.90	16.4	5.21
HCTM_3	19	tank	3.60	liquid	yes		112298	670	5092	152	95.3	5.21
HCTM_3	22	tank	3.00	liquid	yes		25587	5.90	1943	4.00	3.29	10.4
HCTM_3	24	tank	3.75	liquid	yes		22114	21.0	2977	76.7	3.29	10.4
HCTM_5	1M	tank	35.49	WG	no		5392	286	11929	230	260	19.4
HCTM_5	2M	tank	37.80	WG	no		1997	35.7	7854	465	243	16.3
HCTM_5	3M	tank	17.50	WG	no		40939	268	21752	1491	1215	89.8
HCTM_5	4M	tank	12.32	WG	no		3396	125	4709	130	634	61.5
HCTM_5	5M	tank	17.50	WG	no		1537	14.3	15797	580	625	105
HCTM_5	6M	tank	7.00	WG	no		21055	3.57	28285	104	86.8	32.2
HCTM_5	7M	tank	13.48	WG	no		3885	14.3	1842	104	182	9.60
HCTM_5	8M	tank	15.75	WG	no		225	21.4	2692	213	130	34.7
HCTM_5	9M	tank	21.00	WG	no		4314	26.8	9851	1307	122	23.9
HCTM_5	10M	tank	7.00	WG	no		6926	7.14	3062	37.0	52.1	10.4
HCTM_5	11M	tank	19.78	WG	no		1672	46.4	2639	80.4	347	33.4
HCTM_5	14M	tank	16.80	WG	no		3403	67.9	67311	530	3134	212
HCTM_6	1	tank	4.50	liquid	no		10434	193	5833	17.4	211	1.20
HCTM_6	2	tank	3.60	liquid	no		9395	239	136188	912	185	1.20
HCTM_6	3	tank	3.60	liquid	no		14001	386	25616	75.9	106	7.18
HCTM_6	4	tank	5.00	liquid	no		2421	11.36	11657	82.3	317	35.9
HCTM_6	5	tank	2.40	liquid	no		12391	102	106740	154	528	12.0
HCTM_6	6	tank	7.20	liquid	no		10316	NA	32809	372	26.4	NA
HCTM_6	7	tank	8.00	liquid	no		7879	409	3168	41.3	687	168

HCTM_6	8	tank	6.25	liquid	no		37297	68.2	186173	3403	6130	4.79
HCTM_6	9	tank	6.69	liquid	no	yes	13103	693	18516	2206	0.01	1.44
HCTM_6	10	tank	10.00	liquid	no		34301	205	20652	250	26.4	12.0
HCTM_6	11	tank	6.25	liquid	no		23658	284	37287	160	52.8	16.8
HCTM_6	12	tank	6.00	liquid	no		7102	114	544	3.92	476	14.4
HCTM_6	13	tank	3.75	liquid	no		5042	102	7498	83.9	344	1.20
HCTM_6	14	tank	5.00	liquid	no		7934	102	2396	28.4	396	35.9
HCTM_6	15	tank	3.60	liquid	no		22437	148	5241	22.4	26.42	1.20
HCTM_6	16	tank	5.40	liquid	no		2323	34.1	1196	46.9	26.42	12.0
HCTM_6	17	tank	3.75	liquid	no		12034	NA	2562	21.9	26.42	4.79
HCTM_7	A	tank	4.00	WG	no	yes	286	2.72	NA	NA	NA	24.6
HCTM_7	B	tank	8.00	WG	no	yes	390	64.0	NA	NA	NA	1.77
HCTM_7	C	tank	7.50	WG	no		1218	9.05	NA	NA	NA	42.7
HCTM_7	D	tank	4.50	WG	no	yes	2157	15.2	NA	NA	NA	8.33
HCTM_7	E	tank	7.50	WG	no		2152	948	NA	NA	NA	24.8
HCTM_7	F	tank	8.00	WG	no	yes	1177	147	NA	NA	NA	106
HCTM_7	G	tank	13.50	WG	no		4356	98.6	NA	NA	NA	188
HCTM_7	H	tank	10.00	WG	no		2046	23.6	NA	NA	NA	132
HCTM_7	I	tank	7.50	WG	no		267	23.6	NA	NA	NA	3.91
HCTM_7	J	tank	3.75	WG	no		1763	6.30	NA	NA	NA	44.9
HCTM_7	K	tank	6.00	WG	no	yes	3609	85.8	NA	NA	NA	63.6
HCTM_7	L	tank	4.80	WG	no	yes	590	7.50	NA	NA	NA	45.1
LCHH_1	2	knapsack	0.10	WG	yes		620	2.30	36.8	2.78	4.00	6.06
LCHH_1	4	knapsack	0.06	WG	yes		197	0.01	112	53.5	0.01	0.01
LCHH_1	6	knapsack	0.10	WG	yes		766	6.98	176	0.01	4.00	0.01
LCHH_1	8	knapsack	0.10	WG	yes		711	2.30	76.0	0.01	4.00	0.01
LCHH_1	10	knapsack	0.11	WG	yes		424	7.53	396	1.39	4.00	0.01
LCHH_1	12	knapsack	0.12	WG	yes		4304	21.1	986	13.2	4.00	6.06

LCHH_1	14	knapsack	0.13	WG	yes		537	2.30	928	8.62	0.01	0.01
LCHH_1	16	knapsack	0.14	WG	yes		241	10.4	1165	0.01	0.01	0.01
LCHH_1	18	knapsack	0.13	WG	yes		864	5.93	58.2	8.79	0.01	6.06
LCHH_1	20	knapsack	0.12	WG	yes		3291	150	9825	234	4.00	0.01
LCHH_2	AA	knapsack	1.50	liquid	no		635	3.73	NA	NA	NA	NA
LCHH_2	AB	knapsack	1.50	liquid	no		877	3.73	NA	NA	NA	NA
LCHH_2	AC	knapsack	1.50	liquid	no		9497	7.46	NA	NA	NA	NA
LCHH_2	AD	knapsack	1.50	liquid	no		272	3.73	NA	NA	NA	NA
LCHH_2	AE	knapsack	1.50	liquid	no		2899	7.46	NA	NA	NA	NA
LCHH_2	AF	knapsack	1.50	liquid	no		1051	71.6	NA	NA	NA	NA
LCHH_2	AH	knapsack	1.20	liquid	no		891	3.73	NA	NA	NA	NA
LCHH_2	AI	knapsack	1.35	liquid	no		1122	11.9	NA	NA	NA	NA
LCHH_2	AJ	knapsack	1.20	liquid	no		722	7.46	NA	NA	NA	NA
LCHH_3	2	knapsack	0.23	liquid	yes		5184	10.4	360	81.9	5.00	35.7
LCHH_3	3	knapsack	0.24	liquid	yes		5147	21.8	830	59.4	5.00	35.7
LCHH_3	4	knapsack	0.23	liquid	yes		11260	150	234	24.9	5.00	35.7
LCHH_3	5	knapsack	0.23	liquid	yes		5721	164	634	12.4	15.0	35.7
LCHH_3	7	knapsack	0.23	liquid	yes		6362	140	543	11.7	5.00	34.8
LCHH_3	8	knapsack	0.23	liquid	yes		13660	10.4	2787	29.3	5.00	32.4
LCHH_3	9	knapsack	0.23	liquid	yes		9389	145	379	13.2	19.0	36.6
LCHH_3	10	knapsack	0.23	liquid	yes		3961	124	120	10.2	5.00	35.7
LCHH_3	11	knapsack	0.23	liquid	yes		7325	340.4	399	22.8	11.4	34.8
LCHH_3	12	knapsack	0.23	liquid	yes		2506	165.0	149	51.8	5.00	35.7
LCHH_3	13	knapsack	0.23	liquid	yes		3868	20.8	31.0	16.0	5.00	35.7
LCHH_3	14	knapsack	0.23	liquid	yes		3738	45.7	865	12.2	5.00	35.7
LCHH_3	15	knapsack	0.23	liquid	yes		2695	10.4	343	102.65	5.00	33.2
LCHH_3	16	knapsack	0.23	liquid	yes		10032	123	721	16.9	5.00	35.7
LCHH_3	17	knapsack	0.23	liquid	yes		25490	10.4	974	60.7	5.00	32.4

LCHH_4	1	knapsack	0.23	liquid	yes		4814	3.65	145	39.8	5.49	2.77
LCHH_4	4	knapsack	0.19	liquid	yes		12115	5.05	607	120	5.49	2.77
LCHH_4	5	knapsack	0.23	liquid	yes		19435	5.01	248	6.03	5.49	2.77
LCHH_4	6	knapsack	0.23	liquid	yes		46642	11.8	496	24.6	5.49	2.77
LCHH_4	7	knapsack	0.23	liquid	yes		13582	2.33	803	5.25	5.49	2.77
LCHH_4	8	knapsack	0.23	liquid	yes		4800	3.05	410	3.51	5.49	2.77
LCHH_4	9	knapsack	0.23	liquid	yes		2924	1.26	244	1.69	5.49	2.77
LCHH_4	10	knapsack	0.23	liquid	yes		9073	1.40	1094	11.9	5.49	2.77
LCHH_4	11	knapsack	0.23	liquid	yes		9318	5.64	261	2.44	5.49	8.50
LCHH_4	12	knapsack	0.23	liquid	yes		54768	8.27	17478	23.2	5.49	8.79
LCHH_4	13	knapsack	0.23	liquid	yes		14792	1.63	365	15.0	5.49	2.70
LCHH_4	14	knapsack	0.23	liquid	yes		9935	0.57	296	4.28	5.49	2.52
LCHH_4	15	knapsack	0.23	liquid	yes		6787	2.87	128	2.56	5.49	11.0
LCHH_4	17	knapsack	0.23	liquid	yes		12872	1.86	460	1.49	5.49	2.77
LCHH_4	18	knapsack	0.23	liquid	yes		9043	0.568	94.4	2.38	5.49	2.77
HCHH_1	1	tank	0.23	liquid	yes	yes	560	2.56	NA	NA	NA	NA
HCHH_1	3	tank	0.26	liquid	yes		561	2.56	NA	NA	NA	NA
HCHH_1	7	tank	0.42	liquid	yes		74	9.39	NA	NA	NA	NA
HCHH_1	9	tank	0.75	liquid	yes		307	299	NA	NA	NA	NA
HCHH_1	11	tank	0.50	liquid	yes		158	5.13	NA	NA	NA	NA
HCHH_1	13	tank	0.35	liquid	yes		7390	7.69	NA	NA	NA	NA
HCHH_1	15	tank	0.48	liquid	yes		2726	27.5	NA	NA	NA	NA
HCHH_1	17	tank	0.42	liquid	yes		1727	2.56	NA	NA	NA	NA
HCHH_1	19	tank	0.60	liquid	yes		172	2.56	NA	NA	NA	NA
HCHH_1	21	tank	0.65	liquid	yes		542	2.56	NA	NA	NA	NA
HCHH_1	23	tank	0.39	liquid	yes		159	5.13	NA	NA	NA	NA
HCHH_1	25	tank	0.42	liquid	yes		541	10.3	NA	NA	NA	NA
HCHH_2	1	tank	7.65	WP	no		106867	3389	346161	13231	1190	4680

HCHH_2	4	tank	5.61	WP	no	yes	36225	1069	105491	3439	121	1433
HCHH_2	9	tank	5.10	WP	no		62290	4179	450081	24891	816	1660
HCHH_2	10	tank	6.80	WP	no		95416	283	52184	2190	80.4	783
HCHH_2	13	tank	6.80	WP	no	yes	21659	614	65332	1333	105	1997
HCHH_2	16	tank	9.35	WP	no	yes	80072	916	222561	7687	952	658
HCHH_2	22	tank	7.48	WP	no		45886	2997	100003	2780	209	3296
HCHH_2	25	tank	7.65	WP	no	yes	88189	2200	441555	15105	1103	5862
HCHH_2	26	tank	6.80	WP	no		65295	95	55905	2266	260	1056
HCHH_2	30	tank	9.18	WP	no		147905	350	192731	5213	842	5026
HCHH_3	3	tank	5.10	WP	no		146554	12054	157044	4646	1015	1162
HCHH_3	6	tank	7.65	WP	no		180190	8690	575869	22639	2610	10246
HCHH_3	7	tank	3.40	WP	no		48761	311	58082	1744	161	2030
HCHH_3	10	tank	5.61	WP	no		129861	12161	473776	6444	599	2753
HCHH_3	18	tank	6.97	WP	no		96612	9962	242436	8896	424	2238
HCHH_3	21	tank	6.80	WP	no		48824	124	30007	2156	403	1155
HCHH_3	24	tank	6.80	WP	no		5853	113	28897	3166	65.8	2127
HCHH_3	30	tank	8.50	WP	no		92972	2392	431327	22397	1477	5858
HCHH_3	33	tank	9.35	WP	no		81629	1389	136223	6887	462	4251
HCHH_3	34	tank	7.65	WP	no		64723	1043	80988	4515	300	6184
HCHH_4	3	tank	10.14	liquid	yes		2728	83.3	1471	34.3	15.9	0.72
HCHH_4	6	tank	12.08	liquid	yes		8433	191	1301	53.3	1.18	1.69
HCHH_4	9	tank	10.14	liquid	yes		4979	94.8	693	58.4	0.64	0.72
HCHH_4	12	tank	11.83	liquid	yes		931	39.5	194	4.81	0.54	0.72
HCHH_4	15	tank	11.83	liquid	yes		15072	2365	13934	287	4.26	2.18
HCHH_4	18	tank	10.14	liquid	yes	yes	20042	200	1818	23.4	1.31	0.72
HCHH_4	21	tank	13.52	liquid	yes		10841	551	4644	54.8	1.09	0.72
HCHH_4	24	tank	10.14	liquid	no		19599	5204	48533	253	6.51	0.72
HCHH_4	27	tank	13.52	liquid	yes		19623	136	1738	68.0	11.01	2.18

HCHH_4	30	tank	10.14	liquid	yes		9845	107	438	6.64	2.24	0.72
HCHH_4	33	tank	11.83	liquid	yes		4369	4.03	6389	140	5970	0.72
HCHH_4	36	tank	10.14	liquid	yes		782	66.7	914	5.28	14.8	0.72
HCHH_5	1	tank	1.05	WG	no		2010	42.9	NA	NA	NA	3.77
HCHH_5	2	tank	1.03	WG	no		542	18.6	NA	NA	NA	13.3
HCHH_5	3	tank	0.99	WG	no		15945	200	NA	NA	NA	27.8
HCHH_5	4	tank	0.70	WG	no		2950	327	NA	NA	NA	3.56
HCHH_5	5	tank	0.75	WG	no		130	25.6	NA	NA	NA	3.76
HCHH_5	6	tank	0.75	WG	no		1304	5.72	NA	NA	NA	52.3
HCHH_5	7	tank	0.68	WG	no		169	45.8	NA	NA	NA	1.76
HCHH_5	8	tank	0.73	WG	no		189	46.4	NA	NA	NA	14.1
HCHH_5	9	tank	0.37	WG	no		2019	12.6	NA	NA	NA	12.2
HCHH_5	10	tank	0.90	WG	no		641	21.7	NA	NA	NA	12.0
HCHH_6	14	tank	0.98	WG	no		564	6.29	NA	NA	NA	16.2
HCHH_6	15	tank	0.67	WG	no		114	4.76	NA	NA	NA	0.73
HCHH_6	16	tank	0.90	WG	no		1419	34.4	NA	NA	NA	63.3
HCHH_6	17	tank	0.90	WG	no		430	26.7	NA	NA	NA	0.73
HCHH_6	18	tank	1.36	WG	no		438	21.6	NA	NA	NA	2.56
HCHH_6	19	tank	0.75	WG	no		497	77.6	NA	NA	NA	2.13
HCHH_6	20	tank	0.56	WG	no		541	4.29	NA	NA	NA	60.1
HCHH_6	21	tank	0.53	WG	no		297	169	NA	NA	NA	15.0
HCHH_6	22	tank	0.82	WG	no		49	20.3	NA	NA	NA	7.35
HCHH_6	23	tank	1.35	WG	no		238	13.9	NA	NA	NA	0.73
LCHH_5	1	tank	0.23	WG	yes		713	0.09	NA	NA	NA	21.2
LCHH_5	3	tank	0.23	WG	yes		166	2.02	NA	NA	NA	3.14
LCHH_5	5	tank	0.30	WG	yes		219	0.09	NA	NA	NA	0.77
LCHH_5	7	tank	0.68	WG	yes		2870	2.13	NA	NA	NA	5.64
LCHH_5	9	tank	0.68	WG	yes		476	0.09	NA	NA	NA	2.14

LCHH_5	11	tank	0.30	WG	yes		2091	0.09	NA	NA	NA	5.79
LCHH_5	13	tank	0.45	WG	yes		777	0.09	NA	NA	NA	0.77
LCHH_5	15	tank	0.25	WG	yes		542	0.09	NA	NA	NA	5.19
LCHH_5	17	tank	0.44	WG	yes		1017	2.02	NA	NA	NA	76.9
LCHH_5	19	tank	0.23	WG	yes		127	0.09	NA	NA	NA	0.77
HCHH_7	1	tank	1.50	WG	no		1245	32.6	NA	NA	234	10.9
HCHH_7	3	tank	1.10	WG	no	yes	NA	29.4	NA	NA	17.3	2.48
HCHH_7	7	tank	0.70	WG	no		615	0.63	NA	NA	1.67	2.48
HCHH_7	9	tank	1.43	WG	no		3715	176	NA	NA	7.57	6.55
HCHH_7	11	tank	0.83	WG	no		1958	8.00	NA	NA	1.67	10.1
HCHH_7	13	tank	0.47	WG	no		647	9.02	NA	NA	1.67	2.48
HCHH_7	15	tank	0.88	WG	no		1074	7.62	NA	NA	26.5	14.9
HCHH_7	17	tank	0.35	WG	no		2303	4.35	NA	NA	216	15.9
HCHH_7	19	tank	0.31	WG	no		1099	1.66	NA	NA	5.57	13.7
HCHH_7	21	tank	0.91	WG	no		1580	25.4	NA	NA	11.7	22.1
HCHH_8	1	tank	0.48	WG	no		3229	2.10	NA	NA	1.37	1.58
HCHH_8	3	tank	0.60	WG	no		21	0.63	NA	NA	3.40	1.58
HCHH_8	5	tank	0.94	WG	no		1748	56.3	NA	NA	58.3	12.7
HCHH_8	9	tank	1.20	WG	no		1862	5.44	NA	NA	10.9	27.4
HCHH_8	11	tank	0.55	WG	no		552	20.7	NA	NA	5.25	1.58
HCHH_8	13	tank	0.52	WG	yes		746	0.63	NA	NA	NA	1.58
HCHH_8	15	tank	0.97	WG	no		1233	360	NA	NA	28.0	1.58
HCHH_8	17	tank	0.61	WG	no		1033	4.77	NA	NA	5.01	1.58
HCHH_8	19	tank	0.46	WG	no		1776	10.8	NA	NA	28.8	1.58
HCHH_8	21	tank	1.40	WG	no		6775	357	NA	NA	119	85.4
LCHH_6	21	tank	0.038	sachets	no		6425	2.49	NA	NA	NA	3.13
LCHH_6	22	tank	0.068	sachets	no		2290	3.81	NA	NA	NA	7.91
LCHH_6	23	tank	0.059	sachets	no		1603	2.01	NA	NA	NA	5.88

LCHH_6	24	tank	0.068	sachets	no		2587	3.36	NA	NA	NA	6.07
LCHH_6	25	tank	0.075	sachets	no		13064	107	NA	NA	NA	33.2
LCHH_6	26	tank	0.075	sachets	no		9000	120	NA	NA	NA	4.11
LCHH_6	27	tank	0.075	sachets	no		824	4.23	NA	NA	NA	27.7
LCHH_6	28	tank	0.038	sachets	no		1900	3.14	NA	NA	NA	2.81
LCHH_6	29	tank	0.075	sachets	no		1871	7.78	NA	NA	NA	1.62
LCHH_6	30	tank	0.038	sachets	no		15831	2.58	NA	NA	NA	7.12
LCHH_6	31	tank	0.056	sachets	no		2227	3.25	NA	NA	NA	1.85
LCHH_6	32	tank	0.056	sachets	no		987	3.24	NA	NA	NA	5.49
LCHH_6	33	tank	0.038	sachets	no		1211	10.0	NA	NA	NA	2.93
LCHH_6	34	tank	0.034	sachets	no		1944	3.04	NA	NA	NA	0.16
LCHH_6	35	tank	0.075	sachets	no		2979	3.03	NA	NA	NA	0.17
LCHH_6	36	tank	0.038	sachets	no		3358	53.8	NA	NA	NA	15.7
LCHH_6	37	tank	0.029	sachets	no		1001	3.80	NA	NA	NA	2.63
LCHH_6	38	tank	0.068	sachets	no		2417	20.0	NA	NA	NA	9.07
LCHH_6	39	tank	0.038	sachets	no		795	1.23	NA	NA	NA	2.47
LCHH_6	40	tank	0.034	sachets	no		10591	0.95	NA	NA	NA	3.08
GH_3	1	tank	0.068	liquid	no		504	0.57	95.1	3.41	0.71	NA
GH_3	2	tank	0.075	liquid	no		792	338	1880	3.41	0.74	NA
GH_3	3	tank	0.081	liquid	no		310	34.5	98.4	3.45	0.72	NA
GH_3	1	tank	0.021	liquid	no		1946	10.0	144	5.00	0.68	NA
GH_3	2	tank	0.025	liquid	no		1934	269	233	5.06	0.69	NA
GH_3	3	tank	0.021	liquid	no		2397	112	56.0	16.7	0.69	NA

Application

Study code	Operator	Appl. type	TA (kg a.s.)	Scenario	Protection	Face mask	Glove wash	Total hands (µg)	Prot. hands (µg)	Total body (µg)	Inner body (µg)	Head (µg)	Inhalation (µg)
HCHH_5	1	HCHH	1.050	dense	none	yes		92300	58.5	1513304	294375	159	615
HCHH_5	2	HCHH	1.026	dense	none	yes		49019	270	1839486	846244	549	3219
HCHH_5	3	HCHH	0.986	dense	none	yes		32393	1083	1665642	219191	500	426
HCHH_5	4	HCHH	0.697	dense	none	yes		60082	277	2649485	951656	1250	567
HCHH_5	5	HCHH	0.750	dense	none	yes	yes	NA	481	935175	209289	110	377
HCHH_5	6	HCHH	0.747	dense	none	yes		10877	NA	798811	346213	200	170
HCHH_5	7	HCHH	0.675	dense	none	yes		6025	950	869396	57091	801	809
HCHH_5	8	HCHH	0.731	dense	none	yes		28332	NA	2160484	247535	495	551
HCHH_5	9	HCHH	0.371	dense	none	yes		9822	NA	496867	252623	187	193
HCHH_5	10	HCHH	0.900	dense	none	yes		22674	NA	972527	265844	218	222
HCHH_5	11	HCHH	0.860	dense	cert. coverall	yes		NA	5.32	NA	24209	90.8	429
HCHH_5	12	HCHH	1.500	dense	cert. coverall	yes		18597	NA	NA	475732	293	1106
HCHH_5	13	HCHH	0.600	dense	cert. coverall	yes		2361	NA	NA	4379	118	40.6
HCHH_5	14	HCHH	0.500	dense	cert. coverall	yes		2286	NA	NA	141919	50.2	1409
HCHH_5	15	HCHH	0.700	dense	cert. coverall	yes		2738	NA	NA	135311	22.2	125
HCHH_5	17	HCHH	0.600	dense	cert. coverall	yes		2503	NA	NA	29551	7905	236
HCHH_5	18	HCHH	0.650	dense	rain coat	yes		NA	93.3	NA	130	10.8	130
HCHH_5	19	HCHH	0.550	dense	rain coat	yes		NA	11.8	NA	403	29.6	258
HCHH_5	20	HCHH	0.940	dense	rain coat	yes		NA	91.5	NA	1609	898	203
HCHH_5	21	HCHH	0.940	dense	rain coat	yes		NA	1263	NA	1927	286	292
HCHH_5	22	HCHH	0.630	dense	rain coat			NA	593	NA	521	NA	339
HCHH_5	23	HCHH	0.500	dense	rain coat	yes		NA	544	NA	1273	1182	478
HCHH_5	24	HCHH	0.860	dense	rain coat	yes		10966	NA	NA	4269	7424	224
HCHH_5	25	HCHH	0.790	dense	rain coat	yes		5968	NA	NA	484	422	54.6
HCHH_5	26	HCHH	0.410	dense	rain coat	yes		7521	NA	NA	430	78.6	75.0

HCHH_5	27	HCHH	0.750	dense	rain coat	yes		NA	103	NA	1314	2249	458
HCHH_5	28	HCHH	0.530	dense	rain coat	yes		NA	762	NA	4656	4721	99.0
HCHH_5	29	HCHH	0.740	dense	rain coat	yes		NA	86.7	NA	2655	3972	178
HCHH_5	30	HCHH	0.710	dense	rain coat	yes		3057	NA	NA	1268	294	57.3
HCHH_5	31	HCHH	0.710	dense	rain coat	yes		4117	NA	NA	1242	251	173
HCHH_5	32	HCHH	0.750	dense	rain coat	yes		NA	45.2	NA	817	356	101
HCHH_5	33	HCHH	0.830	dense	rain coat	yes		NA	530	NA	1168	296	334
HCHH_6	14	HCHH	0.975	normal	none	yes		9335	NA	363653	20632	498	211
HCHH_6	15	HCHH	0.672	normal	none	yes		3092	44.3	36037	1023	264	203
HCHH_6	16	HCHH	0.900	normal	none	yes		NA	76.0	344252	13921	396	309
HCHH_6	17	HCHH	0.903	normal	none	yes		18523	NA	791582	190124	2652	500
HCHH_6	18	HCHH	1.361	normal	none	yes		13984	NA	496378	109038	447	657
HCHH_6	19	HCHH	0.749	normal	none	yes		19742	NA	289619	8262	828	499
HCHH_6	20	HCHH	0.555	normal	none	yes		7305	NA	46631	361	99.6	0.64
HCHH_6	21	HCHH	0.525	normal	none	yes		37264	NA	160208	4324	425	288
HCHH_6	22	HCHH	0.825	normal	none	yes		5439	NA	67742	1040	93.1	71.2
HCHH_6	23	HCHH	1.353	normal	none	yes		13122	NA	104499	988	476	507
LCHH_5	2	LCHH	0.207	normal	none	yes		1222	0.09	17232	132	1.23	73.1
LCHH_5	4	LCHH	0.180	normal	none	yes		4878	1.04	16797	160	1.23	71.2
LCHH_5	6	LCHH	0.255	normal	none	yes		1886	0.18	28082	25.1	1.23	41.6
LCHH_5	8	LCHH	0.495	normal	none	yes		4337	0.18	21120	12.4	1.23	9.8
LCHH_5	10	LCHH	0.600	normal	none	yes		4159	0.18	6754	25.3	11.0	39.3
LCHH_5	12	LCHH	0.293	normal	none	yes		4104	5.67	8025	18.2	1.23	35.5
LCHH_5	14	LCHH	0.231	normal	none	yes		751	0.18	5635	12.8	3.32	49.3
LCHH_5	16	LCHH	0.230	normal	none	yes		1179	0.18	4936	186	1.23	111
LCHH_5	18	LCHH	0.413	normal	none	yes		931	0.09	3478	42.8	7.81	0.77
LCHH_5	20	LCHH	0.225	normal	none	yes		1989	0.09	1203	8.64	1.23	0.77
HCHH_7	2	HCHH	1.275	normal	none			22348	28.4	721844	36935	1376	2214

HCHH_7	4	HCHH	0.819	normal	none			9514	0.63	108517	2264	376	318
HCHH_7	8	HCHH	0.525	normal	none			9846	7.70	655745	36757	699	71.7
HCHH_7	10	HCHH	1.126	normal	none			8624	0.63	612605	19843	439	591
HCHH_7	12	HCHH	0.627	normal	none	yes		4343	0.63	88599	3673	505	154
HCHH_7	14	HCHH	0.429	normal	none	yes		9350	1.41	84421	179	147	186
HCHH_7	16	HCHH	0.561	normal	none			6666	18.5	214998	496	13.5	217
HCHH_7	18	HCHH	0.277	normal	none	yes	yes	NA	4.52	42142	3002	1.67	93.7
HCHH_7	20	HCHH	0.267	normal	none			5708	1.27	80817	1170	74.3	53.8
HCHH_7	22	HCHH	0.719	normal	none	yes		7273	1.27	33482	326	17.9	54.9
HCHH_8	2	HCHH	0.444	normal	none			3127	12.9	39667	135	41.4	162
HCHH_8	4	HCHH	0.495	normal	none			10202	25.2	190395	3172	380	250
HCHH_8	6	HCHH	0.736	normal	none	yes		30784	301	1085188	86506	506	196
HCHH_8	10	HCHH	1.050	normal	none			52945	12.0	378027	2684	NA	254
HCHH_8	12	HCHH	0.440	normal	none	yes		5701	35.6	34781	340	55.0	103
HCHH_8	14	HCHH	0.403	normal	none			12898	13.6	78915	314	88.3	127
HCHH_8	16	HCHH	0.639	normal	none			44220	5.70	683412	522	411	275
HCHH_8	18	HCHH	0.435	normal	none			17905	88.9	195157	20933	697	212
HCHH_8	20	HCHH	0.379	normal	none			21644	120	178312	828	423	211
HCHH_8	22	HCHH	0.902	normal	none			29670	33.2	446745	1758	172	231
LCHH_6	1	LCHH	0.028	dense	none	yes		740	0.26	28514	1313	10.4	22.1
LCHH_6	2	LCHH	0.057	dense	none	yes		1423	0.60	77688	22629	14.8	45.1
LCHH_6	3	LCHH	0.041	dense	none	yes		787	1.70	92050	27958	13.2	43.1
LCHH_6	4	LCHH	0.066	dense	none			448	0.18	13817	35.6	8.21	4.54
LCHH_6	5	LCHH	0.067	dense	none			815	44.5	38252	1654	17.2	5.73
LCHH_6	6	LCHH	0.058	dense	none			490	3.66	22282	1364	8.12	5.83
LCHH_6	7	LCHH	0.075	dense	none	yes		1393	0.38	77559	12180	9.61	63.6
LCHH_6	8	LCHH	0.035	dense	none			1057	0.44	85382	35803	39.2	6.64
LCHH_6	9	LCHH	0.062	dense	none			228	0.33	29394	183	3.13	70.2

LCHH_6	10	LCHH	0.029	dense	none			916	0.74	58038	15990	11.4	6.00
LCHH_6	11	LCHH	0.045	dense	none			730	0.54	47218	10177	12.5	7.02
LCHH_6	12	LCHH	0.045	dense	none			654	12.1	53492	3448	2.57	NA
LCHH_6	13	LCHH	0.034	dense	none			1323	1.41	55521	13959	21.1	43.3
LCHH_6	14	LCHH	0.026	dense	none			755	0.12	17192	72.9	28.3	7.61
LCHH_6	15	LCHH	0.066	dense	none			164	0.50	15276	509	23.3	7.06
LCHH_6	16	LCHH	0.032	dense	none			691	1.62	46342	8888	7.29	7.61
LCHH_6	17	LCHH	0.024	dense	none	yes		899	0.68	41756	925	6.70	26.6
LCHH_6	18	LCHH	0.056	dense	none			622	0.54	25333	269	22.5	79.8
LCHH_6	19	LCHH	0.035	dense	none			179	0.29	11026	17.2	2.60	8.26
LCHH_6	20	LCHH	0.031	dense	none	yes		1531	6.93	24676	168	38.5	46.9
LCHH_7	1	LCHH	0.066	dense	rain trousers	yes		390	0.19	NA	44.3	21.2	12.8
LCHH_7	2	LCHH	0.025	dense	rain trousers	yes		1036	12.3	NA	20.8	4.85	25.9
LCHH_7	3	LCHH	0.041	dense	rain trousers	yes		1427	1.29	NA	55.4	4.37	23.4
LCHH_7	4	LCHH	0.046	dense	rain trousers			360	0.17	NA	68.4	7.90	44.3
LCHH_7	5	LCHH	0.086	dense	rain trousers	yes		568	1.89	NA	19.8	5.80	8.32
LCHH_7	6	LCHH	0.031	dense	rain trousers	yes		351	0.28	NA	40.0	1.62	26.1
LCHH_7	7	LCHH	0.040	dense	rain trousers			969	0.64	NA	88.5	9.34	59.8
LCHH_7	8	LCHH	0.070	dense	rain trousers	yes		1257	1.51	NA	154	30.2	78.6
LCHH_7	9	LCHH	0.054	dense	rain trousers			1307	0.93	NA	79.9	8.01	5.61
LCHH_7	10	LCHH	0.026	dense	rain trousers			450	0.15	NA	42.4	1.20	4.66
GH_1	1	LCHH	0.003	normal	none			185	1.90	5554	640	22.4	NA
GH_1	4	HCHH	0.010	dense	cert. coverall			1763	57.5	11842	71.1	320	NA
GH_1	5	HCHH	0.004	dense	cert. coverall			555	0.25	11947	657	1325	NA
GH_1	6	HCHH	0.004	dense	cert. coverall			359	0.25	3446	43.6	360	NA
GH_1	7	HCHH	0.005	dense	cert. coverall			355	0.25	2161	3.03	377	NA
GH_1	8	HCHH	0.005	dense	cert. coverall			268	0.25	2923	48.6	83.4	NA
GH_1	9	LCHH	0.019	normal	none			455	0.25	4203	39.3	215	NA

GH_1	10	LCHH	0.019	normal	none			611	1.48	4897	23.8	300	NA
GH_2	1	HCHH	0.067	normal	trolley			647	0.01	1386	20.2	168	11.9
GH_2	2	HCHH	0.072	normal	trolley			437	0.30	5909	164	45.6	26.6
GH_2	3	HCHH	0.053	normal	trolley			667	0.25	1703	94.6	40.5	18.3
GH_2	4	HCHH	0.072	normal	trolley			318	2.54	3638	42.1	81.1	19.9
GH_2	5	HCHH	0.115	normal	trolley			345	0.10	5126	78.5	35.1	28.0
GH_2	6	HCHH	0.067	normal	trolley			293	0.01	2263	43.1	38.5	15.9
GH_2	7	HCHH	0.074	normal	trolley			573	1.70	4501	59.5	109	15.4
GH_2	8	HCHH	0.086	normal	trolley			1225	0.15	13076	78.4	1024	26.4
GH_2	9	HCHH	0.082	normal	trolley			265	0.01	1338	51.6	123	23.9
GH_2	10	HCHH	0.067	normal	trolley			231	0.01	1660	20.7	13.6	21.1
GH_3	1	HCHH	0.068	normal	none			588	1.14	9739	35.2	4.71	NA
GH_3	2	HCHH	0.075	normal	none			524	1.14	9229	60.2	37.0	NA
GH_3	3	HCHH	0.081	normal	none			433	2.30	12740	27.6	19.3	NA
GH_3	1	HCHH	0.021	normal	none			120	1.11	1310	7.78	4.55	NA
GH_3	2	HCHH	0.025	normal	none			158	1.12	1553	11.2	36.8	NA
GH_3	3	HCHH	0.021	normal	none			191	10.0	2690	13.3	11.5	NA

14 Appendix 3 Additional figures

14.1 Comparison of models for the 75th and 95th percentile (ML tank)

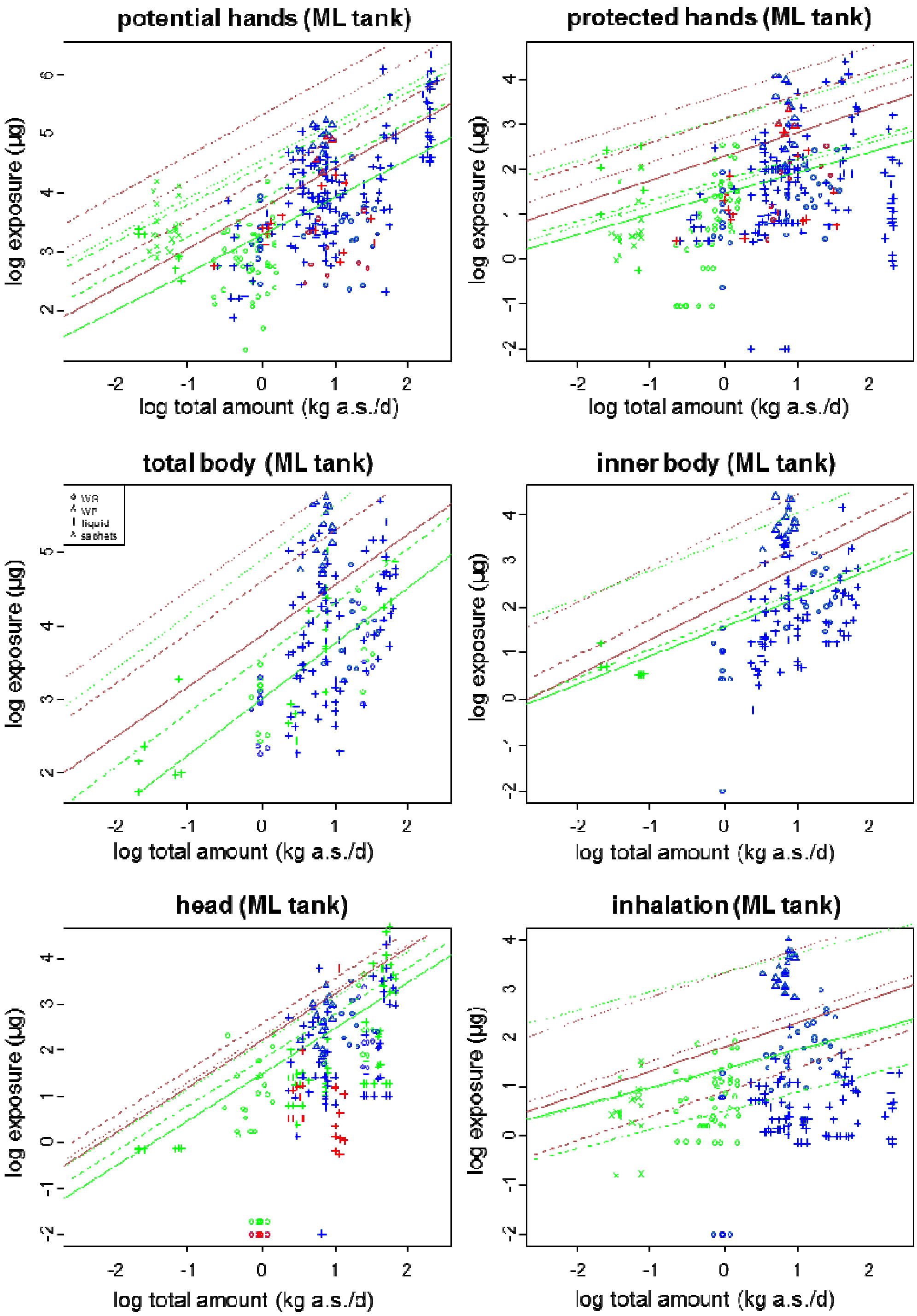

Figure A1: Comparison of the tank mixing/loading models for the 75th percentile (in green) and 95th percentile (in brown); dotted lines: WP formulation, broken/dotted lines: sachets (WP), broken lines: liquid formulations, solid lines: WG formulation; Δ: WP; x: sachets; o: WG; +: liquids, green: greenhouse data, blue/red: outdoor data

14.2 Comparison of models for the 75th and 95th percentile (GH HCHH)

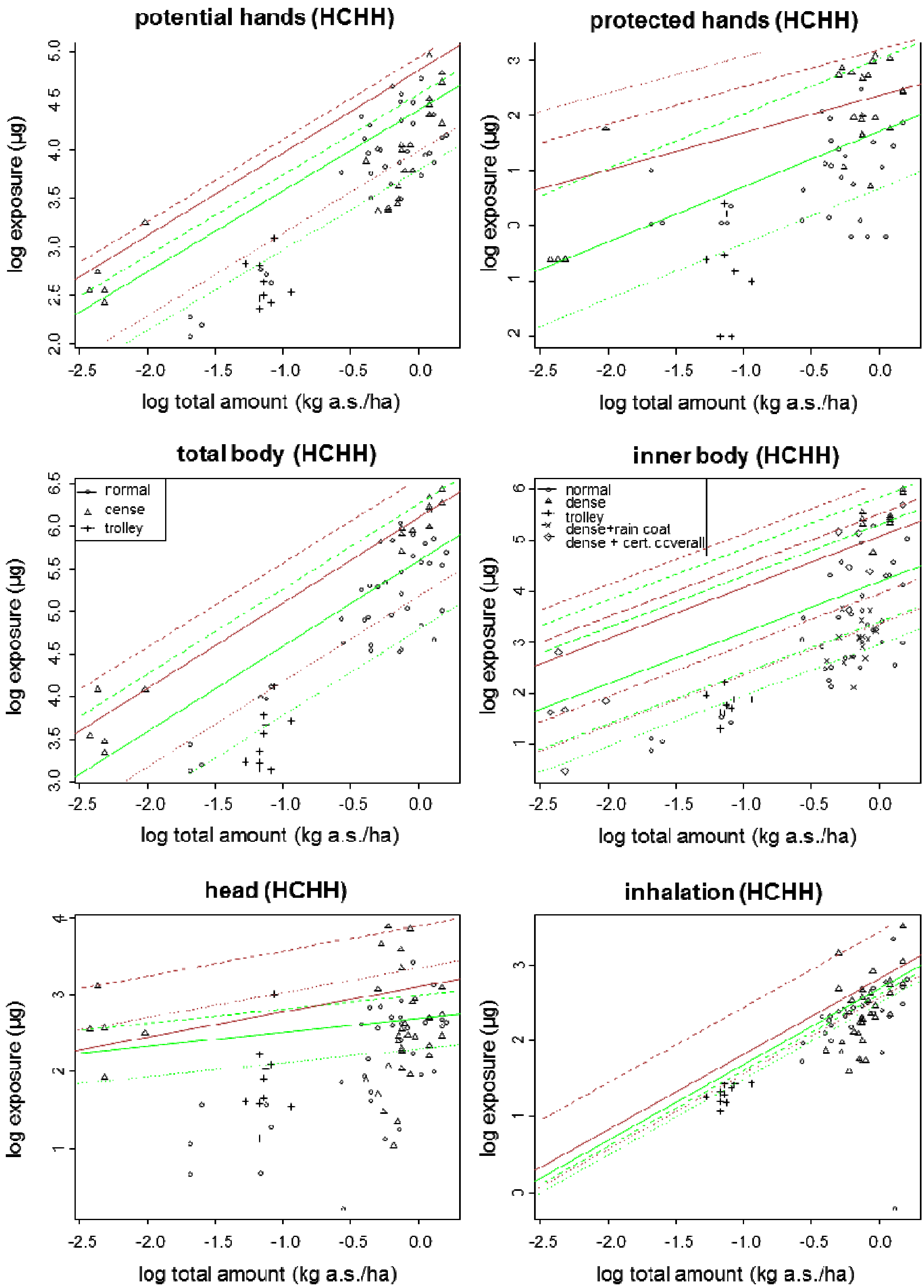

Figure A2: Comparison of the GH HCHH models for the 75th percentile (in green) and 95th percentile (in brown); solid line: normal scenario, broken line: dense scenario with certified coverall, dotted line: trolley sprayer, broken/dotted line: dense scenario with rain suits, small broken line: dense scenario; Δ : dense scenario; o : normal scenario; + : trolley sprayer; x : rain coat; ◊ certified coverall

14.3 Confidence intervalls (ML tank, 75th percentile)

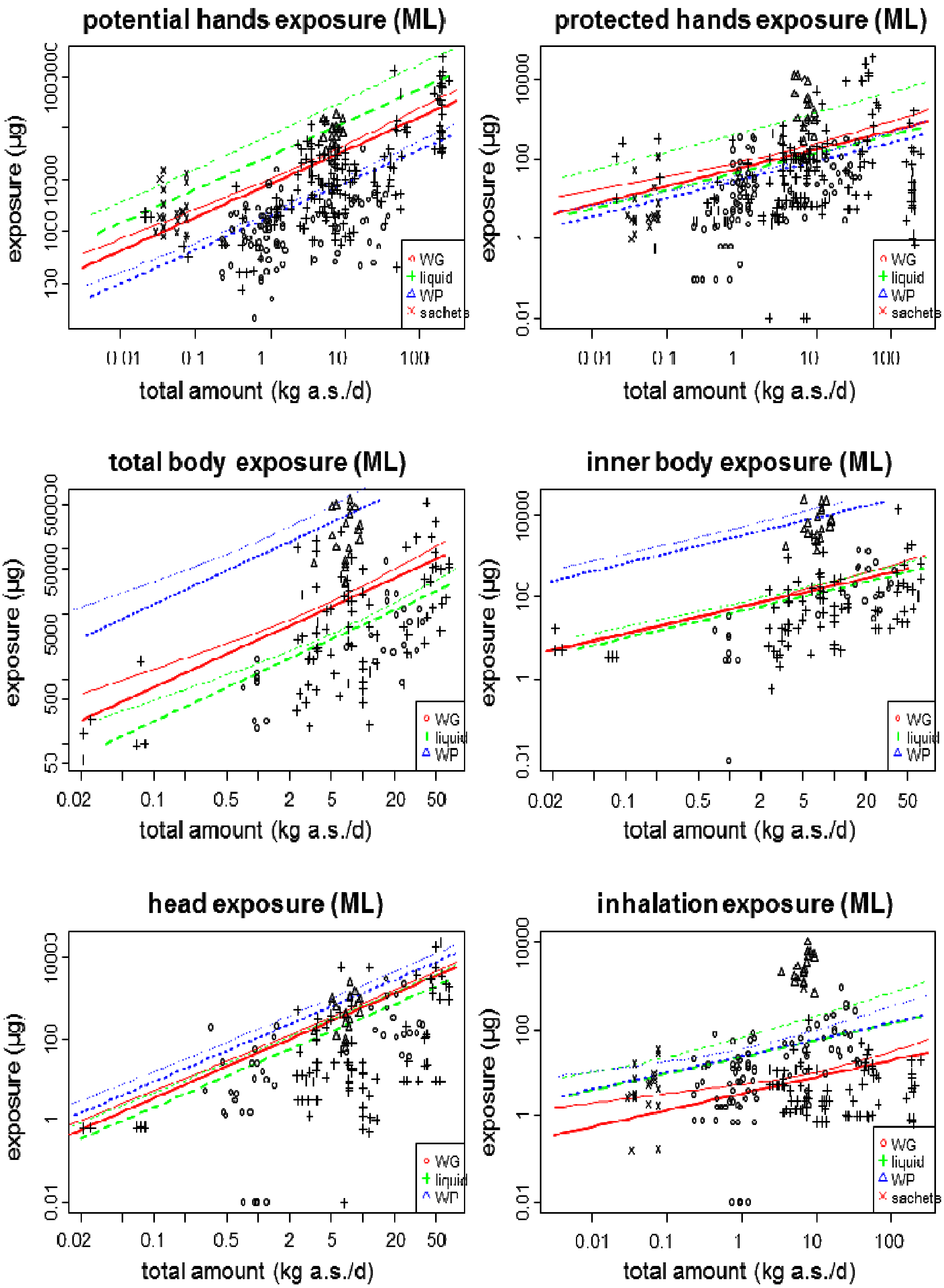

Figure A3: Tank mixing/loading models (75th percentile level) plus upper confidence level (95%), green: liquid, red: WG, blue: WP; Δ: WP; x: sachets; o: WG; +: liquids

14.4 Confidence intervalls (ML tank, 95th percentile)

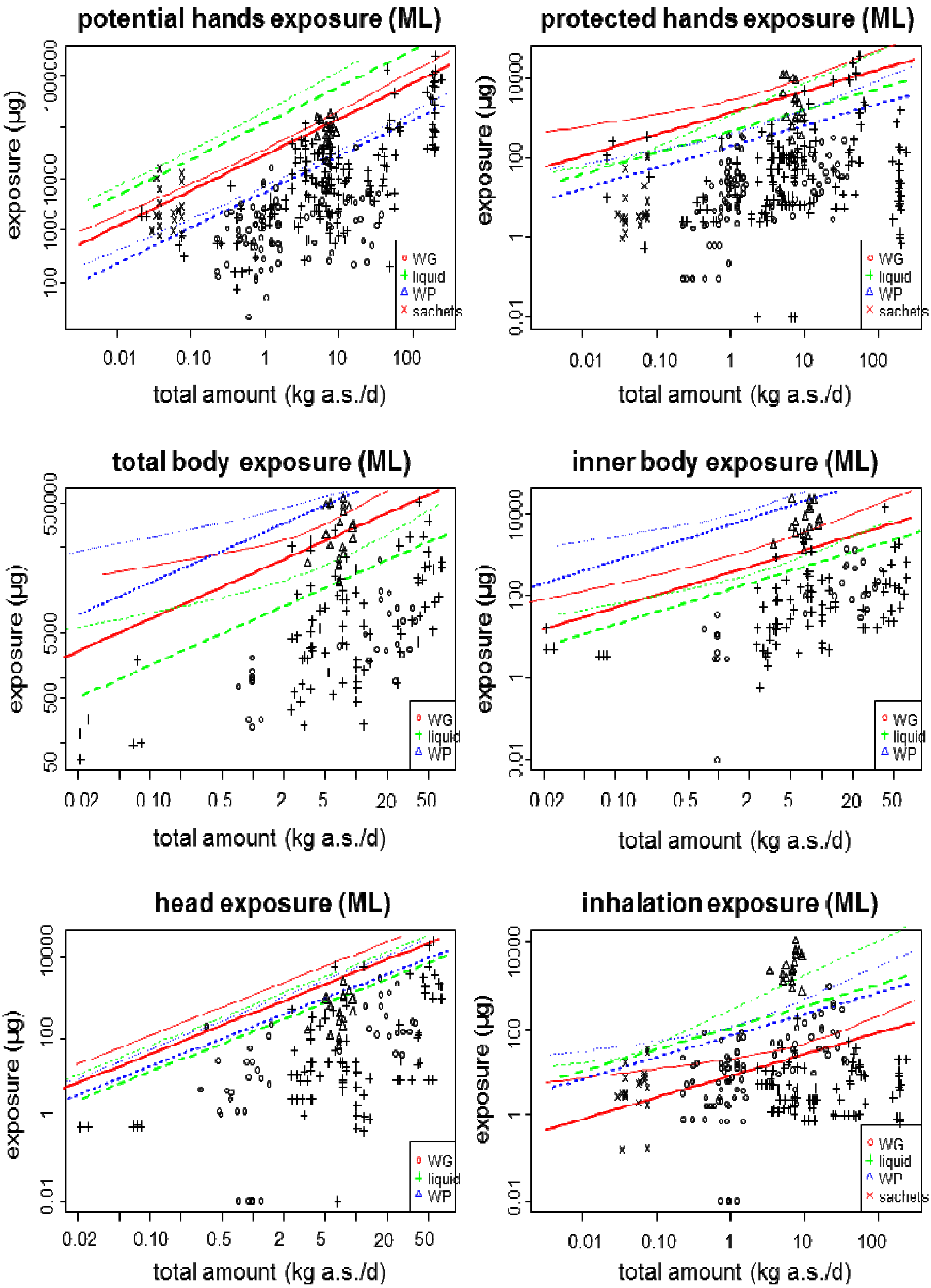

Figure A4: Tank mixing/loading models (95th percentile level) plus upper confidence level (95%), green: liquid, red: WG, blue: WP; Δ: WP; x: sachets; o: WG; +: liquids

14.5 Confidence intervalls (GH HCHH, 75th percentile)

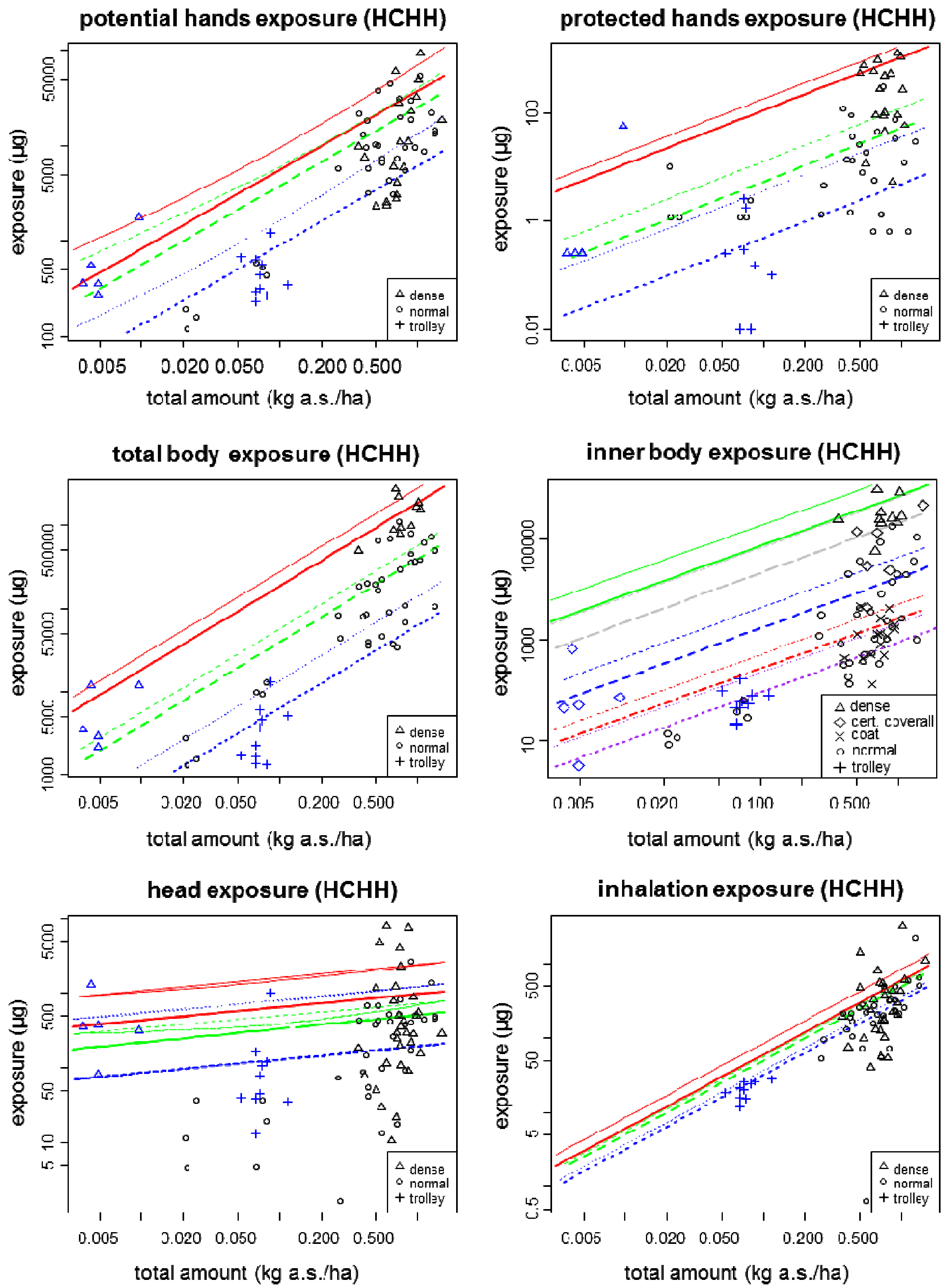

Figure A5: GH HCHH models (75th percentile level) plus upper confidence level (95%), red lines: dense, green lines: normal, blue lines: normal with trolley sprayer, grey lines: dense with certified coverall, purple lines: dense with rain coat; Δ : dense scenario; o : normal scenario; + : trolley sprayer; x : rain coat; ◊ certified coverall; blue: new data, black: old data

14.6 Percentiles (knapsack ML, 75th percentile)

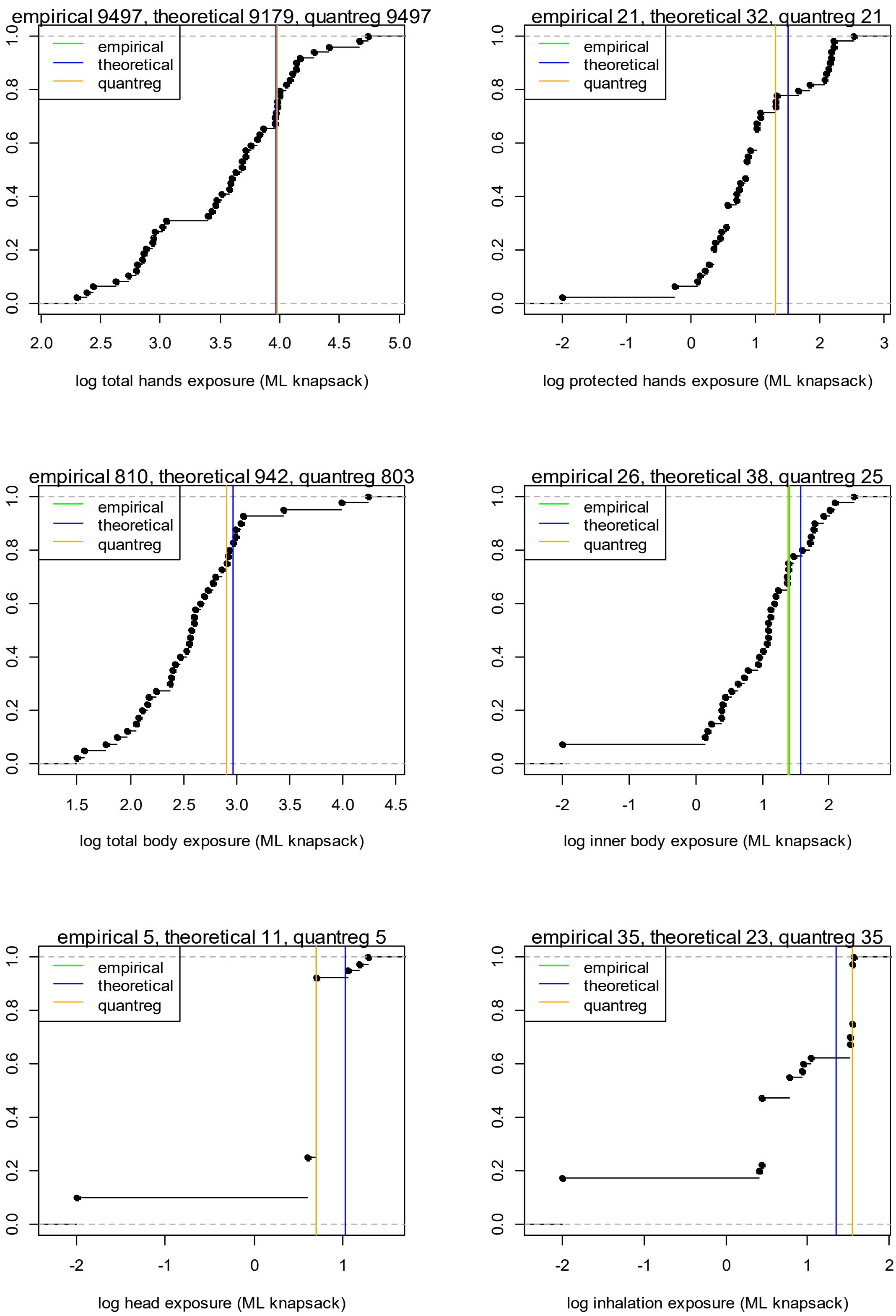

Figure A6: Comparison of the empirical 75th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 75th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.7 Percentiles (knapsack ML, 95th percentile)

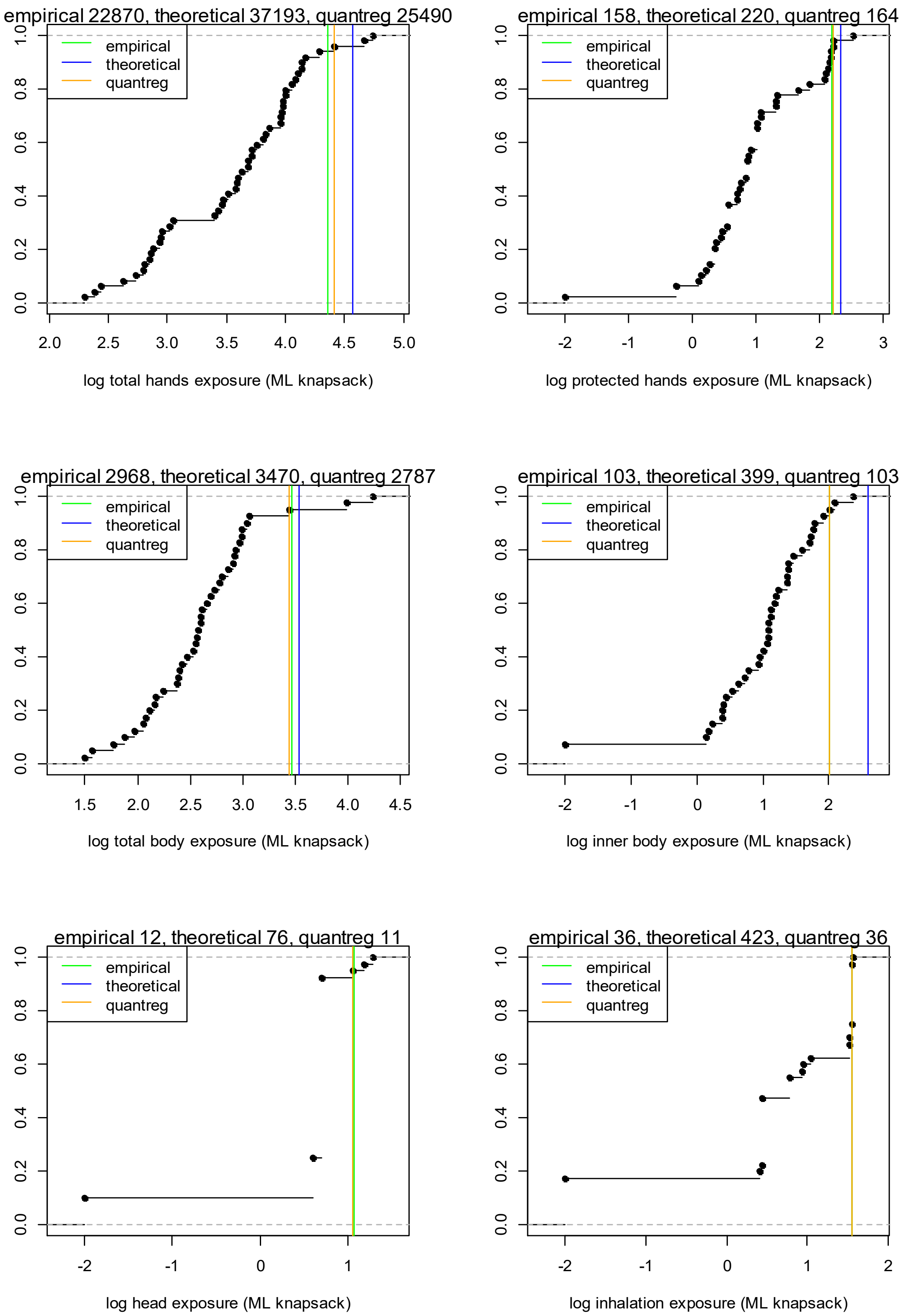

Figure A7: Comparison of the empirical 95th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 95th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.8 Percentiles (GH LCHH, 75th percentile, dense and normal combined)

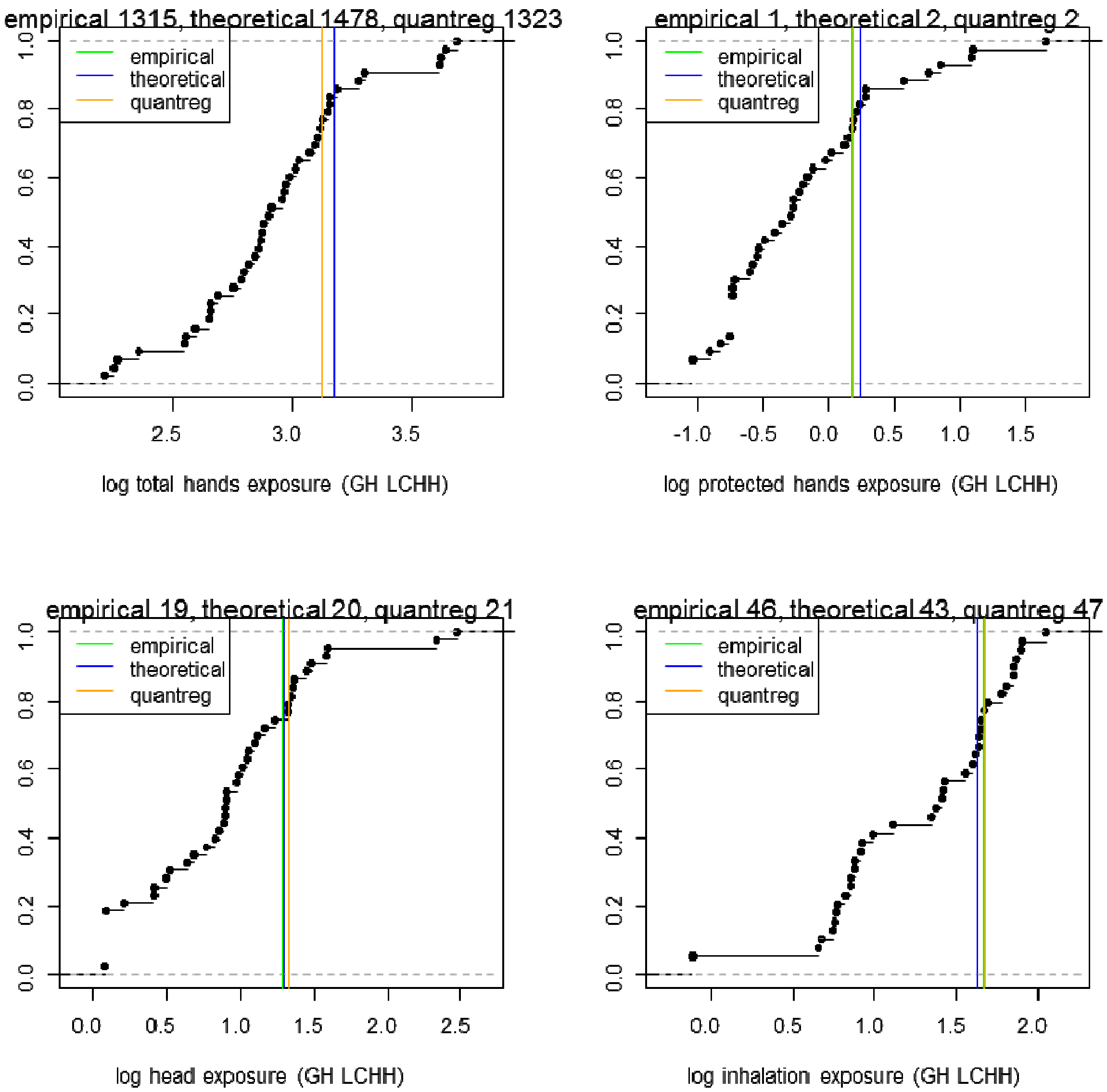

Figure A8: Comparison of the empirical 75th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 75th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.9 Percentiles (GH LCHH, 75th percentile, total body)

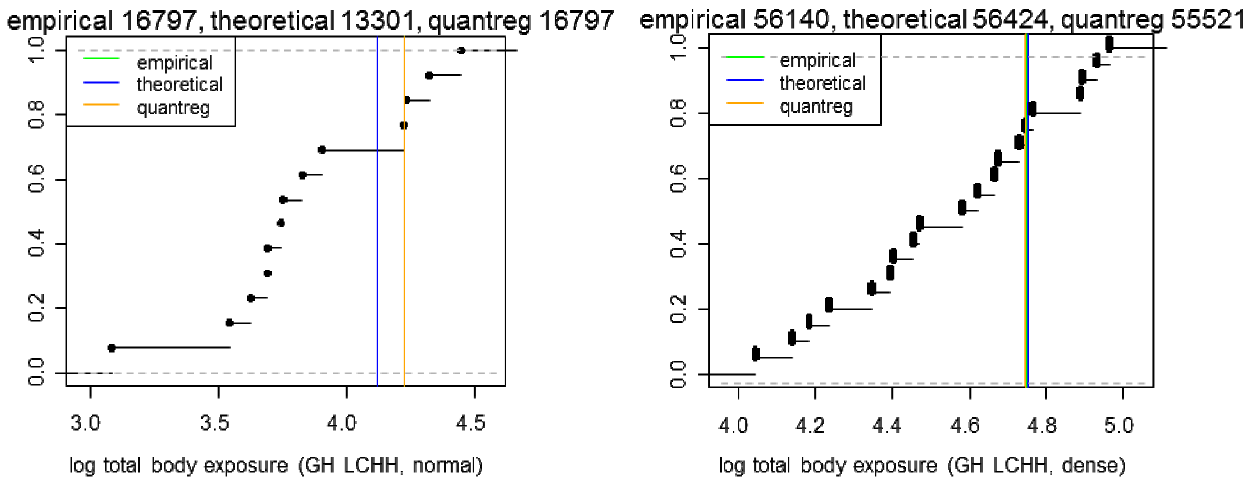

Figure A9: Comparison of the empirical 75th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 75th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.10 Percentiles (GH LCHH, 75th percentile, inner body)

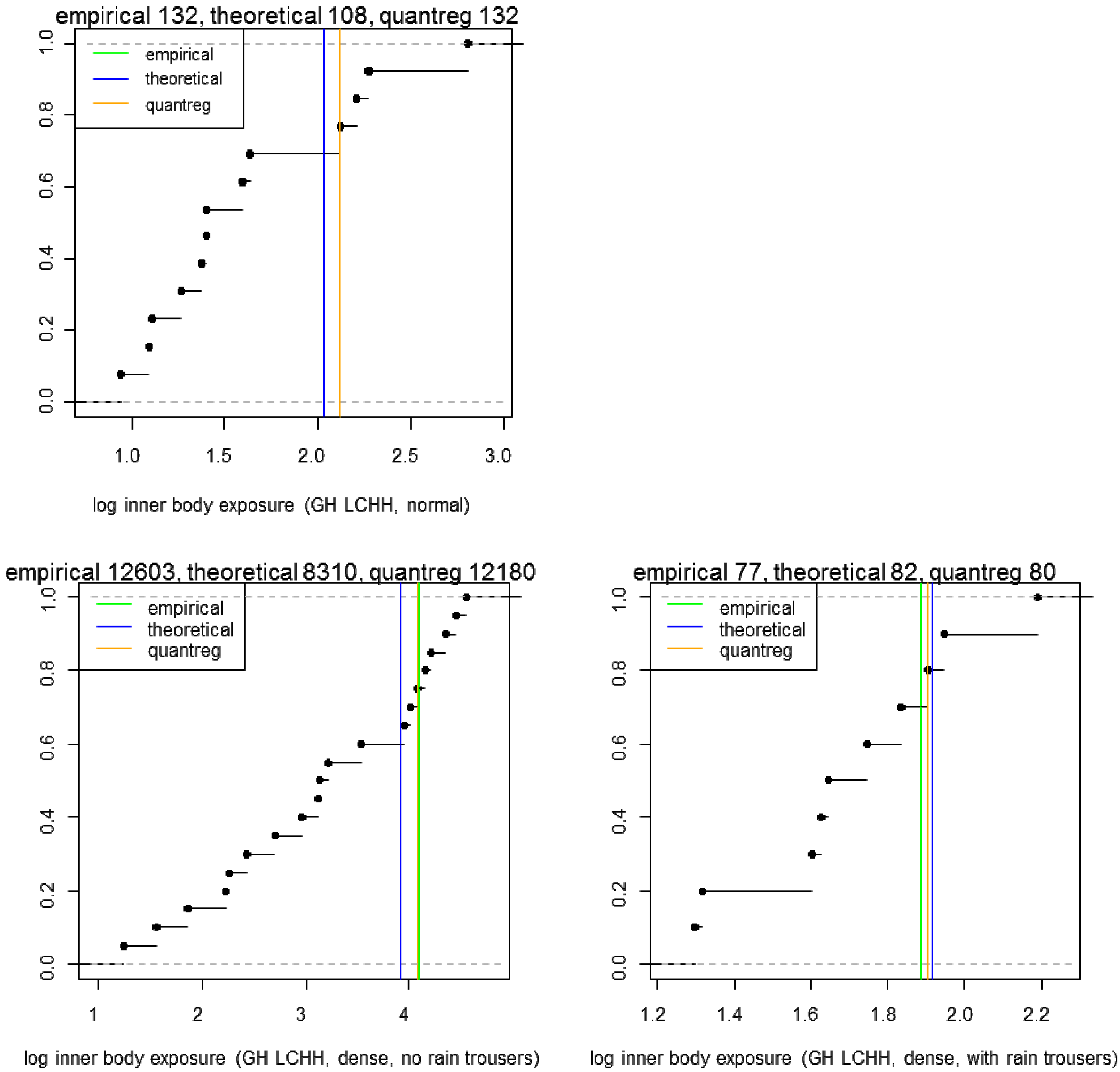

Figure A10: Comparison of the empirical 75th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 75th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.11 Percentiles (GH LCHH, 95th percentile, dense and normal combined)

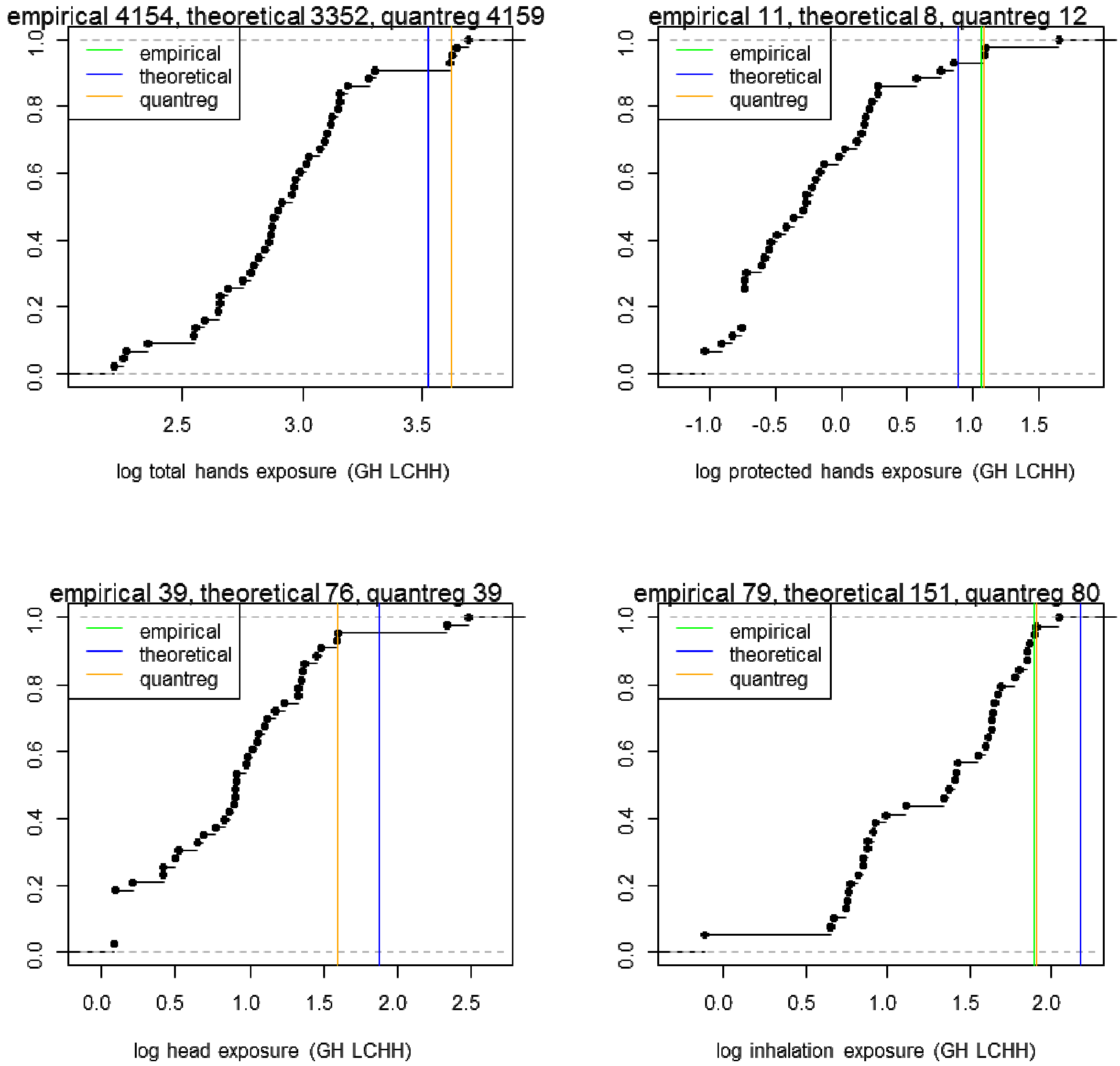

Figure A10: Comparison of the empirical 95th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 95th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.12 Percentiles (GH LCHH, 95th percentile, total body)

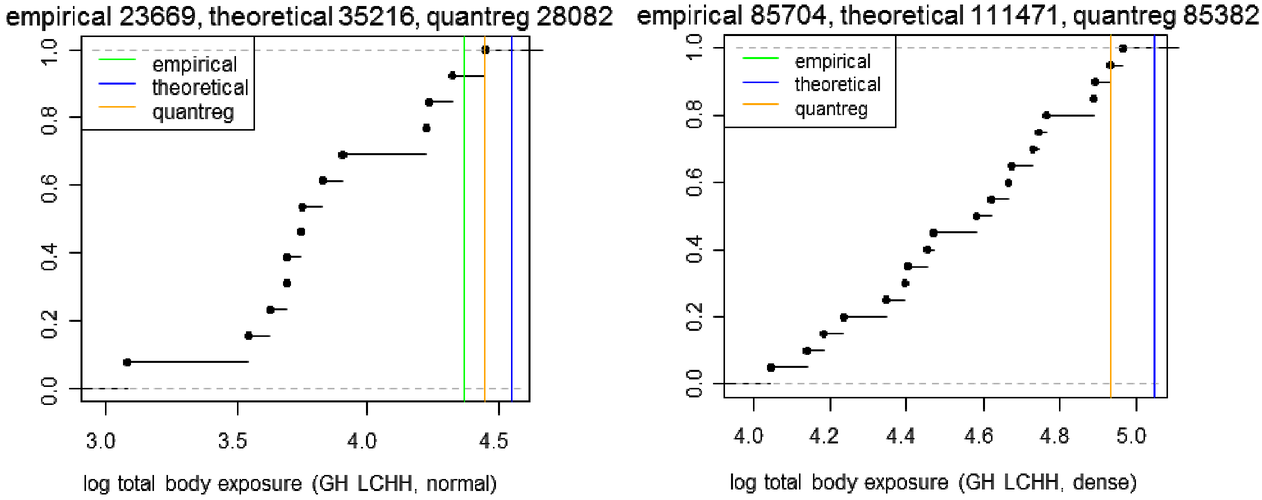

Figure A11: Comparison of the empirical 95th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 95th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.13 Percentiles (GH LCHH, 95th percentile, inner body)

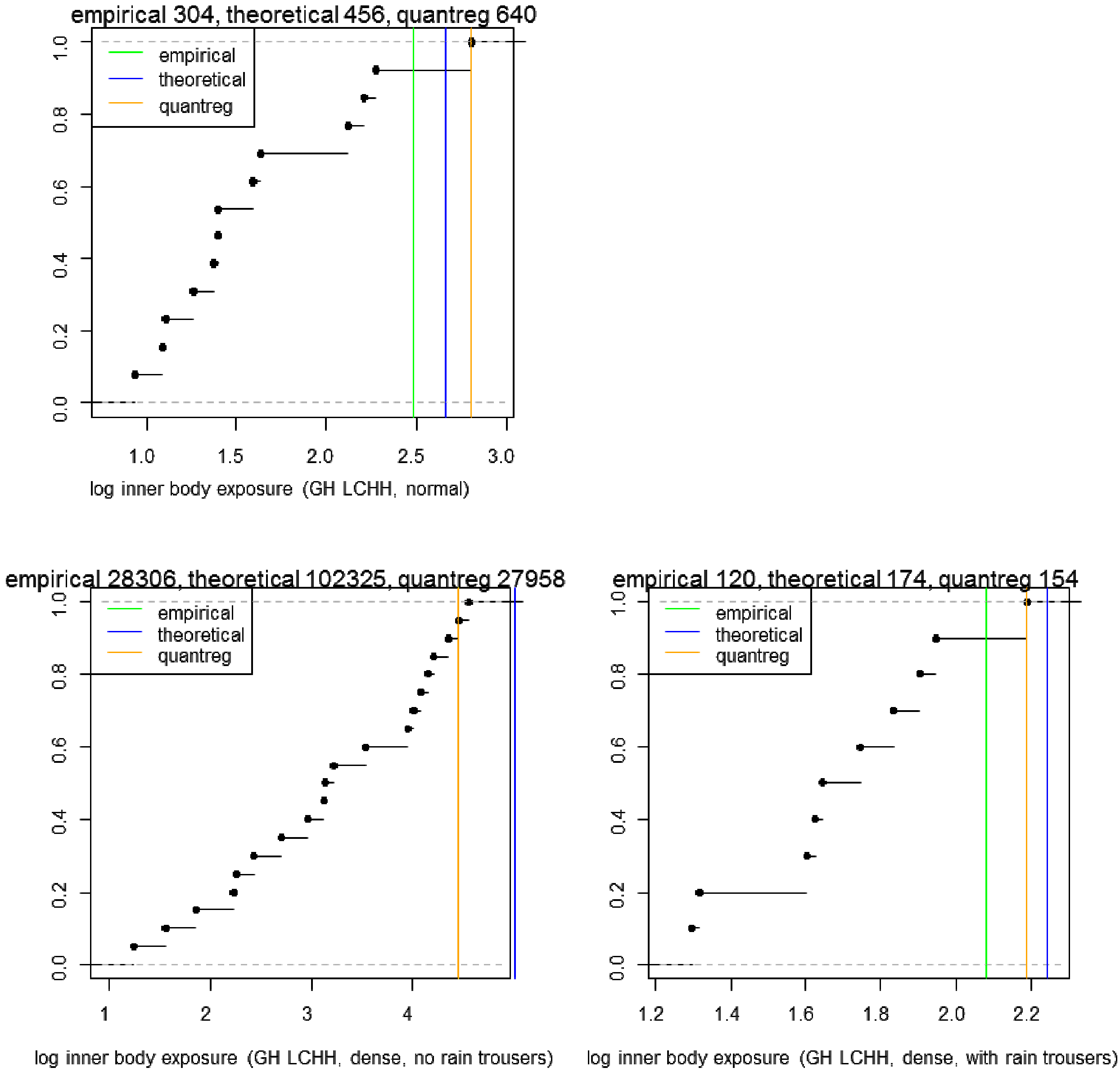

Figure A12: Comparison of the empirical 95th percentile (green) with the parametric estimate of the percentile calculated according EFSA guidance (blue) and the 95th percentile obtained by quantile regression (orange); the y-axis gives the proportion of data with values below a certain level of exposure.

14.14 Cross validation (tank ML, 75th percentile)

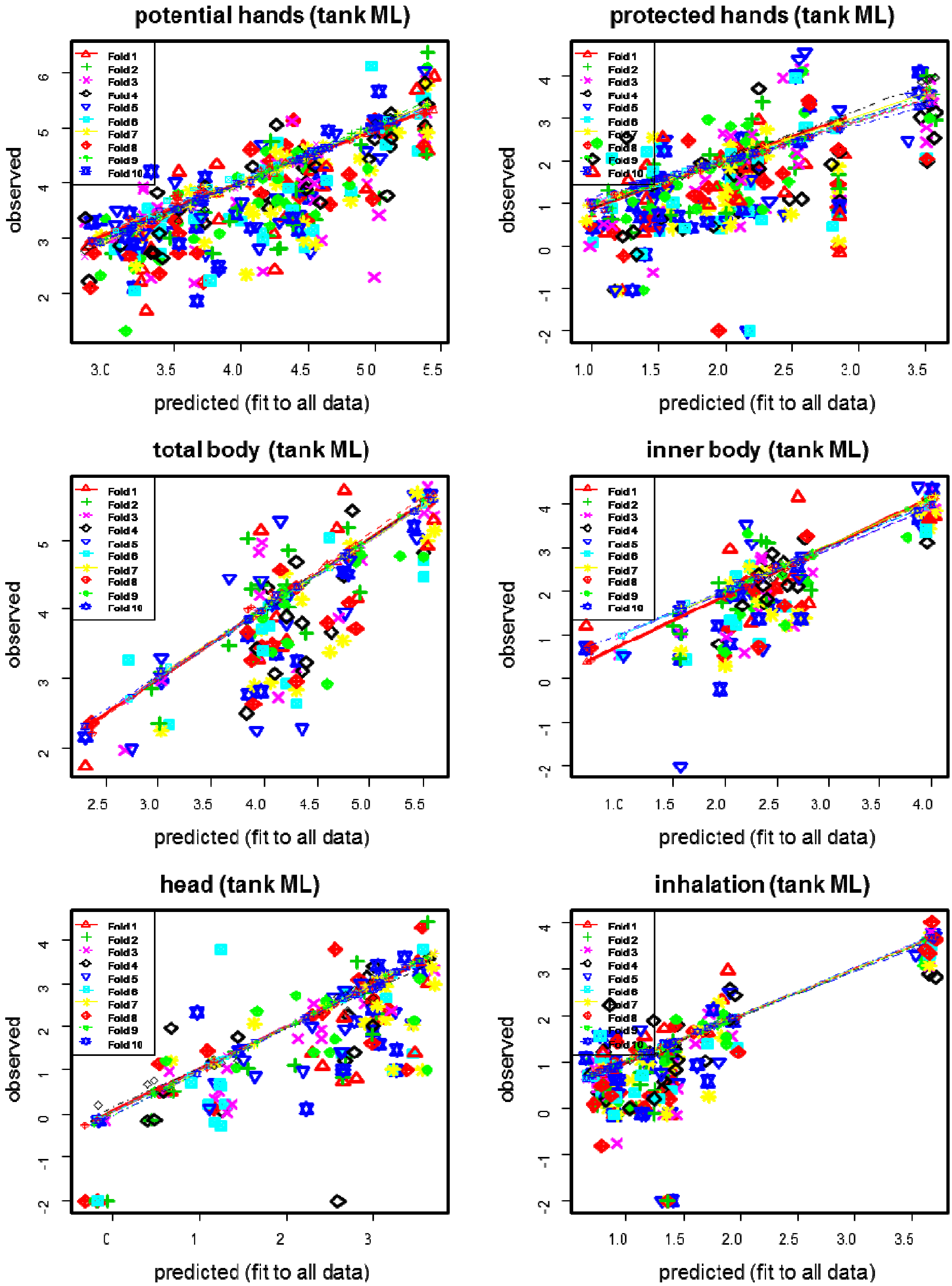

Figure A13: Cross validation of the tank mixing/loading model (75th percentile); shown are random subsets of the whole database in different colours together with the respective models for the reduced datasets

14.15 Cross validation (tank ML, 95th percentile)

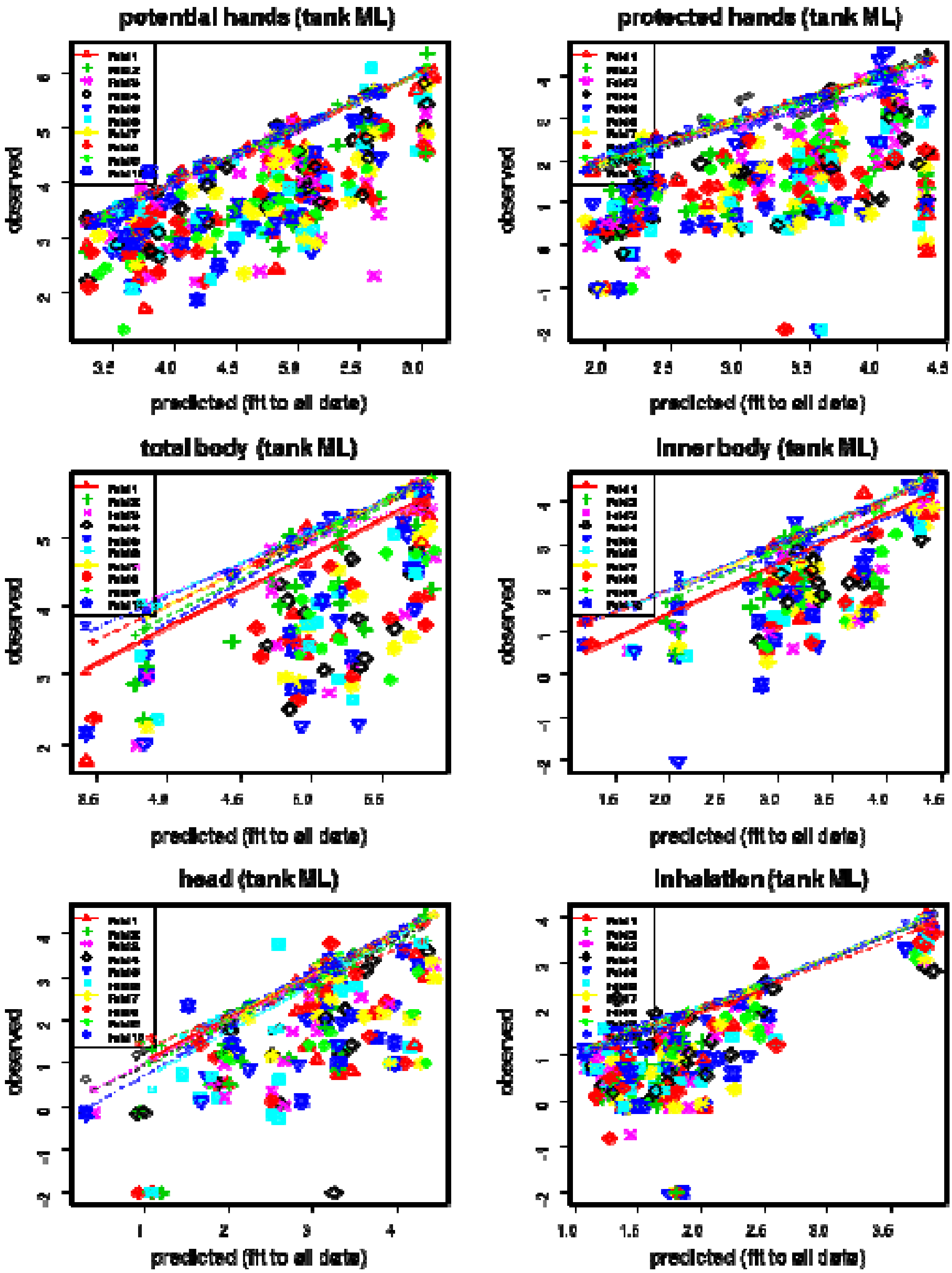

Figure A14: Cross validation of the tank mixing/loading model (95th percentile); shown are random subsets of the whole database in different colours together with the respective models for the reduced datasets

14.16 Cross validation (GH HCHH, 75th percentile)

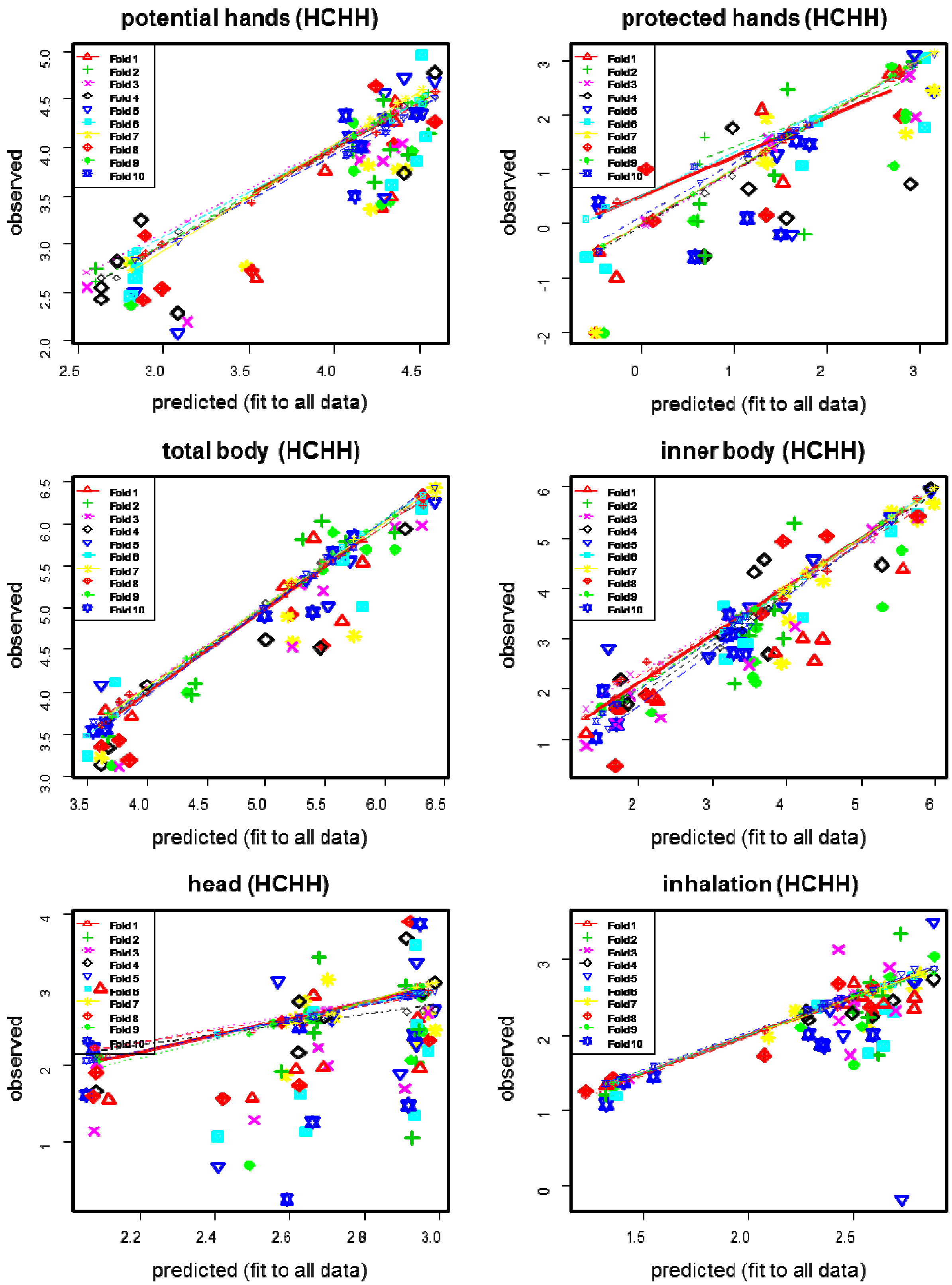

Figure A15: Cross validation of the GH HCHH model (75th percentile); shown are random subsets of the whole database in different colours together with the respective models for the reduced datasets

14.17 Cross validation (GH HCHH, 95th percentile)

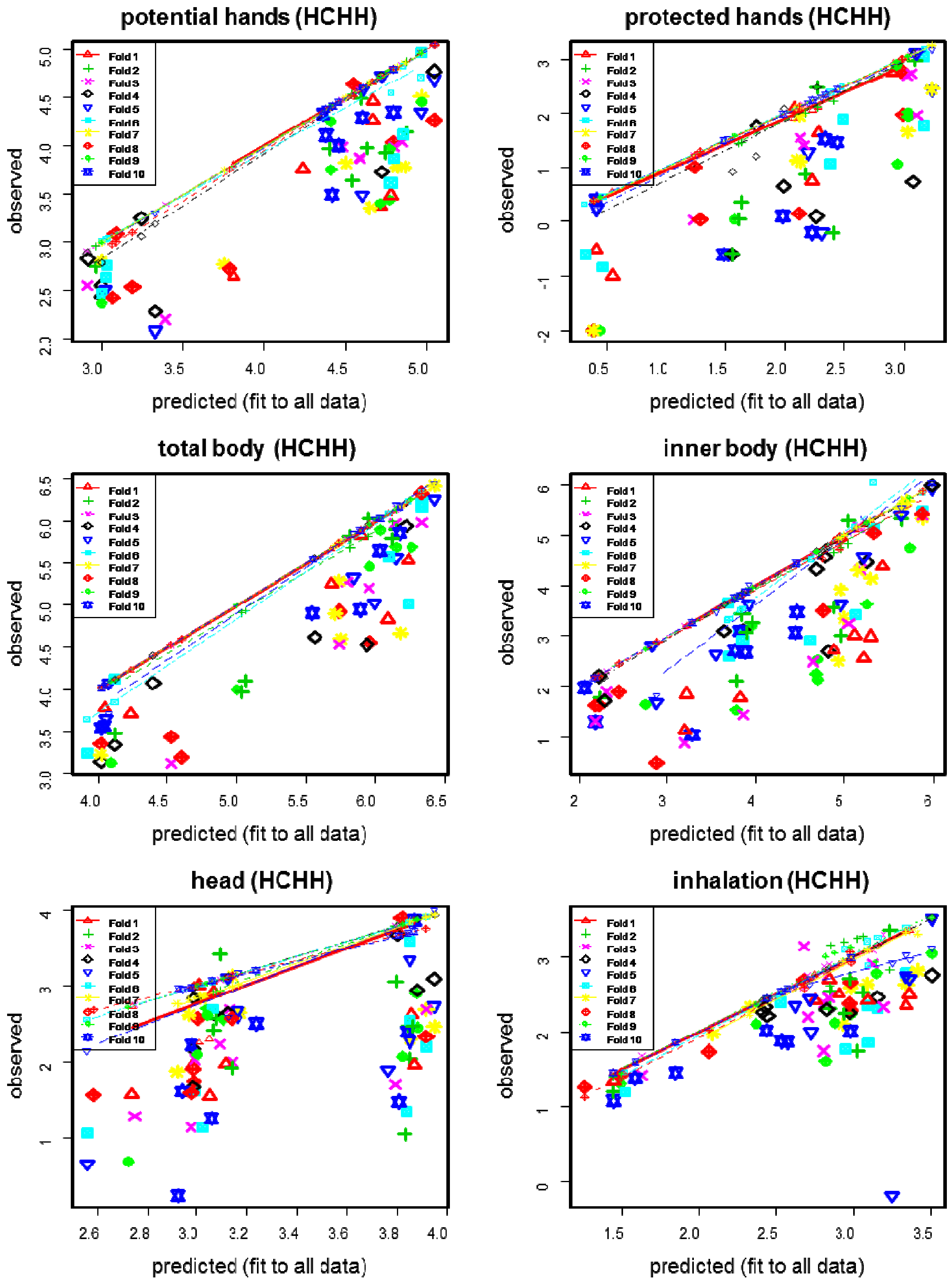

Figure A16: Cross validation of the GH HCHH model (95th percentile); shown are random subsets of the whole database in different colours together with the respective models for the reduced datasets

15 Appendix 4 Model computations

15.1 Abbreviations

Response variables
All exposure (response) variable names are of the following form:
l[r]xx.YY
where

l	log (to remind that all computations are with log expo values)
r	ratio (in order to fix the coefficient of lTA to 1, log of expo/TA was used)
ph	Potential hand
ah	Actual hand
tb	Total body
ib	Inner body
hd	Head
ia	Inhalation
ML	Mixing/loading
A	Application

Covariates

TA	Total amount of active substance, usually used as
lTA	log total amount
form	Product formulation, levels “WG”, “WP”, “liquid”
form2	Product formulation, levels “WG”, “WP”, “liquid”, “sachets”
dense4	Originally designed to distinguish between normal and dense culture, an additional level for trolley was added. Factor levels: “normal culture”, “dense culture”, “normal culture with trolley”.
dense5	Culture. Factor levels: “normal culture”, “dense culture”, “normal culture with trolley”, “dense culture with rain coat”, “dense culture with certified coverall”. Only relevant for inner body exposure..

15.2 75th percentile

```
####################################################
###
### model output for ML - tank
###
####################################################
```

Model: lrph.ML ~ form2 + glove.wash.ML

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
WG    90  21.34896 1225.741 2530.052  5045.769  7279.347  40938.82
WP    20 5852.58065 80850.401 99175.969 146688.913 149519.509 180190.32
liquid 175  73.56494 8681.192 36069.752 126389.812 520084.592 2346736.06
sachets 20 795.10000 2258.369 4124.857 10838.527 13202.153  15830.54

Table of predicted values (75th percentile):
  TA  form2 glove.wash.ML lTA    LS.75    QR.75
1  1   WP         0  34240.829  16531.141
2  10   WP         1  342408.293 165311.411
3 100   WP         2 3424082.933 1653114.107
4  1   WG         0   1739.908  1799.502
5  10   WG         1  17399.084  17995.016
6 100   WG         2  173990.836 179950.163
7  1 liquid         0   3579.101  3841.614
8  10 liquid         1  35791.011  38416.137
9 100 liquid         2  357910.113 384161.374
10  1 sachets         0  150920.981  89549.821
```

```
11 10 sachets         1 1509209.814 895498.208
12 100 sachets         2 15092098.141 8954982.079

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min      1Q  Median      3Q     Max
-2.49952 -0.47297 0.01155 0.46294 1.95074

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)    2.79221  0.07082 39.427 < 2e-16 ***
form2WP      1.28522  0.16371  7.851 7.39e-14 ***
form2liquid    0.31447  0.08564  3.672 0.000285 ***
form2sachets   1.92977  0.16371 11.788 < 2e-16 ***
glove.wash.MLyes -0.42320  0.13198 -3.207 0.001488 **
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6601 on 300 degrees of freedom
 (364 observations deleted due to missingness)
Multiple R-squared: 0.3901,  Adjusted R-squared: 0.382
F-statistic: 47.98 on 4 and 300 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrph.ML ~ form2 + glove.wash.ML

N: 305   tau: 0.75   AIC: 652.013207782643

         coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)     3.2551522 3.2140887 3.3780091 0.06143926 52.981628 0.000000e+00
form2WP       0.9631506 0.8214243 1.1268055 0.15272796 6.306315 1.021169e-09
form2liquid     0.3293615 0.1661535 0.3927364 0.07378166 4.464002 1.139850e-05
form2sachets    1.6969125 1.3790137 2.0032975 0.23767952 7.139498 7.097878e-12
glove.wash.MLyes  -0.2856362 -0.4782113 -0.1968359 0.06976519 -4.094250 5.451465e-05

Formula for mean (based on LS-estimate):
log(ph.ML) = log(TA) + 2.792 + 1.285 form2WP + 0.314 form2liquid + 1.93 form2sachets + -0.423
glove.wash.MLyes
Formula for 75th percentile (based on quantile regression):
log(ph.ML) = log(TA) + 3.255 + 0.963 form2WP + 0.329 form2liquid + 1.697 form2sachets + -0.286
glove.wash.MLyes

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

Model: lph.ML ~ lTA + form2 + glove.wash.ML

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
WG    90  21.34896 1225.741 2530.052  5045.769  7279.347  40938.82
WP    20 5852.58065 80850.401 99175.969 146688.913 149519.509 180190.32
liquid 175  73.56494 8681.192 36069.752 126389.812 520084.592 2346736.06
sachets 20 795.10000 2258.369 4124.857 10838.527 13202.153  15830.54

Table of predicted values (75th percentile):
  TA  form2 glove.wash.ML lTA    LS.75   QR.75
1  1   WP         0  64831.428 35546.172
2  10   WP         1 265105.361 156271.205
3 100   WP         2 1090146.714 687013.202
4  1   WG         0  2059.248  1859.619
5  10   WG         1  8445.669  8175.419
6 100   WG         2  34836.159 35941.495
7  1 liquid         0  7428.748  8036.241
8  10 liquid         1  30358.647 35329.628
9 100 liquid         2 124777.882 155319.213
10  1 sachets         0  43171.834 27740.654
11 10 sachets         1 178633.195 121955.898
12 100 sachets         2 743106.477 536153.234

Summary of LS fit (mean):
```

```
Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.19998 -0.35300 -0.01213 0.41159 1.63076

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)    2.90826  0.06556 44.361 < 2e-16 ***
lTA        0.61243  0.04700 13.030 < 2e-16 ***
form2WP      1.48940  0.15007  9.925 < 2e-16 ***
form2liquid    0.55736  0.08285  6.728 8.78e-11 ***
form2sachets   1.31192  0.16590  7.908 5.10e-14 ***
glove.wash.MLyes -0.40695  0.11934 -3.410 0.000739 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5968 on 299 degrees of freedom
 (364 observations deleted due to missingness)
Multiple R-squared: 0.5748,   Adjusted R-squared: 0.5677
F-statistic: 80.84 on 5 and 299 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lph.ML ~ lTA + form2 + glove.wash.ML

N: 305   tau: 0.75   AIC: 604.98929801544

         coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)     3.2694239 3.2124633 3.4216246 0.06835938 47.826999 0.000000e+00
lTA         0.6430861 0.4740712 0.7718204 0.05605530 11.472351 0.000000e+00
form2WP       1.2813689 1.1076884 1.5548866 0.10017441 12.791380 0.000000e+00
form2liquid     0.6356290 0.4466736 0.9090443 0.08952586 7.099949 9.126921e-12
form2sachets    1.1736928 0.7326917 1.6359539 0.26747637 4.388024 1.587735e-05
glove.wash.MLyes  -0.4699328 -0.5613571 -0.2712758 0.07785350 -6.036116 4.667750e-09


Formula for mean (based on LS-estimate):
log(ph.ML) = 2.908 + 0.612 log(TA) + 1.489 form2WP + 0.557 form2liquid + 1.312 form2sachets +
-0.407 glove.wash.MLyes
Formula for 75th percentile (based on quantile regression):
log(ph.ML) = 3.269 + 0.643 log(TA) + 1.281 form2WP + 0.636 form2liquid + 1.174 form2sachets +
-0.47 glove.wash.MLyes

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

Model: lrah.ML ~ form2

```
Table of measured values:
     n     min     50%     75%     90%    95%    max
WG    91 0.09090909  16.870588  46.409286  168.90000  306.4571  948.1000
WP    20 94.60000000 1229.123656 3586.500000 10171.50538 12059.1398 12161.2903
liquid 173 0.01000000  48.478261 141.000000  688.54545 2466.8251 37085.1549
sachets 20 0.95010753  3.306452  8.347043  59.11828  107.4919  120.1075

Table of predicted values (75th percentile):
  TA  form2 lTA    LS.75    QR.75
1  1   WP  0  964.05364  443.00654
2  10   WP  1 9640.53638 4430.06536
3 100   WP  2 96405.36382 44300.65359
4  1   WG  0  31.10619  19.38751
5  10   WG  1  311.06192  193.87505
6 100   WG  2 3110.61925 1938.75051
7  1 liquid  0  25.11747  22.41907
8  10 liquid  1  251.17465  224.19073
9 100 liquid  2 2511.74652 2241.90726
10  1 sachets  0  580.42167  129.10541
11 10 sachets  1 5804.21668 1291.05406
12 100 sachets  2 58042.16682 12910.54056

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)
```

```
Residuals:
  Min   1Q Median   3Q   Max
-3.5717 -0.5806 0.0872 0.6141 3.3344

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.78770  0.10886  7.236 3.89e-12 ***
form2WP    1.47778  0.25647  5.762 2.06e-08 ***
form2liquid -0.09105  0.13448 -0.677  0.499
form2sachets 1.25742  0.25647  4.903 1.55e-06 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.038 on 300 degrees of freedom
 (365 observations deleted due to missingness)
Multiple R-squared: 0.1815,  Adjusted R-squared: 0.1733
F-statistic: 22.17 on 3 and 300 DF, p-value: 5.377e-13

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrah.ML ~ form2

N: 304   tau: 0.75   AIC: 899.79137189803

       coefficients  lower bd upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  1.28752193 1.1681786 1.4765344 0.1008029 12.7726614 0.0000000000
form2WP    1.35888821 1.0911659 1.8965100 0.3516394 3.8644364 0.0001364967
form2liquid  0.06309572 -0.1351295 0.2301142 0.1330752 0.4741357 0.6357480494
form2sachets  0.82342250 0.5860235 1.8950040 0.5892117 1.3974984 0.1632963399


Formula for mean (based on LS-estimate):
log(ah.ML) = log(TA) + 0.788 + 1.478 form2WP + -0.091 form2liquid + 1.257 form2sachets
Formula for 75th percentile (based on quantile regression):
log(ah.ML) = log(TA) + 1.288 + 1.359 form2WP + 0.063 form2liquid + 0.823 form2sachets

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

Model: lah.ML ~ lTA + form2

```
Table of measured values:
     n     min     50%     75%     90%    95%    max
WG    91 0.09090909  16.870588  46.409286  168.90000  306.4571  948.1000
WP    20 94.60000000 1229.123656 3586.500000 10171.50538 12059.1398 12161.2903
liquid 173 0.01000000  48.478261 141.000000  688.54545 2466.8251 37085.1549
sachets 20 0.95010753  3.306452  8.347043  59.11828  107.4919  120.1075

Table of predicted values (75th percentile):
  TA  form2 lTA    LS.75    QR.75
1  1   WP  0 2708.17648 1318.40779
2  10   WP  1 6447.99607 3837.54115
3 100   WP  2 15487.70361 11170.08119
4  1   WG  0  40.69532  29.01827
5  10   WG  1  97.35199  84.46460
6 100   WG  2  234.97189  245.85442
7  1 liquid  0  81.49198  60.04761
8  10 liquid  1  193.84516  174.78294
9 100 liquid  2  465.25706  508.74755
10  1 sachets  0  77.58415  46.08060
11 10 sachets  1  188.18568  134.12860
12 100 sachets  2  460.30442  390.41336

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.6072 -0.5639 -0.0135 0.5102 2.6299

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.97475  0.10044  9.704 < 2e-16 ***
lTA      0.37803  0.07361  5.135 5.09e-07 ***
```

```
form2WP    1.80985  0.23414  7.730 1.65e-13 ***
form2liquid  0.30169  0.12965  2.327  0.0206 *
form2sachets 0.26508  0.25898  1.024  0.3069
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9346 on 299 degrees of freedom
 (365 observations deleted due to missingness)
Multiple R-squared: 0.2843,   Adjusted R-squared: 0.2747
F-statistic: 29.69 on 4 and 299 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lah.ML ~ lTA + form2

N: 304   tau: 0.75   AIC: 858.058447717705

       coefficients  lower bd upper bd Std. Error  t value     Pr(>|t|)
(Intercept)   1.4626714 1.4090356 1.6609152 0.09084104 16.1014392 0.00000000000000
lTA       0.4640033 0.1739186 0.6450587 0.08318585 5.5779114 0.00000005450718
form2WP     1.6573783 1.4416420 2.2045079 0.33329034 4.9727764 0.00000111441966
form2liquid   0.3158243 0.1122561 0.4585434 0.13437066 2.3503964 0.01940309066814
form2sachets  0.2008467 -0.5933705 0.9813377 0.61596248 0.3260696 0.74459977355648


Formula for mean (based on LS-estimate):
log(ah.ML) = 0.975 + 0.378 log(TA) + 1.81 form2WP + 0.302 form2liquid + 0.265 form2sachets
Formula for 75th percentile (based on quantile regression):
log(ah.ML) = 1.463 + 0.464 log(TA) + 1.657 form2WP + 0.316 form2liquid + 0.201 form2sachets

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

Model: lrtb.ML ~ form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  181.69720  2691.732  9850.784 20638.24 25671.59 67310.76
WP   20 28896.67519 146633.657 367452.410 452450.19 478880.28 575868.61
liquid 86  55.95238  5600.451 28926.789 91002.52 145449.83 511526.97

Table of predicted values (75th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0  60430.003  45249.8039
2 10   WP  1 604300.026 452498.0392
3 100   WP  2 6043000.264 4524980.3922
4  1   WG  0  1237.450   995.7286
5 10   WG  1  12374.496  9957.2862
6 100   WG  2 123744.956  99572.8615
7  1 liquid  0  2364.388  2449.0338
8 10 liquid  1  23643.875  24490.3382
9 100 liquid  2 236438.753 244903.3816

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.70952 -0.50156 -0.00823 0.39845 1.72338

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.6385   0.1226 21.528 < 2e-16 ***
form2WP    1.6853   0.1918  8.785 7.17e-15 ***
form2liquid  0.2862   0.1417  2.020  0.0454 *
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.66 on 132 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.402,   Adjusted R-squared: 0.393
F-statistic: 44.37 on 2 and 132 DF, p-value: 1.826e-15

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

```
Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrtb.ML ~ form2

N: 135   tau: 0.75   AIC: 302.000391749022

      coefficients lower bd upper bd Std. Error  t value  Pr(>|t|)
(Intercept)  2.9981410 2.9615521 3.1130029 0.05185932 57.812963 0.000000000
form2WP    1.6574757 1.4314624 1.8528635 0.15237822 10.877379 0.000000000
form2liquid  0.3908538 0.2095722 0.5044238 0.13318669 2.934631 0.003939706


Formula for mean (based on LS-estimate):
log(tb.ML) = log(TA) + 2.638 + 1.685 form2WP + 0.286 form2liquid
Formula for 75th percentile (based on quantile regression):
log(tb.ML) = log(TA) + 2.998 + 1.657 form2WP + 0.391 form2liquid

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

Model: ltb.ML ~ lTA + form2

```
Table of measured values:
    n     min     50%     75%     90%     95%     max
WG   29  181.69720  2691.732  9850.784 20638.24 25671.59 67310.76
WP   20 28896.67519 146633.657 367452.410 452450.19 478880.28 575868.61
liquid 86  55.95238  5600.451 28926.789 91002.52 145449.83 511526.97

Table of predicted values (75th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0 103493.923  76504.971
2 10   WP  1 512476.443 422269.512
3 100   WP  2 2576912.231 2330718.368
4  1   WG  0  2123.110  1089.319
5 10   WG  1  10512.399  6012.503
6 100   WG  2  52862.446  33186.036
7  1 liquid  0  4104.575  3598.487
8 10 liquid  1  20317.290  19861.864
9 100 liquid  2 102153.906 109627.645
Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-1.6426 -0.4004 0.0208 0.3977 1.5803

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 2.89199  0.13455 21.494 < 2e-16 ***
lTA     0.69699  0.07987  8.726 1.05e-14 ***
form2WP   1.68474  0.18279  9.217 6.63e-16 ***
form2liquid 0.29099  0.13505  2.155  0.033 *
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6289 on 131 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.5686,  Adjusted R-squared: 0.5587
F-statistic: 57.56 on 3 and 131 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: ltb.ML ~ lTA + form2

N: 135   tau: 0.75   AIC: 291.19693483362

      coefficients lower bd upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  3.0371552 3.0023963 3.4594498 0.1490205 20.380782 0.000000e+00
lTA      0.7419001 0.5139077 0.8852366 0.1161254 6.388781 2.686496e-09
form2WP    1.8465344 1.3824708 2.0841422 0.1967461 9.385369 2.220446e-16
form2liquid  0.5189647 0.2143445 0.6266098 0.1592473 3.258861 1.425141e-03


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

```
log(tb.ML) = 2.892 + 0.697 log(TA) + 1.685 form2WP + 0.291 form2liquid
Formula for 75th percentile (based on quantile regression):
log(tb.ML) = 3.037 + 0.742 log(TA) + 1.847 form2WP + 0.519 form2liquid

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

Model: lrib.ML ~ form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  0.0100000 104.34783 230.4348  607.6532 1070.524 1491.304
WP   20 1333.4900000 4929.54637 9979.8946 22420.8358 22751.213 24890.700
liquid 86  0.5747126  54.07694 175.8362  504.6776 1550.291 14684.270

Table of predicted values (75th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0  2596.29413  1276.35477
2 10   WP  1 25962.94127 12763.54769
3 100   WP  2 259629.41266 127635.47694
4  1   WG  0   24.01766   22.26526
5 10   WG  1  240.17661  222.65258
6 100   WG  2  2401.76613  2226.52582
7  1 liquid  0   24.55259   24.96635
8 10 liquid  1  245.52594  249.66353
9 100 liquid  2  2455.25942  2496.63534

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.85756 -0.39006 -0.09731 0.47627 2.00917

Coefficients:
      Estimate Std. Error t value   Pr(>|t|)
(Intercept) 0.87528  0.13639  6.418 0.00000000228 ***
form2WP   2.03005  0.21348  9.509    < 2e-16 ***
form2liquid 0.01518  0.15771  0.096     0.923
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7345 on 132 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.4937,  Adjusted R-squared: 0.486
F-statistic: 64.36 on 2 and 132 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrib.ML ~ form2

N: 135   tau: 0.75   AIC: 324.619471618816

      coefficients  lower bd upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  1.34762774 1.0891346 1.5124290 0.1347682 9.9995960 0.000000e+00
form2WP    1.75834367 1.4912616 2.2424245 0.2171230 8.0983755 3.252953e-13
form2liquid  0.04972738 -0.1570713 0.4092056 0.1746309 0.2847571 7.762765e-01


Formula for mean (based on LS-estimate):
log(ib.ML) = log(TA) + 0.875 + 2.03 form2WP + 0.015 form2liquid
Formula for 75th percentile (based on quantile regression):
log(ib.ML) = log(TA) + 1.348 + 1.758 form2WP + 0.05 form2liquid

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

Model: lib.ML ~ lTA + form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  0.0100000 104.34783 230.4348  607.6532 1070.524 1491.304
WP   20 1333.4900000 4929.54637 9979.8946 22420.8358 22751.213 24890.700
liquid 86  0.5747126  54.07694 175.8362  504.6776 1550.291 14684.270
```

```
Table of predicted values (75th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0  4644.05724 2655.95123
2 10   WP  1 21788.76175 11137.94595
3 100   WP  2 103994.98598 46707.87575
4  1   WG  0   43.04387  38.28770
5 10   WG  1  201.93568  160.56258
6 100   WG  2  963.86210  673.33213
7  1 liquid  0   44.56226  50.26215
8 10 liquid  1  208.98822  210.77838
9 100 liquid  2  997.38053  883.91614

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-3.13621 -0.39305 -0.00853 0.41067 1.90882

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.14816  0.15025  7.642 4.03e-12 ***
lTA     0.67383  0.08920  7.554 6.43e-12 ***
form2WP   2.02941  0.20413  9.942 < 2e-16 ***
form2liquid 0.02029  0.15081  0.135  0.893
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7023 on 131 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.5994,  Adjusted R-squared: 0.5902
F-statistic: 65.33 on 3 and 131 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lib.ML ~ lTA + form2

N: 135   tau: 0.75   AIC: 307.186738245563

      coefficients  lower bd upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  1.5830593 1.3154584 2.0237908 0.12892944 12.278494 0.000000e+00
lTA      0.6225850 0.4684511 0.8401391 0.05948156 10.466858 0.000000e+00
form2WP    1.8411608 1.3869335 2.2255770 0.21590593 8.527607 3.153033e-14
form2liquid  0.1181817 -0.4193619 0.2927626 0.15988438 0.739170 4.611262e-01


Formula for mean (based on LS-estimate):
log(ib.ML) = 1.148 + 0.674 log(TA) + 2.029 form2WP + 0.02 form2liquid
Formula for 75th percentile (based on quantile regression):
log(ib.ML) = 1.583 + 0.623 log(TA) + 1.841 form2WP + 0.118 form2liquid

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

Model: lrhd.ML ~ form + face.shield.ML

```
Table of measured values:
    n  min    50%   75%    90%   95%    max
WG   48 0.01 28.39726 160.0394 627.6042 1341.689 3133.681
WP   20 65.76 443.00000 968.0100 1218.2515 1533.650 2610.000
liquid 87 0.01 16.84783 215.6943 2655.3390 5378.830 25757.774

Table of predicted values (75th percentile):
  TA  form face.shield.ML lTA     LS.75     QR.75
1  1   WP       no  0  268.2546109  144.2155465
2  10   WP       no  1 2682.5461093 1442.1554647
3 100   WP       no  2 26825.4610929 14421.5546472
4  1   WG       no  0  30.0256253  28.9256198
5  10   WG       no  1  300.2562531  289.2561983
6 100   WG       no  2 3002.5625305 2892.5619835
7  1 liquid       no  0  49.9754716  63.4165676
8  10 liquid       no  1  499.7547161  634.1656758
9 100 liquid       no  2 4997.5471615 6341.6567578
10  1   WP      yes  0   7.1488893   3.1148626
```

```
11 10   WP      yes  1  71.4888929  31.1486262
12 100   WP      yes  2  714.8889289  311.4862616
13  1   WG      yes  0   0.7911049   0.6247546
14 10   WG      yes  1   7.9110490   6.2475464
15 100   WG      yes  2  79.1104895  62.4754640
16  1 liquid      yes  0   1.3126275   1.3697129
17 10 liquid      yes  1  13.1262753  13.6971291
18 100 liquid      yes  2  131.2627526  136.9712908

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.8944 -0.5796 0.0204 0.6030 3.2205

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.8451   0.1390  6.081 9.38e-09 ***
formWP       0.9426   0.2492  3.783 0.000223 ***
formliquid     0.2238   0.1666  1.343 0.181181
face.shield.MLyes -1.5865   0.1856 -8.548 1.28e-14 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9249 on 151 degrees of freedom
Multiple R-squared: 0.4041,   Adjusted R-squared: 0.3922
F-statistic: 34.13 on 3 and 151 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

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

N: 155   tau: 0.75   AIC: 426.662615589109
         coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)     1.4612827 1.1461536 1.7976680 0.1980838 7.377094 1.001421e-11
formWP        0.6977294 0.3506391 0.9832948 0.2174186 3.209152 1.626156e-03
formliquid      0.3409201 -0.2397185 0.7012226 0.2196090 1.552396 1.226609e-01
face.shield.MLyes  -1.6655732 -1.8256985 -0.9196865 0.2509463 -6.637169 5.394889e-10


Formula for mean (based on LS-estimate):
log(hd.ML) = log(TA) + 0.845 + 0.943 formWP + 0.224 formliquid + -1.586 face.shield.MLyes
Formula for 75th percentile (based on quantile regression):
log(hd.ML) = log(TA) + 1.461 + 0.698 formWP + 0.341 formliquid + -1.666 face.shield.MLyes

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

Model: lhd.ML ~ lTA + form + face.shield.ML

```
Table of measured values:
    n  min    50%   75%    90%   95%    max
WG   48 0.01 28.39726 160.0394 627.6042 1341.689 3133.681
WP   20 65.76 443.00000 968.0100 1218.2515 1533.650 2610.000
liquid 87 0.01 16.84783 215.6943 2655.3390 5378.830 25757.774

Table of predicted values (75th percentile):
  TA  form face.shield.ML lTA     LS.75     QR.75
1  1   WP       no  0  297.8326758  117.9751106
2  10   WP       no  1 2644.2296777 1480.7961031
3 100   WP       no  2 23936.5563996 18586.6076972
4  1   WG       no  0  32.0181661  29.0186260
5  10   WG       no  1  286.0450891  364.2350328
6 100   WG       no  2 2606.0574415 4571.7932738
7  1 liquid       no  0  56.2329280  48.0859088
8  10 liquid       no  1  498.1833816  603.5631250
9 100 liquid       no  2 4501.6682225 7575.7837303
10  1   WP      yes  0   7.6602794   2.8406792
11 10   WP      yes  1  68.3851783  35.6555430
12 100   WP      yes  2  622.2030408  447.5400692
13  1   WG      yes  0   0.8156018   0.6987288
14 10   WG      yes  1   7.3266466   8.7702810
15 100   WG      yes  2  67.0951828  110.0825235
```

```
16  1 liquid      yes  0   1.4245295   1.1578429
17 10 liquid      yes  1  12.6912209  14.5329738
18 100 liquid      yes  2  115.2983391  182.4145014

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.8998 -0.5641 0.0355 0.5897 3.2409

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.8702   0.1502  5.794 3.91e-08 ***
lTA         0.9512   0.1091  8.719 4.90e-15 ***
formWP       0.9583   0.2523  3.799 0.000211 ***
formliquid     0.2445   0.1733  1.411 0.160418
face.shield.MLyes -1.6003   0.1886 -8.484 1.92e-14 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9274 on 150 degrees of freedom
Multiple R-squared: 0.5966,  Adjusted R-squared: 0.5858
F-statistic: 55.46 on 4 and 150 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

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

N: 155   tau: 0.75   AIC: 426.094381174466

         coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)     1.4626768 1.11523752 1.7851144 0.20035672 7.300363 1.561284e-11
lTA         1.0987049 0.82220596 1.1354848 0.07045704 15.593968 0.000000e+00
formWP        0.6091135 0.35089171 0.9605442 0.22165635 2.748009 6.731706e-03
formliquid      0.2193410 -0.09805375 0.7225398 0.21709947 1.010325 3.139667e-01
face.shield.MLyes  -1.6183682 -1.75498151 -1.0037066 0.25407120 -6.369743 2.193919e-09


Formula for mean (based on LS-estimate):
log(hd.ML) = 0.87 + 0.951 log(TA) + 0.958 formWP + 0.245 formliquid + -1.6 face.shield.MLyes
Formula for 75th percentile (based on quantile regression):
log(hd.ML) = 1.463 + 1.099 log(TA) + 0.609 formWP + 0.219 formliquid + -1.618
face.shield.MLyes

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

Model: lria.ML ~ form2

```
Table of measured values:
     n     min     50%     75%    90%    95%     max
WG    91  0.0100000  12.043854  35.196200  89.84375 199.62565  937.38163
WP    20 658.1527348 2182.479920 4766.754555 5893.93643 6387.06140 10246.24815
liquid 100  0.7038288  3.096413  8.530994  16.86825  30.37221  167.62452
sachets 20  0.1562500  3.622396  7.317909  16.89530  27.97703  33.18376

Table of predicted values (75th percentile):
  TA  form2 lTA     LS.75    QR.75
1  1   WP  0  1251.9398857  596.982525
2  10   WP  1 12519.3988567 5969.825247
3 100   WP  2 125193.9885672 59698.252469
4  1   WG  0   13.2313036  13.497653
5  10   WG  1  132.3130357  134.976526
6 100   WG  2  1323.1303574 1349.765258
7  1 liquid  0   0.7510272   1.191563
8  10 liquid  1   7.5102725  11.915628
9 100 liquid  2   75.1027246  119.156278
10  1 sachets  0  254.5767543  117.129630
11 10 sachets  1  2545.7675431 1171.296296
12 100 sachets  2 25457.6754313 11712.962963

Summary of LS fit (mean):
```

```
Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.66974 -0.36148 0.07019 0.50298 1.97638

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.59056  0.08195  7.206 8.44e-12 ***
form2WP    1.96583  0.19307 10.182 < 2e-16 ***
form2liquid -1.24569  0.11326 -10.998 < 2e-16 ***
form2sachets 1.27407  0.19307  6.599 2.88e-10 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7818 on 227 degrees of freedom
 (438 observations deleted due to missingness)
Multiple R-squared: 0.6426,   Adjusted R-squared: 0.6379
F-statistic: 136.1 on 3 and 227 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lria.ML ~ form2

N: 231   tau: 0.75   AIC: 539.463815397041

       coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   1.1302582 1.0727745 1.2354721 0.07129725 15.852762 0.000000e+00
form2WP     1.6457034 1.5469215 1.7770174 0.11127756 14.789175 0.000000e+00
form2liquid  -1.0541413 -1.4793424 -0.9305352 0.15604743 -6.755262 1.183871e-10
form2sachets  0.9384085 0.8451244 1.4601196 0.26511811 3.539587 4.860506e-04


Formula for mean (based on LS-estimate):
log(ia.ML) = log(TA) + 0.591 + 1.966 form2WP + -1.246 form2liquid + 1.274 form2sachets
Formula for 75th percentile (based on quantile regression):
log(ia.ML) = log(TA) + 1.13 + 1.646 form2WP + -1.054 form2liquid + 0.938 form2sachets

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

Model: lia.ML ~ lTA + form2

```
Table of measured values:
     n     min     50%     75%    90%    95%     max
WG    91  0.0100000  12.043854  35.196200  89.84375 199.62565  937.38163
WP    20 658.1527348 2182.479920 4766.754555 5893.93643 6387.06140 10246.24815
liquid 100  0.7038288  3.096413  8.530994  16.86825  30.37221  167.62452
sachets 20  0.1562500  3.622396  7.317909  16.89530  27.97703  33.18376

Table of predicted values (75th percentile):
  TA  form2 lTA    LS.75    QR.75
1  1   WP  0 3191.327591 2147.180407
2  10   WP  1 9354.577865 5186.030960
3 100   WP  2 27852.831368 12525.690448
4  1   WG  0  17.512143  23.724752
5  10   WG  1  51.766688  57.301797
6 100   WG  2  155.459223  138.399593
7  1 liquid  0   3.007418   3.188993
8  10 liquid  1   8.763853   7.702294
9 100 liquid  2  25.948914  18.603157
10  1 sachets  0  48.476189  22.197704
11 10 sachets  1  146.831165  53.613558
12 100 sachets  2  451.069241  129.491482

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.78731 -0.36923 0.03582 0.47501 1.81989

Coefficients:
```

```
       Estimate Std. Error t value   Pr(>|t|)
(Intercept)  0.75015  0.08040  9.330   < 2e-16 ***
lTA      0.46933  0.08663  5.418 0.0000001543 ***
form2WP    2.24916  0.18506 12.153   < 2e-16 ***
form2liquid -0.76955  0.13073 -5.886 0.0000000142 ***
form2sachets 0.42740  0.22630  1.889    0.0602 .
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7256 on 226 degrees of freedom
 (438 observations deleted due to missingness)
Multiple R-squared: 0.5646,  Adjusted R-squared: 0.5569
F-statistic: 73.27 on 4 and 226 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lia.ML ~ lTA + form2

N: 231   tau: 0.75   AIC: 484.855818970168

       coefficients  lower bd  upper bd Std. Error   t value     Pr(>|t|)
(Intercept)  1.37520167 1.2266265 1.5280117 0.09777578 14.06485043 0.00000000000000
lTA      0.38296657 0.3048746 0.5367132 0.10852538 3.52882029 0.00050558841434
form2WP    1.95666686 1.7543380 2.1054522 0.16202720 12.07616317 0.00000000000000
form2liquid  -0.87154816 -0.9699640 -0.7693222 0.15703385 -5.55006559 0.00000007967123
form2sachets -0.02889361 -0.2783504 0.5431566 0.29704515 -0.09727011 0.92259810226350

Formula for mean (based on LS-estimate):
log(ia.ML) = 0.75 + 0.469 log(TA) + 2.249 form2WP + -0.77 form2liquid + 0.427 form2sachets
Formula for 75th percentile (based on quantile regression):
log(ia.ML) = 1.375 + 0.383 log(TA) + 1.957 form2WP + -0.872 form2liquid + -0.029 form2sachets

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

####################################################
###
### model output for A - HCHH - GH only
###
####################################################
```

Model: lrph.A ~ dense4

```
Table of measured values:
     n   min   50%    75%   90%    95%   max
normal 34 120.3419 9342.857 18368.5188 30449.98 39698.634 52944.93
dense  24 268.2500 5996.327 19616.5019 44031.13 58422.835 92299.54
trolley 10 230.6100 391.050  628.6578  723.22  974.185 1225.15

Table of predicted values (75th percentile):
  TA dense4   lTA   LS.75   QR.75
1 0.2  dense -0.69897  8157.605 11177.083
2 1.0  dense 0.00000 40788.026 55885.417
3 5.0  dense 0.69897 203940.128 279427.083
4 0.2 normal -0.69897  5807.206  5271.455
5 1.0 normal 0.00000 29036.029 26357.276
6 5.0 normal 0.69897 145180.146 131786.382
7 0.2 trolley -0.69897  2329.227  1928.229
8 1.0 trolley 0.00000 11646.136  9641.144
9 5.0 trolley 0.69897 58230.680 48205.720

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-0.73179 -0.29426 -0.06322 0.32778 0.93969

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.17826  0.07094 58.896 < 2e-16 ***
dense4dense  0.14591  0.11028  1.323 0.19047
dense4trolley -0.40635  0.14881 -2.731 0.00813 **
---
```

```
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4137 on 65 degrees of freedom
  (35 observations deleted due to missingness)
Multiple R-squared: 0.1625,   Adjusted R-squared: 0.1367
F-statistic: 6.304 on 2 and 65 DF, p-value: 0.003145

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrph.A ~ dense4

N: 68   tau: 0.75   AIC: 95.8360222892193

              coefficients  lower bd   upper bd Std. Error  t value  Pr(>|t|)
(Intercept)       4.420901 4.31262118 4.6194527 0.1155350 38.264604 0.00000000
dense4dense       0.326398 0.03033475 0.6206968 0.1701596 1.918187 0.05948184
dense4trolley    -0.436772 -0.72788374 -0.2024055 0.1918379 -2.276776 0.02609954


Formula for mean (based on LS-estimate):
log(ph.A) = log(TA) + 4.178 + 0.146 dense4dense + -0.406 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(ph.A) = log(TA) + 4.421 + 0.326 dense4dense + -0.437 dense4trolley

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

Model: lph.A ~ lTA + dense4

```
Table of measured values:
     n    min     50%      75%      90%      95%     max
normal 34 120.3419 9342.857 18368.5188 30449.98 39698.634 52944.93
dense  24 268.2500 5996.327 19616.5019 44031.13 58422.835 92299.54
trolley 10 230.6100 391.050  628.6578  723.22  974.185 1225.15

Table of predicted values (75th percentile):
  TA dense4    lTA    LS.75    QR.75
1 0.2  dense -0.69897  8365.786  9688.064
2 1.0  dense 0.00000 31561.341 36724.330
3 5.0  dense 0.69897 120350.246 139210.099
4 0.2 normal -0.69897  6453.288  6615.903
5 1.0 normal 0.00000 24272.684 25078.754
6 5.0 normal 0.69897 92293.243 95065.476
7 0.2 trolley -0.69897  1915.175  1598.051
8 1.0 trolley 0.00000  7283.735  6057.695
9 5.0 trolley 0.69897 27978.584 22962.769

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
     Min       1Q   Median       3Q      Max
-0.66470 -0.30098 -0.04694 0.29742 0.72750

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    4.10878    0.07493  54.835  < 2e-16 ***
lTA            0.82271    0.07650  10.755 5.55e-16 ***
dense4dense    0.11149    0.10778   1.034  0.30485
dense4trolley -0.53728    0.15473  -3.472  0.00093 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4004 on 64 degrees of freedom
  (35 observations deleted due to missingness)
Multiple R-squared: 0.7411,   Adjusted R-squared: 0.7289
F-statistic: 61.06 on 3 and 64 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lph.A ~ lTA + dense4

N: 68   tau: 0.75   AIC: 89.4241828259014
```

```
       coefficients  lower bd  upper bd Std. Error  t value     Pr(>|t|)
(Intercept)   4.3993060 4.2429048 4.5690364 0.1221099 36.0274186 0.000000000000000
lTA       0.8279567 0.5930819 0.9061265 0.1174004 7.0524171 0.000000001505282
dense4dense   0.1656479 -0.2041783 0.6210181 0.1867282 0.8871072 0.378342740563061
dense4trolley  -0.6169986 -0.9421367 -0.3104532 0.2086834 -2.9566253 0.004351736020495


Formula for mean (based on LS-estimate):
log(ph.A) = 4.109 + 0.823 log(TA) + 0.111 dense4dense + -0.537 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(ph.A) = 4.399 + 0.828 log(TA) + 0.166 dense4dense + -0.617 dense4trolley

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

Model: lrah.A ~ dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 28 0.6329114 8.848734 29.57333 79.85985 109.28823 301.4933
dense  23 0.2500000 93.291139 537.02532 912.45570 1069.70000 1263.0380
trolley 10 0.0100000 0.125000  0.28750  1.78490  2.16245  2.5400

Table of predicted values (75th percentile):
  TA dense4   lTA    LS.75    QR.75
1 0.2  dense -0.69897 154.6162048 217.6202532
2 1.0  dense 0.00000 773.0810238 1088.1012658
3 5.0  dense 0.69897 3865.4051190 5440.5063291
4 0.2 normal -0.69897  15.3022846  10.3600104
5 1.0 normal 0.00000  76.5114230  51.8000518
6 5.0 normal 0.69897 382.5571152 259.0002590
7 0.2 trolley -0.69897  0.9092839  0.9478673
8 1.0 trolley 0.00000  4.5464196  4.7393365
9 5.0 trolley 0.69897  22.7320982  23.6966825
Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.59186 -0.58168 0.07624 0.56673 1.44888

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.3417   0.1483  9.047 1.11e-12 ***
dense4dense   1.0025   0.2208  4.540 2.89e-05 ***
dense4trolley -1.2426   0.2891 -4.298 6.66e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7847 on 58 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.5068,   Adjusted R-squared: 0.4898
F-statistic: 29.8 on 2 and 58 DF, p-value: 0.000000001252

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrah.A ~ dense4

N: 61   tau: 0.75   AIC: 156.177523881133

       coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)    1.714330 1.5806846 2.2450255 0.2333117 7.347811 7.629524e-10
dense4dense    1.322339 0.8798574 1.4621991 0.2760051 4.790996 1.190914e-05
dense4trolley  -1.038613 -1.6415679 -0.1723479 0.5734614 -1.811129 7.530030e-02


Formula for mean (based on LS-estimate):
log(ah.A) = log(TA) + 1.342 + 1.002 dense4dense + -1.243 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(ah.A) = log(TA) + 1.714 + 1.322 dense4dense + -1.039 dense4trolley

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

Model: lah.A ~ lTA + dense4

```
Table of measured values:
      n    min     50%     75%     90%     95%     max
normal 28 0.6329114 8.848734 29.57333 79.85985 109.28823 301.4933
dense  23 0.2500000 93.291139 537.02532 912.45570 1069.70000 1263.0380
trolley 10 0.0100000 0.125000  0.28750  1.78490  2.16245  2.5400

Table of predicted values (75th percentile):
  TA dense4   lTA    LS.75    QR.75
1 0.2  dense -0.69897 157.8706184 196.527011
2 1.0  dense 0.00000 742.2496537 1099.338377
3 5.0  dense 0.69897 3567.7604815 6149.510239
4 0.2 normal -0.69897  15.8194180  12.105160
5 1.0 normal 0.00000  74.0997111  67.714187
6 5.0 normal 0.69897 354.9268008 378.781541
7 0.2 trolley -0.69897  0.8840234  1.040178
8 1.0 trolley 0.00000  4.2250742  5.818578
9 5.0 trolley 0.69897  20.6129937  32.548129

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.56900 -0.59813 0.08362 0.57032 1.44833

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.3210   0.1668  7.920 9.35e-11 ***
lTA       0.9569   0.1547  6.184 7.16e-08 ***
dense4dense   0.9974   0.2233  4.466 3.82e-05 ***
dense4trolley -1.2708   0.3084 -4.121 0.000124 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.791 on 57 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.6858,  Adjusted R-squared: 0.6693
F-statistic: 41.47 on 3 and 57 DF, p-value: 2.382e-14

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lah.A ~ lTA + dense4

N: 61   tau: 0.75   AIC: 157.742334960045

       coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)    1.830680 1.4709514 2.5126328 0.2081003 8.797104 3.316902e-12
lTA        1.069730 0.3403341 1.4698797 0.3122895 3.425443 1.144427e-03
dense4dense    1.210452 0.7537605 1.6126537 0.2495256 4.851012 9.890010e-06
dense4trolley  -1.065863 -1.8837113 -0.1433963 0.6135385 -1.737239 8.774626e-02


Formula for mean (based on LS-estimate):
log(ah.A) = 1.321 + 0.957 log(TA) + 0.997 dense4dense + -1.271 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(ah.A) = 1.831 + 1.07 log(TA) + 1.21 dense4dense + -1.066 dense4trolley

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

Model: lrtb.A ~ dense4

```
Table of measured values:
     n   min    50%     75%     90%     95%     max
normal 36 1310.187 106508.00 367246.563 669578.452 739278.346 1085188.28
dense  15 2161.030 869396.32 1589473.063 2032085.216 2307184.470 2649484.71
trolley 10 1337.900  2950.49  4970.132  6625.582  9851.011  13076.44

Table of predicted values (75th percentile):
  TA dense4   lTA    LS.75   QR.75
1 0.2  dense -0.69897  485548.29 358574.36
2 1.0  dense 0.00000 2427741.45 1792871.82
```

```
3 5.0  dense 0.69897 12138707.24 8964359.12
4 0.2 normal -0.69897  80253.20  77334.90
5 1.0 normal 0.00000  401265.99 386674.51
6 5.0 normal 0.69897 2006329.96 1933372.55
7 0.2 trolley -0.69897  14938.42  12112.07
8 1.0 trolley 0.00000  74692.09  60560.34
9 5.0 trolley 0.69897  373460.47 302801.70

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min     1Q  Median     3Q    Max
-0.68955 -0.23543 -0.02489 0.22741 0.81099

Coefficients:
       Estimate Std. Error t value   Pr(>|t|)
(Intercept)  5.35764  0.05953 89.994    < 2e-16 ***
dense4dense  0.77716  0.10977  7.080 0.00000000215 ***
dense4trolley -0.73865  0.12768 -5.785 0.00000030751 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3572 on 58 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.6577,   Adjusted R-squared: 0.6459
F-statistic: 55.71 on 2 and 58 DF, p-value: 3.156e-14

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrtb.A ~ dense4

N: 61   tau: 0.75   AIC: 61.6974196943512

       coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   5.5873455 5.5788798 5.7415697 0.0998179 55.975386 0.00000000000
dense4dense   0.6662037 0.4594946 0.8863312 0.1501987 4.435482 0.00004157109
dense4trolley  -0.8051572 -1.0248400 -0.4045436 0.2351664 -3.423777 0.00113934534


Formula for mean (based on LS-estimate):
log(tb.A) = log(TA) + 5.358 + 0.777 dense4dense + -0.739 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(tb.A) = log(TA) + 5.587 + 0.666 dense4dense + -0.805 dense4trolley

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

Model: ltb.A ~ lTA + dense4

```
Table of measured values:
     n   min    50%     75%     90%     95%    max
normal 36 1310.187 106508.00 367246.563 669578.452 739278.346 1085188.28
dense  15 2161.030 869396.32 1589473.063 2032085.216 2307184.470 2649484.71
trolley 10 1337.900  2950.49  4970.132  6625.582  9851.011  13076.44

Table of predicted values (75th percentile):
  TA dense4   lTA   LS.75    QR.75
1 0.2  dense -0.69897  501058.0  443901.25
2 1.0  dense 0.00000 3400207.4 3167400.62
3 5.0  dense 0.69897 23298856.9 22600581.95
4 0.2 normal -0.69897  68319.5  62967.27
5 1.0 normal 0.00000  460605.8  449294.89
6 5.0 normal 0.69897 3137157.0 3205886.25
7 0.2 trolley -0.69897  17464.8  15073.11
8 1.0 trolley 0.00000  118983.1  107552.23
9 5.0 trolley 0.69897  818159.7  767425.21

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
```

```
  Min   1Q Median   3Q   Max
-0.7347 -0.2178 -0.0392 0.2006 0.7640

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.42936  0.06235 87.084 < 2e-16 ***
lTA      1.18538  0.06815 17.394 < 2e-16 ***
dense4dense  0.86133  0.10867  7.926 9.13e-11 ***
dense4trolley -0.60082  0.13134 -4.574 2.62e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.339 on 57 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.8964,  Adjusted R-squared: 0.8909
F-statistic: 164.4 on 3 and 57 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: ltb.A ~ lTA + dense4

N: 61   tau: 0.75   AIC: 56.5675675457924

       coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   5.6525315 5.5964229 5.7316385 0.1209521 46.733633 0.000000e+00
lTA       1.2209632 0.9188790 1.3642658 0.1509571 8.088148 4.906830e-11
dense4dense   0.8481715 0.5229498 1.1057358 0.1768734 4.795360 1.205565e-05
dense4trolley  -0.6209120 -0.9556911 -0.1806244 0.2830601 -2.193569 3.235978e-02


Formula for mean (based on LS-estimate):
log(tb.A) = 5.429 + 1.185 log(TA) + 0.861 dense4dense + -0.601 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(tb.A) = 5.653 + 1.221 log(TA) + 0.848 dense4dense + -0.621 dense4trolley

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

Model: lrib.A ~ dense5

```
Table of measured values:
        n     min    50%    75%    90%     95%    max
normal    36   7.777778  1105.097  9676.475 36845.699 92139.0200 190123.900
dense     10 57091.100000 259233.450 333253.775 856785.270 904220.5350 951655.800
trolley    10  20.230000   55.525   78.455  101.541  132.7305  163.920
coat     16  130.000000  1255.079  1688.734  3462.032  4366.0624  4656.211
zertcov+dense 11   3.030000  4379.110 82431.000 141919.000 308825.5000 475732.000

Table of predicted values (75th percentile):
  TA    dense5   lTA    LS.75    QR.75
1 0.2    normal -0.69897  1848.5973  3093.5778
2 1.0    normal 0.00000  9242.9864  15467.8889
3 5.0    normal 0.69897  46214.9319  77339.4444
4 0.2     dense -0.69897 222637.5981 136368.7989
5 1.0     dense 0.00000 1113187.9907 681843.9946
6 5.0     dense 0.69897 5565939.9537 3409219.9730
7 0.2    trolley -0.69897   437.2676   181.7634
8 1.0    trolley 0.00000  2186.3379   908.8171
9 5.0    trolley 0.69897  10931.6895  4544.0853
10 0.2     coat -0.69897   896.5146   509.1494
11 1.0     coat 0.00000  4482.5730  2545.7471
12 5.0     coat 0.69897  22412.8652  12728.7356
13 0.2 zertcov+dense -0.69897  17526.0923  38660.2857
14 1.0 zertcov+dense 0.00000  87630.4614 193301.4286
15 5.0 zertcov+dense 0.69897 438152.3072 966507.1429

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.66978 -0.43541 -0.05711 0.37919 1.81633

Coefficients:
```

```
          Estimate Std. Error t value Pr(>|t|)
(Intercept)      3.5070   0.1113 31.508 < 2e-16 ***
dense5dense      2.0649   0.2387  8.650 5.16e-13 ***
dense5trolley    -0.6419   0.2387 -2.689 0.00876 **
dense5coat      -0.3220   0.2007 -1.605 0.11263
dense5zertcov+dense  0.9630   0.2301  4.185 7.41e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6678 on 78 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.608,   Adjusted R-squared: 0.5879
F-statistic: 30.25 on 4 and 78 DF, p-value: 3.396e-15

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrib.A ~ dense5

N: 83   tau: 0.75   AIC: 190.060305414087

          coefficients  lower bd  upper bd Std. Error  t value   Pr(>|t|)
(Intercept)      4.1894310 3.7940274 4.5335246 0.2815077 14.882118 0.00000000000
dense5dense      1.6442540 1.2810269 2.1044227 0.3892749 4.223889 0.00006449455
dense5trolley     -1.2309546 -1.4150435 -0.6733518 0.3651715 -3.370895 0.00116769887
dense5coat      -0.7836158 -1.0770241 -0.2915379 0.3231673 -2.424799 0.01762958592
dense5zertcov+dense  1.0968040 0.4170235 1.4809463 0.4276222 2.564891 0.01223959914


Formula for mean (based on LS-estimate):
log(ib.A) = log(TA) + 3.507 + 2.065 dense5dense + -0.642 dense5trolley + -0.322 dense5coat +
0.963 dense5zertcov+dense
Formula for 75th percentile (based on quantile regression):
log(ib.A) = log(TA) + 4.189 + 1.644 dense5dense + -1.231 dense5trolley + -0.784 dense5coat +
1.097 dense5zertcov+dense

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

Model: lib.A ~ lTA + dense5

```
Table of measured values:
        n     min    50%    75%    90%     95%    max
normal    36   7.777778  1105.097  9676.475 36845.699 92139.0200 190123.900
dense     10 57091.100000 259233.450 333253.775 856785.270 904220.5350 951655.800
trolley    10  20.230000   55.525   78.455  101.541  132.7305  163.920
coat     16  130.000000  1255.079  1688.734  3462.032  4366.0624  4656.211
zertcov+dense 11   3.030000  4379.110 82431.000 141919.000 308825.5000 475732.000

Table of predicted values (75th percentile):
  TA    dense5   lTA     LS.75     QR.75
1 0.2    normal -0.69897   1115.1608   1160.3384
2 1.0    normal 0.00000  13759.6024  16567.7546
3 5.0    normal 0.69897  173248.7873  236560.7167
4 0.2     dense -0.69897  94869.3224  56806.9601
5 1.0     dense 0.00000 1161589.8471  811111.4355
6 5.0     dense 0.69897 14506436.5698 11581358.3280
7 0.2    trolley -0.69897   687.4018   314.3808
8 1.0    trolley 0.00000   8659.7123   4488.8488
9 5.0    trolley 0.69897  111111.2164  64093.4951
10 0.2     coat -0.69897   405.4447   280.1557
11 1.0     coat 0.00000   4970.2251   4000.1699
12 5.0     coat 0.69897  62164.5475  57115.9504
13 0.2 zertcov+dense -0.69897  26922.6024  31235.9511
14 1.0 zertcov+dense 0.00000  339026.2721  445998.8191
15 5.0 zertcov+dense 0.69897 4348686.4945 6368141.1846

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.10594 -0.35534 -0.03765 0.34132 1.62430

Coefficients:
```

```
          Estimate Std. Error t value Pr(>|t|)
(Intercept)      3.7239   0.1119 33.285 < 2e-16 ***
lTA          1.5606   0.1283 12.168 < 2e-16 ***
dense5dense      1.9134   0.2178  8.784 3.14e-13 ***
dense5trolley    -0.2252   0.2353 -0.957  0.3415
dense5coat      -0.4480   0.1831 -2.447  0.0167 *
dense5zertcov+dense  1.3696   0.2272  6.028 5.36e-08 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6016 on 77 degrees of freedom
  (20 observations deleted due to missingness)
Multiple R-squared: 0.8197,   Adjusted R-squared: 0.808
F-statistic: 70.03 on 5 and 77 DF, p-value: < 2.2e-16

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lib.A ~ lTA + dense5

N: 83   tau: 0.75   AIC: 174.573168370625

          coefficients  lower bd  upper bd Std. Error  t value    Pr(>|t|)
(Intercept)      4.2192637 3.9866295 4.4265186 0.2733227 15.436929 0.0000000000000
lTA          1.6519721 1.1597872 1.8548774 0.2820617 5.856776 0.0000001098618
dense5dense      1.6898169 1.2880679 2.1136388 0.3755230 4.499903 0.0000237373279
dense5trolley     -0.5671287 -0.8551738 0.1118708 0.4330770 -1.309533 0.1942478494123
dense5coat      -0.6171852 -1.0416922 -0.3809187 0.3109654 -1.984739 0.0507357195373
dense5zertcov+dense  1.4300701 1.0419977 2.6665556 0.2855110 5.008810 0.0000033951742


Formula for mean (based on LS-estimate):
log(ib.A) = 3.724 + 1.561 log(TA) + 1.913 dense5dense + -0.225 dense5trolley + -0.448
dense5coat + 1.37 dense5zertcov+dense
Formula for 75th percentile (based on quantile regression):
log(ib.A) = 4.219 + 1.652 log(TA) + 1.69 dense5dense + -0.567 dense5trolley + -0.617
dense5coat + 1.43 dense5zertcov+dense

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

Model: lrhd.A ~ dense4

```
Table of measured values:
     n    min    50%    75%     90%     95%    max
normal 35 1.666667 263.800 461.300 698.0000 992.2000 2651.60
dense  36 10.800000 308.100 824.900 3110.6000 5396.8000 7905.40
trolley 10 13.560000 63.346 119.675 253.7867 638.7333 1023.68

Table of predicted values (75th percentile):
  TA dense4 rain    lTA    LS.75    QR.75
1 0.2  dense coat -0.69897  655.8521  599.7867
2 1.0  dense coat 0.00000 3279.2605 2998.9333
3 5.0  dense coat 0.69897 16396.3026 14994.6667
4 0.2 normal coat -0.69897  230.0795  161.2121
5 1.0 normal coat 0.00000 1150.3975  806.0606
6 5.0 normal coat 0.69897 5751.9877 4030.3030
7 0.2 trolley coat -0.69897  743.4302  302.2571
8 1.0 trolley coat 0.00000 3717.1511 1511.2856
9 5.0 trolley coat 0.69897 18585.7554 7556.4279
10 0.2  dense none -0.69897  655.8521  599.7867
11 1.0  dense none 0.00000 3279.2605 2998.9333
12 5.0  dense none 0.69897 16396.3026 14994.6667
13 0.2 normal none -0.69897  230.0795  161.2121
14 1.0 normal none 0.00000 1150.3975  806.0606
15 5.0 normal none 0.69897 5751.9877 4030.3030
16 0.2 trolley none -0.69897  743.4302  302.2571
17 1.0 trolley none 0.00000 3717.1511 1511.2856
18 5.0 trolley none 0.69897 18585.7554 7556.4279

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
```

```
-1.75447 -0.46733 -0.00353 0.38828 2.51158

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.5198   0.1331 18.938  <2e-16 ***
dense4dense   0.4551   0.1869  2.436  0.0171 *
dense4trolley  0.4909   0.2823  1.739  0.0860 .
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7872 on 78 degrees of freedom
 (22 observations deleted due to missingness)
Multiple R-squared: 0.08116,  Adjusted R-squared: 0.0576
F-statistic: 3.445 on 2 and 78 DF, p-value: 0.03684

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrhd.A ~ dense4

N: 81   tau: 0.75   AIC: 210.577331234644

       coefficients lower bd upper bd Std. Error  t value Pr(>|t|)
(Intercept)   2.9063677 2.7339754 3.045845 0.1015231 28.627643 0.0000000
dense4dense   0.5705991 0.2017984 1.166043 0.4056261 1.406712 0.1634848
dense4trolley  0.2729788 0.1007992 1.021350 0.4611378 0.591968 0.5555840


Formula for mean (based on LS-estimate):
log(hd.A) = log(TA) + 2.52 + 0.455 dense4dense + 0.491 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(hd.A) = log(TA) + 2.906 + 0.571 dense4dense + 0.273 dense4trolley

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

Model: lhd.A ~ lTA + dense4

```
Table of measured values:
     n    min   50%   75%    90%    95%   max
normal 35 1.666667 263.800 461.300 698.0000 992.2000 2651.60
dense  36 10.800000 308.100 824.900 3110.6000 5396.8000 7905.40
trolley 10 13.560000 63.346 119.675 253.7867 638.7333 1023.68

Table of predicted values (75th percentile):
  TA dense4 rain   lTA   LS.75   QR.75
1 0.2  dense coat -0.69897 824.3610 735.6453
2 1.0  dense coat 0.00000 1393.9919 982.1977
3 5.0  dense coat 0.69897 2398.2617 1311.3825
4 0.2 normal coat -0.69897 307.9324 374.6913
5 1.0 normal coat 0.00000 520.1904 500.2695
6 5.0 normal coat 0.69897 894.0718 667.9355
7 0.2 trolley coat -0.69897 317.6164 144.7472
8 1.0 trolley coat 0.00000 545.9952 193.2594
9 5.0 trolley coat 0.69897 953.6234 258.0305
10 0.2  dense none -0.69897 824.3610 735.6453
11 1.0  dense none 0.00000 1393.9919 982.1977
12 5.0  dense none 0.69897 2398.2617 1311.3825
13 0.2 normal none -0.69897 307.9324 374.6913
14 1.0 normal none 0.00000 520.1904 500.2695
15 5.0 normal none 0.69897 894.0718 667.9355
16 0.2 trolley none -0.69897 317.6164 144.7472
17 1.0 trolley none 0.00000 545.9952 193.2594
18 5.0 trolley none 0.69897 953.6234 258.0305

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min    1Q Median   3Q   Max
-1.8478 -0.3366 0.0000 0.4685 1.2912

Coefficients:
        Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.250847  0.124582 18.067 < 2e-16 ***
```

```
lTA      0.325014  0.125317  2.594 0.01137 *
dense4dense  0.428016  0.160363  2.669 0.00927 **
dense4trolley -0.003091  0.258902 -0.012 0.99050
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6752 on 77 degrees of freedom
 (22 observations deleted due to missingness)
Multiple R-squared: 0.1838,   Adjusted R-squared: 0.1521
F-statistic: 5.782 on 3 and 77 DF, p-value: 0.001281

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lhd.A ~ lTA + dense4

N: 81   tau: 0.75   AIC: 175.059987926481

       coefficients  lower bd upper bd Std. Error  t value  Pr(>|t|)
(Intercept)   2.6992040 2.63825581 2.7775743 0.08810378 30.6366441 0.00000000
lTA       0.1795935 -0.08757849 0.3195155 0.07694059 2.3341837 0.02219528
dense4dense   0.2929949 0.02209940 0.7136495 0.22434914 1.3059773 0.19544839
dense4trolley  -0.4130635 -0.60618886 0.2320060 0.47853322 -0.8631866 0.39071556


Formula for mean (based on LS-estimate):
log(hd.A) = 2.251 + 0.325 log(TA) + 0.428 dense4dense + -0.003 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(hd.A) = 2.699 + 0.18 log(TA) + 0.293 dense4dense + -0.413 dense4trolley

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

Model: lria.A ~ dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 30 0.6378853 211.70691 303.29372 515.70138 627.36835 2213.54167
dense  32 40.6250000 247.22222 463.28125 789.70133 1242.36872 3218.75000
trolley 10 11.8854167 20.51562 25.76625 26.76401  27.38498  28.00595

Table of predicted values (75th percentile):
  TA dense4   lTA   LS.75   QR.75
1 0.2  dense -0.69897 145.8553 117.20322
2 1.0  dense 0.00000 729.2766 586.01610
3 5.0  dense 0.69897 3646.3829 2930.08048
4 0.2 normal -0.69897 110.3301  97.47257
5 1.0 normal 0.00000 551.6505 487.36285
6 5.0 normal 0.69897 2758.2527 2436.81426
7 0.2 trolley -0.69897 109.6053  62.96862
8 1.0 trolley 0.00000 548.0267 314.84309
9 5.0 trolley 0.69897 2740.1333 1574.21545

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.38431 -0.15674 0.05351 0.19484 0.93025

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.44476  0.07864 31.086  <2e-16 ***
dense4dense  0.12153  0.10947  1.110  0.271
dense4trolley -0.01229  0.15729 -0.078  0.938
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4308 on 69 degrees of freedom
 (31 observations deleted due to missingness)
Multiple R-squared: 0.02119,  Adjusted R-squared: -0.007183
F-statistic: 0.7468 on 2 and 69 DF, p-value: 0.4777

Summary of RQ fit (75th percentile):

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

```
Formula: lria.A ~ dense4

N: 72   tau: 0.75   AIC: 53.6735127780058

       coefficients  lower bd  upper bd Std. Error  t value  Pr(>|t|)
(Intercept)   2.68785242 2.61282906 2.7406509 0.03897364 68.9659108 0.000000000
dense4dense   0.08005712 -0.01540072 0.2428026 0.10386541 0.7707775 0.443470159
dense4trolley -0.18975826 -0.24358380 -0.0836456 0.05788325 -3.2782931 0.001637708


Formula for mean (based on LS-estimate):
log(ia.A) = log(TA) + 2.445 + 0.122 dense4dense + -0.012 dense4trolley
Formula for 75th percentile (based on quantile regression):
log(ia.A) = log(TA) + 2.688 + 0.08 dense4dense + -0.19 dense4trolley

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

Model: lia.A ~ lTA + dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 30 0.6378853 211.70691 303.29372 515.70138 627.36835 2213.54167
dense  32 40.6250000 247.22222 463.28125 789.70133 1242.36872 3218.75000
trolley 10 11.8854167 20.51562 25.76625 26.76401  27.38498  28.00595

Table of predicted values (75th percentile):
  TA dense4   lTA    LS.75   QR.75
1 0.2  dense -0.69897  107.49612 102.99436
2 1.0  dense 0.00000  805.73954 583.79200
3 5.0  dense 0.69897 7284.28959 3309.04632
4 0.2 normal -0.69897  82.98262  91.74498
5 1.0 normal 0.00000  629.65290 520.02833
6 5.0 normal 0.69897 5750.48546 2947.62147
7 0.2 trolley -0.69897  151.47064  68.56058
8 1.0 trolley 0.00000 1448.24532 388.61469
9 5.0 trolley 0.69897 15153.36403 2202.74343

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-2.3645 -0.1722 0.0358 0.1950 0.9292

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.4984   0.1014 24.636 < 2e-16 ***
lTA       1.2873   0.3418  3.766 0.000348 ***
dense4dense   0.1087   0.1108  0.981 0.329834
dense4trolley  0.2588   0.3590  0.721 0.473375
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4317 on 68 degrees of freedom
 (31 observations deleted due to missingness)
Multiple R-squared: 0.4949,   Adjusted R-squared: 0.4726
F-statistic: 22.21 on 3 and 68 DF, p-value: 3.903e-10

Summary of RQ fit (75th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lia.A ~ lTA + dense4

N: 72   tau: 0.75   AIC: 55.4264445920243

       coefficients  lower bd upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   2.71602701 2.59136263 2.7843275 0.07844933 34.6214174 0.00000000000
lTA       1.07793568 0.76152203 1.2853291 0.25480676 4.2304045 0.00007141617
dense4dense   0.05023114 0.01200241 0.2954249 0.10979524 0.4574983 0.64877133553
dense4trolley -0.12650780 -0.33584760 0.1670585 0.24430037 -0.5178371 0.60625262247


Formula for mean (based on LS-estimate):
log(ia.A) = 2.498 + 1.287 log(TA) + 0.109 dense4dense + 0.259 dense4trolley
```

```
Formula for 75th percentile (based on quantile regression):
log(ia.A) = 2.716 + 1.078 log(TA) + 0.05 dense4dense + -0.127 dense4trolley

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

15.3 95th percentile

```
####################################################
###
### model output for ML - tank
###
####################################################
```

Model: lrph.ML ~ form2 + glove.wash.ML

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
WG    90  21.34896 1225.741 2530.052  5045.769  7279.347  40938.82
WP    20 5852.58065 80850.401 99175.969 146688.913 149519.509 180190.32
liquid 175  73.56494 8681.192 36069.752 126389.812 520084.592 2346736.06
sachets 20 795.10000 2258.369 4124.857 10838.527 13202.153  15830.54

Table of predicted values (95th percentile):
  TA  form2 glove.wash.ML lTA    LS.75    QR.75
1  1   WP         0  34240.829  69442.489
2  10   WP         1  342408.293  694424.893
3 100   WP         2 3424082.933 6944248.934
4  1   WG         0   1739.908   6727.855
5  10   WG         1  17399.084  67278.546
6 100   WG         2  173990.836  672785.457
7  1 liquid         0   3579.101  20359.671
8  10 liquid         1  35791.011  203596.705
9 100 liquid         2  357910.113 2035967.054
10  1 sachets         0  150920.981  313351.263
11 10 sachets         1 1509209.814 3133512.630
12 100 sachets         2 15092098.141 31335126.296

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.49952 -0.47297 0.01155 0.46294 1.95074

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)    2.79221  0.07082 39.427 < 2e-16 ***
form2WP      1.28522  0.16371  7.851 7.39e-14 ***
form2liquid    0.31447  0.08564  3.672 0.000285 ***
form2sachets   1.92977  0.16371 11.788 < 2e-16 ***
glove.wash.MLyes -0.42320  0.13198 -3.207 0.001488 **
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6601 on 300 degrees of freedom
 (364 observations deleted due to missingness)
Multiple R-squared: 0.3901,   Adjusted R-squared: 0.382
F-statistic: 47.98 on 4 and 300 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrph.ML ~ form2 + glove.wash.ML

N: 305   tau: 0.95   AIC: 795.020604593813

         coefficients  lower bd   upper bd Std. Error  t value  Pr(>|t|)
(Intercept)     3.8278766 3.6589630 3.943739e+00 0.1309073 29.2411295 0.000000000
form2WP       1.0137487 0.5721693 1.797693e+308 0.8264933 1.2265661 0.220947517
form2liquid     0.4808942 0.2167277 7.075134e-01 0.1843121 2.6091298 0.009532265
form2sachets    1.6681549 1.4234004 1.797693e+308 0.1647493 10.1254133 0.000000000
glove.wash.MLyes  -0.9089586 -0.9990084 1.797693e+308 1.2873826 -0.7060517 0.480703941


Formula for mean (based on LS-estimate):
log(ph.ML) = log(TA) + 2.792 + 1.285 form2WP + 0.314 form2liquid + 1.93 form2sachets + -0.423
glove.wash.MLyes
Formula for 95th percentile (based on quantile regression):
```

```
log(ph.ML) = log(TA) + 3.828 + 1.014 form2WP + 0.481 form2liquid + 1.668 form2sachets + -0.909
glove.wash.MLyes

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

Model: lph.ML ~ lTA + form2 + glove.wash.ML

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
WG    90  21.34896 1225.741 2530.052  5045.769  7279.347  40938.82
WP    20 5852.58065 80850.401 99175.969 146688.913 149519.509 180190.32
liquid 175  73.56494 8681.192 36069.752 126389.812 520084.592 2346736.06
sachets 20 795.10000 2258.369 4124.857 10838.527 13202.153  15830.54

Table of predicted values (95th percentile):
  TA  form2 glove.wash.ML lTA    LS.75    QR.75
1  1   WP         0  64831.428  89831.835
2  10   WP         1 265105.361 439968.061
3 100   WP         2 1090146.714 2154825.130
4  1   WG         0  2059.248  5498.562
5  10   WG         1  8445.669  26930.225
6 100   WG         2  34836.159 131895.770
7  1 liquid         0  7428.748  27975.209
8  10 liquid         1  30358.647 137013.769
9 100 liquid         2 124777.882 671050.332
10  1 sachets         0  43171.834 109643.329
11 10 sachets         1 178633.195 536998.526
12 100 sachets         2 743106.477 2630049.815

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.19998 -0.35300 -0.01213 0.41159 1.63076

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)    2.90826  0.06556 44.361 < 2e-16 ***
lTA        0.61243  0.04700 13.030 < 2e-16 ***
form2WP      1.48940  0.15007  9.925 < 2e-16 ***
form2liquid    0.55736  0.08285  6.728 8.78e-11 ***
form2sachets   1.31192  0.16590  7.908 5.10e-14 ***
glove.wash.MLyes -0.40695  0.11934 -3.410 0.000739 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5968 on 299 degrees of freedom
 (364 observations deleted due to missingness)
Multiple R-squared: 0.5748,  Adjusted R-squared: 0.5677
F-statistic: 80.84 on 5 and 299 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lph.ML ~ lTA + form2 + glove.wash.ML

N: 305   tau: 0.95   AIC: 703.33821462733

         coefficients  lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)     3.7402491 3.7041278 3.933930e+00 0.07746158 48.285213 0.000000e+00
lTA         0.6899909 0.6396480 7.066048e-01 0.05927878 11.639762 0.000000e+00
form2WP       1.2131812 0.9137829 1.797693e+308 0.19662991  6.169871 2.217437e-09
form2liquid     0.7065242 0.4741189 7.877518e-01 0.07081195  9.977472 0.000000e+00
form2sachets    1.2997331 1.0024388 1.797693e+308 0.17742238  7.325644 2.223555e-12
glove.wash.MLyes  -0.7198032 -0.8525017 1.797693e+308 0.07077656 -10.170078 0.000000e+00


Formula for mean (based on LS-estimate):
log(ph.ML) = 2.908 + 0.612 log(TA) + 1.489 form2WP + 0.557 form2liquid + 1.312 form2sachets +
-0.407 glove.wash.MLyes
Formula for 95th percentile (based on quantile regression):
log(ph.ML) = 3.74 + 0.69 log(TA) + 1.213 form2WP + 0.707 form2liquid + 1.3 form2sachets + -
0.72 glove.wash.MLyes
```

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

Model: lrah.ML ~ form2

```
Table of measured values:
     n     min     50%     75%     90%    95%    max
WG    91 0.09090909  16.870588  46.409286  168.90000  306.4571  948.1000
WP    20 94.60000000 1229.123656 3586.500000 10171.50538 12059.1398 12161.2903
liquid 173 0.01000000  48.478261 141.000000  688.54545 2466.8251 37085.1549
sachets 20 0.95010753  3.306452  8.347043  59.11828  107.4919  120.1075

Table of predicted values (95th percentile):
  TA  form2 lTA    LS.75    QR.75
1  1   WP  0  964.05364  2167.7879
2  10   WP  1 9640.53638 21677.8794
3 100   WP  2 96405.36382 216778.7936
4  1   WG  0  31.10619  166.3333
5  10   WG  1  311.06192  1663.3333
6 100   WG  2 3110.61925 16633.3333
7  1 liquid  0  25.11747  398.9513
8  10 liquid  1  251.17465  3989.5131
9 100 liquid  2 2511.74652 39895.1311
10  1 sachets  0  580.42167  1435.1254
11 10 sachets  1 5804.21668 14351.2545
12 100 sachets  2 58042.16682 143512.5448

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.5717 -0.5806 0.0872 0.6141 3.3344

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.78770  0.10886  7.236 3.89e-12 ***
form2WP    1.47778  0.25647  5.762 2.06e-08 ***
form2liquid -0.09105  0.13448 -0.677  0.499
form2sachets 1.25742  0.25647  4.903 1.55e-06 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.038 on 300 degrees of freedom
 (365 observations deleted due to missingness)
Multiple R-squared: 0.1815,   Adjusted R-squared: 0.1733
F-statistic: 22.17 on 3 and 300 DF, p-value: 5.377e-13

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrah.ML ~ form2

N: 304   tau: 0.95   AIC: 1065.1739156027

       coefficients  lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   2.2209793 2.01629749 2.399614e+00 0.1415807 15.687020 0.000000e+00
form2WP     1.1150375 0.84728976 1.797693e+308 0.1445155 7.715694 1.794120e-13
form2liquid   0.3799406 0.02583516 6.681382e-01 0.1956966 1.941478 5.313647e-02
form2sachets  0.9359106 0.81545925 1.797693e+308 0.1462752 6.398286 6.028218e-10


Formula for mean (based on LS-estimate):
log(ah.ML) = log(TA) + 0.788 + 1.478 form2WP + -0.091 form2liquid + 1.257 form2sachets
Formula for 95th percentile (based on quantile regression):
log(ah.ML) = log(TA) + 2.221 + 1.115 form2WP + 0.38 form2liquid + 0.936 form2sachets

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

Model: lah.ML ~ lTA + form2

```
Table of measured values:
```

```
     n     min     50%     75%     90%    95%    max
WG    91 0.09090909  16.870588  46.409286  168.90000  306.4571  948.1000
WP    20 94.60000000 1229.123656 3586.500000 10171.50538 12059.1398 12161.2903
liquid 173 0.01000000  48.478261 141.000000  688.54545 2466.8251 37085.1549
sachets 20 0.95010753  3.306452  8.347043  59.11828  107.4919  120.1075

Table of predicted values (95th percentile):
  TA  form2 lTA    LS.75   QR.75
1  1   WP  0 2708.17648 4852.5092
2  10   WP  1 6447.99607 16547.0586
3 100   WP  2 15487.70361 56425.4775
4  1   WG  0  40.69532  196.8753
5  10   WG  1  97.35199  671.3450
6 100   WG  2  234.97189 2289.2867
7  1 liquid  0  81.49198 1341.4975
8  10 liquid  1  193.84516 4574.5072
9 100 liquid  2  465.25706 15599.0717
10  1 sachets  0  77.58415  477.4043
11 10 sachets  1  188.18568 1627.9489
12 100 sachets  2  460.30442 5551.3065

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.6072 -0.5639 -0.0135 0.5102 2.6299

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.97475  0.10044  9.704 < 2e-16 ***
lTA      0.37803  0.07361  5.135 5.09e-07 ***
form2WP    1.80985  0.23414  7.730 1.65e-13 ***
form2liquid  0.30169  0.12965  2.327  0.0206 *
form2sachets 0.26508  0.25898  1.024  0.3069
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9346 on 299 degrees of freedom
 (365 observations deleted due to missingness)
Multiple R-squared: 0.2843,   Adjusted R-squared: 0.2747
F-statistic: 29.69 on 4 and 299 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lah.ML ~ lTA + form2

N: 304   tau: 0.95   AIC: 1019.46106371718

       coefficients lower bd   upper bd Std. Error  t value     Pr(>|t|)
(Intercept)   2.2941913 1.9779590 2.509842e+00 0.1910078 12.010980 0.000000000000000
lTA       0.5327544 0.3537460 7.662970e-01 0.1612003 3.304922 0.001065657404610
form2WP     1.3917751 1.1204490 1.797693e+308 0.2237906 6.219095 0.000000001681083
form2liquid   0.8333986 0.3712154 1.081173e+00 0.2800213 2.976197 0.003156831886910
form2sachets  0.3846950 0.1194680 1.797693e+308 0.3087019 1.246170 0.213677477074707


Formula for mean (based on LS-estimate):
log(ah.ML) = 0.975 + 0.378 log(TA) + 1.81 form2WP + 0.302 form2liquid + 0.265 form2sachets
Formula for 95th percentile (based on quantile regression):
log(ah.ML) = 2.294 + 0.533 log(TA) + 1.392 form2WP + 0.833 form2liquid + 0.385 form2sachets

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

Model: lrtb.ML ~ form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  181.69720  2691.732  9850.784 20638.24 25671.59 67310.76
WP   20 28896.67519 146633.657 367452.410 452450.19 478880.28 575868.61
liquid 86  55.95238  5600.451 28926.789 91002.52 145449.83 511526.97

Table of predicted values (95th percentile):
```

```
  TA form2 lTA    LS.75    QR.75
1  1   WP  0  60430.003  84451.985
2 10   WP  1 604300.026 844519.848
3 100   WP  2 6043000.264 8445198.480
4  1   WG  0  1237.450  4006.593
5 10   WG  1  12374.496  40065.930
6 100   WG  2 123744.956 400659.301
7  1 liquid  0  2364.388  25069.845
8 10 liquid  1  23643.875 250698.448
9 100 liquid  2 236438.753 2506984.479

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.70952 -0.50156 -0.00823 0.39845 1.72338

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.6385   0.1226 21.528 < 2e-16 ***
form2WP    1.6853   0.1918  8.785 7.17e-15 ***
form2liquid  0.2862   0.1417  2.020  0.0454 *
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.66 on 132 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.402,   Adjusted R-squared: 0.393
F-statistic: 44.37 on 2 and 132 DF, p-value: 1.826e-15

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrtb.ML ~ form2

N: 135   tau: 0.95   AIC: 364.067553803023

      coefficients    lower bd   upper bd Std. Error  t value  Pr(>|t|)
(Intercept)  3.6027752  3.245129e+00 1.797693e+308 0.1384127 26.029228 0.000000000
form2WP    1.3238346  1.293287e+00 1.797693e+308 0.1388695 9.532937 0.000000000
form2liquid  0.7963764 -1.797693e+308 1.185353e+00 0.2419847 3.291020 0.001280602


Formula for mean (based on LS-estimate):
log(tb.ML) = log(TA) + 2.638 + 1.685 form2WP + 0.286 form2liquid
Formula for 95th percentile (based on quantile regression):
log(tb.ML) = log(TA) + 3.603 + 1.324 form2WP + 0.796 form2liquid

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

Model: ltb.ML ~ lTA + form2

```
Table of measured values:
    n     min     50%     75%     90%     95%    max
WG   29  181.69720  2691.732  9850.784 20638.24 25671.59 67310.76
WP   20 28896.67519 146633.657 367452.410 452450.19 478880.28 575868.61
liquid 86  55.95238  5600.451 28926.789 91002.52 145449.83 511526.97

Table of predicted values (95th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0 103493.923 143606.404
2 10   WP  1 512476.443 706853.657
3 100   WP  2 2576912.231 3479246.595
4  1   WG  0  2123.110  7355.493
5 10   WG  1  10512.399  36204.911
6 100   WG  2  52862.446 178206.352
7  1 liquid  0  4104.575  38873.400
8 10 liquid  1  20317.290 191341.084
9 100 liquid  2 102153.906 941811.374
Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)
```

```
Residuals:
  Min   1Q Median   3Q   Max
-1.6426 -0.4004 0.0208 0.3977 1.5803

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 2.89199  0.13455 21.494 < 2e-16 ***
lTA     0.69699  0.07987  8.726 1.05e-14 ***
form2WP   1.68474  0.18279  9.217 6.63e-16 ***
form2liquid 0.29099  0.13505  2.155  0.033 *
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6289 on 131 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.5686,  Adjusted R-squared: 0.5587
F-statistic: 57.56 on 3 and 131 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: ltb.ML ~ lTA + form2

N: 135   tau: 0.95   AIC: 357.209751477471

      coefficients    lower bd   upper bd Std. Error  t value    Pr(>|t|)
(Intercept)  3.8666118  3.321178e+00 1.797693e+308 0.3598892 10.743894 0.000000000000
lTA      0.6921557  4.019368e-02 1.014025e+00 0.2378017 2.910642 0.004240020440
form2WP    1.2905620  1.027943e+00 1.797693e+308 0.2774629 4.651295 0.000007957987
form2liquid  0.7230408 -1.797693e+308 1.239856e+00 0.3160882 2.287465 0.023771621983


Formula for mean (based on LS-estimate):
log(tb.ML) = 2.892 + 0.697 log(TA) + 1.685 form2WP + 0.291 form2liquid
Formula for 95th percentile (based on quantile regression):
log(tb.ML) = 3.867 + 0.692 log(TA) + 1.291 form2WP + 0.723 form2liquid

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

Model: lrib.ML ~ form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  0.0100000 104.34783 230.4348  607.6532 1070.524 1491.304
WP   20 1333.4900000 4929.54637 9979.8946 22420.8358 22751.213 24890.700
liquid 86  0.5747126  54.07694 175.8362  504.6776 1550.291 14684.270

Table of predicted values (95th percentile):
  TA form2 lTA    LS.75    QR.75
1  1   WP  0  2596.29413  2959.29516
2 10   WP  1 25962.94127 29592.95160
3 100   WP  2 259629.41266 295929.51597
4  1   WG  0   24.01766   62.21532
5 10   WG  1  240.17661  622.15321
6 100   WG  2  2401.76613  6221.53209
7  1 liquid  0   24.55259  253.39378
8 10 liquid  1  245.52594  2533.93783
9 100 liquid  2  2455.25942 25339.37834

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.85756 -0.39006 -0.09731 0.47627 2.00917

Coefficients:
      Estimate Std. Error t value   Pr(>|t|)
(Intercept) 0.87528  0.13639  6.418 0.00000000228 ***
form2WP   2.03005  0.21348  9.509    < 2e-16 ***
form2liquid 0.01518  0.15771  0.096     0.923
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.7345 on 132 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.4937,   Adjusted R-squared: 0.486
F-statistic: 64.36 on 2 and 132 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrib.ML ~ form2

N: 135   tau: 0.95   AIC: 391.822623953312

      coefficients    lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  1.7938973  1.548657e+00 1.797693e+308 0.1778849 10.084598 0.000000e+00
form2WP    1.6772909  1.513534e+00 1.797693e+308 0.2191327 7.654223 3.644640e-12
form2liquid  0.6098986 -1.797693e+308 9.910873e-01 0.2664239 2.289204 2.365518e-02


Formula for mean (based on LS-estimate):
log(ib.ML) = log(TA) + 0.875 + 2.03 form2WP + 0.015 form2liquid
Formula for 95th percentile (based on quantile regression):
log(ib.ML) = log(TA) + 1.794 + 1.677 form2WP + 0.61 form2liquid

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

Model: lib.ML ~ lTA + form2

```
Table of measured values:
    n     min    50%    75%    90%    95%    max
WG   29  0.0100000 104.34783 230.4348  607.6532 1070.524 1491.304
WP   20 1333.4900000 4929.54637 9979.8946 22420.8358 22751.213 24890.700
liquid 86  0.5747126  54.07694 175.8362  504.6776 1550.291 14684.270

Table of predicted values (95th percentile):
  TA form2 lTA    LS.75     QR.75
1  1   WP  0  4644.05724  4648.4539
2 10   WP  1 21788.76175 27884.8329
3 100   WP  2 103994.98598 167273.6629
4  1   WG  0   43.04387  122.2788
5 10   WG  1  201.93568  733.5181
6 100   WG  2  963.86210  4400.1793
7  1 liquid  0   44.56226  336.7146
8 10 liquid  1  208.98822  2019.8612
9 100 liquid  2  997.38053 12116.6075

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-3.13621 -0.39305 -0.00853 0.41067 1.90882

Coefficients:
      Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.14816  0.15025  7.642 4.03e-12 ***
lTA     0.67383  0.08920  7.554 6.43e-12 ***
form2WP   2.02941  0.20413  9.942 < 2e-16 ***
form2liquid 0.02029  0.15081  0.135  0.893
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7023 on 131 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.5994,   Adjusted R-squared: 0.5902
F-statistic: 65.33 on 3 and 131 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lib.ML ~ lTA + form2

N: 135   tau: 0.95   AIC: 384.917900378603
```

```
      coefficients    lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)  2.0873513  1.668354e+00 1.797693e+308 0.1507026 13.850802 0.000000e+00
lTA      0.7780595 -1.372918e-01 1.024954e+00 0.1847663 4.211046 4.692662e-05
form2WP    1.5799572  1.422950e+00 1.797693e+308 0.1916003 8.246111 1.501022e-13
form2liquid  0.4399107 -1.797693e+308 9.737976e-01 0.3073713 1.431203 1.547533e-01


Formula for mean (based on LS-estimate):
log(ib.ML) = 1.148 + 0.674 log(TA) + 2.029 form2WP + 0.02 form2liquid
Formula for 95th percentile (based on quantile regression):
log(ib.ML) = 2.087 + 0.778 log(TA) + 1.58 form2WP + 0.44 form2liquid

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

Model: lrhd.ML ~ form + face.shield.ML

```
Table of measured values:
    n  min    50%   75%    90%    95%    max
WG   48 0.01 28.39726 160.0394 627.6042 1341.689 3133.681
WP   20 65.76 443.00000 968.0100 1218.2515 1533.650 2610.000
liquid 87 0.01 16.84783 215.6943 2655.3390 5378.830 25757.774

Table of predicted values (95th percentile):
  TA  form face.shield.ML lTA     LS.75    QR.75
1  1   WP       no  0  268.2546109  198.94118
2  10   WP       no  1 2682.5461093 1989.41176
3 100   WP       no  2 26825.4610929 19894.11765
4  1   WG       no  0  30.0256253  156.17778
5  10   WG       no  1  300.2562531 1561.77778
6 100   WG       no  2 3002.5625305 15617.77778
7  1 liquid       no  0  49.9754716  384.74589
8  10 liquid       no  1  499.7547161 3847.45888
9 100 liquid       no  2 4997.5471615 38474.58881
10  1   WP      yes  0   7.1488893  13.69263
11 10   WP      yes  1  71.4888929  136.92633
12 100   WP      yes  2  714.8889289 1369.26334
13  1   WG      yes  0   0.7911049  10.74933
14 10   WG      yes  1   7.9110490  107.49334
15 100   WG      yes  2  79.1104895 1074.93336
16  1 liquid      yes  0   1.3126275  26.48112
17 10 liquid      yes  1  13.1262753  264.81116
18 100 liquid      yes  2  131.2627526 2648.11162

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.8944 -0.5796 0.0204 0.6030 3.2205

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.8451   0.1390  6.081 9.38e-09 ***
formWP       0.9426   0.2492  3.783 0.000223 ***
formliquid     0.2238   0.1666  1.343 0.181181
face.shield.MLyes -1.5865   0.1856 -8.548 1.28e-14 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9249 on 151 degrees of freedom
Multiple R-squared: 0.4041,   Adjusted R-squared: 0.3922
F-statistic: 34.13 on 3 and 151 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

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

N: 155   tau: 0.95   AIC: 510.663345029742
         coefficients  lower bd   upper bd Std. Error  t value     Pr(>|t|)
(Intercept)     2.1936192 1.93730719 1.797693e+308 0.3861146 5.6812649 0.00000006677105
formWP       0.1051054 -0.02180212 1.797693e+308 0.4122570 0.2549512 0.79910766580318
formliquid      0.3915547 -0.53458042 8.411818e-01 0.4983403 0.7857176 0.43326410801813
face.shield.MLyes  -1.1622377 -2.00924911 1.797693e+308 0.9773081 -1.1892234 0.23621845975389
```

```
Formula for mean (based on LS-estimate):
log(hd.ML) = log(TA) + 0.845 + 0.943 formWP + 0.224 formliquid + -1.586 face.shield.MLyes
Formula for 95th percentile (based on quantile regression):
log(hd.ML) = log(TA) + 2.194 + 0.105 formWP + 0.392 formliquid + -1.162 face.shield.MLyes

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

Model: lhd.ML ~ lTA + form + face.shield.ML

```
Table of measured values:
    n  min    50%   75%    90%   95%    max
WG   48 0.01 28.39726 160.0394 627.6042 1341.689 3133.681
WP   20 65.76 443.00000 968.0100 1218.2515 1533.650 2610.000
liquid 87 0.01 16.84783 215.6943 2655.3390 5378.830 25757.774

Table of predicted values (95th percentile):
  TA  form face.shield.ML lTA     LS.75    QR.75
1  1   WP       no  0  297.8326758  147.75043
2  10   WP       no  1 2644.2296777 2249.67470
3 100   WP       no  2 23936.5563996 34253.95199
4  1   WG       no  0  32.0181661  111.43331
5  10   WG       no  1  286.0450891 1696.70368
6 100   WG       no  2 2606.0574415 25834.31576
7  1 liquid       no  0  56.2329280  187.66665
8  10 liquid       no  1  498.1833816 2857.44624
9 100 liquid       no  2 4501.6682225 43507.99094
10  1   WP      yes  0   7.6602794  16.50069
11 10   WP      yes  1  68.3851783  251.24249
12 100   WP      yes  2  622.2030408 3825.46344
13  1   WG      yes  0   0.8156018  12.44481
14 10   WG      yes  1   7.3266466  189.48698
15 100   WG      yes  2  67.0951828 2885.16287
16  1 liquid      yes  0   1.4245295  20.95851
17 10 liquid      yes  1  12.6912209  319.11810
18 100 liquid      yes  2  115.2983391 4858.94967

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-3.8998 -0.5641 0.0355 0.5897 3.2409

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
(Intercept)     0.8702   0.1502  5.794 3.91e-08 ***
lTA         0.9512   0.1091  8.719 4.90e-15 ***
formWP       0.9583   0.2523  3.799 0.000211 ***
formliquid     0.2445   0.1733  1.411 0.160418
face.shield.MLyes -1.6003   0.1886 -8.484 1.92e-14 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9274 on 150 degrees of freedom
Multiple R-squared: 0.5966,  Adjusted R-squared: 0.5858
F-statistic: 55.46 on 4 and 150 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

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

N: 155   tau: 0.95   AIC: 509.124718416923

         coefficients  lower bd   upper bd Std. Error  t value    Pr(>|t|)
(Intercept)     2.0470150 1.88466825 2.829013e+00 0.4126907 4.9601677 0.000001886495
lTA         1.1825910 0.55498935 1.323409e+00 0.3153641 3.7499225 0.000252040807
formWP        0.1225137 -0.06900669 1.797693e+308 0.2390218 0.5125630 0.609011016384
formliquid      0.2263721 -0.87487206 1.043012e+00 0.3483161 0.6499042 0.516748169222
face.shield.MLyes  -0.9520266 -2.33629044 1.797693e+308 0.9994206 -0.9525786 0.342336102547
```

```
Formula for mean (based on LS-estimate):
log(hd.ML) = 0.87 + 0.951 log(TA) + 0.958 formWP + 0.245 formliquid + -1.6 face.shield.MLyes
Formula for 95th percentile (based on quantile regression):
log(hd.ML) = 2.047 + 1.183 log(TA) + 0.123 formWP + 0.226 formliquid + -0.952
face.shield.MLyes

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

Model: lria.ML ~ form2

```
Table of measured values:
     n     min     50%     75%    90%    95%     max
WG    91  0.0100000  12.043854  35.196200  89.84375 199.62565  937.38163
WP    20 658.1527348 2182.479920 4766.754555 5893.93643 6387.06140 10246.24815
liquid 100  0.7038288  3.096413  8.530994  16.86825  30.37221  167.62452
sachets 20  0.1562500  3.622396  7.317909  16.89530  27.97703  33.18376

Table of predicted values (95th percentile):
  TA  form2 lTA     LS.75    QR.75
1  1   WP  0  1251.9398857  808.358995
2  10   WP  1 12519.3988567 8083.589950
3 100   WP  2 125193.9885672 80835.899498
4  1   WG  0   13.2313036  46.202522
5  10   WG  1  132.3130357  462.025217
6 100   WG  2  1323.1303574 4620.252171
7  1 liquid  0   0.7510272   4.016885
8  10 liquid  1   7.5102725  40.168845
9 100 liquid  2   75.1027246  401.688453
10  1 sachets  0  254.5767543  418.518519
11 10 sachets  1  2545.7675431 4185.185185
12 100 sachets  2 25457.6754313 41851.851852

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.66974 -0.36148 0.07019 0.50298 1.97638

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.59056  0.08195  7.206 8.44e-12 ***
form2WP    1.96583  0.19307 10.182 < 2e-16 ***
form2liquid -1.24569  0.11326 -10.998 < 2e-16 ***
form2sachets 1.27407  0.19307  6.599 2.88e-10 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7818 on 227 degrees of freedom
 (438 observations deleted due to missingness)
Multiple R-squared: 0.6426,  Adjusted R-squared: 0.6379
F-statistic: 136.1 on 3 and 227 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lria.ML ~ form2

N: 231   tau: 0.95   AIC: 615.695908684968

       coefficients  lower bd    upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   1.664666 1.6436071  1.958162e+00 0.1088814 15.288801 0.000000e+00
form2WP     1.242939 1.1034694 1.797693e+308 0.1889990 6.576430 3.277401e-10
form2liquid   -1.060776 -1.4133204 -7.913573e-01 0.1856035 -5.715282 3.423126e-08
form2sachets   0.957049 0.7917837 1.797693e+308 0.1102024 8.684467 8.881784e-16


Formula for mean (based on LS-estimate):
log(ia.ML) = log(TA) + 0.591 + 1.966 form2WP + -1.246 form2liquid + 1.274 form2sachets
Formula for 95th percentile (based on quantile regression):
log(ia.ML) = log(TA) + 1.665 + 1.243 form2WP + -1.061 form2liquid + 0.957 form2sachets

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

Model: lia.ML ~ lTA + form2

```
Table of measured values:
     n      min      50%      75%     90%     95%      max
WG    91  0.0100000  12.043854  35.196200  89.84375 199.62565  937.38163
WP    20 658.1527348 2182.479920 4766.754555 5893.93643 6387.06140 10246.24815
liquid 100  0.7038288  3.096413  8.530994  16.86825  30.37221  167.62452
sachets 20  0.1562500  3.622396  7.317909  16.89530  27.97703  33.18376

Table of predicted values (95th percentile):
  TA  form2 lTA    LS.75    QR.75
1  1   WP  0 3191.327591 2262.574455
2  10   WP  1 9354.577865 7059.185820
3 100   WP  2 27852.831368 22024.514747
4  1   WG  0  17.512143  64.893903
5  10   WG  1  51.766688  202.467644
6 100   WG  2  155.459223  631.694890
7  1 liquid  0   3.007418   7.768326
8  10 liquid  1   8.763853  24.237019
9 100 liquid  2  25.948914  75.619002
10  1 sachets  0  48.476189  99.636186
11 10 sachets  1  146.831165  310.862855
12 100 sachets  2  451.069241  969.885720

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min     1Q  Median     3Q   Max
-2.78731 -0.36923 0.03582 0.47501 1.81989

Coefficients:
       Estimate Std. Error t value   Pr(>|t|)
(Intercept)  0.75015  0.08040  9.330   < 2e-16 ***
lTA      0.46933  0.08663  5.418 0.0000001543 ***
form2WP    2.24916  0.18506 12.153   < 2e-16 ***
form2liquid -0.76955  0.13073 -5.886 0.0000000142 ***
form2sachets 0.42740  0.22630  1.889    0.0602 .
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7256 on 226 degrees of freedom
 (438 observations deleted due to missingness)
Multiple R-squared: 0.5646,   Adjusted R-squared: 0.5569
F-statistic: 73.27 on 4 and 226 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lia.ML ~ lTA + form2

N: 231   tau: 0.95   AIC: 570.917571071503

       coefficients  lower bd    upper bd Std. Error  t value     Pr(>|t|)
(Intercept)   1.8122039 1.6999693  2.369327e+00 0.1382516 13.1080134 0.000000000000000
lTA       0.4941517 0.2932718  6.524962e-01 0.1840970 2.6841921 0.007808866050302
form2WP     1.5423990 1.4695262 1.797693e+308 0.2460653 6.2682502 0.000000001829755
form2liquid  -0.9218764 -1.0454828 -6.896474e-01 0.2732395 -3.3738770 0.000872067688678
form2sachets  0.1862132 -0.2269114 1.797693e+308 0.2996931 0.6213462 0.534998058750110


Formula for mean (based on LS-estimate):
log(ia.ML) = 0.75 + 0.469 log(TA) + 2.249 form2WP + -0.77 form2liquid + 0.427 form2sachets
Formula for 95th percentile (based on quantile regression):
log(ia.ML) = 1.812 + 0.494 log(TA) + 1.542 form2WP + -0.922 form2liquid + 0.186 form2sachets

=================================================================================
####################################################
###
### model output for A - HCHH - GH only
###
####################################################
```

Model: lrph.A ~ dense4

```
Table of measured values:
     n   min   50%    75%   90%    95%   max
normal 34 120.3419 9342.857 18368.5188 30449.98 39698.634 52944.93
dense  24 268.2500 5996.327 19616.5019 44031.13 58422.835 92299.54
trolley 10 230.6100 391.050  628.6578  723.22  974.185 1225.15

Table of predicted values (95th percentile):
  TA dense4   lTA   LS.75   QR.75
1 0.2  dense -0.69897  8157.605 25706.019
2 1.0  dense 0.00000 40788.026 128530.093
3 5.0  dense 0.69897 203940.128 642650.463
4 0.2 normal -0.69897  5807.206 13840.522
5 1.0 normal 0.00000 29036.029 69202.612
6 5.0 normal 0.69897 145180.146 346013.059
7 0.2 trolley -0.69897  2329.227  2838.953
8 1.0 trolley 0.00000 11646.136 14194.763
9 5.0 trolley 0.69897 58230.680 70973.815

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-0.73179 -0.29426 -0.06322 0.32778 0.93969

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.17826  0.07094 58.896 < 2e-16 ***
dense4dense  0.14591  0.11028  1.323 0.19047
dense4trolley -0.40635  0.14881 -2.731 0.00813 **
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4137 on 65 degrees of freedom
 (35 observations deleted due to missingness)
Multiple R-squared: 0.1625,   Adjusted R-squared: 0.1367
F-statistic: 6.304 on 2 and 65 DF, p-value: 0.003145

Summary of RQ fit (95th percentile):
[1] "No nid summary"

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrph.A ~ dense4

N: 68   tau: 0.95   AIC: 102.899998495328

       coefficients  lower bd   upper bd
(Intercept)   4.8401225 4.7123374 1.797693e+308
dense4dense   0.2688823 0.1786053 1.797693e+308
dense4trolley  -0.6879943 -0.7422036 1.797693e+308


Formula for mean (based on LS-estimate):
log(ph.A) = log(TA) + 4.178 + 0.146 dense4dense + -0.406 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ph.A) = log(TA) + 4.84 + 0.269 dense4dense + -0.688 dense4trolley

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

Model: lph.A ~ lTA + dense4

```
Table of measured values:
     n   min   50%    75%   90%    95%   max
normal 34 120.3419 9342.857 18368.5188 30449.98 39698.634 52944.93
dense  24 268.2500 5996.327 19616.5019 44031.13 58422.835 92299.54
trolley 10 230.6100 391.050  628.6578  723.22  974.185 1225.15

Table of predicted values (95th percentile):
  TA dense4   lTA   LS.75   QR.75
1 0.2  dense -0.69897  8365.786 22804.079
2 1.0  dense 0.00000 31561.341 88579.704
3 5.0  dense 0.69897 120350.246 344077.219
4 0.2 normal -0.69897  6453.288 16516.088
```

```
5 1.0 normal 0.00000 24272.684 64154.758
6 5.0 normal 0.69897 92293.243 249201.451
7 0.2 trolley -0.69897  1915.175  2488.313
8 1.0 trolley 0.00000  7283.735  9665.553
9 5.0 trolley 0.69897 27978.584 37544.680

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-0.66470 -0.30098 -0.04694 0.29742 0.72750

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.10878  0.07493 54.835 < 2e-16 ***
lTA      0.82271  0.07650 10.755 5.55e-16 ***
dense4dense  0.11149  0.10778  1.034 0.30485
dense4trolley -0.53728  0.15473 -3.472 0.00093 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4004 on 64 degrees of freedom
 (35 observations deleted due to missingness)
Multiple R-squared: 0.7411,  Adjusted R-squared: 0.7289
F-statistic: 61.06 on 3 and 64 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):
[1] "No nid summary"

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lph.A ~ lTA + dense4

N: 68   tau: 0.95   AIC: 93.5886168452531

       coefficients    lower bd   upper bd
(Intercept)   4.8072289  4.696071e+00 1.797693e+308
lTA       0.8431287 -1.797693e+308 1.405870e+00
dense4dense   0.1401054  1.025244e-01 1.797693e+308
dense4trolley  -0.8220022 -9.205027e-01 1.797693e+308


Formula for mean (based on LS-estimate):
log(ph.A) = 4.109 + 0.823 log(TA) + 0.111 dense4dense + -0.537 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ph.A) = 4.807 + 0.843 log(TA) + 0.14 dense4dense + -0.822 dense4trolley

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

Model: lrah.A ~ dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 28 0.6329114 8.848734 29.57333 79.85985 109.28823 301.4933
dense  23 0.2500000 93.291139 537.02532 912.45570 1069.70000 1263.0380
trolley 10 0.0100000 0.125000  0.28750  1.78490  2.16245  2.5400

Table of predicted values (95th percentile):
  TA dense4   lTA    LS.75    QR.75
1 0.2  dense -0.69897 154.6162048 287.652257
2 1.0  dense 0.00000 773.0810238 1438.261285
3 5.0  dense 0.69897 3865.4051190 7191.306425
4 0.2 normal -0.69897  15.3022846  81.927536
5 1.0 normal 0.00000  76.5114230 409.637681
6 5.0 normal 0.69897 382.5571152 2048.188406
7 0.2 trolley -0.69897  0.9092839  7.062422
8 1.0 trolley 0.00000  4.5464196  35.312109
9 5.0 trolley 0.69897  22.7320982 176.560545

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)
```

```
Residuals:
   Min     1Q  Median     3Q    Max
-1.59186 -0.58168 0.07624 0.56673 1.44888

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.3417    0.1483  9.047 1.11e-12 ***
dense4dense   1.0025    0.2208  4.540 2.89e-05 ***
dense4trolley -1.2426    0.2891 -4.298 6.66e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7847 on 58 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.5068,  Adjusted R-squared: 0.4898
F-statistic: 29.8 on 2 and 58 DF, p-value: 0.000000001252

Summary of RQ fit (95th percentile):
[1] "No nid summary"

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrah.A ~ dense4

N: 61   tau: 0.95   AIC: 170.952013220916

       coefficients  lower bd   upper bd
(Intercept)   2.6123999 2.4388689 1.797693e+308
dense4dense   0.5454379 0.4763562 1.797693e+308
dense4trolley  -1.0644762 -1.2282803 1.797693e+308


Formula for mean (based on LS-estimate):
log(ah.A) = log(TA) + 1.342 + 1.002 dense4dense + -1.243 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ah.A) = log(TA) + 2.612 + 0.545 dense4dense + -1.064 dense4trolley

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

Model: lah.A ~ lTA + dense4

```
Table of measured values:
     n    min     50%     75%     90%     95%     max
normal 28 0.6329114 8.848734 29.57333 79.85985 109.28823 301.4933
dense  23 0.2500000 93.291139 537.02532 912.45570 1069.70000 1263.0380
trolley 10 0.0100000 0.125000  0.28750  1.78490  2.16245  2.5400

Table of predicted values (95th percentile):
  TA dense4   lTA    LS.75    QR.75
1 0.2  dense -0.69897 157.8706184 445.094707
2 1.0  dense 0.00000 742.2496537 1316.821887
3 5.0  dense 0.69897 3567.7604815 3895.844760
4 0.2 normal -0.69897  15.8194180  78.183346
5 1.0 normal 0.00000  74.0997111 231.307045
6 5.0 normal 0.69897 354.9268008 684.326672
7 0.2 trolley -0.69897  0.8840234  5.060003
8 1.0 trolley 0.00000  4.2250742  14.970122
9 5.0 trolley 0.69897  20.6129937  44.289416

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min     1Q  Median     3Q    Max
-1.56900 -0.59813 0.08362 0.57032 1.44833

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.3210    0.1668  7.920 9.35e-11 ***
lTA       0.9569    0.1547  6.184 7.16e-08 ***
dense4dense   0.9974    0.2233  4.466 3.82e-05 ***
dense4trolley -1.2708    0.3084 -4.121 0.000124 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 0.791 on 57 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.6858,   Adjusted R-squared: 0.6693
F-statistic: 41.47 on 3 and 57 DF, p-value: 2.382e-14

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lah.A ~ lTA + dense4

N: 61   tau: 0.95   AIC: 159.553552971336

       coefficients    lower bd   upper bd Std. Error  t value    Pr(>|t|)
(Intercept)   2.3641889  2.118235e+00 1.797693e+308 0.3979794 5.940481 0.0000001800024
lTA       0.6739554 -1.797693e+308 9.290967e-01 0.5596583 1.204227 0.2334788392823
dense4dense   0.7553382  5.263366e-01 1.797693e+308 0.3596506 2.100200 0.0401477771211
dense4trolley  -1.1889635 -1.583058e+00 1.797693e+308 0.4461319 -2.665049 0.0099952893447


Formula for mean (based on LS-estimate):
log(ah.A) = 1.321 + 0.957 log(TA) + 0.997 dense4dense + -1.271 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ah.A) = 2.364 + 0.674 log(TA) + 0.755 dense4dense + -1.189 dense4trolley

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

Model: lrtb.A ~ dense4

```
Table of measured values:
     n   min    50%     75%     90%     95%    max
normal 36 1310.187 106508.00 367246.563 669578.452 739278.346 1085188.28
dense  15 2161.030 869396.32 1589473.063 2032085.216 2307184.470 2649484.71
trolley 10 1337.900  2950.49  4970.132  6625.582  9851.011  13076.44

Table of predicted values (95th percentile):
  TA dense4   lTA    LS.75   QR.75
1 0.2  dense -0.69897  485548.29  760690.4
2 1.0  dense 0.00000 2427741.45 3803452.1
3 5.0  dense 0.69897 12138707.24 19017260.4
4 0.2 normal -0.69897  80253.20  249807.7
5 1.0 normal 0.00000  401265.99 1249038.5
6 5.0 normal 0.69897 2006329.96 6245192.4
7 0.2 trolley -0.69897  14938.42  30301.1
8 1.0 trolley 0.00000  74692.09  151505.5
9 5.0 trolley 0.69897  373460.47  757527.5

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-0.68955 -0.23543 -0.02489 0.22741 0.81099

Coefficients:
       Estimate Std. Error t value   Pr(>|t|)
(Intercept)  5.35764  0.05953 89.994    < 2e-16 ***
dense4dense  0.77716  0.10977  7.080 0.00000000215 ***
dense4trolley -0.73865  0.12768 -5.785 0.00000030751 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3572 on 58 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.6577,   Adjusted R-squared: 0.6459
F-statistic: 55.71 on 2 and 58 DF, p-value: 3.156e-14

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrtb.A ~ dense4

N: 61   tau: 0.95   AIC: 83.7998286854031

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

```
(Intercept)   6.0965758 5.9440311 1.797693e+308 0.09394756 64.893393 0.000000e+00
dense4dense   0.4836021 0.3123438 1.797693e+308 0.14798122 3.267997 1.822979e-03
dense4trolley  -0.9161474 -1.2045426 1.797693e+308 0.09394756 -9.751689 7.815970e-14


Formula for mean (based on LS-estimate):
log(tb.A) = log(TA) + 5.358 + 0.777 dense4dense + -0.739 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(tb.A) = log(TA) + 6.097 + 0.484 dense4dense + -0.916 dense4trolley

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

Model: ltb.A ~ lTA + dense4

```
Table of measured values:
     n   min     50%      75%      90%      95%     max
normal 36 1310.187 106508.00 367246.563 669578.452 739278.346 1085188.28
dense  15 2161.030 869396.32 1589473.063 2032085.216 2307184.470 2649484.71
trolley 10 1337.900  2950.49  4970.132  6625.582  9851.011  13076.44

Table of predicted values (95th percentile):
  TA dense4   lTA   LS.75    QR.75
1 0.2  dense -0.69897  501058.0  703442.15
2 1.0  dense 0.00000 3400207.4 3890654.06
3 5.0  dense 0.69897 23298856.9 21518740.46
4 0.2 normal -0.69897  68319.5  235140.33
5 1.0 normal 0.00000  460605.8 1300532.93
6 5.0 normal 0.69897 3137157.0 7193091.49
7 0.2 trolley -0.69897  17464.8  31940.47
8 1.0 trolley 0.00000  118983.1  176658.92
9 5.0 trolley 0.69897  818159.7  977079.25

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min    1Q Median    3Q    Max
-0.7347 -0.2178 -0.0392 0.2006 0.7640

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.42936  0.06235 87.084 < 2e-16 ***
lTA      1.18538  0.06815 17.394 < 2e-16 ***
dense4dense  0.86133  0.10867  7.926 9.13e-11 ***
dense4trolley -0.60082  0.13134 -4.574 2.62e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.339 on 57 degrees of freedom
 (42 observations deleted due to missingness)
Multiple R-squared: 0.8964,  Adjusted R-squared: 0.8909
F-statistic: 164.4 on 3 and 57 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):
[1] "No nid summary"

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: ltb.A ~ lTA + dense4

N: 61   tau: 0.95   AIC: 82.394494246748

       coefficients    lower bd   upper bd
(Intercept)   6.1141214  5.966531e+00 1.797693e+308
lTA       1.0626983 -1.797693e+308 1.655639e+00
dense4dense   0.4759013  3.458173e-01 1.797693e+308
dense4trolley  -0.8669858 -1.165910e+00 1.797693e+308


Formula for mean (based on LS-estimate):
log(tb.A) = 5.429 + 1.185 log(TA) + 0.861 dense4dense + -0.601 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(tb.A) = 6.114 + 1.063 log(TA) + 0.476 dense4dense + -0.867 dense4trolley

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

Model: lrib.A ~ dense5

```
Table of measured values:
        n     min    50%    75%    90%     95%    max
normal    36   7.777778  1105.097  9676.475 36845.699 92139.0200 190123.900
dense     10 57091.100000 259233.450 333253.775 856785.270 904220.5350 951655.800
trolley    10  20.230000   55.525   78.455  101.541  132.7305  163.920
coat     16  130.000000  1255.079  1688.734  3462.032  4366.0624  4656.211
zertcov+dense 11   3.030000  4379.110 82431.000 141919.000 308825.5000 475732.000

Table of predicted values (95th percentile):
  TA    dense5   lTA    LS.75    QR.75
1 0.2    normal -0.69897  1848.5973  23507.0453
2 1.0    normal 0.00000  9242.9864 117535.2265
3 5.0    normal 0.69897  46214.9319 587676.1326
4 0.2     dense -0.69897 222637.5981 273228.7683
5 1.0     dense 0.00000 1113187.9907 1366143.8415
6 5.0     dense 0.69897 5565939.9537 6830719.2076
7 0.2    trolley -0.69897   437.2676   455.7764
8 1.0    trolley 0.00000  2186.3379  2278.8822
9 5.0    trolley 0.69897  10931.6895  11394.4112
10 0.2     coat -0.69897   896.5146  1757.0609
11 1.0     coat 0.00000  4482.5730  8785.3047
12 5.0     coat 0.69897  22412.8652  43926.5235
13 0.2 zertcov+dense -0.69897  17526.0923  63430.9333
14 1.0 zertcov+dense 0.00000  87630.4614 317154.6667
15 5.0 zertcov+dense 0.69897 438152.3072 1585773.3333

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.66978 -0.43541 -0.05711 0.37919 1.81633

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
(Intercept)      3.5070   0.1113 31.508 < 2e-16 ***
dense5dense      2.0649   0.2387   8.650 5.16e-13 ***
dense5trolley    -0.6419   0.2387 -2.689 0.00876 **
dense5coat      -0.3220   0.2007 -1.605 0.11263
dense5zertcov+dense  0.9630   0.2301   4.185 7.41e-05 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6678 on 78 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.608,   Adjusted R-squared: 0.5879
F-statistic: 30.25 on 4 and 78 DF, p-value: 3.396e-15

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrib.A ~ dense5

N: 83   tau: 0.95   AIC: 207.598135375832

          coefficients  lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)      5.0701680 4.8465366 1.797693e+308 0.1784922 28.405543 0.000000e+00
dense5dense      1.0653284 0.7684434 1.797693e+308 0.1784922 5.968487 6.663715e-08
dense5trolley     -1.7124462 -1.8941903 1.797693e+308 0.1784922 -9.593955 7.549517e-15
dense5coat      -1.1264112 -1.6292401 1.797693e+308 0.2261085 -4.981728 3.702846e-06
dense5zertcov+dense  0.4311031 0.2843251 1.797693e+308 0.1814357 2.376065 1.995195e-02
Formula for mean (based on LS-estimate):
log(ib.A) = log(TA) + 3.507 + 2.065 dense5dense + -0.642 dense5trolley + -0.322 dense5coat +
0.963 dense5zertcov+dense
Formula for 95th percentile (based on quantile regression):
log(ib.A) = log(TA) + 5.07 + 1.065 dense5dense + -1.712 dense5trolley + -1.126 dense5coat +
0.431 dense5zertcov+dense

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

Model: lib.A ~ lTA + dense5

```
Table of measured values:
        n     min    50%    75%    90%     95%    max
normal    36   7.777778  1105.097  9676.475 36845.699 92139.0200 190123.900
dense     10 57091.100000 259233.450 333253.775 856785.270 904220.5350 951655.800
trolley    10  20.230000   55.525   78.455  101.541  132.7305  163.920
coat     16  130.000000  1255.079  1688.734  3462.032  4366.0624  4656.211
zertcov+dense 11   3.030000  4379.110 82431.000 141919.000 308825.5000 475732.000

Table of predicted values (95th percentile):
  TA    dense5   lTA     LS.75    QR.75
1 0.2    normal -0.69897   1115.1608  19809.3177
2 1.0    normal 0.00000  13759.6024 122364.2877
3 5.0    normal 0.69897  173248.7873 755857.3762
4 0.2     dense -0.69897  94869.3224 231919.1476
5 1.0     dense 0.00000 1161589.8471 1432589.5379
6 5.0     dense 0.69897 14506436.5698 8849259.7749
7 0.2    trolley -0.69897   687.4018   521.3033
8 1.0    trolley 0.00000   8659.7123  3220.1468
9 5.0    trolley 0.69897  111111.2164  19891.1933
10 0.2     coat -0.69897   405.4447  1545.9312
11 1.0     coat 0.00000   4970.2251  9549.3837
12 5.0     coat 0.69897  62164.5475  58987.5712
13 0.2 zertcov+dense -0.69897  26922.6024  50330.1249
14 1.0 zertcov+dense 0.00000  339026.2721 310894.5988
15 5.0 zertcov+dense 0.69897 4348686.4945 1920429.4006

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.10594 -0.35534 -0.03765 0.34132 1.62430

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
(Intercept)      3.7239   0.1119 33.285 < 2e-16 ***
lTA          1.5606   0.1283 12.168 < 2e-16 ***
dense5dense      1.9134   0.2178  8.784 3.14e-13 ***
dense5trolley    -0.2252   0.2353 -0.957  0.3415
dense5coat      -0.4480   0.1831 -2.447  0.0167 *
dense5zertcov+dense  1.3696   0.2272  6.028 5.36e-08 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6016 on 77 degrees of freedom
 (20 observations deleted due to missingness)
Multiple R-squared: 0.8197,  Adjusted R-squared: 0.808
F-statistic: 70.03 on 5 and 77 DF, p-value: < 2.2e-16

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lib.A ~ lTA + dense5

N: 83   tau: 0.95   AIC: 204.603777858984

          coefficients  lower bd   upper bd   Std. Error     t value
(Intercept)      5.0876547 4.8829981 1.797693e+308 0.1669434741065    30.475313
lTA          1.1313578 -1.4888761 2.475214e+00 0.0000000405121 27926416.936982
dense5dense      1.0684671 0.7574815 1.797693e+308 0.1669434741065    6.400173
dense5trolley     -1.5797790 -1.9264251 1.797693e+308 0.1669434741065    -9.462958
dense5coat      -1.1076793 -1.6202143 1.797693e+308 0.2273037243458    -4.873124
dense5zertcov+dense  0.4049585 0.1614025 1.797693e+308 0.1669434741065    2.425722
            Pr(>|t|)
(Intercept)     0.000000e+00
lTA         0.000000e+00
dense5dense     1.109074e-08
dense5trolley    1.554312e-14
dense5coat     5.756685e-06
dense5zertcov+dense 1.761875e-02


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

```
log(ib.A) = 3.724 + 1.561 log(TA) + 1.913 dense5dense + -0.225 dense5trolley + -0.448
dense5coat + 1.37 dense5zertcov+dense
Formula for 95th percentile (based on quantile regression):
log(ib.A) = 5.088 + 1.131 log(TA) + 1.068 dense5dense + -1.58 dense5trolley + -1.108
dense5coat + 0.405 dense5zertcov+dense

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

Model: lrhd.A ~ dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 35 1.666667 263.800 461.300 698.0000 992.2000 2651.60
dense  36 10.800000 308.100 824.900 3110.6000 5396.8000 7905.40
trolley 10 13.560000 63.346 119.675 253.7867 638.7333 1023.68

Table of predicted values (95th percentile):
  TA dense4 rain   lTA   LS.75    QR.75
1 0.2  dense coat -0.69897  655.8521 19251.3369
2 1.0  dense coat 0.00000 3279.2605 96256.6845
3 5.0  dense coat 0.69897 16396.3026 481283.4225
4 0.2 normal coat -0.69897  230.0795  320.3678
5 1.0 normal coat 0.00000 1150.3975  1601.8391
6 5.0 normal coat 0.69897 5751.9877  8009.1954
7 0.2 trolley coat -0.69897  743.4302  2372.1006
8 1.0 trolley coat 0.00000 3717.1511 11860.5028
9 5.0 trolley coat 0.69897 18585.7554 59302.5142
10 0.2  dense none -0.69897  655.8521 19251.3369
11 1.0  dense none 0.00000 3279.2605 96256.6845
12 5.0  dense none 0.69897 16396.3026 481283.4225
13 0.2 normal none -0.69897  230.0795  320.3678
14 1.0 normal none 0.00000 1150.3975  1601.8391
15 5.0 normal none 0.69897 5751.9877  8009.1954
16 0.2 trolley none -0.69897  743.4302  2372.1006
17 1.0 trolley none 0.00000 3717.1511 11860.5028
18 5.0 trolley none 0.69897 18585.7554 59302.5142

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-1.75447 -0.46733 -0.00353 0.38828 2.51158

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.5198   0.1331 18.938  <2e-16 ***
dense4dense   0.4551   0.1869  2.436  0.0171 *
dense4trolley  0.4909   0.2823  1.739  0.0860 .
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.7872 on 78 degrees of freedom
 (22 observations deleted due to missingness)
Multiple R-squared: 0.08116, Adjusted R-squared: 0.0576
F-statistic: 3.445 on 2 and 78 DF, p-value: 0.03684

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lrhd.A ~ dense4

N: 81   tau: 0.95   AIC: 242.967211227724

       coefficients lower bd   upper bd Std. Error  t value     Pr(>|t|)
(Intercept)   3.2046189 3.1287749 1.797693e+308 0.1290348 24.835305 0.000000000000000
dense4dense   1.7788120 1.2048400 2.340547e+00 0.3794274 4.688149 0.000011513730448
dense4trolley  0.8694842 0.1025297 1.797693e+308 0.1290348 6.738369 0.000000002468071


Formula for mean (based on LS-estimate):
log(hd.A) = log(TA) + 2.52 + 0.455 dense4dense + 0.491 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(hd.A) = log(TA) + 3.205 + 1.779 dense4dense + 0.869 dense4trolley
```

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

Model: lhd.A ~ lTA + dense4

```
Table of measured values:
     n    min   50%   75%    90%    95%   max
normal 35 1.666667 263.800 461.300 698.0000 992.2000 2651.60
dense  36 10.800000 308.100 824.900 3110.6000 5396.8000 7905.40
trolley 10 13.560000 63.346 119.675 253.7867 638.7333 1023.68

Table of predicted values (95th percentile):
  TA dense4 rain   lTA   LS.75   QR.75
1 0.2  dense coat -0.69897 824.3610 4616.9619
2 1.0  dense coat 0.00000 1393.9919 7797.2591
3 5.0  dense coat 0.69897 2398.2617 13168.2370
4 0.2 normal coat -0.69897 307.9324  752.6886
5 1.0 normal coat 0.00000 520.1904 1271.1624
6 5.0 normal coat 0.69897 894.0718 2146.7759
7 0.2 trolley coat -0.69897 317.6164 1345.8561
8 1.0 trolley coat 0.00000 545.9952 2272.9208
9 5.0 trolley coat 0.69897 953.6234 3838.5745
10 0.2  dense none -0.69897 824.3610 4616.9619
11 1.0  dense none 0.00000 1393.9919 7797.2591
12 5.0  dense none 0.69897 2398.2617 13168.2370
13 0.2 normal none -0.69897 307.9324  752.6886
14 1.0 normal none 0.00000 520.1904 1271.1624
15 5.0 normal none 0.69897 894.0718 2146.7759
16 0.2 trolley none -0.69897 317.6164 1345.8561
17 1.0 trolley none 0.00000 545.9952 2272.9208
18 5.0 trolley none 0.69897 953.6234 3838.5745

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min    1Q Median    3Q    Max
-1.8478 -0.3366 0.0000 0.4685 1.2912

Coefficients:
        Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.250847  0.124582 18.067 < 2e-16 ***
lTA      0.325014  0.125317  2.594 0.01137 *
dense4dense  0.428016  0.160363  2.669 0.00927 **
dense4trolley -0.003091  0.258902 -0.012 0.99050
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6752 on 77 degrees of freedom
 (22 observations deleted due to missingness)
Multiple R-squared: 0.1838,   Adjusted R-squared: 0.1521
F-statistic: 5.782 on 3 and 77 DF, p-value: 0.001281

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lhd.A ~ lTA + dense4

N: 81   tau: 0.95   AIC: 200.413409203222

       coefficients  lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   3.1042010  2.9593674 1.797693e+308 0.1726175 17.983114 0.000000e+00
lTA       0.3256015 -13.8345966 4.972576e-01 0.0386829 8.417195 1.596279e-12
dense4dense   0.7877409  0.3399769 1.965208e+00 0.1844193 4.271467 5.492450e-05
dense4trolley  0.2523833 -0.6927402 1.797693e+308 0.1721111 1.466397 1.466123e-01


Formula for mean (based on LS-estimate):
log(hd.A) = 2.251 + 0.325 log(TA) + 0.428 dense4dense + -0.003 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(hd.A) = 3.104 + 0.326 log(TA) + 0.788 dense4dense + 0.252 dense4trolley

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

Model: lria.A ~ dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 30 0.6378853 211.70691 303.29372 515.70138 627.36835 2213.54167
dense  32 40.6250000 247.22222 463.28125 789.70133 1242.36872 3218.75000
trolley 10 11.8854167 20.51562 25.76625 26.76401  27.38498  28.00595

Table of predicted values (95th percentile):
  TA dense4   lTA   LS.75    QR.75
1 0.2  dense -0.69897 145.8553  563.50626
2 1.0  dense 0.00000 729.2766 2817.53131
3 5.0  dense 0.69897 3646.3829 14087.65653
4 0.2 normal -0.69897 110.3301  133.19794
5 1.0 normal 0.00000 551.6505  665.98971
6 5.0 normal 0.69897 2758.2527 3329.94854
7 0.2 trolley -0.69897 109.6053  74.03313
8 1.0 trolley 0.00000 548.0267  370.16566
9 5.0 trolley 0.69897 2740.1333 1850.82832

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
   Min    1Q  Median    3Q   Max
-2.38431 -0.15674 0.05351 0.19484 0.93025

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.44476  0.07864 31.086  <2e-16 ***
dense4dense  0.12153  0.10947  1.110  0.271
dense4trolley -0.01229  0.15729 -0.078  0.938
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4308 on 69 degrees of freedom
 (31 observations deleted due to missingness)
Multiple R-squared: 0.02119,  Adjusted R-squared: -0.007183
F-statistic: 0.7468 on 2 and 69 DF, p-value: 0.4777

Summary of RQ fit (95th percentile):
[1] "No nid summary"

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lria.A ~ dense4

N: 72   tau: 0.95   AIC: 105.597691447998

       coefficients  lower bd   upper bd
(Intercept)   2.8234675 2.7448541 1.797693e+308
dense4dense   0.6264012 -0.1901586 7.464127e-01
dense4trolley  -0.2550714 -0.6851032 1.797693e+308


Formula for mean (based on LS-estimate):
log(ia.A) = log(TA) + 2.445 + 0.122 dense4dense + -0.012 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ia.A) = log(TA) + 2.823 + 0.626 dense4dense + -0.255 dense4trolley

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

Model: lia.A ~ lTA + dense4

```
Table of measured values:
     n    min    50%    75%    90%    95%    max
normal 30 0.6378853 211.70691 303.29372 515.70138 627.36835 2213.54167
dense  32 40.6250000 247.22222 463.28125 789.70133 1242.36872 3218.75000
trolley 10 11.8854167 20.51562 25.76625 26.76401  27.38498  28.00595

Table of predicted values (95th percentile):
  TA dense4   lTA    LS.75    QR.75
1 0.2  dense -0.69897  107.49612  135.82624
2 1.0  dense 0.00000  805.73954  3062.71982
```

```
3 5.0  dense 0.69897 7284.28959 69060.68347
4 0.2 normal -0.69897  82.98262   61.33506
5 1.0 normal 0.00000  629.65290  1383.03258
6 5.0 normal 0.69897 5750.48546 31185.73714
7 0.2 trolley -0.69897  151.47064  241.54816
8 1.0 trolley 0.00000 1448.24532  5446.62331
9 5.0 trolley 0.69897 15153.36403 122814.86746

Summary of LS fit (mean):

Call:
lm(formula = frm, contrasts.arg = contrasts)

Residuals:
  Min   1Q Median   3Q   Max
-2.3645 -0.1722 0.0358 0.1950 0.9292

Coefficients:
       Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.4984   0.1014 24.636 < 2e-16 ***
lTA       1.2873   0.3418  3.766 0.000348 ***
dense4dense   0.1087   0.1108  0.981 0.329834
dense4trolley  0.2588   0.3590  0.721 0.473375
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4317 on 68 degrees of freedom
 (31 observations deleted due to missingness)
Multiple R-squared: 0.4949,  Adjusted R-squared: 0.4726
F-statistic: 22.21 on 3 and 68 DF, p-value: 3.903e-10

Summary of RQ fit (95th percentile):

Call: rq(formula = frm, tau = TAU, contrasts = contrasts)
Formula: lia.A ~ lTA + dense4

N: 72   tau: 0.95   AIC: 101.554344526924

       coefficients  lower bd   upper bd Std. Error  t value   Pr(>|t|)
(Intercept)   3.1408324 2.7865594 1.797693e+308 0.2950164 10.6462959 4.440892e-16
lTA       1.9358822 0.7004912 2.029769e+00 0.9153709 2.1148609 3.810949e-02
dense4dense   0.3452749 -0.1149203 6.766105e-01 0.3989949 0.8653616 3.898831e-01
dense4trolley  0.5952949 -0.9845574 7.473500e-01 0.7742321 0.7688844 4.446243e-01


Formula for mean (based on LS-estimate):
log(ia.A) = 2.498 + 1.287 log(TA) + 0.109 dense4dense + 0.259 dense4trolley
Formula for 95th percentile (based on quantile regression):
log(ia.A) = 3.141 + 1.936 log(TA) + 0.345 dense4dense + 0.595 dense4trolley

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