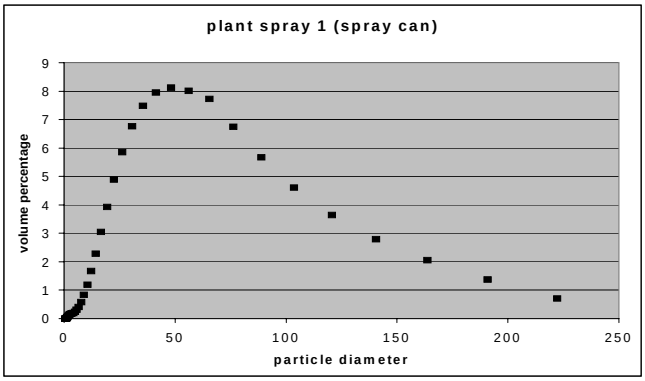
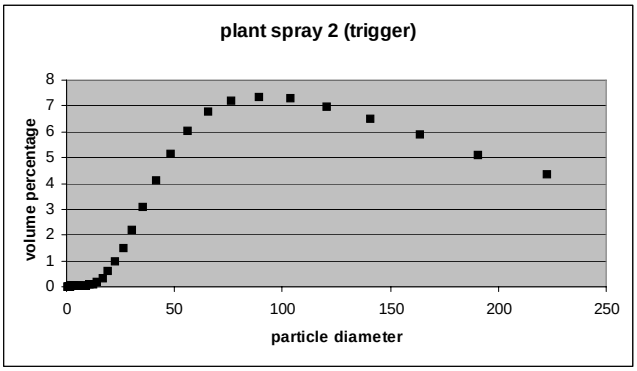
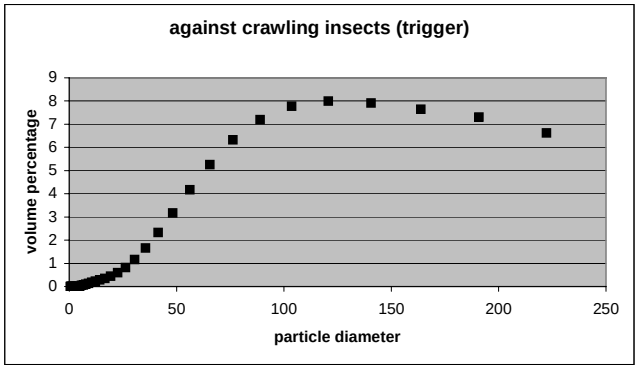
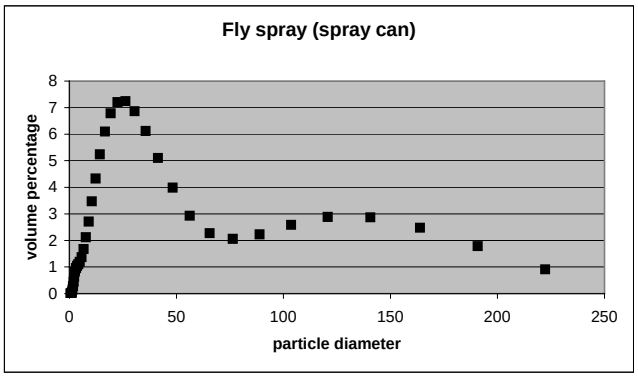
## Spray parameters

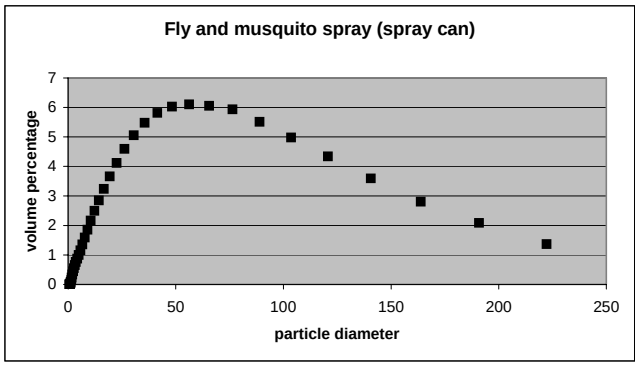
For a number of products available on the market, particle size distributions have been measured using a standardized light scattering experiment. Also, the amount of mass sprayed per unit time has been determined.
The results of these measurements are given below.

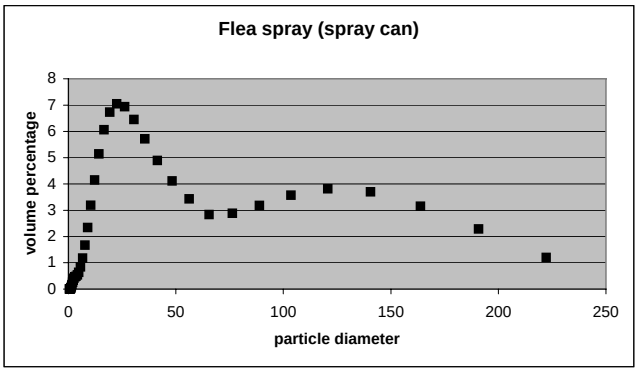


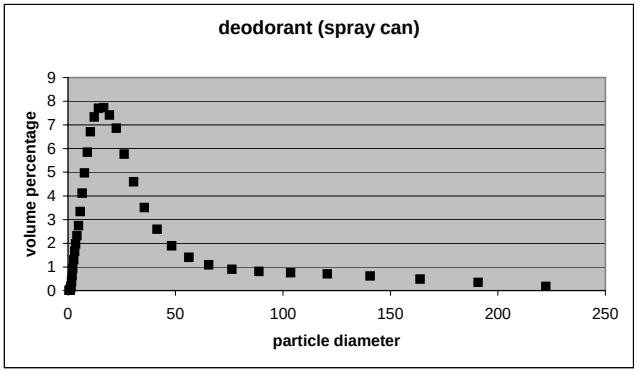



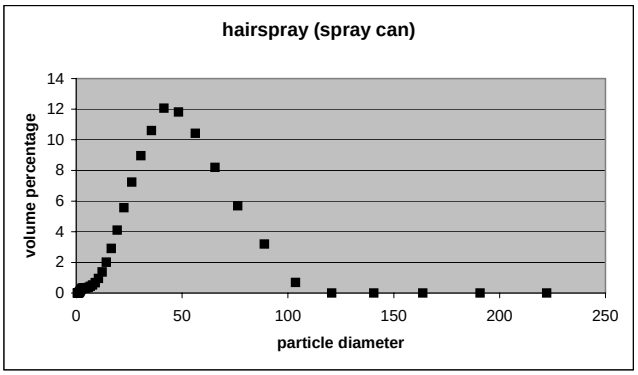



**mass sprayed:**

| product | spray duration | mass sprayed (g) |
|---|---|---|
| against crawling insects | 10 x pumping | 9.47 |
| plant spray 2 | 10 x pumping | 8.83 |
| deodorant | 10 sec | 6.85 |
| fly and musquito spray | 10 sec | 10.36 |
| plant spray 1 | 10 sec | 12.83 |
| hairspray | 10 sec | 6.99 |
| fly spray | 10 sec | 4.17 |
| flea spray | 10 sec | 11.33 |

# 3. Ventilation and room size

## 3.1. General

The ventilation and volume of the room where consumer products are utilised greatly influence the exposure to substances in these products. Both are thus important factors within all the main categories. For the benefit of the definition of the defaults in all the other fact sheets, argumentation is included in this general fact sheet about the rate of ventilation, the surface area and the volume of the rooms in a home that are described in a default. Where necessary, in the fact sheets that describe the main and product categories, attention is given to aspects that are specific to the category concerned. Sub-section 3.2 focuses on the surface area and the volume of rooms in Dutch homes. In sub-section 3.3, the ventilation of these rooms is discussed.

## 3.2 Room size

The volume and surface area of the individual rooms in Dutch homes is one of the considerations of the Qualitative Registration for Homes (KWR). The KWR is a large-scale investigation to reveal and document the quality and quality development of Dutch housing stock. Research of this kind has been carried out four times, so far; the first investigation was in 1975. The figures shown in Table 3 are taken from a KWR file dated 1989-1991.[9] This file contains data on approximately 15,000 homes.[8]

Based on the information above, a 25th percentile was calculated for the living areas listed. These values are given again in Table 4, with a quality factor 9. The values for bathroom, toilet, shed and garage, shown in Table 4, cannot be extracted directly from the KWR. These estimates are based on the rooms for which the surface area and volume can be extracted from the KWR, and on our own estimates of the surface area and volume of these rooms. In Table 4, if the space is unspecified, then it is noted down as a default value for a room. As there are many different spaces in use in a home, the space chosen is one that is comparable in volume with a smallish bedroom.

*Table 3: Surface area and volume of rooms in Dutch homes*

| | Surface Area | | Volume | |
|---|---|---|---|---|
| Space | $m^2$ | s.d. | $m^3$ | s.d. |
| living room | 28 | 8.4 | 74 | 23 |
| kitchen (incl. open kitchen) | 8.5 | 3.6 | 22 | 9.6 |
| bedroom 1 | 14 | 4.0 | 35 | 11.2 |
| bedroom 2 | 11 | 3.0 | 28 | 8.3 |
| bedroom 3 | 8.5 | 2.8 | 21 | 7.6 |
| attic | 23 | 15.8 | | |

*Key*: s.d.: standard deviation

*Table 4: Default values of spaces in Dutch homes*

| Space | Surface Area [$m^2$] | Volume [$m^3$] | Q |
|---|---|---|---|
| living room | 22 | 58 | 9 |
| kitchen (incl. open kitchen) | 6 | 15 | 9 |
| bedroom 1 | 11 | 27 | 9 |
| bedroom 2 | 9 | 22 | 9 |
| bedroom 3 | 7 | 16 | 9 |
| bathroom | 4 | 10 | 6 |
| toilet | 1 | 2.5 | 6 |
| shed | 4 | 10 | 6 |
| garage | 10 | 25 | 6 |
| room, if the space is unspecified | 8 | 20 | 8 |

### 3.3 Ventilation

The number of times an hour that the air in a space is freshened is known as the ventilation rate [unit: $h^{-1}$]. As an exchange of air takes place between the different rooms in a home, part of the air that leaves a certain space can return again later. For the purposes of this investigation, the ventilation rate is taken to be the *effective* flow of air from the space concerned.

The ventilation rate of a home or of a spatial area in a home is dependent on a large number of factors, such as the age of the building, the insulation of the building, natural or mechanical ventilation, the climate, the weather conditions (wind speed and outside temperature), the season, the way in which residents in the building use the ventilation, closed or open windows and doors. Table 5 shows measurements of ventilation rates in Dutch homes and Table 6, ventilation rates observed abroad.

From the information in the literature (Tables 5 and 6), it appears that:

– there are significant differences between the ventilation rates noted in the different research projects,

– within research projects, the difference between the highest and the lowest value of similar homes is always large.

Important contributing factors for these large differences are given below.

*The age of the building*

Older houses have a higher rate of ventilation than newer, better insulated, more airtight buildings.

*Natural or mechanical ventilation*

Mechanically ventilated houses have a higher ventilation rate than the same sort of houses with natural ventilation.

*The climate*

In more northerly situated countries (Scandinavia, Canada), the rate of ventilation is lower, on average, than in the Netherlands.

*Residents' behaviour*

The ventilation rate is much higher if the windows and/or doors are open.

*The season*

Buildings are ventilated less in the winter, so then the ventilation rate is lower than in the summer.

*The weather conditions*

Within the framework of research on radon, RIVM has developed a computer model to calculate radon concentrations within a home.[6] For a standard Dutch home, ventilation rates have been calculated for thirty different weather conditions. Wind speed, in particular, was shown to have a large influence on the rate of ventilation. If the wind speed increases from calm to 8 $msec^{-1}$ (approximately wind force 5), then the ventilation rate of the entire house increases by approximately a factor of 4.

*During the day/ at night*

For living rooms, and for complete homes, it was found that the ventilation rate during the day was approximately 10% higher, on average, than at night.

For bedrooms, a significantly larger rate of ventilation was found during the day than at night. On average, the rate of ventilation is approximately 50% higher during the day than at night. This is probably because bedrooms are aired during the day.

*Measurement methods*

Rates of ventilation can be determined in a number of ways. It appeared that the ventilation rate is dependent on the method used to determine it. Bloemen et al. [2] have compared the tracer method with the inflation method. The ventilation rates determined by using the inflation method were clearly higher than, and did not correlate with those calculated by using the perfluorine tracer-gas method. Finnish researchers (see[2]) have compared two different tracer techniques, and also here, differences were found between the methods. The most reliable determination method seems to be the frequently used perfluorine-tracer method.

*Table 5: Measurement values for ventilation rates in Dutch homes*

| Space[a] | Situation | Season | Measuring Method [b] | No. of Measure-ments | Ventilation Rate [$h^{-1}$] (range) | Ref. |
|---|---|---|---|---|---|---|
| whole house | *natural ventilation*; renovated in 1984; windows, doors, additional ventilation openings closed | winter | inflation method | 6 | 0.6 (0.3-0.95) | 1 |
| | *mechanical ventilation*; renovated in 1983; windows, doors, additional ventilation openings closed | winter | inflation method | 4 | 1.2 (1.05-.35) | 1 |
| living room | *mechanical ventilation*; renovated in 1987 | winter | inflation method | 4 | 1.85 (0.6-3.1) | 1 |
| | front room | Mar/Apr | tracer method | 1 | 0.98 | 2 |
| | back room | Mar/Apr | tracer method | 1 | 0.86 | 2 |
| | ‘60s flats | Apr/May | tracer method | 6 | 1.15 | 2 |
| | ‘80s flats | Apr/May | tracer method | 3 | 0.77 | 2 |
| | ‘60s family house | Apr/May | tracer method | 4 | 1.08 | 2 |
| | ‘80s family house | Apr/May | tracer method | 4 | 0.81 | 2 |
| | during the day | Nov/Dec | tracer method | 36 | 0.42 (0.19-1.79) | 3 |
| | at night | Nov/Dec | tracer method | 36 | 0.39 (0.18-1.05) | 3 |
| | with open kitchen, pre-1940 houses | Oct/Mar | tracer method | 6 | 1 (0, 3-3) | 4 |
| | with open kitchen, post-1945 houses | Oct/Mar | tracer method | 26 | 2 (0, 5-7) | 4 |
| | family houses built between 1985 and 1993 | whole year | tracer method | 1253 | 0.9<br>s.d. 0.7 | 16 |
| | family houses built between 1985 and 1993 | whole year | tracer method | 827 | 0.97<br>0.85 (median)<br>0.56 (25th perc.)<br>1.17 (75th perc.) | 16,17 |
| kitchen | *mechanical ventilation*; renovated in 1987 | winter | inflation method | 4 | 5 (1.7-8.3) | 1 |
| | pre-1940s houses | Oct/Mar | tracer method | 69 | 6 (0.9-47) | 4 |
| | post-1945 houses | Oct/Mar | tracer method | 72 | 4 (0.5-24) | 4 |
| bedroom | *mechanical ventilation*; renovated in 1987; closed | winter | inflation method | 4 | 0.6 (0.3-0.9) | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | windows | | | | | |
| | *mechanical ventilation*; renovated in 1987; open windows | winter | inflation method | 4 | 2.75 (1.5-4.0) | 1 |
| | ’60s flats | Mar/Apr | tracer method | 1 | 1.04 | 2 |
| | ’80s flats | Apr/May | tracer method | 6 | 2.88 | 2 |
| | ’60s family house | Apr/May | tracer method | 3 | 0.81 | 2 |
| | ’80s family house | Apr/May | tracer method | 4 | 2.07 | 2 |
| | during the day | Apr/May | tracer method | 4 | 1.21 | 2 |
| | at night | Nov/Dec | tracer method | 36 | 3.7 (0.67-25) | 3 |
| | | Nov Dec | tracer method | 36 | 2.36 (0.68-5.39) | 3 |
| office | no extra ventilation, room door open | Jan/Feb | tracer method | 1 | 0.91 | 2 |
| | outside window and room door opened | Jan/Feb | tracer method | 1 | 2.31 | 2 |
| | window and door mostly closed | Jan/Feb | tracer method | 1 | 0.41 | 2 |
| | window and door closed, non-residential | | tracer method | 1 | 0.14 | 5 |
| | window and door opened, non-residential | | tracer method | 1 | 6.3 | 5 |

[a] Unless otherwise stated, constantly occupied domestic living spaces
[b] See reference 2

*Table 6: Measurement values of ventilation rates of homes outside the Netherlands*

| Remarks | Season | No.of measure-ments | Ventilation Rate [$h^{-1}$] (range) | Reference |
|---|---|---|---|---|
| USA; perfluorine-tracer method | | 735 | 1 [median] | 7 |
| | | | 0.5 [25th perc.] | 7 |
| | | | 1.7 [75th perc.] | 7 |
| measured during the day | | 175 | 0.87 | |
| measured at night | | 175 | 0.78 | |
| USA; tracer method | heating season | 9 | 0.39 | 2 (from Dietz et al., 1986) |
| Canada; energy-saving homes; tracer method | heating season | 7 | 0.25 | |
| USA; tracer method | heating season | 30 | 0.44 | |
| Finland, measured with two different tracer techniques: | | | | 2 (from Ruotsalainen et al., 1989) |
| - rate-of-decay method | | 50 | 0.5 (0.1-1.2) | |
| - perfluorine tracer method | | 50 | 0.8 (0.2-1.9) | |
| Finland; perfluorine tracer method | | | | 2 (from Rönnberf et al., 1990) |
| - family houses | winter | 162 | 0.45 | |
| - flats | winter | 89 | 0.65 | |
| Denmark, post-1982 living accommodation; perfluorine-tracer method | | | | 2(from Bergsoe, 1991) |
| - flats, mechanical ventilation | winter | 67 | 0.59 (0.22-1.53) | |
| - family homes, natural ventilation | winter | 20 | 0.33 (0.20-0.50) | |
| - family homes, mechanical ventilation | winter | 36 | 0.55 (0.22-1.16) | |
| Denmark, newer family homes | | | 0.37 | 16 (from Andersen et al., 1997) |
| USA, *natural ventilation*, closed ventilation openings | | | 0.25-0.4 | 16 (from Cavallo et al., 1996) |
| *natural ventilation*, ventilation openings open | | | 1 | |

### 3.3.1 Defaults

Because the ventilation rate depends on parameters such as climate, type of housing and residents' behaviour, to estimate the defaults, the Dutch survey data were used. The foreign observations are mostly used as substantiating background information, in support of the accuracy of the estimate. The defaults were deduced according to the criteria listed below.

*Occupied domestic houses*
The Dutch observations presented in Table 5 for domestic houses were all conducted in normally occupied accommodation.

*A 25 percentile average throughout the year*
As stated in sub-section 2.1, a 75th or 25th percentile is assumed for the default values. A 25th percentile is estimated for ventilation rates, because the consequence of relatively limited ventilation is that exposure will be relatively large. For the default, a 25th percentile is estimated throughout the year. By far the most of the ventilation-rate measurements are carried out in the winter. The estimation of the defaults, therefore, is based on the average ventilation rates during the winter. If the ventilation rate during the whole year is taken into consideration, it is assumed that the average ventilation rates during the winter will correspond with a 25th percentile.

*House built during the '80s*
Regarding the type of domestic accommodation, for defaults such as standard housing, the choice was made for new, well-insulated housing, built during the '80s.

*During the day/ at night*
For the living room and for whole houses, the values of ventilation rates during the day and at night are so similar that one single value is given as default. For bedrooms, two default values are given, a general value, where there is relatively little ventilation, and a value with an 'open window'. The latter can be read as the value during the day, when the bedroom is being aired, while the general value can be read as the default value for the nights.

The default values for ventilation rates in the different spatial areas of a home are shown in Table 7.

*Table 7: Defaults for ventilation rates in domestic homes*

| Space | Ventilation rate [$h^{-1}$] | Q |
|---|---|---|
| the whole house | 0.6 | 8 |
| living room | 0.5 | 8 |
| kitchen | 2.5 | 7 |
| bedroom | 1 | 7 |
| bedroom (window open) | 2.5 | 7 |
| bathroom | 2 | 6 |
| toilet | 2 | 6 |
| shed | 1.5 | 6 |
| garage | 1.5 | 6 |
| default, if space is unspecified | 0.6 | 8 |

Table 8 shows multiplying factors, based on information from the literature, using the default values given in Table 7, to be able to extrapolate to more specific situations, such as during summer, during winter, or for older housing. If the ventilation rate during the whole year is taken into consideration, the defaults shown in Table 7 are estimates for the 25th percentile of newer, post-1980, housing. On average, during the *winter,* newer houses have a multiplication factor of 1 (see Table 8), because, in estimating the defaults, a 25th percentile is *assumed* if the ventilation rate for the whole year is considered to be the same as the average rate of ventilation during the winter. As the measurements are usually taken during the winter, the quality factor is a point higher than those chosen in Table 7.

*Table 8: Factors influencing ventilation rates in more specific situations*

| Multiplication factors for the default values listed in Table 5 | Factor | Q |
|---|---|---|
| The average for newer[a] houses during the winter | 1<br>0.6 | (Q, Table 7)[b] + 1 |
| The 25th percentile of newer[a] houses during the winter | 1.4<br>1.6 | (Q, Table 7) |
| The 25th percentile of newer[a] houses during the summer | | (Q, Table 7) |
| Pre-1980 housing | | (Q, Table 7) - 1 |

[a] Newer housing: built after 1980

[b] The Q value shown in Table 7 for the space concerned

# 5. Body surface area and body weight

The surface area of (parts of) the human body is dealt with in detail in the EPA's '*Exposure Factors Handbook*' [10] and the ICRP's '*Report of the Task Group on Reference Man*'.[11] The total surface area of the body is dependent on body length and weight.

For body surface area, the following empirical formula is used:

$$SA = a_0 H^{a1} W^{a2}$$

in which *SA* is the body surface area (in $m^2$), *H* is the body height (in cm), and *W* is the weight (in kg).[10,11]

Based on measurements of the surface area of people, and their weights and lengths, different researchers have arrived at values for the constants. On the basis of these investigations, EPA considers the parameters shown below to be the best choice

$$SA = 0.02350\ H^{0.42246} W^{0.51456} \quad (**)$$

From research on children and adults, the above parameters appeared to predict the body surface area of both, very well.[10]

## 5.1 Adults

### 5.1.1 Total body surface area

Table 13 gives information from different surveys about the weight, length and body surface of adults. The data presented by the ICPR[11] are the default values. The EPA's body *weights*[10] are averages, and for the body *surface areas*, they give the median. Neither the CBS[12] nor the RIVM[24] give information about body surface area. Body surface areas have been calculated with the aid of the formulas presented above (**).

*Table 13: Human weight, length and body surface area*

| | Weight [kg] | Length [cm] | Surface area [$m^2$] | Reference |
|---|---|---|---|---|
| men | 70 (ref.) | 170 (ref) | 1.8 (ref.) | 11 (ICRP, 1992) |
| | 78.1 (av.) | | 1.94 (med.) | 10 (EPA, 1996) |
| | 79.2 (av.) | 179.5 (av.) | 2.0 (calc.) | 12 (CBS, 1998) |
| | 82.3 (av.) | | 2.03 (calc.) | 24 (RIVM, 1999) |
| women | 58 (ref) | 160 (ref.) | 1.6 (ref.) | 11 (ICRP, 1992) |
| | 65.4 (av.) | | 1.69 (med.) | 10 (EPA, 1996) |
| | 66.8 (av.) | 167.2 (av.) | 1.78 (calc.) | 12 (CBS, 1998) |
| | 69.0 (av.) | | 1.79 (calc.) | 24 (RIVM, 1999) |
| adults | 71.8 (av.) | | | 10 (EPA, 1996) |
| | 75.0 (av.) | | 1.90 (calc.) | 24 (RIVM, 1999) |

*Key*: *ref*: reference value; *av*.: average; *med*: median; *calc*.: calculated from information about body length and weight using the above formula (**)

The ICRP reference values in Table 13 are significantly different from the current averages of Dutch people, as calculated from the information supplied by the CBS and the RIVM. The ICRP has made use of less recent information, predominantly that from the early '60s, while the length of Dutch people has increased during recent decades. Another, additional, factor is that Dutch people are amongst the tallest in the world. The reasons given above also apply, though to a lesser extent, to the information related to body weight and surface area as supplied by EPA, and as shown in Table 13.

The CBS information about the length and weight of human beings (ref.)[12] originates from survey data, in which the participants themselves say how tall and how heavy they are. The RIVM data on human length and weight (ref.)[24] comprise measurement data taken during the period 1995 to 1997, inclusive. The measurements were carried out within the framework of the project 'MORGEN' [TOMORROW].[25] Because the RIVM data on the length and weight of human beings are based on measurements and the CBS data on the outcome of a questionnaire, the RIVM data are considered to be more reliable. The results of the RIVM research are shown in Table 14. The departure points for calculating the default values for the body weight and total surface area of human beings is summarised below:

- There are good, very recent, Dutch data on body length and weight.
- The total surface area of the body is calculated by means of the formula (**) shown at the beginning of this sub-section.
- The values measured by the RIVM for length and weight are used to make the calculation.[24]
- For the default values, the 25th percentile is used for the length and for the surface area of men and women, and for adults in general.

*Table 14: The weight and surface area of human beings* [a]

| | Men | Women | Adults |
|---|---|---|---|
| **Weight [kg]** | | | |
| average | 82.3 | 69.0 | 75.0 |
| s.d. | 12.4 | 12.0 | 13.9 |
| 25th percentile | 74.2 | 60.7 | 64.8 |
| 50th percentile | 81.0 | 67.2 | 73.7 |
| 75th percentile | 89.3 | 75.0 | 83.3 |
| default | 74 | 61 | 65 |
| **Surface area [$m^2$]** | | | |
| average | 2.03 | 1.79 | 1.90 |
| s.d. | 0.17 | 0.17 | 0.21 |
| 25th percentile | 1.91 | 1.68 | 1.75 |
| 50th percentile | 2.02 | 1.78 | 1.89 |
| 75th percentile | 2.13 | 1.89 | 2.03 |
| default | 1.91 | 1.68 | 1.75 |

[a] data from 1995, 1996 and 1997
No. of men: 6,094; No. of women = 7,443; s.d.: standard deviation

### 5.1.2 Surface area of parts of the body

The EPA[10] gives information about the surface area of parts of the human body. This information is based on various data sets. The figures from these different surveys are presented. For example, the sum of the surface areas of the various parts of the body is very different from the amount for the total body surface area. Table 15 gives the EPA data for surface areas of the various parts of the body, for men. The sum of all parts of the body gives a surface area of 1.62 $m^2$, while the total (median!) body surface area is given as 1.94 $m^2$. These are frequently applied figures for the surface areas of parts of the body, mostly for adults, even though the data relate to men. The ICRP[11] gives the relative surface area of the larger parts of the body (see Table 15). EPA's core data [10] give separate figures for the surface area of parts of the body for men *and* women. Table 15 lists the 50th percentile of the core data for men. The relative surface areas of the EPA data, the EPA core data and the ICRP data correspond well with each other.

In summary, therefore:

– the total surface area given by the EPA data does not correspond with the sum of the surface areas of the parts,
– the relative values of the EPA data, the EPA core data and the ICRP data correspond well with each other,
– the surface area of parts of the body of men and women is given separately in the EPA core data.

Bearing the above in mind, the following criteria are maintained for calculating default values.

– The surface area of parts of the body is taken to be the relative (median) body surface area of parts of mens' and womens' bodies, as is given in the core data of the EPA.[10]
– For the absolute value, the relative body surface area is multiplied by the default value of the total body surface area.

*Table 15: Data from the literature on body surface area*

| | **EPA data**[10] | | **EPA data**[10] | **ICRP**[11] |
|---|---|---|---|---|
| | **for men** | | **core data for men** | **adults** |
| **Weight** [kg] | 78.1 | | | |
| surface area | [$m^2$] | [%][b] | [%] | [%] |
| total | 1.94[a] | 100 | 100 | 100 |
| head | 0.118 | 7.3 | 6.4 | 7.5 |
| trunk | 0.569 | 35.1 | 36.4 | 34.6 |
| arms | 0.228 | 14.1 | 14.3 | ] |
| | | | | } 19.4 |
| hands | 0.084 | 5.2 | 4.9 | ] |
| legs | 0.505 | 31.2 | 31.5 | ] |
| | | | | } 38.5 |
| feet | 0.112 | 6.9 | 6.5 | ] |

[a] *median*: the sum of parts of the body is 1.62 $m^2$, see text.
[b] calculated with respect to the sum of the parts of the body.

– To calculate the absolute value, the relative surface area of the body is multiplied by the default value of the total surface area of the body.
– To calculate the relative surface area of the parts of the body for adults, the average is taken for men and women.

The outcome of these calculations is shown in Table 16. Not only do the default values for body weight and total surface area of the body conform with the 25th percentile values, but so, too, do the default values for the surface area of the various parts of the body.

### 5.2 Children

In contrast with the data for adults, no data are available on an individual level for children, with respect to length and weight. The total body surface area for children is therefore calculated on the basis of the averages and the standard deviations for length and weight, and the correlation coefficient between length and weight. Recent data in relation to the body length and weight of Dutch children of various ages are given in Table 17. In a preliminary survey for Steenbekkers' thesis (1993)[26], 176 children aged up to 1.5 years were measured and weighed. In the research, the weight and length of 2,245 children between the ages of 2 and 13 years was established. The CBS data with respect to the length and weight of children [15,22] were gained from questionnaires. For the other two named sources, the length and weight were actually measured. In the *Statistical Yearbook 1997*, [15] published by the CBS, no standard deviation is given, only the average values for the weight and length of children from 1992 to 1995. It is not possible, using these data, to determine the distribution of childrens' body surface area. Instead of using these data, therefore, the extremely detailed CBS data of 1994 [22] is used as the point of departure. These data were collected between 1989 and 1992. The very recent growth study carried out by the TNO[27] has determined the body length and weight of a large number of children. Of the children older than 1.5 years, data are available about length at a certain age, and about weight at a certain length. However, data on weight at a certain age are not available. To calculate the body surface area of children for a certain age group, it is necessary to have data relating to weight at a certain age. However, data concerning length and weight at a certain age are available for children *younger* than 1.5 years.

*Table 16: Default values for body weight and surface area*

| | Default Values | | | | | | |
|---|---|---|---|---|---|---|---|
| | adults | | men | | women | | quality factor Q |
| weight [kg] | 65 | | 74 | | 61 | | 9 |
| surface area | [$m^2$] | [%] | [$m^2$] | [%] | [$m^2$] | [%] | |
| total | 1.75 | 100 | 1.91 | 100 | 1.68 | 100 | 8 |
| head | 0.116 | 6.6 | 0.122 | 6.4 | 0.113 | 6.7 | 7 |
| trunk | 0.630 | 36 | 0.695 | 36.4 | 0.585 | 34.8 | 7 |
| arms | 0.245 | 14 | 0.273 | 14.3 | 0.232 | 13.8 | 7 |
| hands | 0.086 | 4.9 | 0.094 | 4.9 | 0.082 | 4.9 | 7 |
| legs | 0.560 | 32 | 0.602 | 31.5 | 0.553 | 32.9 | 7 |
| feet | 0.117 | 6.7 | 0.124 | 6.5 | 0.116 | 6.9 | 7 |

These data, taken from TNO's growth survey[27] were used to calculate the body surface area of children younger than 1.5 years.
For data on children above 1.5 years, the CBS statistics from 1994[22] were used. From Table 17 it can be seen that these data conform well to those of Steenbekkers and of the TNO. The data from which the calculations of the body surface area of children were made are given in Table 18.

Data for children, rather than for boys or girls, is almost always used as the point of departure for estimating risk. The body weight and surface area of children, therefore, was calculated from the data on length and weight and the standard deviation for boys and girls, and not for boys and girls separately. The computer program 'At Risk' for Windows (version 3.5e) was used to make these calculations. From the average length, the average weight and the standard deviations of, respectively, boys and girls, data was taken from a sample population of 2000. For this, use was made of the partial correlation coefficient (excluding age and sex) between body weight and length, as given by Steenbekkers.[26]

> The *partial* correlation coefficient is based on the correlation within a certain age group for either boys or for girls (excluded from the correlation is the fact that the older the children, the taller and heavier they will). The partial correlation coefficient (excluding age and sex) between body length and weight amounts to 0.6246, and the correlation coefficient to 0.9284.[26]

From the 2000 values drawn for the body weight and length of a certain age category, for boys and girls separately, the body surface area is calculated using the formula given at the beginning of this section:

$$SA = 0.02350\, H^{0.42246} W^{0.51456}$$

From the 4000 values drawn for body surface area, the average, the standard deviation and the 25th percentile have been determined. In making these calculations, it was assumed that the weights and lengths of boys and girls within a certain age category are divided normally. From the 4000 values drawn for body weight, the average, the standard deviation and the 25th percentile have been calculated. The results of the calculations are shown in Table 19. For the default value for body weight and surface area, the 25th percentile was used.

With respect to children, the EPA[10] and ICRP[11] data give the relative share of the larger parts of the body, separated out according to *age*. There are usually only one or two children in a certain age category in the EPA data. For this reason, the ICRP data was used as a basis. In the above approach, it was assumed that the relative surface area of the various parts of the body in children is dependent on age and not on weight or length. In the ICRP data, the relative surface area of parts of the body is given per year, so at birth, at the end of the first year, and second year, etc. The body surface areas were calculated on the basis of the CBS and TNO data at 1.5, 2.5 and 3.5 years. The ICRP data were, therefore, recalculated to the ages just given. In making this calculation, the assumption was that the change in relative body surface areas within a year is linear. This assumption will probably be the least accurate in the first 1.5 years after birth. For this reason, the quality factor Q for the ages up to 1.5 years was estimated lower than for a later age. The outcome of the calculations is shown in Table 19.

*Table 17: <u>Average</u> values for the length and weight of children of different ages*

| Source | | Steenbekkers (1993)[26] | | | | CBS (1994)[22] | | | | TNO (1999)[27] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| age | | boys | | girls | | boys | | girls | | boys | | girls | |
| month [b] | year | length [cm] | weight [kg] | length [cm] | weight [kg] | length [cm] | weight [kg] | length [cm] | weight [kg] | length [cm] | weight[a] [kg] | length [cm] | weight[a] [kg] |
| 0.0-2.9 (1.5) | | 59.8 | 5.6 | 57.0 | 5.0 | | | | | 56.3 | 4.8 | 55.1 | 4.5 |
| 3.0-5.9 (4.5) | | 65.6 | 7.3 | 62.3 | 6.1 | | | | | 65.0 | 7.0 | 62.2 | 6.5 |
| 6.0-8.9 (7.5) | | 71.2 | 8.6 | 69.3 | 8.1 | | | | | 70.5 | 8.5 | 68.8 | 8.0 |
| 9.0-1.9 (10...5) | | 75.5 | 9.5 | 73.5 | 9.1 | | | | | 74.8 | 9.8 | 73.1 | 9.1 |
| 12.0-14.9(13.5) | | 78.1 | 10.7 | 77.3 | 9.6 | | | | | 78.4 | 10.7 | 77.0 | 9.9 |
| 15.0-17.9(16.6) | | 83.3 | 11.2 | 77.1 | 9.8 | | | | | | | | |
| | 1.5 | | | | | 82.8 | 11.5 | 80.2 | 10.8 | 84 | 12 | 82 | 11 |
| | 2.5 | 93.3 | 14.5 | 92.9 | 14.1 | 93.3 | 14.2 | 93.3 | 13.5 | 94 | 14.5 | 92 | 13.5 |
| | 3.5 | 102.1 | 17.0 | 100.4 | 16.6 | 101.9 | 16.1 | 102.1 | 16.0 | 102 | 17 | 100.5 | 16 |
| | 4.5 | 108.5 | 18.6 | 108.2 | 18.4 | 110.2 | 18.7 | 109.4 | 18.0 | 110 | 19 | 108 | 18 |
| | 6.5 | 122.5 | 23.5 | 122.7 | 23.6 | 123 | 23.5 | 123.3 | 22.8 | 124 | 24 | 122 | 23.5 |
| | 9.5 | 141.8 | 31.9 | 139.2 | 32.1 | 140 | 32.1 | 141.2 | 32.7 | 141 | 33 | 140 | 32.5 |
| | 12.5 | 156.3 | 42.5 | 156.6 | 44.4 | 157.2 | 44.2 | 158.3 | 45.3 | 158 | 44.5 | 158 | 46 |
| | 13.5 | | | | | 162.6 | 49.4 | 164.0 | 50.6 | 164 | 50 | 163 | 51 |
| | 16.5 | | | | | 179.9 | 65.6 | 170.5 | 60.2 | 180 | 63.5 | 169 | 56 |
| | 17.... | | | | | 181.3 | 69.7 | 170.0 | 60.9 | 182 | 65 | 169.5 | 57 |
| | ..... | | | | | | | | | | | | |
| | .....5 | | | | | | | | | | | | |

[a] The weight of children between 1.5 and 17.5 years old is the average weight that corresponds with the average length. There is no relation between age and weight.

[b] Steenbekkers' data: length and weight in the period from ... to .... months
TNO's data: length and weight at (...) months

*Table 18: The **average** length and weight of children of different ages (core date used for calculations)*

| Age | | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|---|
| month | year | length [cm] | sd | weight [kg] | sd | length [cm] | sd | weight [kg] | sd |
| 1.5 | | 56.5 | 2.2 | 4.8 | 0.5 | 55.1 | 2.1 | 4.5 | 0.5 |
| 4.5 | | 65.0 | 2.4 | 7.0 | 0.8 | 63.2 | 2.3 | 6.5 | 0.7 |
| 7.5 | | 70.5 | 2.5 | 8.6 | 1.0 | 68.8 | 2.4 | 8.0 | 0.9 |
| 10.5 | | 74.8 | 2.7 | 9.8 | 1.1 | 73.0 | 2.6 | 9.1 | 1.0 |
| 13.5 | | 78.4 | 2.8 | 10.7 | 1.2 | 77.0 | 2.7 | 9.9 | 1.1 |
| | 1.5 | 82.8 | 7.5 | 11.5 | 1.9 | 80.2 | 7.0 | 10.8 | 1.9 |
| | 2.5 | 93.3 | 7.3 | 14.2 | 2.0 | 93.3 | 6.5 | 13.5 | 2.1 |
| | 3.5 | 101.9 | 6.1 | 16.1 | 2.8 | 102.1 | 5.9 | 16.0 | 2.9 |
| | 4.5 | 110.2 | 7.1 | 18.7 | 3.0 | 109.4 | 6.0 | 18.0 | 3.2 |
| | 6.5 | 123.0 | 7.6 | 23.5 | 3.9 | 123.3 | 7.0 | 22.8 | 3.7 |
| | 9.5 | 140.0 | 7.9 | 32.1 | 6.2 | 141.2 | 9.1 | 32.7 | 5.7 |
| | 12.5 | 157.2 | 9.1 | 44.2 | 8.2 | 158.3 | 8.1 | 45.3 | 7.9 |
| | 13.5 | 162.6 | 8.9 | 49.4 | 9.2 | 164.0 | 8.0 | 50.6 | 8.8 |
| | 16.5 | 179.9 | 7.7 | 65.6 | 8.6 | 170.5 | 6.2 | 60.2 | 8.6 |
| | 17.5 | 181.3 | 8.3 | 69.7 | 10.5 | 170.0 | 6.6 | 60.9 | 7.9 |

*Table 19: Averages and default values for the body weight and surface area of children*

| Age | | Weight in kg | | | | Total body surface area in $m^2$ | | | | Relative body surface area in % | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| month | year | average. | s.d. | default value[1] | Q | average | s.d. | default value[1] | Q | head | trunk | arms and hands | legs and feet | Q |
| 1.5 | | 4.65 | 0.52 | 4.30 | 8 | 0.283 | 0.020 | 0.270 | 7 | 20.4 | 32.2 | 16.9 | 30.5 | 5 |
| 4.5 | | 6.75 | 0.79 | 6.21 | 8 | 0.364 | 0.026 | 0.346 | 7 | 19.5 | 32.8 | 17.2 | 30.5 | 5 |
| 7.5 | | 8.30 | 1.0 | 7.62 | 8 | 0.419 | 0.031 | 0.398 | 7 | 18.5 | 33.5 | 17.4 | 30.6 | 5 |
| 10.5 | | 9.45 | 1.1 | 8.69 | 8 | 0.459 | 0.033 | 0.437 | 7 | 17.6 | 34.1 | 17.7 | 30.6 | 5 |
| 13.5 | | 10.3 | 1.2 | 9.47 | 8 | 0.490 | 0.035 | 0.467 | 7 | 16.9 | 34.3 | 17.9 | 30.9 | 5 |
| | 1.5 | 11.1 | 1.9 | 9.85 | 8 | 0.520 | 0.062 | 0.480 | 7 | 16.2 | 34.0 | 18.15 | 31.65 | 6 |
| | 2.5 | 13.9 | 2.1 | 12.5 | 8 | 0.616 | 0.062 | 0.575 | 7 | 14.8 | 33.6 | 18.65 | 32.95 | 6 |
| | 3.5 | 16.0 | 2.9 | 14.1 | 8 | 0.690 | 0.076 | 0.640 | 7 | 14.05 | 33.35 | 19.1 | 33.5 | 6 |
| | 4.5 | 18.4 | 3.1 | 16.3 | 8 | 0.762 | 0.081 | 0.709 | 7 | 13.4 | 33.05 | 19.5 | 34.05 | 6 |
| | 6.5 | 23.1 | 3.8 | 20.6 | 8 | 0.902 | 0.093 | 0.841 | 7 | 12.5 | 33.45 | 19.45 | 34.55 | 6 |
| | 9.5 | 32.4 | 6.0 | 28.4 | 8 | 1.13 | 0.13 | 1.05 | 7 | 11.2 | 33.55 | 19.3 | 35.95 | 6 |
| | 12.5 | 44.8 | 8.1 | 39.3 | 8 | 1.40 | 0.15 | 1.31 | 7 | 9.8 | 33.15 | 19.6 | 37.4 | 6 |
| | 13.5 | 50.0 | 9.0 | 43.9 | 8 | 1.51 | 0.16 | 1.40 | 7 | 9.4 | 32.75 | 20.0 | 37.8 | 6 |
| | 16.5 | 62.9 | 9.0 | 56.8 | 8 | 1.75 | 0.16 | 1.65 | 7 | 8.3 | 31.65 | 21.35 | 38.65 | 6 |
| | 17.5 | 65.3 | 10 | 58.2 | 8 | 1.79 | 0.18 | 1.67 | 7 | 8.05 | 32.1 | 21.0 | 38.8 | 6 |

[1] concerns the 25th percentile

# Data on dermal transfer of dislodgeable pesticide residu from floor covering

**Annex 6: Dislodgeable residues**

| Substrate | Residue | Transfer efficiency | Reference no. |
|---|---|---|---|
| Painted wood (MDF) | Dried fluid | 3 % | 1 |
| Short pile tufted nylon carpet | Dried fluid | 6 % | 1 |
| Carpet | Powder | <1 % | 4 |
| Nylon carpet | Powder | 1 to 3 % | 5 |
| Carpet | Dried fluid | 9 % averaged | 6 |
| Carpet | Powder | 9 %, 3 % if trodden-in | 8 |
| Rough sawn wood | Dried fluid | 2 % | 1 |
| White smooth glazed tile | Dried fluid | 55 % | 1 |
| Brown rough glazed tile | Dried fluid | 60 % | 1 |
| Non-slip vinyl flooring | Dried fluid | 15 % | 1 |
| Vinyl | Powder | 50 % | 8 |
| Various types of surface | Dried fluids | 8 to 18 % | 2 |
| Smooth surface | Powder | 2 to 6 % | 3 |
| Cotton, knitwear, plastic, wood | Dried fluid | 20 % - dry hand | 7 |
| Cotton, knitwear, plastic, wood | Dried fluid | 30 % - wet hand | 7 |
| Stainless steel | Powder | 70 % - dry hand | 8 |

References:


1 Roff and Wheeler, HSL reports IR/ECO/00/11 and IR/ECO/01/02
2 Houghton, thesis 1997, UK
3 Brouwer et al., Appl. Occ. Env. Hyg. 14:231-239, 1999
4 Lu & Fenske, Env. Health Perspect. 107(6):463-467, 1999
5 Ross et al., Chemosphere 22(9-10):975-984, 1991
6 Jazzercise data - Ross et al., Chemosphere 20(3-4):349-360, 1990
7 Fogh et al., Riso-R-1075, Riso Lab, Roskilde, Denmark, 1999
8 Rodes et al., JEA & E, 11:123-139 (2001)
9 Coldwell and Corns, 2001, HSL report OMS/2001/14


Table taken from ECBs TNsG on Human Exposure to Biocidal Products (http://ecb.jrc.it)

**Dermal transfer coefficients children**

**Table 3.** Dermal-transfer coefficients [median (range)].

| Visit | Transfer coefficient ($cm^2$/hr) |
|---|---|
| Visit 1 | |
| Infants | 1,000 (35–3,800) |
| Preschoolers | 950 (34–3,600) |
| All children | 980 (34–3,700) |
| Visit 2 | |
| Infants | 740 (79–2,500) |
| Preschoolers | 440 (47–1,500) |
| All children | 560 (60–1,900) |
| Visit 3 | |
| Infants | 85 (7.8–1,700) |
| Preschoolers | 49 (4.5–960) |
| All children | 66 (6.0–1,300) |

Experimentally determined dermal whole body transfer coefficients for infants (6-12 months of age, N = 9) and preschool children (2-3 years of age, N = 7).
Data taken from: Cohen Hubal et al. *Measuring Potential Dermal Transfer of a Pesticide to Children in a Child Care Centrer.* Environ. Health Perspect 114: 264-269 (2006)