Background and purpose

The composition of the food we eat has a significant influence on our health. Including a high percentage of fruit and vegetables in our daily nutrition is of advantage, because they are important sources of vitamins, minerals, trace elements, dietary fibres and phytochemicals. They usually have high water content and a very low fat content, which means that they contain only few calories per volume unit. The favourable ratio of high nutrient and low energy content with a relatively good satiety effect makes fruits and vegetables particularly valuable from a nutritional physiological perspective. In addition, a high percentage of fruit and vegetables in our daily nutrition can help to reduce consumption of animal-based foods, thereby also reducing the intake of saturated fatty acids. Furthermore, systematic reviews emphasise the importance of high fruit and vegetable consumption with regard to the prevention of various chronic diseases, such as coronary heart disease, hypertension and stroke [1, 2, 3].

According to the current recommendations of the German Nutrition Society (DGE), adults are encouraged to eat at least 400 g of vegetables and 250 g of fruit every day [4]. Parallel to this, the “5-a-day” campaign, which promotes the consumption of five portions of fruit and vegetables per day, has been running in Germany since 2002. Up to one portion can be substituted by a glass of fruit or vegetable juice. This is roughly equal to the quantities recommended by the DGE for adults [4]. In the past, however, these recommended levels were not met by the majority of the German population [5, 6, 7]. With the “German Health Interview and Examination Survey for Adults” (DEGS), the current fruit and vegetable consumption was evaluated on the basis of representative data.

Methods

DEGS is part of the national health monitoring system at the Robert Koch Institute (RKI). The concept and design of DEGS are described in detail elsewhere [8, 9, 10, 11, 12]. The first wave (DEGSI) was conducted from 2008 to 2011 and comprised interviews, examinations and tests [13, 14]. The target population comprises residents of Germany aged 18 to 79 years. DEGSI has a mixed design that permits both cross-sectional and longitudinal analyses. For this purpose, a random sample from local population registers was drawn to complete the participants of the “German National Health Interview and Examination Survey 1998” (GNHIES98) who re-participated. A total of 8,152 persons participated, including 4,193 first-time participants (response rate, 42%) and 3,959 revisiting participants of GNHIES98 (response rate, 62%). In all, 7,238 persons attended one of the 180 examination centres, and 914 were interviewed only. The net sample (n=7,988) permits representative cross-sectional and time trend analyses to be performed for the age range of 18–79 years in comparison with GNHIES98 (n=7,124) [12]. The data of the revisiting participants are suitable for longitudinal analyses.

To assess food intake, the participants received a nutrition questionnaire several days before their visit to the study centre and were asked to take the completed questionnaire to the appointment. The semi-quantitative food frequency questionnaire assesses the food consumption frequencies and amounts of a total of 53 food groups consumed over a period of 4 weeks, and is a further development of the nutrition questionnaire used in the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) [5]. The main modification was the adaptation of the questions on food portions to the usual dietary habits of adults. For this, information on the frequency of food consumption from the German Nutrition Survey 1998 [15], a module of GNHIES98, and the National Nutrition Survey II (NVS II) [7] was used. Both nutrition questionnaires of KiGGS [16] and DEGSI [17] were validated. The DEGSI nutrition questionnaire was validated among 161 adults who completed standardised 24-
h dietary recalls two times in addition to the nutrition questionnaire. The ranking of intake quantities per food group in the same or adjacent quartile for both methods ranged between 68% for cooked vegetables and 94% for coffee, which implies a reasonable to good validity [17].

In the DEGS1 nutrition questionnaire, the question “How often did you eat (or drink),…?” is asked for each food group (referring to the last 4 weeks). The presented analyses include the following food groups: “fruit juice (e.g. orange, apple, cherry juice),” “vegetable juice (e.g. tomato or carrot juice),” “fresh fruit (e.g. apple, banana),” “cooked fruit (e.g. compote, canned fruit),” “raw vegetables (e.g. garden lettuce, raw vegetables salads),” “legumes (e.g. beans, peas, lentils)” and “cooked vegetables”.

The consumption frequencies can be answered with the categories “never”, “once a month,” “2–3 times a month,” “1–2 times a week,” “3–4 times a week,” “5–6 times a week,” “once a day,” “2 times a day,” “3 times a day,” “4–5 times a day” or “more often than 5 times a day”. For the portion size, a choice can be made between “1/2 portion (or less),” “1 portion,” “2 portions,” “3 portions” or “4 portions (or more)” as well as—depending on the food—“1/4 portion”. Standard portion units are given, depending on the food group, for example: glass, cup, mug, bowl, plate, slice or piece. In addition, photos are included alongside many of the questions to illustrate the portion sizes. The average consumption expressed as portions per day was calculated from the data on frequency and quantities. Calculations were made for the separate groups (fruit, vegetables, juices), as well as for the aggregated group. In accordance with the dietary recommendations for fruit and vegetables, up to one portion (one glass) of consumed fruit or vegetable juice was added to total fruit and vegetable intake.

Data from GNHIES98 were included to determine the change in fruit and vegetable intake over the last 10 years. In addition to the associated German Nutrition Survey 1998, food frequency questions about various food groups were included in the general health questionnaire of GNHIES98. The central question on food consumption frequency was: “How often do you consume the following foods and/or convenience products? Please consider the last 12 months”. After this, the foods were listed in a tabular format that included among others “fresh or frozen vegetables (cooked),” “canned vegetables,” “leaf lettuce, raw vegetable salad, raw vegetables (e.g. tomatoes, carrots, sweet pepper)” and “fresh fruit”. Another question was: “How frequently do you consume the following drinks? Please consider the last 12 months”. The drinks included among others “fruit and vegetable juices”. The answer options for both question blocks were “several times a day”, “daily or almost daily”, “several times a week”, “roughly once a week”, “two to three times a month”, “once a month or less” and “(almost) never”. The answer options from DEGS1 and GNHIES98 were combined for the analyses in order to make the best possible comparison. To compare the frequencies of fruit and juice consumption with the GNHIES98 answer category “several times a day”, the DEGS1 answer categories “2 times a day” and higher frequencies were combined. To compare vegetable consumption, the category “almost daily and more often” was constructed by combining the GNHIES98 answer categories “several times a day” and “daily or almost daily” as well as the DEGS1 answer categories “5–6 times a week” and higher frequencies.

Socioeconomic status was determined using an index that includes information on school education and vocational training, professional status and net household income (weighted by household needs) which enables a classification into low-, middle- and high-status groups [18].

The cross-sectional analyses included persons aged 18–79 years who participated in the examination part (n=7,116), since only this group also completed the DEGS1 nutrition questionnaire. A total of 7,080 nutrition questionnaires were completed. After plausibility checks, 70 participants were included because their questionnaires showed either very high (n=9) or very low (n=53) amounts of intake or were incomplete (more than 20 missing values; n=8). Accordingly, 7,010 participants were included in the analysis. The trend analyses included the 18- to 79-year-old participants in GNHIES98 (n=7,124) and DEGS1 (n=7,010).

The cross-sectional and trend analyses were conducted with a weighting factor that corrects deviations in the sample from the population structure (as of 31 December 2010) with regard to age, sex,
The mean number of portions consumed per day of total fruit and vegetables (including up to one glass of juice) and separately for fruit, vegetables and fruit and vegetable juices, according to sex and age groups, are shown in Tab. 1. Overall, with an average of 3.1 portions, women consume significantly more fruit and vegetables than men, who have an average of 2.4 portions. This is attributable in particular to a significantly higher consumption of fruit and a slightly but still significantly higher consumption of vegetables. Fruit consumption becomes higher with advancing age among both women and men up to the 60–69-year age group. Vegetable intake, on the other hand, is almost constant over all age groups. Vegetable juices, according to sex and age group. The percentage of persons who meet the “5-a-day” recommendation is of particular interest, and more than twice as many women (15.1%) as men (7.0%) achieved this. Nevertheless, 39.0% of women and 24.7% of men manage to eat at least three portions of fruit and vegetables per day. Comparing age groups, the lowest prevalence of women who consume at least five portions a day is seen among the 40- to 49-year-olds. The percentage of men who consume at least five portions increases with age up to the 60–69 years age group. Among both sexes, the percentage of persons who consume at least three portions a day is highest among the 60–69-year-olds. About half of the women and more than half of the men consume between one and less than three portions per day. The percentage of those who eat less than one portion per day decreases with age.

Tab. 2 shows the percentage of persons consuming certain quantities of total fruit and vegetables (including up to one glass of juice) according to sex and age groups. The percentage of persons who meet the “5-a-day” recommendation is of particular interest, and more than twice as many women (15.1%) as men (7.0%) achieved this. Nevertheless, 39.0% of women and 24.7% of men manage to eat at least three portions of fruit and vegetables per day. Comparing age groups, the lowest prevalence of women who consume at least five portions a day is seen among the 40- to 49-year-olds. The percentage of men who consume at least five portions increases with age up to the 60–69 years age group. Among both sexes, the percentage of persons who consume at least three portions a day is highest among the 60–69-year-olds. About half of the women and more than half of the men consume between one and less than three portions per day. The percentage of those who eat less than one portion per day decreases with age.

Tab. 3 shows the percentage of persons who reach a certain amount of por-
tions of total fruit and vegetables (including up to one glass of juice) per day according to sex and socioeconomic status groups. The percentage of persons who consume three to less than five and five or more portions per day tends to increase (but not significantly) with rising socioeconomic status in both sexes, while the percentage that consumes less than one portion per day decreases significantly.

Tab. 4 presents the percentage of women and men who consume fresh fruit and/or fruit juice (GNHIES98: “fruit and vegetable juices”) several times a day calculated from GNHIES98 and DEGS1. The percentages of women and men who consume raw vegetables (GNHIES98: “leaf lettuce, raw vegetable salad, raw vegetables”) or cooked vegetables [GNHIES98: “fresh or frozen vegetables (cooked)”,] almost daily or more often are also presented. The percentage of women who eat fruit several times a day has increased significantly from 18.5% in GNHIES98 to 26.2% in DEGS1. The percentage of men who eat fruit several times a day is significantly lower than it is among women. Again, the percentage in DEGS1 is higher (13.9%) than in GNHIES98 (9.8%). While DEGS1 shows an increase with advancing age in the percentage of persons who eat fruit several times a day, this is not the case in GNHIES98. The percentage of persons who drink juice several times a day has increased among women and even more substantially among men since the GNHIES98 survey. Overall, the percentages are roughly the same among men and women in DEGS1. Whereas the percentage of those who drink juice several times a day decreases with advancing age in GNHIES98, no clear age difference can be seen in DEGS1. The percentage of persons who eat raw vegetables almost daily or several times a day is higher among women than among men. A clear and significant decline between GNHIES98 and DEGS1 can be seen for both men and women. A clear increase or decrease with age cannot be observed in either survey. The percentage of those who consume cooked vegetables almost daily or several times a day is higher among women than among men. This percentage has decreased between GNHIES98 and DEGS1, slightly among women and substantially among men, and the difference is significant for both sexes as a whole and also in some age groups. This decline applies to all age groups with the exception of 18- to 29-year-old women.

**Discussion**

On average, women consume 3.1 and men 2.4 portions of fruit and vegetables per day, and 15% of women and 7% of men meet the recommended five portions per day. As much as 39% of women and 25% of men, however, consume at least three portions of fruit and vegetables per day. Women in all age groups consume fruit and vegetables more fre-
The consumption frequencies from DEGS1 were compared with the data from GNHIES98 on a relatively rough level. Owing to methodological differences, a more detailed comparison of the two consumption estimates is not possible. Questions on consumption frequency were integrated into the general health questionnaire in GNHIES98, whereas a separate nutrition questionnaire was used in DEGS1. The reference period covered the “last 12 months” in GNHIES98 and the “last 4 weeks” in DEGS1. Portion amounts were not assessed in GNHIES98 [21]. In addition, there were small differences in the answer categories for the frequency questions between the two surveys, and some food groups were defined differently. This also applies to juices and vegetables. In GNHIES98, “leaf lettuce, raw vegetable salad, raw vegetables” and “fruit and vegetable juices” were assessed with one question. In our opinion, the first grouping can reasonably be compared with the question on raw vegetables from DEGS1. However, in DEGS1 separate questions were asked on the intake of fruit and vegetable juice. Owing to the lack of information on portions in GNHIES98, the consumption frequency of vegetable juice cannot simply be added to that of fruit juice because, for example, a combination of “several times a week” for each of these foods can mean that juices are consumed every day, but not necessarily so. The consumption frequency of vegetable juices was very low in DEGS1 and is therefore neglectable for the comparison of these food groups. The questions on the consumption of cooked vegetables also differed: “cooked fresh or deep frozen vegetables” (one question) and “canned vegetables” were assessed with separate questions in GNHIES98, whereas “cooked vegetables” without any further differentiation and “legumes” were assessed separately in DEGS1. However, the figures for legumes in DEGS1 as well as canned vegetables in GNHIES98 were so low that this difference is of no consequence. The information on fresh fruit, on the other hand, was assessed more or less similarly in both surveys.

Despite the above-mentioned methodological differences, it was observed that the percentage of men and women who consume fruit several times a day has increased. This observation is confirmed by the increasing consumption figures for fruit derived from food balance sheets [22]. The increase between GNHIES98 and DEGS1 is only significant, however, in men and women in the age groups 60–69 and 70–79 years and in women aged 30–39 years. Perhaps persons in these age groups in particular are susceptible to preventive measures. Another remarkable development is the increase in the percentage of men and women who drink juice several times a day. On the contrary, there is a slight reduction in the percentage of men and women who consume raw veg-

<table>
<thead>
<tr>
<th>Age group in years</th>
<th>18–29</th>
<th>30–39</th>
<th>40–49</th>
<th>50–59</th>
<th>60–69</th>
<th>70–79</th>
<th>Total</th>
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<td>15.8 (12.9–19.3)</td>
<td>19.3 (16.2–22.8)</td>
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<td>24.1 (19.5–29.5)</td>
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<td>27.5 (24.1–31.2)</td>
<td>33.4 (28.7–38.4)</td>
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<td>7.9 (5.5–11.1)</td>
<td>8.3 (6.3–10.8)</td>
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<td>15.7 (12.7–19.3)</td>
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<td>8.4 (6.6–10.7)</td>
<td>7.9 (6.0–10.4)</td>
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<td>12.9 (10.2–16.2)</td>
<td>10.5 (8.1–13.6)</td>
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<td>10.9 (7.9–14.7)</td>
<td>13.2 (9.3–18.5)</td>
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<td>Raw vegetables almost every day or more often</td>
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<td>38.2 (33.6–43.0)</td>
<td>45.6 (41.3–50.1)</td>
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</table>
etables almost every day and the percentage of men who eat cooked vegetables every day. An influence of the EHEC (enterohaemorrhagic *Escherichia coli*) crisis in 2011 [23] may be conceivable, but preliminary analyses showed no substantial reduction in consumption frequency during the corresponding months.

Other nationwide representative surveys including fruit and vegetable consumption have been conducted in recent years. In the "German Health Update 2010 (GEDA 2010)", which is part of the national health monitoring at the Robert Koch Institute, approximately 22,000 persons were interviewed by telephone [24]. The survey period (September 2009 to July 2010) lies within the DEGS1 survey period. The percentage of persons who consumed five portions of fruit and vegetables per day was slightly lower in GEDA 2010 than in DEGS1 (women 12% vs. 15%, men 5% vs. 7%). The difference is probably attributable to the communication approach and the interview method. A slightly more detailed assessment of foods was possible with the self-administered questionnaire in DEGS1, whereas the assessment by telephone in GEDA 2010 consisted merely of three simple questions on fruit and vegetable intake. An increase in the consumed portions of fruit and vegetables per day with advancing age was observed in both surveys, however. While the differences in prevalence between age groups among women were small, the difference among men was particularly pronounced from the age of 60 years (DEGS1: 60–69 years 12%, 70–79 years 10%; GEDA 2010: 60–69 years 5%, 70–79 years 4%).

In the NVS II, representative consumption data, including fruit, vegetables and juices, were collected throughout Germany from 2005 to 2006 [7]. However, there are also restrictions in comparability between the NVS II and DEGS1, since the NVS II used more quantitative assessment instruments and therefore the results could be presented as gram amounts. Despite this, increased fruit consumption with advancing age was also observed in the NVS II, with the highest intake amounts being observed among 65- to 80-year-old men and 51- to 64-year-old women [7]. The NVS II also recorded a higher consumption of fruit and vegetables in individuals with a higher socioeconomic status. Whereas almost no difference was observed in the number of vegetable portions per day between age groups in DEGS1, the consumed amounts of vegetables increased with advancing age in the NVS II. This is probably attributable to the more detailed assessment of several kinds of vegetables.

Within all surveys used to evaluate fruit and vegetable consumption, there are methodological differences in the assessment instruments, the sampling procedures and the communication approaches (telephone, self-administered or face-to-face interviews). This complicates the comparison and interpretation of the results. In addition, there are differences in the reference periods, which have probably strained the memory skills of the participants to different degrees, and seasonal fluctuations were also accounted for in different ways.

**Conclusion**

Fruit intake has increased slightly compared to previous surveys. The percentage of persons who reach the recommended five portions of fruit and vegetables per day is still very low.

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**References**