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ORIGINAL CONTRIBUTION

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Energy intake of 1 to 18 year old German children and adolescents

Energiezufuhr von 1 bis 18jährigen deutschen Kindern und Jugendlichen

Summary In a sample of 695 healthy well-nourished German children and adolescents covering the total age range from 1 to 18 years, 3d weighed diet records were collected and measurements of body height and weight were taken. 10 % non-plausible records (reported energy intake (EI):estimated basal metabolic rate (BMR) < Cut off 1.06) were excluded from further analysis. The rate of non-plausible records was low in the childhood age groups (2-6 %), higher in the male (10 %), and highest in the female adolescents (30 %). Recalculation of age and sex specific cut offs based on assumed light physical activity levels (PAL) reduced the exclusion rate to 6.5 % (total) and 20 % (female adolescents). The reported energy intake of the total sample based on plausible records (n=627, EI:BMR ≥1.06) was close to the new estimations of energy requirements assuming light physical activity which are proposed for the revision of the current FAO/WHO energy requirements. The sample was of normal height and weight compared to the Netherlands growth references. For a definite interpretation of the low reported energy intake in the context of health promoting physical activity patterns of children and adolescents more scientific evidence should be available.

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Zusammenfassung Bei 695 gesunden, gut ernährten deutschen Kindern und Jugendlichen aller Altersgruppen von 1 bis 18 Jahren wurden 3d Wiege-Ernährungsprotokolle gesammelt sowie Körpergröße und -gewicht gemessen. Insgesamt 10 % unplausible Protokolle (Ausschlußkriterium: protokollierte Energiezufuhr (EI): berechneter Grundumsatz (GU) <1.06) wurden von der Auswertung ausgeschlossen. Die Ausschlußquoten unplausibler Protokolle waren bei Kindern niedrig (2-6 %), bei männlichen Jugendlichen höher (10 %) und bei weiblichen Jugendlichen am höchsten (30 %). Mit Ausschlußkriterien unter Berücksichtigung alters- und geschlechtsbezogener Schätzungen des Energiebedarfs für geringe körperliche Aktivität ergaben sich niedrigere Ausschlußquoten (insgesamt: 6.5 %, weibliche Jugendliche: 20 %). Die Energiezufuhr des Kollektivs mit plausiblen Protokollen (n=627; EI: GU ≥1.06) entsprach insgesamt weitgehend den neuesten, zur Revision der derzeitigen FAO/WHO-Werte gedachten Angaben zum Energiebedarf bei leichter körperlicher Aktivität. Körpergröße und -gewicht des Kollektivs waren normal, gemessen an niederländischen Referenzwerten. Für eine abschließende Bewertung der ermittelten niedrigen Energiezufuhr im Zusammenhang mit gesundheitsförderlichen körperlichen Aktivitäten von Kindern und Jugendlichen ist eine Erweiterung des derzeitigen Kenntnisstandes abzuwarten.

Key words Children and adolescents – 3d weighed diet record – energy intake – body height and weight – underreporting

Schlüsselwörter Kinder und Jugendliche – 3d Wiege-Protokollmethode – Energiezufuhr – Körpergröße und -gewicht – Unterprotokollierung

Introduction

For about the last 50 years, FAO/WHO reference values for human energy requirements have been used as a basis for worldwide national and international energy intake recommendations. Recently, new estimations of energy requirements for children and adolescents from 1 to 18 years of age based on measured total energy expenditure were proposed as a basis for new FAO/WHO energy requirement data (28). Compared to the current 1985 FAO/WHO requirement data (12) and the almost corresponding German (10) and EC recommendations (24), the new estimations are about – 20 % lower for children under 5 years and about + 10 % higher in adolescent boys and preadolescent girls.

Therefore, the observed energy intakes from nutrition surveys of children and adolescents are evaluated quite differently, dependent on whether the current or the new estimations of energy requirements are used as a reference.

The existing dietary intake data sets from German children and adolescents are mainly old. More recent figures are only available as uncommented tabulated average values and data for children under 4 years nonexistant (11). We have collected dietary data from 695 children and adolescents covering the age range from 1 to 18 years for a detailed assessment of the food and nutrient intake of a well nourished healthy population. Here, we report on the energy intake of the different age and sex groups using the new energy requirement estimations (28) and hint at the problem of defining underreporting and physical activity levels for the evaluation of the data.

Subjects and methods

Subjects

Part of this sample came from the „DONALD Study“ (Dortmund Nutritional and Anthropometrical Longitudinally Designed Study) of 0 to 18 year old infants, children, and adolescents which was established at the Research Institute of Child Nutrition Dortmund in 1985.

Participants in the DONALD Study came from voluntary families interested in the longterm course of diet and health of their children. The DONALD Study protocol comprises among other examinations of anthropometrical measurements once a year at our institute followed by a 3d weighed diet record and a 24h urine collection at home. This report only includes the data from the first examination (first diet record) of an individual to eliminate follow-up effects. From the total of first diet records (n=466 with a plausible energy intake, see later) 80 % came from between 1985-1989 and 20 % from between 1990-1995; 93 % came from children (1-12 years) and 7 % from adolescents (13-18 years).

The other part of this sample came from the cross sectional „DAD Study“ (Dortmund ADolescent Study) carried out in parallel with the DONALD Study between 1987-89. The DAD Study protocol also included anthropometrical measurements and a 3d weighed diet record. The DAD Study was aimed at interested adolescents to enlarge the cross sectional sample of mostly younger subjects from the first examinations of the DONALD Study. Therefore, school classes with nutritional education and leisure sport clubs (e. g., hockey, swimming) were addressed with teachers and coaches as mediators for recruitment. Secondary schools as well as technical schools were chosen to include both pupils and working adolescents. 70 % of the total diet records (n=161 with a plausible energy intake, see later) were from mostly female school classes, the others from mostly male members of sport clubs. The energy and macronutrient intake of the total sample according to age did not vary significantly with the year of recruitment (Kruskal-Wallis test).

The social background of the study population was relatively high compared to the official German statistics (27). From the subjects older than elementary school age 62/20/8 % visited a grammar school/secondary school/ “Hauptschule“, respectively, (German statistics: 37/26/37 %) and 10 % a technical school (statistics: not included). The highest school educational level of the mothers/fathers of the study subjects was a grammar school certificate in 34/45 % (statistics 18/25 %) and a lower level in 66/55 % (statistics 72/75 %). The mothers’/fathers’ professional qualification was at university or graduate level in 21/39 % (statistics 14/21 %) and apprenticeship or training level in 79/61 % (statistics 86/79 %). The occupation of the mothers/fathers was non-manual in 42/82 % and manual (including housewives) in 58/18 % (statistics: not available).

Weighed diet record

Trained dietitians were each responsible for a record throughout the study. 3d consecutive weighed diet records were performed by use of electronical food scales (Soehnle digita 8000, accuracy 1 g (<64 g) and 2 g (65-1000 g) and WEDO Digi 2000 (0-2000 g), accuracy 1 g). Recording was explained to the parents and older children of the DONALD Study individually and to the groups of the DAD Study in the classroom or at the sport club. An information sheet and a written example of a 1d form free record was left with the participants. The choice of the recording days was left free. Week-days (76 %) and week-end days (24 %) were almost equally distributed in the sample.

The weighed amount of each food and drink taken both in and out of home as well as the time and place of each meal should be recorded. Different components

of a dish, e. g., bread, butter, jam, or of a composite meal, e. g., vegetable soup, were recorded separately. However, emphasis was laid on maintaining the usual diet over the indispensable weighing of each consumed item. Therefore semiquantitative amounts (household measures, numbers of portions) were allowed, particularly at school or in a restaurant. For estimating the weights of semiquantitative amounts, a set of our own standard conversion data was used. Each food item was described in detail, e. g. brand name, method of preparation. Wrappers, cartons, and packs from commercial products were kept.

At the end of the 3d record period, the dietitian visited the family or the group and checked the record for completeness and accuracy. If further queries turned up during the coding the dietitian contacted the participant via telephone.

Record keeping switched from the parents to the children/adolescents dependent on age. Some children assisted their parents in recording from the age of 7 years. 80 % of the 10 to 12 year old children already helped with the recording. In the adolescent groups totally self-reliant records were kept by 20 % of the males and 30 % of the females at the age of 13 to 14 years and by 70 % of the males and 90 % of the females at the age of 15 to 18 years. In about 80 % of the daily records, >90 % of the consumed food items was weighed rather than estimated irrespective of age and sex, whereas in only 2 % of the records <5 % of the food items was weighed.

Energy computations

Energy and nutrient intakes were calculated with our continuously updated nutrient database LEBTAB which contains at present 3660 food items (2030 common foods, composites and commercial products, 1340 commercial infant foods, 290 special preparations) with listings of energy and 30 nutrients. For LEBTAB, the energy and nutrient data of basic food items were taken from the German food tables; missing data was taken from food tables from the UK and the Netherlands. The energy and nutrient content of commercial products was estimated by a simulated recipe from the ingredients listed on the label and checked by the data declared by the manufacturer.

Validation of records

To check for underreporting, the ratio of reported energy intake (EI) and estimated basal metabolic rate (BMR, according to Schofield (26) taking into account age, sex, body weight, and height) was used as proposed by Goldberg et al. (13). Records with an EI:BMR ratio <1.06 („cut off 2“, 95 % confidence limits), indicating a non-plausible individual actual 3d energy intake, were excluded from further analysis.

The „cut off 2“ from Goldberg et al. (13) is based on the following assumptions:

- a physical activity level (PAL = total energy expenditure as multiple of BMR) of 1.55, equivalent to a sedentary lifestyle in an adult population,
- a within-individual coefficient of variation (CV) for EI of 23 %,
- a CV for calculated BMR of 8 %,
- a CV for PAL of 12.5 %,
- 4 recorded days.

For comparison, we have recalculated age and sex specific cut offs using the procedures of Goldberg et al. (13) with the following modifications:

- the new estimations of the PAL assuming light physical activity (Table 1) given for 6 different age/sex groups of children and adolescents (28),

Table 1 Numbers of collected records and percentages of non-plausible records in 6 age/sex groups using different cut off levels for the assessment of underreporting

Age groups	Collected records		Non-plausible records			
			Cut off <1.06	Recalculated cut offs		
Years	n	%	%	(PAL)	(Cut off)	%
Males						
1–5	140	100	2.1	(1.45)	(0.97)	1.4
6–13	89	100	5.6	(1.55)	(1.04)	4.5
14–18	64	100	10.9	(1.60)	(1.07)	10.9
Females						
1–5	167	100	1.8	(1.45)	(0.97)	1.2
6–13	89	100	5.6	(1.50	(1.01)	2.3
14–18	146	100	30.8	(1.45)	(0.97)	19.2
Total	695	100	9.8			6.5

- a within-individual CV for EI of 24 % for children under 6 years (18),
- 3 recorded days.

Anthropometry

The subjects (undressed to vest and pants) had their height measured (to the nearest 1 mm) in a standing position using a digital telescopic wall-mounted stadiometer (Harpenden) or alternatively a supine measuring table for toddlers. For weight measurements (to the nearest 0.1 kg) an electronical scale (Seca 753 E) or alternatively a supine infant weighing scale (Mettler PS 15) was used.

Data analysis

SAS procedures (Version 6.11) were used for data analysis. Group specific intakes were calculated from the individual means of the 3 recorded days. For the discussion of underreporting, age groups were defined according to the new estimations of the PAL for children and adolescents (28). For the description of energy intake and growth, age groups were defined according to the German recommendations for nutrient intake (10). Additionally, the 1 to 3 year group was broken down into 1 year categories to separate the 1 year old group because of their different food pattern (20 % of the 1 year olds still received >50 % of their total food and energy intake from commercial infant food).

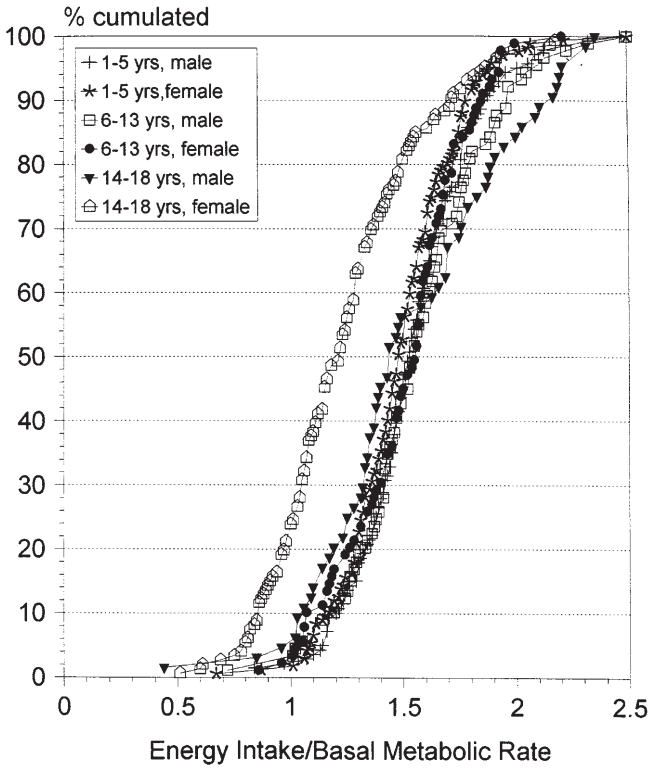

Fig. 1 Cumulative distribution of all individual values of the ratio of reported energy intake : estimated basal metabolic rate (EI:BMR) of the collected dietary records (n=695) in 6 different age/sex groups.

Results

The distributions of the EI:BMR ratios differed between the group of the 14 to 18 year old females with higher proportions of lower values and the other age/sex groups with almost identical distribution patterns (Fig. 1).

From the total of the 695 collected records 9.8 % were identified as non-plausible because of an EI:BMR ratio <1.06 (Table 1). These records were excluded from further analysis resulting in a final sample of 627 subjects with plausible records. The rates of non-plausible records were clearly dependent on age and sex increasing from about 2 % in the young children to about 10 % in adolescent males and about 30 % in adolescent females (Table 1).

The recalculated age and sex specific cut offs were lower than the cut off 1.06 with the exception of the 14 to 18 year old males (Table 1). Using the recalculated cut offs a total of 6.5 % of the collected records was not plausible. In the 14 to 18 year old females, about 20 % of the records were not plausible even with the lower cut off.

The measured height and weight of the final sample of 627 subjects (Table 2) calculated as indices height for age and weight for height conformed to the data from the latest 1980 Netherlands growth survey (23) with an increased weight for height of about +5 % from the age of 8 years except outliers due to small numbers in single year's classes (Fig. 2).

The energy intake as MJ/d increased 2.6 fold in males and 2.2 fold in females between the ages of 1 and 18 years, while the energy intake as MJ/kg/d decreased by 50 % in males and 60 % in females (Table 2). The EI:BMR ratios were higher in the male than in the female groups. The highest EI:BMR ratios were reached at the age of 10 to 14 years in males and 7 to 12 years in females.

The energy intake almost conformed to the new estimated energy requirements in the ranges of light and heavy habitual physical activity in the 1 and 2 year old groups, close to the level of light activity in the 4 to 14 year old groups, and below the level of light activity in the 3 year and 15 to 18 year old groups (Fig. 3). Compared to the energy intakes in international nutrition surveys after 1980, the energy intake was low in our female population and conformed in our male population

Table 2 Height, weight, and energy intake of 627 children and adolescents of different age/sex groups

Age groups	Subjects	Height	Weight	Energy intake		
Years	Number n	cm Median (P_{10}; P_{90})	kg Median (P_{10}; P_{90})	MJ/d Median (P_{10}; P_{90}	MJ/kg/d Median (P_{10}; P_{90}	EI:BMR* Median (P_{10}; P_{90}
Males						
1	66	82.6 (76.0; 88.1)	11.5 (9.9; 13.3)	4.10 (3.28; 5.12)	0.36 (0.29;0.44)	1.57 (1.29; 1.89)
2	26	89.6 (86.1; 93.6)	13.4 (11.7; 15.7)	4.60 (3.91; 6.45)	0.33 (0.28;0.53)	1.52 (1.17; 2.13)
3	13	96.8 (92.1; 104.7)	15.5 (13.4; 17.9)	4.80 (4.21; 5.70)	0.30 (0.25;0.39)	1.35 (1.16; 1.61)
1-3	105	86.1 (77.0; 95.8)	12.1 (10.3; 15.4)	4.31 (3.49; 5.59)	0.36 (0.27;0.44)	1.54 (1.20; 1.88)
4-6	41	111.5 (103.9; 117.5)	19.2 (16.5; 21.9)	5.96 (5.03; 7.10)	0.32 (0.26;0.38)	1.52 (1.24; 1.79)
7-9	39	129.8 (118.5; 142.5)	26.5 (20.6; 37.7)	7.67 (5.77; 9.26)	0.27 (0.21;0.36)	1.55 (1.34; 1.17)
10-12	16	147.7 (143.0; 154.2)	39.3 (31.4; 47.0)	9.23 (8.27; 11.32)	0.24 (0.20;0.29)	1.65 (1.43; 1.19)
13-14	36	163.0 (151.8; 178.0)	49.6 (41.2; 63.1)	10.31 (7.79; 14.35)	0.20 (0.16;0.27)	1.63 (1.19; 2.10)
15-18	41	176.0 (165.4; 184.4)	65.1 (50.4; 74.6)	10.93 (9.21; 17.60)	0.18 (0.14;0.25)	1.47 (1.23; 2.19)
Total	278					1.55 (1.24; 1.97)
Females						
1	78	80.9 (73.5; 85.4)	10.6 (9.1; 12.9)	3.75 (2.89; 4.69)	0.35 (0.27;0.42)	1.51 (1.28; 1.88)
2	25	89.9 (84.2; 92.5)	12.8 (10.6; 14.0)	4.12 (3.44; 5.18)	0.32 (0.28;0.44)	1.43 (1.23; 1.75)
3	22	96.4 (92.9; 104.5)	14.3 (11.9; 18.1)	4.48 (3.67; 5.41)	0.31 (0.24;0.38)	1.38 (1.10; 1.64)
1-3	125	84.0 (74.7; 95.2)	11.6 (9.5; 14.4)	3.89 (3.01; 5.15)	0.34 (0.27;0.42)	1.49 (1.22; 1.78)
4-6	47	108.1 (101.6; 122.8)	18.8 (15.4; 26.0)	5.36 (4.05; 6.87)	0.30 (0.21;0.36)	1.50 (1.11; 1.83)
7-9	36	132.3 (122.4; 143.2)	27.4 (21.3; 32.7)	6.89 (5.55; 8.13)	0.26 (0.19;0.32)	1.60 (1.17; 1.89)
10-12	31	147.4 (132.4; 155.3)	36.6 (26.9; 48.5)	7.25 (5.99; 9.08)	0.20 (0.16;0.28)	1.57 (1.19; 1.82)
13-14	10	160.5 (154.3; 167.6)	43.6 (37.5; 60.1)	8.09 (6.82; 9.52)	0.19 (0.12;0.22)	1.45 (1.16; 1.73)
15-18	100	167.8 (160.0; 175.9)	58.5 (50.9; 70.3)	8.30 (6.79; 11.06)	0.14 (0.11;0.19)	1.33 (1.10; 1.81)
Total	349					1.47 (1.15; 1.82)
Both sexes	627					

*Energy intake: Basal metabolic rate

Discussion

The reported energy intake of groups of healthy well nourished children and adolescents was almost in accordance with the new estimations of energy requirements assuming light physical activity but much lower than the current FAO/WHO energy requirement data and the lower the younger the children.

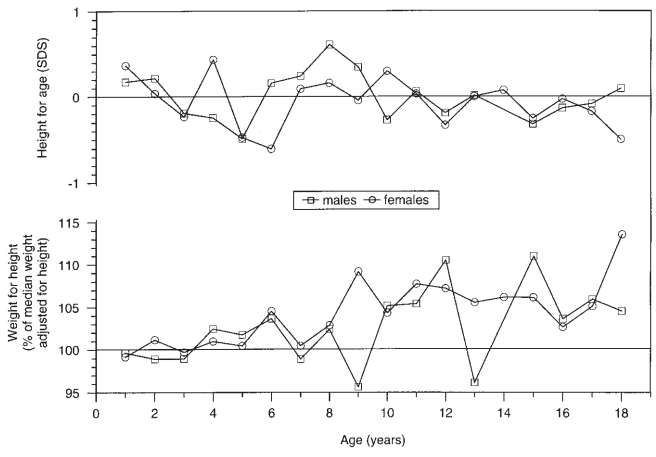

Figure 2 Height for age (standard deviation score, SDS) and weight for height (% of median weight adjusted for height) of year`s classes in the study population in comparison with the Netherlands third nation-wide survey 1980 (23) used as a reference.

Energy requirement data

The new estimations of energy requirements for 1 to 18 year old children and adolescents (28), which are proposed for a revision of the current FAO/WHO data from 1985 (12), are based on the same procedures to measure total energy expenditure (doubly labelled water, heart rate monitoring) throughout the age groups whereas for the 1985 FAO/WHO energy requirements different procedures were used depending on age (observed energy intakes for children under 10 years; factorial method for others). Now ranges of energy requirements for light and heavy physical activity have been given instead of single average values in the 1985 data. In addition, basic data and derivation procedures were now presented in detail. For comparison, observed energy intakes from about 90 nutrition surveys of healthy children and adolescents later than 1980 were listed.

However, for the new estimations of energy requirements only measurements of total energy expenditure from few and small samples of 10 to 30 subjects have been available, some reporting surprisingly high and others surprisingly low energy expenditures. Furthermore, only the new energy requirements for moderate habitual physical activity were experimentally based, while the lower/upper ranges for light/heavy activity were arbitrarily defined by a CV of ± 12 %.

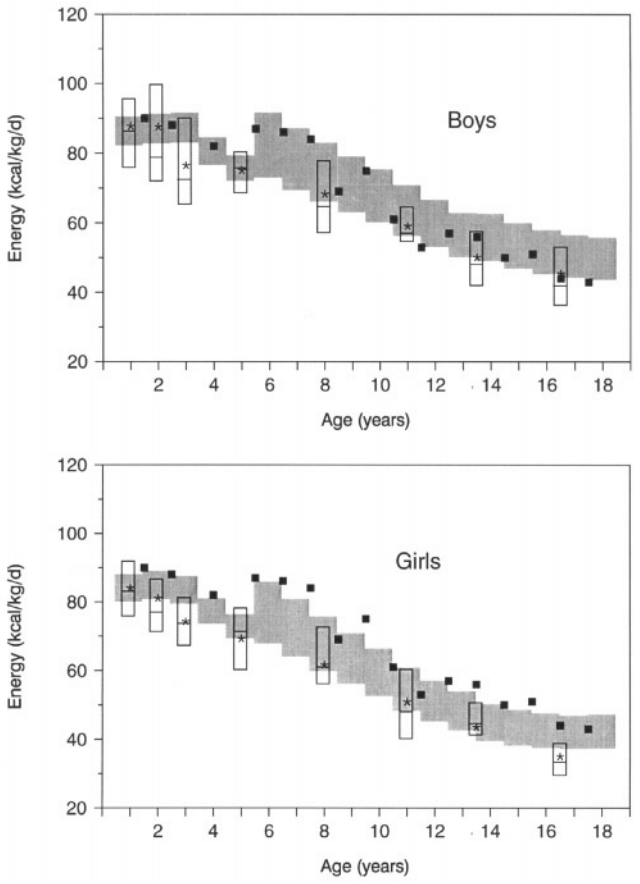

Figure 3 Distribution of age group specific plausible reported energy intake (boxes: P25, P50, P75; mean value as star) of boys and girls in the study population in comparison with the new estimations of energy requirements (shaded area) ranging between assumed habitual light and heavy physical activity (calculated from tabulations of yearly data from (28)) and in comparison with averaged energy intakes (filled squares) from about 90 nutrition surveys carried out later than 1980 (28).

4. Sample and methods

Our study sample covered the total age range from 1 to 18 years uninterrupted and close-meshed, whereas nutrition surveys are usually confined to specific age groups, e.g., preschool children or adolescents. Here, subjects from two studies, one concentrating on children and another on adolescents, were combined because both studies were carried out with identical methods and comparable study populations, and the reported energy intake as well as measured height and weight were continuous with age without a disjunction between children and adolescents.

Weighed diet records are generally regarded as the gold standard among the nutrition survey methods (4, 5). We chose 3d weighed diet records instead of 7 days to encourage a longterm commitment (DONALD Study) and to overcome the problem of low interest of many adolescents for demanding dietary studies (DAD Study).

Moreover, recruiting aimed at families and adolescents with interest in the field of diet to favor the quality of recording. In the DAD Study teachers, who gave nutritional lessons, e. g., home economics were addressed, because their pupils were supposed to be interested in the subject. As an incentive, the nutrient computations of the own record with an explanation by the dietitians were offered to the adolescents. Probably, the obligatory study participation of the whole class may have diminished the quality of recording in part of the pupils.

Low reported energy intake

The relatively low reported energy intake of the study population was not attributable to inaccurate assessments of food amounts. The documented high proportions of weighed foods point to careful food intake measurements throughout the age groups.

Neither was the total dietary intake inferior. Height and weight were normal and even an increased weight for height was observable through adolescence. Also the upper social background of the study population precluded an inferior dietary intake not meeting the energy requirements. As a reference for height and weight, we favored the latest Netherlands growth survey (23), which was from a representative neighboring population, covered all age groups from birth to adolescence and provided the necessary statistical data. The often used US-NCHS growth data originating from studies between 1929-1975 need an update (20) and recent data from national European samples of children and adolescents are only available as uncommented mean values (24).

Assessment of underreporting

For the evaluation of the findings from nutrition surveys bias due to underreporting has to be considered even in carefully conducted studies (4, 5). Bias due to overreporting is of no importance (5, 13). We chose the procedure ("cut off 2") as proposed by Goldberg et al. (13) to exclude obviously non-plausible diet records as a measure to improve the survey data set (5, 13). This procedure is well suited for field studies and has gained more interest in recent time (7, 8, 21, 29).

The published calculations of cut offs (13) refer to adults, e. g., a PAL 1.55 for a sedentary life style (12). Given the new estimations of PALs for light physical activity for children and adolescents (28) and the almost conforming reported energy intake of our study population, a recalculation of age and sex specific cut offs seemed of interest. The recalculated lower cut off would have resulted in a significantly lower exclusion rate in the group of the 14 to 18 year old females but the different levels of the EI:BMR ratios of this group and the total of the other groups as demonstrated by the cumulative curves remained. Ideally, for calculating a

suitable cut off for underreporting the particular PAL of the group or even better of the individual should be known (5, 7, 21).

Our finding of a marked influence of age and sex on the extent of underreporting in children and adolescents is in accordance with other nutrition surveys where the Goldberg "cut off 2" was used and with experimental validation studies.

In the Austrian Study of Nutritional Status (29) almost the same proportions of underreporters (4 % in 6-9 year old children, 12/25 % in male/female adolescents) were identified as in our study. In a British survey of adolescents (8) lower proportions of underreporters (males/females 6 %) were observed but dieters (proportions not reported) were excluded. In adults the proportions of underreporters (males/females 10/16 % (5), 19/23 % (21)) were in the same order as in the adolescent groups in the Austrian and our study.

In experimental validation studies comparing reported energy intake from weighed diet records with measured total energy expenditure (doubly labelled water) for a quantification of underreporting, underreporting was found to be almost absent in children under 10 years as in adult volunteers, but increased with age from 12 to 18 years to about -10 % to -20 % approaching the level found in randomly chosen adults (3, 6, 9, 15, 25). Underreporting amounted up to -40 to -50 % in groups of obese or previously obese children, adolescents, and adults (3, 6, 25). Females seemed to be more prone to underreporting than males (4, 15).

Underreporting in this study

Underreporting can be almost neglected in all age groups of the children and in the males in this study. An explanation with respect to the children is the interest of the parents in the diet and health of their family as was demonstrated by the volunteer participation in the demanding DONALD Study. Furthermore, the food consumption of younger children is mostly under parental control compared to the higher outdoor food consumption of school aged children and adolescents.

Males are less diet conscious than females (21). This may also be assumed for our males recording on their own so that they neither had an interest in modifying their diet because of recording nor consciously omitted specific foods with an unhealthy image from the record. Moreover, EI:BMR ratios >1.8 (moderate PAL) and >2.0 (heavy PAL (28)) were found more often in males from the age of 6 years than in the other groups. This is in accordance with findings from male adults (21) and may have been accentuated in our participants by the boys from the leisure sport clubs.

Underreporting was a problem in our female adolescents as in other studies (6, 15, 25, 29). Females are more preoccupied with diet and body image than males and more in higher social classes (21). Most of the female adolescents in our study were pupils of secondary or technical schools who had chosen a nutrition related curriculum. Particularly such females may be prone to report a healthy diet to give the impression that they conform to what is perceived to be desirable. Indeed, the adolescent underreporters recorded fewer meals per day and a lower sugar intake (% of energy intake) than the adolescent non-underreporters as was observed by others (29). This may be an indication of particular omissions of sweet and/or snack meals in the record. Snack eating is the most uncertain and problematic area of monitoring dietary intake particularly in children and adolescents (15).

The underreporters in this and other studies (5, 15, 29) had a higher BMI than the non-underreporters pointing to a higher preoccupation with body image and dietary restraint. Restraint eating and dieting is observable in overweight as in normalweight subjects (21) and is often practiced by female adolescents, beginning already around 10 years of age (16, 17, 22). In the USA between 40 and 70 % of female adolescents have already tried a weight reducing diet (16, 17). In Germany, extreme thinness was the ideal body image for about 90 % of the female teenagers and about 40 % of them wanted to loose weight although only 4 % were really obese (22).

As there are no indications that eating and dieting behavior of the females in our study differed from the practices of German female adolescents, a proportion of them recorded their intake during a period of controlled eating or dieting which means that they reported a "true" period of dietary intake in their range of intakes. Others may have unconsciously misused the recording days to diet. Bias due to underreporting could probably be diminished in adolescents by use of the diet history method, but this method is less accurate and more difficult to accomplish than diet records (15).

By the cut off for exclusion used here, obviously underreported energy intakes were identified but records in a "grey area" just above the cut off were accepted. The proportion of records just above the cut off was greater in the group of female adolescents than in the other groups irrespective of whether the Goldberg "cut off 2" or age and sex specific cut offs were used. Nevertheless, the mean EI:BMR ratio 1.33 in the female adolescents of the final sample, which was the lowest among all study groups, can be accepted as representative of the habitual intake within the recently proposed limits of 1.30 to 2.10 for these age groups (28).

Physical activity

The reported energy intake of our study population points to low physical activity patterns in these groups. Physical activity was not assessed in this study. Data from other groups of German children and adolescents are not avail-

able. British children and adolescents from the age of about 10 years demonstrated surprisingly low levels of habitual physical activity (2, 14). Physical activity seems to decline steadily from childhood through adolescence to adulthood and in particular in females (19). This may also occur in German children and adolescents including our study population.

At present, a definite interpretation of our findings within the context of physical activity is impeded by imcomplete scientific evidence. The new estimations of energy requirements for different physical activity patterns (28), although welcome for a more differentiated valuation than was possible by the current FAO/WHO data, are no more than arbitrary because of limited measurement data in children and adolescents. Furthermore, there is at present insufficient evidence for the exact properties of health-enhancing physical activity patterns in children and for a direct link of exercise and fitness in childhood and adolescence with health in adult years. Nevertheless, the hypothesis is widely agreed upon that exercise and fitness in early years can establish lifetime regular physical activity with beneficial effects for disease prevention (14, 19).

Conclusion

With respect to the low reported energy intakes in our study and the as yet limited scientific evidence for the definition of health promoting physical activity patterns in children and adolescents an overall appeal to increase the current physical activity levels cannot be justified unanimously. Nevertheless, physical activity should be addressed in the context of the establishment of healthy dietary habits in childhood for health promotion in youth and prevention of chronic lifestyle related diseases in adulthood (1). Female adolescents should be considered as a specific subgroup with respect to dietary evaluations and healthy lifestyle habits.

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