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ORIGINAL CONTRIBUTION

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

Die Zufuhr von Makronährstoffen bei 1 bis 18 Jahre alten deutschen Kindern und Jugendlichen

Summary In a sample of 627 healthy German children and adolescents between the age of 1 and 18 years the intake of macronutrients (protein, fat, carbohydrates) and their specific subgroups (animal protein, saturated (SFA), monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA), cholesterol, added sugars, dietary fiber) were assessed from 3d weighed diet records. The medians of the nutrient intake (% of energy) were 13 % protein (2/3 animal), 38 % fat, 49 % carbohydrates, 17 % SFA, 16 % MUFA, 5 % PUFA, 12 % added sugars and (per MJ) 34 mg cholesterol, 1.9 g dietary fiber. The macronutrient patterns were almost uniform across the age and sex groups with the exception of lower fat, PUFA, and sugar intakes in the 1 year olds. The findings were almost in accordance with former and current dietary surveys in Germany and neighboring countries. Several findings, particularly the high SFA and low fiber intake, differed considerably from the diet for the prevention of the chronic diseases related to nutrition in western societies which is recommended for this age range. Based on the findings of this study, a preventive dietary concept for German children and adolescents was proposed.

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Zusammenfassung Bei 627 gesunden deutschen Kindern und Jugendlichen aller Altersgruppen von 1 bis 18 Jahren wurde auf der Basis von 3d Wiege-Ernährungsprotokollen die Zufuhr von Makronährstoffen (Protein, Fett, Kohlenhydrate) und spezieller Fraktionen (tierisches Protein, gesättigte (SFA), einfach ungesättigte (MUFA) und mehrfach ungesättigte (PUFA) Fettsäuren, Cholesterin, Zuckerzusätze, Ballaststoffe) berechnet. Die Zufuhrwerte (Mediane) beliefen sich (in % der Energiezufuhr) auf 13 % Protein (2/3 tierisch), 38 % Fett, 49 % Kohlenhydrate, 17 % SFA, 16 % MUFA, 5 % PUFA, 12 % Zuckerzusätze und (pro MJ) 34 mg Cholesterin und 1,9 g Ballaststoffe. Im untersuchten Altersbereich war die Nährstoffverteilung weitgehend ähnlich, mit Ausnahme niedrigerer Anteile von Fett, PUFA und Zuckerzusätzen bei den 1-jährigen Kindern. Die Nährstoffzufuhr entsprach Befunden aus früheren und neueren Erhebungen in Deutschland und in den Nachbarländern, wich aber in wesentlichen Aspekten (hoher Anteil von SFA, niedriger Anteil von Ballaststoffen) von den Ernährungsempfehlungen für Kinder und Jugendliche zur Prävention ernährungsmitbedingter Zivilisationskrankheiten ab. Deshalb wurde ein Konzept für eine allgemeine Präventionsernährung von Kindern und Jugendlichen in Deutschland entwickelt.

Key words Children and adolescents – protein intake – fat and fatty acid intake – carbohydrate, sugar, and fiber intake – preventive diet

Schlüsselwörter Kinder und Jugendliche – Proteinzufuhr – Fett-, Fettsäuren-Zufuhr – Kohlenhydrat-, Zucker-, Ballaststoffzufuhr – Präventionsernährung

Introduction

A diet can roughly be characterized by the amounts of the macronutrients protein, fat, and carbohydrates and their specific composition, e.g., animal and plant proteins, fatty acids and cholesterol, complex and simple carbohydrates, and dietary fiber. This applies in particular to the evaluation of dietary risks or prevention with respect to the chronic diseases associated with the affluent diet in industrialized countries (23, 33, 34). Based on the concept of prevention of atherosclerosis, several authors and committees recommend a fat reduced and fat modified diet with more complex carbohydrates as a population based preventive strategy starting as soon as in "early childhood" (33) or from the age of 2 years (2, 4, 14, 24) while others call for specific dietary guidelines for young children (8, 10, 21).

The existing dietary intake data from German children and adolescents are out of date (15, 30). More recent figures are merely available as tabulated average values whereas data for children under the age of 4 are nonexistent (11). We have collected 3d weighed diet records from children and adolescents between the age of 1 and 18 years for a detailed assessment of the food and nutrient intake of a well nourished healthy population. Here, we report on the macronutrient intake of the different age and sex groups in the context of preventive dietary recommendations.

Subjects and methods

Subjects

Details of the study sample were published recently (18). In short, the sample (normal height and weight) is comprised of 466 participants between the age of 1 and 18 from the DONALD Study (Dortmund Nutritional and Anthropometrical Longitudinally Designed Study) from 1985 to 1995 and of 161 participants aged 13 to 18 years from the cross-sectional DAD Study (Dortmund ADolescent Study) from 1987 to 1989. From the DONALD Study only cross-sectional data from the first examination (first diet record) were used here to exclude unknown follow-up effects. The enery and macronutrient intake in the age groups studied did not vary with the year of recruitment (Kruskal-Wallis test n.s.). This is in accordance with representative German household based data which show only insignificant variations in the energy and macronutrient supply between 1986 and 1994 (12). Based on these observations the studies were combined here. The DONALD Study sample is comprised of families who are interested in the long-term nutrition and health of their children. The DAD Study sample is comprised of interested adolescents recruited mainly from secondary and technical schools (70 %) and from leisure sport clubs (30 %). On the whole, the social background (parental school educational and professional level) of the study sample was relatively high (18).

Weighed diet records

Details of the method were published recently (18). In short, parents or subjects themselves weighed all consumed foods and drinks (to the nearest 1 g) during 3 consecutive days. If weighing was not possible, semiquantitative amounts (household measures, numbers of portions) were accepted. Nevertheless, in 80 % of the daily records > 90 % of the consumed food items were weighed rather than estimated irrespective of age and sex, whereas in only 2 % of the records < 5 % of the food items were weighed. Week-days (76 %) and week-end days (24 %) were almost equally distributed in the sample (18).

Nutrient intakes were calculated with our continuously updated nutrient database LEBTAB (at present 3 660 food items, listings of 30 nutrients; added sugar = sum of added mono-, di-, and oligosaccharides; fatty acids summarized to the subgroups saturated (SFA), monounsaturated (MUFA), and polyunsaturated (PUFA) fatty acid (18).

Records with a non-plausible low ratio (< 1.06) of reported energy intake (EI) to estimated basal metabolic rate (BMR) were not accepted for this data analysis (10 % of the collected records) (18). The possible implications of underreporting on the reported macronutrient data (29) are discussed below.

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. In addition to the age and sex groups defined for the German recommendations for nutrient intake (10), the 1 to 3 year old 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).

Nutrient intakes in absolute amounts are given as percentiles (10th, 50th (median), 90th) and relative amounts as medians only. Variations of intakes due to age and sex were assessed by use of ANOVA. Since the factorial model with interactions (age, sex) gave no significant interactions, main effect models were used.

Interrelations (total fat and added sugars) were assessed by use of the Pearson correlation coefficient. P values were considered significant at $P < 0.05$.

Table 1 Sample characteristics and data on the dietary intake of protein in 627 children and adolescents

Age groups	Sample characteristics		Protein			
	Subjects	Energy intake				
Years	Number N	MJ/d Median	g/d Median (P_{10}; P_{90})	g/(kg.d) Median	% energy Median	% animal Median
Males						
1	66	4.10	32.7 (23.8; 40.8)	2.87	13.3	67.9
2	26	4.60	36.6 (22.2; 46.4)	2.71	13.2	69.1
3	13	4.80	34.7 (31.1; 45.5)	2.46	13.7	67.0
1-3	105	4.31	33.5 (24.3; 44.8)	2.80	13.3	67.7
4-6	41	5.96	41.9 (34.6; 55.0)	2.29	12.1	66.7
7-9	39	7.67	56.9 (37.5; 72.5)	1.95	12.4	65.5
10-12	16	9.23	68.0 (50.0; 81.9)	1.75	12.8	62.0
13-14	36	10.31	75.3 (59.5; 108.3)	1.40	12.9	65.0
15-18	41	10.93	85.8 (62.9; 153.6)	1.31	12.5	63.1
Total	278			2.07	12.8	65.5
Females						
1	78	3.75	29.4 (22.6; 40.3)	2.74	13.8	70.2
2	25	4.12	31.6 (24.1; 41.5)	2.53	12.8	70.2
3	22	4.48	34.3 (25.8; 46.7)	2.44	13.6	73.2
1-3	125	3.89	30.5 (23.7; 42.5)	2.68	13.6	70.7
4-6	47	5.36	38.0 (25.8; 53.8)	1.97	11.9	65.9
7-9	36	6.89	51.2 (37.5; 62.5)	1.89	12.7	67.9
10-12	31	7.25	55.4 (42.3; 69.8)	1.57	12.5	62.2
13-14	10	8.09	54.8 (40.3; 72.4)	1.35	12.1	60.4
15-18	100	8.30	61.2 (46.4; 87.7)	1.04	12.8	62.6
Total	349			1.85	12.9	66.0

Table 2 Dietary intake of total fat, fatty acids and cholesterol in 627 children and adolescents by age and sex

Age groups	Total fat		Fatty acids SFA	Fatty acids MUFA	Fatty acids PUFA	Cholesterol	
Years	g/d Median (P_{10}; P_{90})	% energy Median	% energy Median	% energy Median	% energy Median	mg/d Median	mg/MJ Median
Males							
1	37.9 (29.9; 53.6)	36.3	17.7	14.7	4.0	147	33.9
2	46.7 (34.4; 72.7)	39.4	18.4	16.1	4.3	186	36.3
3	45.4 (34.1; 57.1)	38.9	18.5	15.6	4.2	187	40.4
1-3	41.7 (30.2; 57.1)	37.4	17.7	15.1	4.0	162	35.6
4-6	59.1 (44.4; 77.4)	38.2	17.3	15.8	4.7	214	34.7
7-9	78.7 (53.5; 100.8)	38.6	17.6	15.8	5.0	283	37.7
10-12	95.7 (78.8; 120.7)	40.3	17.4	17.1	4.8	388	36.9
13-14	105.6 (69.7; 148.0)	39.3	17.0	16.3	5.3	365	34.4
15-18	114.9 (76.8; 171.7)	38.5	16.1	16.0	5.7	405	30.9
Total		38.5	17.3	15.8	4.7		34.8
Females							
1	34.5 (24.7; 47.8)	36.2	17.7	14.6	3.7	116	31.7
2	41.2 (32.3; 53.6)	38.8	17.7	15.7	4.5	165	38.7
3	46.5 (35.0; 60.0)	40.2	18.1	17.0	4.9	183	42.2
1-3	36.6 (26.1; 52.7)	36.8	17.7	15.0	4.1	132	33.8
4-6	54.5 (37.7; 75.5)	39.4	18.2	16.4	4.8	228	41.8
7-9	69.2 (46.7; 90.1)	38.3	16.5	16.1	5.1	251	36.0
10-12	67.3 (55.8; 91.2)	36.4	16.4	15.1	4.8	263	35.3
13-14	92.6 (58.5; 111.0)	42.0	18.6	17.8	5.0	254	29.9
15-18	77.8 (59.2; 118.8)	38.3	16.5	15.7	5.5	270	30.1
Total		38.0	17.4	15.7	4.8		34.4

Results

The distribution of the study sample in the different age/sex groups is given in Table 1 together with median energy intakes which ranged close to recent estimates of energy expenditure for light physical activity (18).

The intake of protein was about 13 % of the energy intake in the total sample (11.9 to 13.8 % in different age/sex groups), two thirds originating form animal foods (Table 1). The younger the children the higher were the values (% energy, % animal protein).

Table 3 Dietary intake of total carbohydrates, added sugars, and fiber in 627 children and adolescents by age and sex

Age groups	Total carbohydrates		Added sugars	Fibre		
Years	g/d Median (P_{10}; P_{90})	% energy Median	% energy Median	g/d Median	g/MJ Median	g/(kg.d) Median
Males						
1	118.6 (92.7; 154.1)	50.3	7.9	8.2	2.00	0.73
2	132.8 (97.4; 160.1)	47.3	11.2	9.1	1.81	0.66
3	135.4 (113.5; 165.2)	47.3	11.7	8.4	1.74	0.54
1-3	124.2 (96.9; 160.1)	48.8	8.7	8.4	1.92	0.71
4-6	170.2 (137.7; 212.8)	49.7	13.7	11.6	1.94	0.59
7-9	203.6 (158.4; 272.8)	47.9	14.1	14.1	1.74	0.52
10-12	252.3 (190.2; 336.6)	48.0	13.5	20.0	1.99	0.49
13-14	269.5 (210.0; 409.6)	47.8	13.9	21.2	1.84	0.39
15-18	332.9 (233.6; 474.1)	49.4	13.5	20.5	1.83	0.31
Total		48.6	12.4		1.90	0.55
Females						
1	107.5 (81.7; 142.8)	50.1	7.7	7.6	2.03	0.70
2	125.4 (86.9; 147.5)	48.2	11.2	8.0	1.93	0.65
3	118.2 (102.0; 147.5)	46.0	9.9	7.8	1.79	0.54
1-3	113.7 (83.1; 146.9)	49.3	9.0	7.7	1.95	0.68
4-6	151.6 (112.0; 208.8)	49.2	14.5	10.3	1.87	0.55
7-9	192.9 (141.4; 234.9)	48.8	12.7	13.8	1.91	0.51
10-12	212.1 (170.4; 275.2)	50.4	14.7	15.4	2.10	0.43
13-14	213.3 (197.6; 244.6)	44.9	12.5	16.3	2.15	0.34
15-18	244.2 (179.5; 318.9)	48.7	13.6	17.4	1.90	0.30
Total		49.1	12.1		1.94	0.48

The intake of fat was about 38 % of the energy intake in the total sample (36.2 to 42.0 % in different age/sex groups). The percentage of energy intake of SFA was 17 % (16.1 to 18.6 %), of MUFA 16 % (14.6 to 16.4 %), and of PUFA 5 % (3.7 to 5.7 %), whereas cholesterol intake amounted to 34 mg/MJ (31.7 to 42.2 mg/MJ) in the total sample (different age/sex groups, respectively) (Table 2). The energy related intakes were lowest in the youngest groups with the exception of SFA and cholesterol.

The intake of carbohydrates was about 49 % of the energy intake in the total sample (44.9 to 50.4 % in different age/sex groups) a quarter of which (12 % of energy) was consumed as added sugars with the lowest

Table 4 Macronutrient intake of children and adolescents from this study and from other nutrition surveys in Germany and neighboring countries

Country	Region	Period	Study population		Survey method	Macronutrient intake [a]						Reference
			Age Years	Number N		P %	F %	C %	SFA %	MUFA %	PUFA % [b]	
Germany	Dortmund	1985-95	1	144	3d WDR [d]	14	36	50	17	15	4	This study
			2-18	483	3d WDR	13	39	49	17	16	5	
	Dortmund	1965-79	1-3 [c] }	310	≥ 7d WDR	12	35	53				(30)
			4-14 }		≥ 7d WDR	12	38	50				
	Potsdam	1979-81	11-13	596	7d WDR	11	39	50				(15)
	National	1982-83	3-18	1500	3d EDR [e]	13	39	48				(28)
	National	1985-89	4->65	23209	7d EDR	14	41	45 [f]	17	15	5	(11)
Austria	5 regions	1991-93	6-18	650	7d WDR		36	49				(13)
Belgium	Regional	1991	6-12	1321	1d EDR	14	37	49	15	14	6	(9)
Netherlands	National	1987-88	1-3 [c]	231	2d EDR	13	34	53	14	13		(22)
			4-9	500	2d EDR	13	37	50	15	14		
			10-21	600	2d EDR	13	39	47	16	15		
Switzerland	St. Gallen	1990	7-16	63	7d EDR	13	38	49				(5)

(a) Literature data aggregated from tabulated values; P = Protein, F = Fat, C = Carbohydrates; (b) % of energy intake (mean values); (c) Age groups separated from published tabulations; (d) WDR = Weighed diet record; (e) EDR = Estimated diet record; (f) Including 4 % of alcohol

Table 5 Macronutrient intake in this study and in preventive recommendations and concepts for children and adolescents

Nutrients		This study	Recommendations			Preventive concept
			Germany (10)	Europe (14)	USA (2, 4, 24)	OMD (17)
		1-18 years	1-18 years	> 2 years	> 2 years	1-18 years
Protein	(% energy)	13	5-9	n. m.[a]	10-20	14
Animal protein	(% protein)	66	n. m.	n. m.	n. m.	50
Fat						
Total	(% energy)	38	30-35[b]	30-35	≤ 30	32
Fatty acids	(% energy)					
SFA	(% energy)	17	< 1/3 of total fat	8-12	< 10	10
MUFA	(% energy)	16	n. m.	no upper limit	10-15	13
PUFA	(% energy)	5	> 3.5	~ 6-10	≤ 10	9
Cholesterol	(mg)	34/MJ	n. m.	< 300/d	24/MJ	19/MJ
Carbohydrates						
Total	(% energy)	49	> 50	n. m.	50-60	54
Added sugars	(% energy)	12	≤ 10	n. m.	n. m.	5
Dietary fiber	(g)	1.9	3/MJ	n. m.	0.5/(kg.d)[c] age + (5-10)/d[d]	3.3/MJ

(a) n.m. = not mentioned; (b) 1-3 years: 35-40; (c) AAP (3); (d) Age plus 5 to age plus 10 as g/d (32)

proportions in the youngest groups (Table 3). Dietary fiber intake was about 1.9 g/MJ in the total sample (1.74 to 2.15 g/MJ in different age/sex groups).

The intakes of added sugars and total fat (% of energy) were inversely related ($r = -0.21$, $P = 0.0001$). Subjects with both a low energy related intake of added sugars (< 10 %) and a low or modest fat intake (< 30 %, n = 16, or 30–35 %, n = 49) were rare; most of them (n = 11 or 27 respectively) in the 1 year age group.

In total the patterns of macronutrients related to energy intake were almost the same throughout the age/sex groups. Nevertheless, age dependent but no sex dependent variations (ANOVA) were observed for several nutrient variables in the total sample as well as in the sub-sample of 1 vs. 2+3 year old children. At the most, about 20 % of the total variability of the different parameters was explained by the main factors age and sex (data not shown).

The macronutrient patterns of the study sample resembled the patterns observed in former and more recent nutrition surveys of children and adolescents in Germany and neighboring countries (Table 4) and deviated considerably from the respective recommendations (Table 5).

Discussion

Across all age groups, the diet of our study population differed fundamentally from the scientific recommendations for macronutrient patterns in a childhood diet. Our findings refer to voluntarily participating families or adolescents, respectively. Nevertheless, the observed macronutrient patterns were no better than the macronutrient patterns of German children and adolescents observed in other studies from comparable and former time periods. Altogether, these observations point to considerable and longstanding problems in the diet of German children and adolescents with respect to the prevention of chronic nutrition related diseases.

Results vs. recommendations

Compared to the practical recommendations for a low fat atherosclerosis prevention diet given by American pediatric authorities (24) the intake of protein (13 % of energy) in our study was moderate but quite high compared to the German and other recommendations referring to physiological requirements (10). Since animal protein is usually combined with high intakes of SFA, cholesterol, and purines, the observed high proportion of animal protein (between 60 and 70 %) is a disadvantage.

Irrespective of the current discussions about the advisable age (about 2 to 5 years) and the extent of fat reduction (30 to 35 % of energy) in preventive diets in childhood (5, 8, 21), our observed intake of total fat (38 % of energy on average) was much higher than all recommendations. Although only a gradual decrease from the recommended high fat diet in early infancy (about 50 % of energy based on human milk) to the low fat preventive diet (30 % of energy) is recommended (10, 21), the youngest 1 year age groups in our study already showed the lowest energy related fat intake (36 % vs. 39 % in the 2 to 18 year old groups) (see below).

The observed intake of SFA and cholesterol was about 50 % above the recommended limits indicating a major preventive problem since a low intake of SFA is strongly recommended with respect to serum cholesterol levels (14, 24). In contrast, the intake of PUFA was rather low particularly in the youngest groups compared to the practical ESPGAN recommendations for atherosclerosis prevention (14) but still satisfactory compared to the German recommendations based on physiological requirements (10). Health aspects were not affected by the observed intake of MUFA (14).

The observed intake of carbohydrates was both quantitatively too low (mainly < 50 % of energy) and also qualitatively inadequate due to the high proportion of added sugars and the low proportion of complex carbohydrates. As with total fat, the diet of the 1 year old children was also a positive exception here.

The reported intake of added sugars may have been biased toward higher values in the adolescents particularly the females of this study due to the exclusion of non-plausible diet records (EI:BMR < 1.06) which were significantly represented in the adolescents (males 10 %, females 30 % of all collected records) (18). In a separate analysis of non-plausible vs. plausible diet records we observed significant differences in the proportions of added sugars (4.4 vs. 7.7 g/MJ) and protein (14.1 vs. 12.9 g/MJ) but not in other macronutrients (29).

Due to lack of scientific evidence, the available recommendations for dietary fiber intake in childhood, based on different estimation procedures, are all pragmatic. Compared to the German energy related recommendations based on adult values of dietary fiber (3 g/MJ) (10), the intake in our study was too low. Compared to the body-weight related recommendations of the American Academy of Pediatrics (0.5 g/(kg•d)) (3) the fiber intake was satisfactory in the age groups under 10 years. Compared to the recommendations of the American Health Foundation (g/d = age (years) plus 5 to 10) (32) the intake was satisfactory for the male groups only. In total, dietary fiber intake proved to be rather low and, thus, typical for high fat/low carbohydrate diets in western societies (23, 34).

Not only the overall macronutrient patterns in the study sample were unfavorable with respect to prevention. Moreover, the energy intake was close to the recent estimates of energy requirements for light physical activity (18) suggesting low habitual physical activity levels. These findings which are confirmed by observations in other childhood populations are unfavorable for the establishment of healthy lifestyles in childhood (2, 20).

Special considerations

With respect to the macronutrients, a low fat diet cannot be considered satisfactory per se since a low fat consumption is often compensated by a high sugar consumption. Both sugar and fat enhance the sensory attractiveness of food. This interrelation is of particular significance to the childhood diet because most children innately prefer sweet tasting food and many have learned a preference for fat by mere exposure (6). In this study as in other studies of infants, children, and adults (7, 16, 21, 25, 31), an inverse relation of total fat to added sugars in the diet was observed. Thus, moderation should be preferred but extreme stipulations avoided in preventive dietary recommendations for children and adolescents.

In this study, the macronutrient pattern of 1 year old children's diets differed from the almost uniform pattern across the other age groups showing lower proportions of fat and added sugars. The diet of the 1 year old group still consisted of a mixture of commercial infant food products and common family food. In infants, the consumption of commercial Beikost[1)] products is usually inversely related to the fat intake as observed in the DONALD Study (1) and in a former representative nutrition survey in Dortmund (16) as well as in studies from other countries (21). The fat proportions in the infant diet in both our former and recent study in Dortmund decreased to a minimum of about 33 % during the second half of the first year of life and increased with increasing proportions of family food substituting commercial infant food (1, 16). This study demonstrates that as soon as the toddlers share the family diet the macronutrient pattern is the same as that of the older age groups. Thus, given the current dietary patterns of toddlers in Germany it proves mandatory for dietary evaluations to separate the 1 year olds from the 1 to 3 year olds.

Conclusion: Proposal of a preventive dietary concept

Comparisons with other nutrition surveys indicate that the dietary patterns of our local sample are typical for the present-day dietary patterns of children and adolescents in Germany and neighboring populations (5, 9, 11, 13, 22, 28). Moreover, the current macronutrient patterns neither differ from those of German children and adolescents 20 years ago (15, 30) nor from those longstanding in German adults. Improving on such persistent and detrimental dietary habits will require much effort as well as endurance.

In the DONALD Study, among the food items most consumed were whole fat milk (3.5 %), high fat sausage, and white or gray bread pointing to unfavorable food choices with respect to preventive recommendations.

To improve the prevailing dietary patterns of children and adolescents in Germany as mirrored in our study sample, we have developed a preventive dietary concept, namely the "Optimized Mixed Diet" (OMD) considering both scientific evidence (prevention, nutrient requirements) and practical considerations, e.g., existing dietary

1) Beikost is the established technical terms for what is meant here.

habits, common rather than highly manufactured foods (Table 5) (17). The OMD is recommended from the age of 1 year in accordance with findings from recent intervention studies demonstrating that a prudent fat reduced diet is not adverse to growth nor to the micronutrient intake or status. This applies to older infants (7, 26) as well as to toddlers and older children (7, 26, 27, 31). The cost (per MJ) for the OMD are not higher than the cost of food for the present nutritionally much inferior diet of the study sample (19), thus, favoring the acceptance and the achievement of the OMD.

Adequate patterns of both dietary habits and physical activity must be laid down as early as possible to establish healthy lifestyles in children and adolescents in order to prevent chronic lifestyle related diseases in adulthood (2, 20). This calls for interdisciplinary efforts to improve the current dietary and lifestyle situation.

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