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Meal patterns among children and adolescents and their associations with weight status and parental characteristics

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Abstract

Objectives: To describe the meal patterns of Jena schoolchildren and their associations with children's weight status and parental characteristics.
Design: Cross-sectional study.
Setting: Twenty schools in Jena (~100 000 inhabitants), south-east Germany.
Subjects: A total of 2054 schoolchildren aged 7–14 years with information on BMI standard deviation score (BMI-SDS) and weight status (based on German reference values), of whom 1571 had additional information about their parents (parental education and employment status, weight status according to WHO guidelines) and meal patterns (school lunch participation rate, meal frequencies, breakfast consumption and frequency of family meals).
Results: Weight status of the children was associated with weight status, education and employment status of the parents. Meal patterns were strongly dependent on children's age and parental employment. As age increased, the frequency of meal consumption, participation rate in school lunches and the number of family meals decreased. Using linear regression analysis, a high inverse association between BMI-SDS and meal frequency was observed, in addition to relationships with parental weight status and paternal education.
Conclusions: Age-specific prevention programmes should encourage greater meal frequency. The close involvement of parents is essential in any strategy for improving children's (families') diets.

Keywords
Meal patterns
Meal frequency
Family meals
Overweight and obesity
Children and adolescents

According to the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) conducted in 2006, 15·0 % of all children and adolescents (aged 3–17 years) in Germany are overweight, including 6·3 % obese[1]. Compared with the German reference data[2] based on studies from 1985 to 1999, the prevalence of overweight rose by about 50 % and that of obesity doubled[1]. In recent years, the prevalence of overweight and obesity among children and adolescents has risen dramatically worldwide[3,4]. This increase has led to many studies postulating potential determinants and prevention strategies[5]. Most people become obese during adulthood, but there are significant correlations between childhood and adolescence BMI and obesity as well as obesity-associated morbidity in adults[6].

Many different variables are considered as risk factors for childhood obesity, ranging from the conditions of the home environment, including overweight parents and nutritional patterns, to physical activity and dietary factors, as well as behavioural and psychological factors[4,7]. The current literature suggests that profound changes in the quantity and quality of diets, combined with a decrease in levels of physical activity as well as an increase in sedentary activities (e.g. watching television), have led to an increase in the prevalence of overweight. Whereas numerous studies have examined the role of changes in dietary habits and the effect of high-energy, nutrient-poor foods on the development of overweight and obesity, recent studies have highlighted the role of eating patterns in terms of e.g. meal frequency and increasing portion sizes. Some researchers found an inverse relationship between meal frequency and the prevalence of overweight and obesity in adults[8] as well as in adolescents[9], while others failed to detect significant associations[8,10]. The association of increasing meal frequency with decreasing BMI might be due to metabolic advantage[11], e.g. increased thermogenesis, and/or higher insulin metabolism[9,12]. In addition, subjects reporting higher meal frequencies often exercised more and made overall healthier food choices[10,13]. Additionally, 'skipping' meals (breakfast) is associated with negative lifestyle factors[14]. Lower meal frequencies and breakfast skipping also seem to be more common among children of families with lower socio-economic

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status[15]. Moore *et al.*[15] found a positively association between the level of deprivation and breakfast skipping as well as the quality of breakfasts consumed.

While numerous studies exist concerning the impact of breakfast consumption, little is known about other nutritional behaviours as well as the extent to which parental characteristics mediate these behaviours. The present paper focuses on different meal patterns (breakfast consumption, meal frequency, family meals, school lunch participation) of children and adolescents and their association with children's weight status and parental characteristics (parental weight status, education and employment status).

Methods

The survey of Jena schoolchildren was initiated in October 2005 and lasted until February 2006. Jena is a university town in East Germany with ~100 000 inhabitants. Relative to Germany as a whole and also to the population in East Germany, it is characterized by a higher proportion of upper middle-class families with an academic background[16].

Primary aims of the study were to describe the prevalence of overweight and obesity among schoolchildren in Jena as well as to analyse several risk factors considered as determinants of childhood overweight. Following previous surveys in Jena[17], the selected design was a cross-sectional study. Study approval was obtained from the Friedrich-Schiller-University ethics committee and from school authorities. Children participated voluntarily, and written consent was obtained from all parents on behalf of their children.

Subjects

A total of 2054 schoolchildren aged 7–14 years (1071 boys, 983 girls) were randomly recruited and measured. Additional parental characteristics were collected for 1571 children (810 boys and 761 girls, response rate 76·5 %). There were no significant differences between the BMI standard deviation score (BMI-SDS) of responders and non-responders. (χ^2 test: $P = 0{\cdot}072$ in total population, $P = 0{\cdot}242$ in boys, $P = 0{\cdot}173$ in girls), indicating no bias. For a better comparison with previous studies of the Jena schoolchildren, children without German nationality were excluded from the analyses.

Instruments

Anthropometric measurements were performed by the research staff of the Institute of Human Genetics and Anthropology in Jena as well as undergraduates at the local schools. The staff were well trained and routinely controlled to ensure data quality. Height was measured with a Martin anthropometer according to the guidelines of Martin and Saller[18] and weight was measured with an electronic scale which was calibrated regularly. Height and weight were measured in light clothing (underwear) and without shoes; no adjustments were made for clothing.

In addition, a questionnaire for assessing parental characteristics and meal patterns was offered to all parents. The questionnaire was a shortened version of the form used in 2001[19]. The reliability of the altered questionnaire was tested by means of the split half procedure, and no significant differences were observed (*P* varied between 0·076 and 0·824).

The variables included in the present analysis are each child's sex, age and BMI-SDS. Age ranged from 7 to 14 years. Individual BMI was calculated from measured height and weight (weight divided by the square of height; kg/m^2) and classified into two groups according to sex- and age-specific percentiles: non-overweight, BMI ≤ 90th percentile; and overweight/obese, BMI > 90th percentile (German reference values)[2]. For the analyses, all individual BMI data were also converted into standard deviation scores (BMI-SDS) using the LMS method[20].

BMI values for the parents were based on self-reported heights and weights, gathered from the questionnaire. The classification for parental weight status was BMI < 25 kg/m^2 for non-overweight and BMI ≥ 25 kg/m^2 for overweight/obese individuals[21].

The following parental characteristics were assessed.

1. Parental education (based on school attendance stated by each parent), categorized as 'high' for 12 years of school attendance, 'middle' for 10 years of school attendance and 'low' for 9 years or less of school attendance.
2. Paternal employment, classified as 'no employment', 'working part-time' and 'working full-time'.
3. Groups for parental employment (refer to both parents together) were 'both full-time workers', 'one full-time worker', 'both part-time or one full-time and the other jobless' and 'at least one working part-time or both jobless'.

Variables used to describe the meal patterns of the children were the following.

1. School lunch participation, designated as 'daily', '1–4× per week' and 'no participation'.
2. Breakfast consumption, designated as '2× breakfast', '1× breakfast' and 'no breakfast'. The 2× breakfast denotes an early breakfast usually taken at home and a late breakfast usually taken at school.
3. Meal frequencies, ranging from 2 to 5. The parents had to decide which of the given traditional meals their children usually consume.
4. Family meals, the frequency of main meals (breakfast, lunch, dinner) eaten together with all family members, ranging from 0 to 3.

Only data from weekdays were analysed with regard to these meal patterns.

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Statistical analysis

The statistical analyses were performed using the SPSS statistical software package version 15·0 (SPSS Inc., Chicago, IL, USA). The distributions of parental variables based on the weight status of their children were examined, and the χ^2 test was used to compare the frequencies of categorical variables. Meal patterns and their distribution among sex and age groups were assessed and differences were proven by means of the χ^2 test. To identify factors related to BMI-SDS in children, an age- and sex-adjusted linear regression analysis was performed. Linear regression analysis adjusted for sex was used to show variables that were strongly associated with meal frequencies. The backward stepwise procedure ensured that variables not significantly explaining or contributing to the fit of the model were excluded. In the multicollinearity statistics, a tolerance above 0·5 suggests the absence of significant correlations between the respective covariates. Statistical tests were two-sided and the accepted significance level was set at $P<0·05$ (highly significant: $P<0·01$).

Results

The prevalence of overweight and obesity in Jena schoolchildren aged 7–14 years was 10·0 % in boys (2·9 % obese) and 9·0 % in girls (2·2 % obese). This sex difference was not statistically significant (χ^2 test, $P=0·427$).

Parental characteristics

Table 1 presents the distribution of the parental characteristics relative to the children's weight status. Several factors differed significantly between overweight and non-overweight children. Overweight and obesity were highly associated with parental weight status, parental education and parental employment status. Children more often were overweight or obese if they had one or two overweight parents. An inverse association was observed regarding parental education and parental employment status. Overweight and obese children belonged more frequently to families with low educated parents or parents working part-time or with no employment, respectively.

Meal patterns

Table 2 summarises the children's meal patterns by sex. There were no statistically significant differences between the sexes for school lunch participation (χ^2 test, $P=0·473$), breakfast consumption (χ^2 test, $P=0·210$), meal frequencies (χ^2 test, $P=0·322$) and eating meals together with all members of the family (χ^2 test, $P=0·579$). The distribution of meal patterns among the age groups showed significant differences. As shown in Fig. 1, which presents the distribution for all age classes, there was a strong relationship between school lunch participation rate and age group (χ^2 test, $P<0·001$). Younger children ate school lunch more often than older children. This fact corresponds to the observed decrease

Table 1 Distribution of parental characteristics in weight status categories*: schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

Variable	Level	Non-overweight children (%)	Overweight/obese children (%)	*P* value (χ^2 test)
Mother's weight status†		(*n* 1382)	(*n* 132)	<0·001
	Non-overweight	75·8	50·0	
	Overweight/obese	24·2	50·0	
Father's weight status†		(*n* 1248)	(*n* 111)	0·011
	Non-overweight	50·5	37·8	
	Overweight/obese	49·5	62·2	
Weight status of both parents†		(*n* 1386)	(*n* 134)	<0·001
	No one overweight	38·9	20·1	
	One parent overweight	43·1	49·3	
	Both parents overweight	18·0	30·6	
Mother's educational status		(*n* 1366)	(*n* 129)	0·006
	High	37·0	23·2	
	Middle	58·4	69·8	
	Low	4·6	7·0	
Father's educational status		(*n* 1291)	(*n* 113)	<0·001
	High	43·1	23·9	
	Middle	51·6	63·7	
	Low	5·3	12·4	
Father's employment status		(*n* 1306)	(*n* 118)	0·001
	Working full-time	88·2	78·0	
	Working part-time	4·0	4·2	
	No employment	7·8	17·8	
Parental employment		(*n* 1368)	(*n* 130)	<0·001
	Both full-time workers	38·7	30·0	
	One full-time worker	35·4	29·2	
	Both part-time or one full-time and the other jobless	18·4	20·8	
	At least one working part-time or both jobless	7·5	20·0	

*Weight status of the children according to national BMI percentiles[2].
†Parental weight status according to WHO guidelines[21].

Table 2 Distribution of meal patterns according to sex: schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

Variable	Level	Boys (%)	Girls (%)	*P* value (χ^2 test)
Meal frequency		(*n* 810)	(*n* 757)	0·322
	2	0·5	1·3	
	3	12·5	13·5	
	4	43·0	41·6	
	5	44·1	43·3	
Breakfast consumption		(*n* 810)	(*n* 758)	0·210
	No breakfast	0·2	0·8	
	1× breakfast	22·2	24·0	
	2× breakfast	77·5	75·2	
Family meals		(*n* 807)	(*n* 754)	0·579
	0	3·2	3·8	
	1	45·8	46·6	
	2	47·0	44·6	
	3	4·0	5·0	
School lunch participation		(*n* 798)	(*n* 744)	0·473
	No participation	23·6	25·0	
	1–4× per week	9·6	11·0	
	Daily	66·8	64·0	

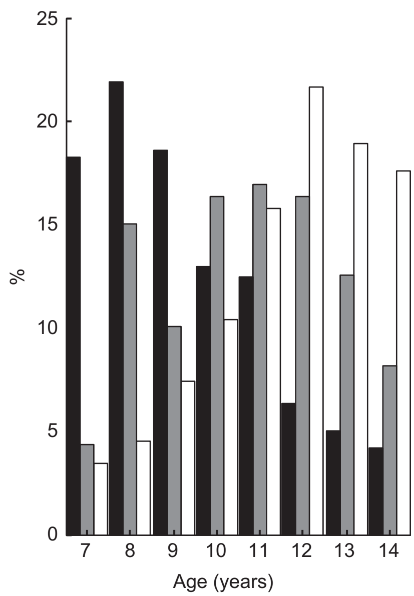

Fig. 1 School lunch participation rate (■, daily; ▨, 1–4× per week; □, no participation) according to age: schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

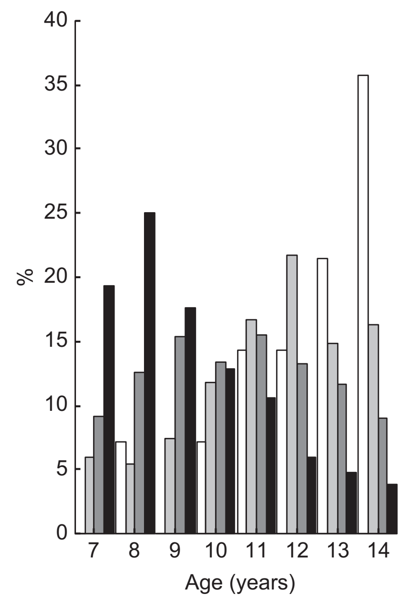

Fig. 2 Meal frequencies (□, 2; ▨, 3; ▨, 4; ■, 5) according to age: schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

in meal frequencies (Fig. 2), as well as the decrease in breakfast consumption and in number of meals eaten with the family as children grow older (χ^2 test, $P < 0{\cdot}001$).

Factors related to weight status of Jena schoolchildren

Linear regression analysis was performed to investigate the factors associated with the children's BMI-SDS, including parental characteristics as well as the variables describing meal patterns. Table 3 presents the remaining sex- and age-adjusted effects of those variables that contributed significantly or at least with explaining contribution to the prediction of BMI-SDS in Jena schoolchildren. The variance explained by the chosen model was 7·0% (R^2). Greater meal frequency was related to decreasing BMI-SDS. Parental weight status and father's education were also significantly related to children's BMI-SDS, corresponding to the bivariate analyses. Breakfast consumption, family meals and parental employment contributed to explain children's BMI, although there were no significant associations.

Factors related to meal frequency among Jena schoolchildren

Table 4 demonstrates the sex-adjusted effects of those variables that contributed independently to the prediction of meal frequencies by means of linear regression analysis. The explained variance attained was 52·9% (R^2).

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Table 3 Factors associated with BMI standard deviation score (sex- and age-adjusted): schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

Variable*	*B*	SE	*β*	*T*	*P value*	Tolerance†
(Constant)	−0·003	0·382		−0·008	0·994	
Mother's weight status	0·321	0·059	0·154	5·414	<0·001	0·950
Father's weight status	0·244	0·052	0·132	4·701	<0·001	0·975
Meal frequency	−0·152	0·050	−0·116	−3·069	0·002	0·543
Father's educational status	0·090	0·045	0·057	1·982	0·048	0·939
Breakfast consumption	−0·136	0·082	0·063	−1·659	0·097	0·537
Parental employment	0·244	0·029	0·051	1·795	0·073	0·962
Family meals	−0·071	0·041	−0·049	−1·712	0·087	0·951

B, unstandardized coefficient; *β*, standardized coefficient.
*Excluded variables in the model: school lunch participation, mother's educational status.
†Collinearity statistics.

Table 4 Factors associated with meal frequencies (sex-adjusted): schoolchildren aged 7–14 years, Jena, south-east Germany, 2005–6

Variable*	*B*	SE	*β*	*T*	*P* value	Tolerance†
(Constant)	1·785	0·148		12·033	<0·001	
Breakfast consumption	1·015	0·034	0·617	30·291	<0·001	0·939
Age	−0·067	0·007	−0·204	−9·231	<0·001	0·797
School lunch participation	0·098	0·019	0·117	5·268	<0·001	0·786
Parental employment	0·053	0·016	0·068	3·378	<0·001	0·974
Family meals	0·038	0·022	0·034	1·680	0·093	0·945

B, unstandardized coefficient; *β*, standardized coefficient.
*Excluded variables in the model: mother's weight status, father's weight status, mother's educational status, father's educational status.
†Collinearity statistics.

A higher participation rate in school lunch and breakfast consumption was positively associated with meal frequency. Meal frequency was also higher among children whose parents had lower employment. As can be seen in the table, the older the children were, the lower the frequency of meals consumed became. Family meals contributed to explain meal frequencies, although there were no significant associations.

Discussion

Factors found in the present study to be significantly associated with BMI (SDS) in 7–14-year-old schoolchildren from Jena were weight status of the parents, frequency of meal consumption and education of the father. Breakfast consumption, parental employment and number of family meals also contributed to the degree of BMI (Table 3). The observation that parental weight status is a major determinant of weight status in children includes genetic as well as environmental components. Twin, adoption and family studies suggest that genetic factors have a major impact on weight (see literature review by Maes *et al.*[22]). Otherwise it was demonstrated frequently that the lifestyle of obese parents (food habits, meal patterns and physical activity) increases the risk of a child being overweight or obese.

As already shown previously[15,23], the present study confirms the inverse relationship between meal frequency and BMI in children. Skipping meals is associated with higher BMI values. The meal frequency itself depends on breakfast consumption, age of the children, participation in school lunch and parental employment, found in the present study. Franko *et al.*[9] similarly demonstrated the age dependency of meal frequency. Skipping meals was most typical for adolescents and breakfast was most commonly missed. Additionally, girls were found to be more likely to skip meals[11]. Kersting *et al.*[24] already ascertained in 1975 that many German children do not have breakfast. The Health Behaviour in School-aged Children (HBSC) survey of 2001–2, conducted by the WHO in European children aged 11–15 years, showed that 40 % of girls and 39 % of boys did not regularly eat breakfast on school days. Between the ages of 11 and 15 years, breakfast consumption decreased by 9 % among boys and 17 % among girls[25].

A number of studies have shown a relationship between socio-economic status (e.g. measured by parental educational level) and meal patterns[9,26], similar to the association between parental employment and meal frequencies found here in the Jena children. In our children, the number of meals was significantly reduced when both parents were working full-time. Neumark-Sztainer *et al.*[26] also observed lower meal frequencies when mothers worked full-time. Parental factors such as the parents' level of education or employment may reflect also the ability of parents to arrange a healthy lifestyle.

The causal linkages that explain our findings according the associations between meal patterns, parental characteristics and weight status may be complex. We found that the relationship between meal frequency and BMI-SDS remained even when social variables were taken into account.

A positive metabolic effect of an increased meal frequency, in addition to the amount of food and diet quality, might explain the inverse relationship with BMI[11]. A reasonable frequency of meals is also essential for an equal energy distribution throughout the day[23]. Regularity in breakfast consumption is associated with higher overall diet quality and less impulsive snack intakes at the rest of the day[13]. Studies have also found a relationship between meal frequency and portion sizes. Reduced meal frequency is usually associated with larger portions[27,28]. Even in 1964, Fábry *et al.*[29] showed that larger food portions at longer intervals between consumption led to a number of adaptive changes in metabolism that suggest biological explanations. The group with the lowest meal frequency had the lowest energy intake, but higher fat mass. The authors assumed that the ability to form metabolic reserves during times of fasting might explain this association. Infrequent consumption of large meals appears to favour fat deposition, whereas frequent consumption of small servings that add up to the same total energy intake does not. This adaptation may have been biologically and ecologically useful in the past, but it could be pathogenic and lead to obesity today[10].

Another interesting aspect of the meal patterns was the frequency of family meals. According to Neumark-Sztainer *et al.*[26], frequent family meals are positively associated with intakes of fruits, vegetables, grains and Ca-rich foods and negatively associated with soft drink consumption. Family meals go along with the development of 'regular' meal patterns and the positive psychosocial development of adolescents, as well as decreased disordered eating[28–30].

Some remarks should be made with regard to the methodology of our study. Due to the volunteer nature and sample size of the present study, the results are not representative of the nation as a whole, although our study was larger than most regionally specific studies. The high return rate of the questionnaire and the lack of significant differences in BMI between the responders and non-responders suggest valid analyses.

Other limitations are the self-reported heights and weights of the parents, which might have resulted in some inaccuracies. A further major problem in nutritional research is reporting bias[27,28,31]. Several studies indicate that non-overweight as well as overweight individuals may under-report their food intake (e.g. Pryer *et al.*[32]), whereas other investigations have shown that under-reporting is more prevalent among the obese than the non-overweight[33,34].

Due to the cross-sectional nature of our study design, it is not possible to ensure whether the differences in determinants precede or follow changes in BMI-SDS or healthy eating behaviour. In the present study, only associations are stated, and no causality can be assumed. Prospective studies are needed to prove causality.

The findings in our study explain only a small amount of the variability in BMI-SDS. The remaining variance might be due to both genetic and environmental factors. Our study focused only on meal patterns, whereas energy intake, energy expenditure and food consumption details, e.g. macronutrient composition of the diet, were not considered.

The present study clearly indicates that more frequent meal consumption predicts a healthier BMI, and that meal frequency decreases with increasing age. Therefore one preventive strategy might be to encourage greater meal frequency. Age differences in meal frequency suggest that age-specific prevention programmes should be targeted to children and adolescents. The close involvement of parents is essential in any strategy for improving children's (families') diets.

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