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PEDIATRIC FOCUS

Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project)

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INTRODUCTION: The prevalence of childhood obesity is increasing with its negative medical and psychosocial consequences. This paper examines the association between body mass index (BMI), motor abilities and leisure habits of 668 children within the CHILT (Children's Health InterventionaL Trial) project.
METHOD: A total of 668 children (51.0% boys; 49.0% girls) and their parents were questioned on sport and leisure behaviour of the children. The anthropometric data were measured. Motor abilities were determined by a body gross motor development test for children (Köperkoordinationstest für Kinder; KTK) and a 6-min run.
RESULTS: The children were 6.70 ± 0.42 y old, 122.72 ± 5.36 cm tall and weighed 24.47 ± 4.59 kg, the average BMI was 16.17 ± 2.27 kg/m^2. KTK showed an average motor quotient (MQ) of 93.49 ± 15.01, the 6-min run an average of 835.24 ± 110.87 m. Both tests were inversely correlated with BMI (KTK and BMI $r = -0.164$ ($P < 0.001$); 6-min run and BMI $r = -0.201$ ($P < 0.001$)); the group of overweight/obese children showed poorer results than the normal/underweight ones, even after adjustment for gender and age (in each case $P < 0.001$). Children with the greatest extent of exercise achieve the highest MQ ($P = 0.035$).
SUMMARY: Overweight/obesity is associated with a poorer body gross motor development and endurance performance. On the other hand, an active lifestyle is positively correlated with a better gross motor development in first-grade children. Therefore, to prevent the negative consequences of physical inactivity and overweight/obesity early intervention to support exercise and movement is recommended.
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Introduction

The prevalence of obesity among adults, children and adolescents is increasing in industrial countries.[1–5] It is a growing problem because of its medical and psychosocial consequences, especially in childhood.[6] Obesity is caused by a multifactorial process that correlates with a high-energy supply and inactivity[7–9] besides possible genetic determination.[10,11] Inactivity also seems to increase in childhood.[12] However, the assessment of their physical activity and leisure habits is one of the most difficult tasks in epidemiologic research. Therefore, no exact definition of inactivity exists in childhood, and data of children's activity and its correlation with obesity are sparse and also inconsistent depending on the used measurement tool.[13] Some authors found differences between the fitness of obese and nonobese children, others not.[14–16] The most popular direct instruments for assessing physical activity are questionnaires, observation and monitors like heart rate monitoring. In addition, the results of motor ability tests could be used as an indirect marker of activity or inactivity.

Therefore, we examined the association between body mass index (BMI) and different motor tests concerning gross motor development and endurance performance as well as leisure habits by questionnaire within the cross-sectional data of the CHILT (Children's Health InterventionaL Trial) project.

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Methods

Population

The study was started in 2001. A total of 18 similar primary schools were randomly selected from the schools in the region of Cologne. Among them, 12 schools decided to participate at the CHILT project for cardiovascular and obesity prevention in primary schools. Six did not take part because of no interest ($n=2$), no time ($n=3$) and working to capacity with other projects ($n=1$).

Written informed consent was obtained from the childrens' parents or guardians. In total, 668 first-grade children were enrolled into the examinations (see Table 1).

Data assessment

The entrance examinations of the children were conducted by the same group of examiners of our CHILT team at the participating schools from September 2001 until January 2002. Anthropometric data were assessed. Subsequently, the children underwent the body gross motor development test for children (Körperkoordinationstest für Kinder; KTK) assessing their gross motor development[17] and a 6-min run[18] for their endurance capacity. Further, questionnaires were distributed to the parents to assess the childrens' leisure time activity.

Anthropometric data of the children

Height and weight were measured using a free-standing Seca-stadiometer. A weight of 500 g was deducted for the light gymnastic gear that the children wore. The BMI was classified according to the German percentile graphs of Kromeyer-Hauschild.[19] Children with BMI <10 percentile were classified as underweight, ≥ 10 to <90 percentile as normal, ≥ 90 to <97 percentile as overweight and ≥ 97 percentile as obese.

Table 1 Anthropometric data of children at the beginning of their first school year indicating mean values, standard deviations and ranges.

Total group	*Girls* n = *327*	*Boys* n = *341*	P	*Total* n = *668*
Age (y)	6.66 ± 0.40 (5.70 – 8.10) *n* = 297	6.75 ± 0.43 (5.71 – 8.84) *n* = 281	0.016	6.70 ± 0.42 (5.70 – 8.84) *n* = 578
Height (cm)	121.93 ± 5.12 (108.0 – 135.0) *n* = 278	123.51 ± 5.49 (105.0 – 138.0) *n* = 280	0.001	122.67 ± 5.40 (105.0 – 138.0) *n* = 558
Weight (kg)	23.80 ± 3.99 (15.50 – 39.50) *n* = 278	25.14 ± 5.04 (16.50 – 45.50) *n* = 280	0.001	24.47 ± 4.59 (15.50 – 45.50) *n* = 558
BMI (kg/m^2)	15.94 ± 2.00 (10.16 – 23.37) *n* = 278	16.39 ± 2.49 (10.99 – 27.99) *n* = 280	0.010	16.17 ± 2.27 (10.16 – 27.99) *n* = 558

P-values refer to gender differences.

Procedure of the body coordination test for children: KTK

KTK was used to examine the gross motor development. It is valid for 5- to 14-y-old children.[17] The children were taken out of their classrooms in small groups. Each child completed each of the four KTK items (balancing backwards, one-legged obstacle jumping, jumping from side to side as well as sideway movements). For each task, points were given that made up the overall motor quotient (MQ) under consideration of gender and age factor. The overall MQ allows an assessment of the gross motor development in the following categories: 'not possible' (MQ <56), 'severe motor disorder' (MQ 56–70), 'moderate motor disorder' (MQ 71–85), 'normal' (MQ 86–115), 'good' (MQ 116–130) and 'high' (MQ 131–145).

The 6-min run procedure

The 6-min run was chosen to analyse endurance performance. It is valid for school children and correlates with results of treadmill testing.[18,20] The children ran a distance of 54 m in small groups (up to eight children) for 6 min. The rounds were counted and the exact distance covered was determined. The performance was then evaluated according to Beck and Bös depending on the distance run (in metres), age and sex, and rated as severely disturbed, moderately disturbed, normal, good and very good.[18]

Determination of leisure behaviour

The information on the children was given by their parents about organised activity, regularly (both times per week) and irregularly (times per year) performed sport disciplines was analysed.

The activities were summarised and classified as follows: no sport activity, only irregular sport activity, regular (and irregular) sport activity, organised (and irregular sport activity) and organised and regular (and irregular sport) activity. Television viewing behaviour was assessed by asking the children directly about their weekly TV viewing frequency (1–3 days/week; 4–6 days/week; daily).

Statistical analysis

The descriptive statistics of the anthropometric data and results of the sport motoric test were provided (mean values (MV), standard deviation (s.d.), minimum (min), maximum (max)).

An analysis of covariances (ANCOVA) served for comparing the differences concerning individual characteristics in the groups (eg BMI in different classifications of the motoric test results etc), adjusted for gender and age. Where global

statistical differences existed in more than two groups (weight classification, classification of the motoric test results), *t*-tests were performed.

Correlations concerning the description of the link between two metric variables (eg BMI with the results of the motoric tests) were determined according to Pearson. *P*-values of <0.05 were considered statistically significant.

All analyses were performed using the statistics system SPSS 10.0.

Results

Anthropometric data of the children

The anthropometric data are shown in Table 1. In all, 51.0% of the children were boys and 49.0% girls. Classification according to the percentile graphs show 5.7% obese, 8.1% overweight, 78.1% normal weight and 8.1% underweight children. Thus, 13.8% of the children were overweight or obese.

Motor tests

KTK. The KTK could be performed in 554 children. The results of the KTK are shown in Table 2 and the distribution is shown in Figure 1. The boys showed significantly better results than the girls ($P<0.001$). A weak inverse correlation between BMI and the test results of the children could be found ($r=-0.162$, $P<0.001$). This effect was shown both for girls (BMI $r=-0.209$, $P=0.001$) and boys (BMI $r=-0.165$, $P=0.006$).

The MQ of the obese and overweight children was worse than the MQ of the normal-weight and underweight children. In the group of obese children, the mean value of the MQ reached the upper limit of moderate motor disorder, with the overweight children it was just about in the normal range (see Table 3). The MQ differs significantly within these groups after adjustment for age ($P=0.620$) and gender ($P=0.451$).

The 6-min run

The results of the 6-min run are shown in Table 2 and the classification in Figure 2. The boys were significantly better than the girls. Again an inverse correlation between BMI and the test result ($r=-0.201$, $P<0.001$) was found for the whole group as well as separately for boys and girls ($r=-0.229$, $P<0.001$; $r=-0.209$, $P=0.001$). The group of obese and overweight children differed significantly from the normal-weight and the underweight ones (see Table 3), even after adjustment for age ($P=0.082$) and gender ($P=0.858$).

Table 2 Results of the motor quotient (MQ) and 6-min run (*m*) indicating *N*, minimum, maximum, mean values and standard deviations.

		N	*Minimum*	*Maximum*	*Mean*	*Standard deviation*	P-*values*
Total	MQ	556	51	139	93.49	15.01	
Boys		281	51	139	95.82	15.18	<0.001
Girls		275	51	130	91.12	14.48	
Total	*m*	529	354	1094	835.24	110.87	
Boys		267	423	1092	852.94	116.99	<0.001
Girls		262	354	1094	817.20	101.34	

P-values refer to gender differences.

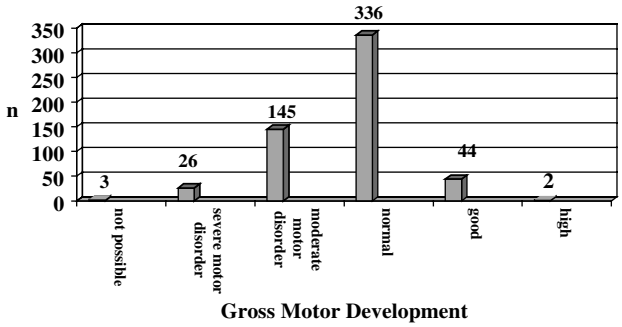

Figure 1 Distribution of the MQ of 558 children according to Schilling.[17]

Table 3 Results of the KTK (MQ) and 6-min run (*m*) according to leisure activities BMI clasification and television frequency (TV) indicating *N*, mean values and standard deviations.

		N	*Mean*	*Standard deviation*	P-*values*
MQ	No sport	87	90.11	14.56	0.035
	Irregular sport	19	92.26	13.96	
	Regular sport	154	93.31	14.28	
	Club sport	76	92.63	15.52	
	Club sport and regular sport	152	96.45	16.29	
m	No sport	81	827.38	121.86	0.927
	Irregular sport	21	825.05	102.34	
	Regular sport	144	834.06	101.74	
	Club sport	71	830.83	103.12	
	Club sport and regular sport	135	840.41	128.23	
MQ	Obesity	32	85.66	12.45	<0.001
	Overweight	44	86.52	13.27	
	Normal weight	429	94.72	14.95	
	Underweight	45	93.07	16.07	
m	Obesity	28	756.64	75.24	<0.001
	Overweight	39	785.95	99.92	
	Normal weight	388	845.49	110.60	
	Underweight	36	838.06	100.17	
MQ	Daily TV	291	834.10	110.27	0.383
	4–6 days TV	116	833.79	105.21	
	1–3 days TV	108	850.43	111.08	
m	Daily TV	290	93.26	14.86	0.076
	4–6 days TV	108	92.52	14.10	
	1–3 days TV	99	96.80	15.84	

P-values refer to group differences.

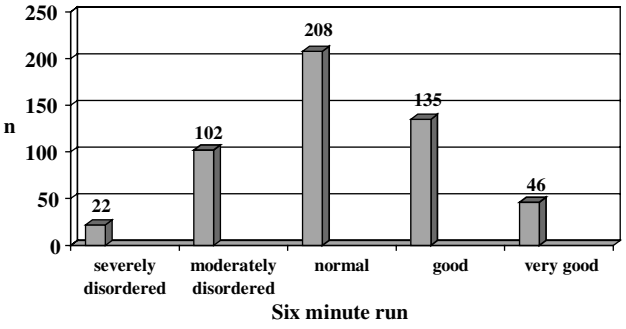

Figure 2 Classification of the 6-min run of 513 children according to Beck and Bös.[18]

Leisure behaviour of the children

The parents of 257 children (38.5%). reported that their children were active in clubs. A total of 343 (51.3%) children were regularly physically active outside a club, while 163 (24.4%) of the children were only irregularly active.

The analysis of the entire sport activity shows that children with the greatest extent of exercise (club and regular sport activity and irregular physical activity) achieve the highest KTK results ($P=0.035$, see Table 3). BMI and endurance performance did not indicate any obvious differences.

Television viewing behaviour

In all, 57.17% of the children reported that they watched television daily ($n=307$), 21.97% reported to do so 4–6 days/week ($n=118$) and 20.86%, 1–3 days/week ($n=112$). The children with the least viewing time per week tended to show the best results with regard to their gross motor development. No differences were found between the groups concerning BMI and endurance performance (see Table 3).

Discussion

Obesity is increasing in childhood too.[2,3] The present study showed markedly worse results of overweight/obese children than the others with regard to gross motor development and endurance performance, even after adjustment for gender and age. The correlation between BMI and the results of the coordinative ($r=-0.164$) and endurance performance ($r=-0.201$) were only slightly pronounced, but these results indicate that high body fat content does have possible negative consequences. This finding is in accordance with a recent study of Chatrath *et al*[21] in which they found an inverse correlation between endurance performance and BMI in 525 children. To our knowledge, there is no published study concerned with correlations between overweight or obesity and gross motor development.

One very important question that needs to be answered is: do overweight and obesity lead to a poor physical performance or is it the other way around? Unfortunately, our findings cannot differentiate between these two possibilities, due to the cross-sectional design. Nevertheless, the analysis of children's leisure behaviour in our study showed that children who are more active—either organised and/or on a regular basis—do have a better gross motor development. There was no correlation with endurance performance. Children at this age, however, prefer playful, coordinative activity over endurance sports.[22] Therefore, habitual physical activity is unlikely to influence endurance performance because children cannot estimate duration and intensity sufficiently enough to improve aerobic fitness.[23]

No correlation was found between leisure behaviour and BMI. This suggests that first there is an inactive lifestyle that leads to motor deficits, which nurtures inactivity and sedentary habits, finally causing overweight and obesity.

It is generally assumed that obese children are more inactive, even if they have a higher total energy expenditure than nonobese children.[24] These sedentary activities include, for the most part, extended television viewing and the use of other audio visual media.[8,25] Berkey *et al*[26] found a higher increase in the BMI in children with a higher TV consumption.

In our study, children with a higher weekly viewing frequency also tended to show poorer gross motor development; any correlation between body measurements or the endurance performance was not detectable. However, results may be biased by misclassification, since it is certainly difficult to collect such data with first-grade as they lack an adequate sense of time. Nonetheless, our data underline the demand for restricting television viewing frequency to only 1–3 days a week. These results also support the findings of Robinson *et al*[27] that the reduction of television consumption is an obesity-preventing measure.

Therefore, we conclude that the combined use of testing and a questionnaire reveal more information about possible correlations and effect of overweight and obesity in childhood. These children showed worse gross motor development and endurance performance, while more active children achieved better results. Our data emphasise the necessity and importance of promoting an active lifestyle in early childhood, thereby underlining the new guidelines of the American Heart Association, which recommend an increase in moderate to vigorous activity each day up to 60 min and a reduction in sedentary time.[12] The focus of attention should be on the group of overweight and obese children especially when one considers all the negative consequences that may occur in childhood and adulthood.[28,29] It is for this reason that the multiple health-promoting measures, for example in schools, should be of a more interdisciplinary cooperative nature and more intensive in their conception, so that their long-term effects are more enduring.

Summary

Increased body mass in first-grade children correlates with poorer results in gross motor development and endurance performance. On the other hand, it is shown that active leisure behaviour is accompanied with the best results of gross motor development, whereas sedentary habits like television viewing correlates slightly with poorer gross motor development. These data underline the importance of an active lifestyle to prevent overweight and obesity in early childhood and the necessity of interdisciplinary cooperation and conceptual development.

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