©Journal of Sports Science and Medicine (2005) **4**, 291-299
http://www.jssm.org

Research article

EFFECTS OF A SCHOOL-BASED INTERVENTION ON BMI AND MOTOR ABILITIES IN CHILDHOOD

Christine Graf [1]✉, Benjamin Koch [1], Gisa Falkowski [1], Stefanie Jouck [1], Hildegard Christ [2], Kathrin Stauenmaier [2], Birna Bjarnason-Wehrens [1], Walter Tokarski [3], Sigrid Dordel [4] and Hans-Georg Predel [1]

[1] Institute of Cardiology and Sports Medicine, [2] Institute of Medical Statistics, Informatics and Epidemiology, [3] Institute for European Sport Development and Leisure Studies, [4] Institute of School Sport and Development, German Sport University Cologne, Germany

Received: 13 April 2005 / Accepted: 18 July 2005 / Published (online): 01 September 2005

ABSTRACT

Obesity in childhood is increasing worldwide. To combat overweight and obesity in childhood, the school-based Children's Health InterventionaL Trial (CHILT) project combines health education and physical activity. This paper examines the effect of intervention on the body mass index (BMI) and motor abilities after 20.8 ± 1.0 months in 12 randomly selected primary schools compared with 5 randomly selected control schools. The anthropometric data were assessed, BMI was calculated. Coordination was determined by lateral jumping and endurance performance by a 6-minute run. No difference in the prevalence of overweight and obesity was found between the intervention (IS) and control schools (CS) either at baseline or following intervention (each $p > 0.05$). The increase in the number of lateral jumps was significantly higher in the IS than in the CS ($p < 0.001$). For the 6-minute run the increase in distance run was significantly improved in IS ($p = 0.020$). All variables were controlled for gender and age. Overweight and obese children in both IS and CS produced significantly lower scores in coordination and endurance tasks than normal and underweight children during both examinations (each $p \leq 0.001$), adjusted for gender and age. Preventive intervention in primary schools offers an effective means to improve motor skills in childhood and to break through the vicious circle of physical inactivity – motor deficits – frustration – increasing inactivity possibly combined with an excess energy intake and weight gain. To prevent overweight and obesity these measures have to be intensified.

KEY WORDS: Health education, children, obesity, inactivity, physical performance.

INTRODUCTION

The prevalence of obesity among children and adolescents is increasing worldwide (Allison et al., 1999; Kavey et al., 2003). The combination of inactivity, excessive energy intake and a possible genetic predisposition plays an increasingly significant role in this development (Bar-Or et al., 1998). School-based interventions in primary schools may contribute to counteract this development (AGA, 2004; Kavey et al., 2003). Worldwide, school-based programs with an emphasis on a healthy lifestyle have provided inconsistent results (Campbell et al., 2002; Müller et al., 2001; Nader et al., 1999; Stone et al., 1998). In a recently published Cochrane review Campbell et al.

(2002) concluded that there is limited high quality data proving the effectiveness of obesity prevention programs.

The CHILT (Children's Health InterventionaL Trial) project is a primary prevention program combining health education and increased physical activity in primary schools (Graf, 2003). The aim of this paper was to examine the influence of intervention on the BMI and motor abilities on first- to second graders.

METHODS

Population and study

Only those children were included who took part in the baseline examination (T1) and follow-up examination (T2) (N = 651). This was 81.0% of the school population that was enrolled in the study. The anthropometric data of the group are shown in Table 1.

Table 1. Anthropometric data of the total group (n = 651) at T1. Data are means (±SD) [range].

Age (yrs.)	6.85 (.47) [5.7 - 9.01]
Height (m)	1.24 (.06) [1.05 -1.48]
Weight (kg)	25.0 (5.0) [15.5 – 50.5]
BMI (kg·m^{-2})	16.28 (2.36) [16.15 – 27.99]

The study started in September 2001. Eighteen primary schools were randomly selected from the schools in the region of Cologne, Germany. Twelve schools (IS) agreed to participate in the CHILT project for cardiovascular and obesity prevention in primary schools. Six did not agree to take part. Five control schools (CS) were randomly selected from the same region. All of the control schools approached took part. The examinations started at the children's first school year. Informed consent was obtained from the parents or guardians of the intervention and control children. An independent Ethical Committee of the German Sport University approved this study.

Intervention time

The interventions started after the initial data collection at the beginning of the first grade and continued for an average of 20.8 ± 1.0 (19.1 – 22.6) months until the follow-up examination which occurred between May and July 2003.

Overview

The CHILT project is a professionally developed program designed to promote a healthy lifestyle in primary schoolchildren (Graf, 2003). The primary aims of this intervention were to increase the total energy expenditure from physical activity during lessons and breaks, to optimise physical education lessons and to enhance pupils' health knowledge. The examined parameters were the anthropometric data and motoric tests (coordination and endurance performance). The main topics of the health education are "My body" (a standardised text and instructional materials for use by schoolteachers - Bundeszentrale für Gesundheitliche Aufklärung, AID, Bewegte Schule etc.), nutrition and self-management (a group program consisting of discussions and exercises on specific topics for 20 to 30 min once a week). In addition physical education activities were performed during classes and intensified during breaks.

Health education

Health education lessons were required weekly for 20 to 30 minutes. The curriculum was revised from the primary school course of instruction for teachers. Lessons were compiled from our professionally developed health texts and additional materials made available from various health agencies across the country. All supplemental materials were supplied and all hand-outs that were part of our curriculum were copied by the study and provided to the teachers

It covered topics such as nutrition (altogether 24 lessons), my body (28), self-esteem and psychosocial aspects (23), special aspects such as how to handle food advertising, avoid sedentary habits (5), hygiene (15), immunology and medical information from pediatricians and health care workers (8), environment and health, allergy, dealing with silence and noises (8). Teachers were free to choose the content of their individual curriculum from within this package. The aim was to increase pupils´ knowledge of health topics, improve self-confidence and lifestyle. Parents were informed via their children, and also by the use of brochures and during regular parent-teacher meetings.

Additional physical activity

Within the first component of the intervention, physical activity was required daily during classes. Various combinations of the following exercises were carried out at least once each morning during lessons for at least five minutes: 11 exercises on coordination, 7 devoted to posture and balance, 16 to relaxation techniques, 8 to rhythm and music, 10 to creative movement, 8 games relating to group participation and 8 practices for back training. The aims were to increase total energy expenditure and to improve fundamental movement skills, esp. coordination and endurance performance.

In addition during leisure periods the children were invited to use the playground equipment such as junglegyms, balls, ropes, stilts etc.. The objective was to increase activity during schoolday and to encourage activity learn games for home use resulting in less sedentary behaviour. Therefore, we developed 13 games which the teachers could adapt to the facilities available in individual playgrounds and at home on a voluntary basis.

Supplementary, the physical education lesson plans were compiled from available physical education texts by the CHILT Team. For the physical education lessons 10 gym examples and 35 different games were developed specifically to optimise motor skills.

Teacher training

At the outset all teachers received a basic training program on all aspects of the study with three main goals: 1) enhance the teachers´ awareness of the need for a healthy lifestyle; 2) assist the teachers to design and implement health education and physical activity during schoolday; and 3) develop teachers´ instructional skills to enhance physical activity in order to focus on general activity and skill acquisition.

Thereafter the teachers only participated in special aspects of the program once or twice a year according to their special interests, such as physical education, nutrition etc. on a voluntary basis. Side visits were made to all schools during the first year of intervention to secure that all aspects were being applied as designed.

Data assessment

The same examiners took all measurements from September 2001 until April 2002 (T1) and May until July 2003 (T2). Subsequently, the children performed standardised lateral jumping to assess their motor development (Schilling, 1974), and a 6-minute run (Beck and Bös, 1995) for their endurance performance.

Anthropometric data

Cole et al. (2005) examined different measures of obesity in growing children. The authors concluded that their results underscore the importance of using a relatively stable method like the BMI to assess obesity change. Therefore within our study height and weight of the children were measured and 500 grams were deducted for their clothes. Body mass index was calculated as weight related to height in square meters and classified according to the German percentile graphs of Kromeyer-Hauschild et al. (2001). Children with a BMI <10th percentile were classified as underweight, ≥ 10th to <90th percentile as normal, ≥ 90th to < 97th percentile as overweight, and ≥ 97th percentile as obese.

Lateral jumping

Lateral jumping was used to assess temporal coordination. It is part of the body co-ordination test for children (= Körperkoordinationstest für Kinder, KTK, Graf et al., 2004a; 2004b) and valid for 5- to 14-year-old children (Dordel and Rittershaußen, 1997; Schilling, 1974). Both, the complete KTK and lateral jumping are well-documented and used in German schoolchildren’s tests (as published in previous studies (Graf et al., 2004a; 2004b). The children were taken out of their classrooms in small groups and requested to repeatedly jump from side to side over a slat (0.8 cm) with both legs. There were two test runs, each lasting 15 sec, and only correctly performed jumps (jumping and landing with both feet on one side) were counted (= number). The results of both series of jumps were added. Coordinative ability was then evaluated in consideration of the numbers, age and gender (Schilling, 1974).

Six-minute run

The 6-minute run was chosen to analyse endurance performance. It is valid for school children and correlates with results of treadmill testing ($r = 0.39$), the shuttle run ($r = 0.88$) and metabolic parameters such as lactate ($r = 0.92$) (Beck and Bös, 1995; Bös, 2001). The children had to run around a standard volleyball court (54 meters) in small groups of upto 8 children for 6 minutes. The children are allowed to walk but not to stop if they are exhausted. The number of rounds run by a maximum of three children were counted by one examiner controlling the right execution (e.g. not cutting corners), the additionally run meters added and the exact distance covered by each child was determined. The performance was then evaluated taking the distance run (in meters), age and gender (Beck and Bös, 1995) into account.

Statistical analysis

The descriptive statistics for the anthropometric data and results of the motoric tests are provided (mean values (m), standard deviation (s), range: minimum (min), maximum (max)). Time points were baseline (= T1) and intervention year 2 (= T2). Differences between the children of the intervention and control schools or between boys and girls were calculated with the unpaired t-test.

An analysis of covariance (ANCOVA) served for comparing the differences concerning individual characteristics in the groups (e.g. motoric test results in the different BMI classifications, difference of lateral jumping, resp. differences of the 6-minutes run between T1 and T2 in the two groups). Gender and age served as covariates and school type (IS or CS) as a factor. A multiple linear regression model was applied to quantify differences of lateral jumping and 6-minute run from T1 to T2 between the intervention and control schools (= school type) controlled by age and gender. Comparisons of frequencies were made by χ^2 method (e.g. BMI classification at T1 and T2 in the different school types). All cited p-values are uncorrected according multiple hypothesis tests, although p-values of <0.05 were considered statistically significant. All analyses were performed using the statistics system SPSS 11.0.

RESULTS

Anthropometric data

The anthropometric data for the whole group at T1 are shown in Table 1, differences between the IS and CS in Table 2 (T1) and Table 3 (T2). Within Table 4 different age groups are demonstrated in both school types, the children of the control schools were older at T1. All anthropometric data increased significantly due to growth (each $p < 0.001$) during the period of follow-up (data not shown). No difference of the BMI were found between IS and CS (each $p > 0.05$) at either examination (see Tables 2 and 3). To quantify the effect of school type a multivariate regression analyses was added. The full model including age, gender and school type accounted for approx. 3% of the variation in the increase of BMI.

Table 2. Differences according to the anthropometric data at T1 between both groups (IS = intervention schools, n = 460; CS = control schools, n = 191). Data are means (±SD).

Age (yrs.)	**IS**	6.71 (.39) ***
	CS	7.20 (.46)
Height (m)	**IS**	1.23 (.05) ***
	CS	1.25 (.06)
Weight (kg)	**IS**	24.6 (4.7) ***
	CS	26.1 (5.4)
BMI (kg·m^{-2})	**IS**	16.2 (2.3)
	CS	16.5 (2.5)

*** $p < 0.001$ compared with CS group.

At the initial examination, 7.4% of children in IS and CS were obese (n = 48), 8.9% were overweight (n = 58), 75.7% were normal weight (n = 493) and 8.0% were underweight (n = 52). At T2 7.2% were obese (n = 47), 9.5% overweight (n = 62), 74.5% normal weight (n = 485) and 8.8% underweight (n = 57). No difference in the BMI-classification was found between IS and CS by χ^2 method (T1 p = 0.283; T2 p = 0.830). The incidence of new onset obesity out of the normal and underweight population during the study period was 0.5% in the IS, and 0.6% in the CS (p = 0.734).

A 68.8% of obese children at T1 remained obese at T2 (33 of 48 obese children at T1), 8.3% reached normal weight (4 of 48 obese children at T1). 4.5% of the normal weight children became overweight or obese (22 of 493 normal weight children at T1).

Table 3. Differences according to the anthropometric data at T2 between both groups (IS = intervention schools, n = 460; CS = control schools, n = 191). Data are means (±SD).

Age (yrs.)	**IS**	8.41 (.40)
	CS	8.47 (.44)
Height (m)	**IS**	1.33 (.06)
	CS	1.33 (.06)
Weight (kg)	**IS**	30.1 (6.5)
	CS	29.8 (6.6)
BMI (kg·m^{-2})	**IS**	17.0 (2.8)
	CS	16.8 (2.9)

Motor tests

Lateral jumping

Within the IS there were no gender differences at T1, but the girls reached higher results at T2 (51.9 ± 11.2 versus 54.0 ± 10.8, p = 0.034). In addition the increase in jumps was significantly higher in girls than in boys (17.9 ± 9.3 versus 20.2 ± 9.5, p = 0.010).

Table 4. Anthropometric data in different age groups.

Age (yrs)		**N**	**Mean (±SD)**	**range**
< 6	**Height (m)**	9	1.19 (.05)	1.13-1.26
	Weight (kg)	9	23.8 (5.3)	19.5-37.0
	BMI (kg·m^{-2})	9	16.7 (2.5)	15.1-23.3
6.0 - 6.9	**Height (m)**	419	1.23 (.05)	1.05-1.38
	Weight (kg)	419	24.4 (4.7)	15.5-45.5
	BMI (kg·m^{-2})	419	16.2 (2.3)	10.2-28.0
7.0 - 7.9	**Height (m)**	212	1.25 (.06)	1.11-1.48
	Weight (kg)	212	25.9 (5.0)	17.5-50.5
	BMI (kg·m^{-2})	212	16.3 (2.3)	11.0-24.9
8.0 - 8.9	**Height (m)**	10	1.30 (.04)	1.22-1.36
	Weight (kg)	10	31.5 (7.2)	22.5-43.5
	BMI (kg·m^{-2})	10	18.7 (4.1)	13.6-25.4
9.0 - 9.9	**Height (m)**	1	1.34	
	Weight (kg)	1	27.00	
	BMI (kg·m^{-2})	1	15.04	

Within the CS there were no gender differences neither at T1 nor at T2, but the increase in jumps was significantly higher in girls than in boys (11.5 ± 9.2 versus 14.3 ± 9.2, p = 0.040).

Table 5. Results of lateral jumping (LJ) and the 6-minute-run in meters.

	Intervention Schools		Control Schools		
	N	**Means (±SD)**	**N**	**Means (±SD)**	**p-value***
LJ T1 (numbers)	456	34.0 (9.3)	190	38.5 (9.7)	.001
LJ T2 (numbers)	459	53.0 (11.0)	189	51.0 (10.9)	.019
Difference T2-T1	451	19.1 (9.4)	188	12.6 (9.3)	<.001
6-min-run T1 (m)	416	835.7 (108.1)	185	845.9 (116.1)	.114
6-min-run T2 (m)	459	923.8 (126.9)	187	918.3 (115.0)	.205
Difference T2-T1	413	87.1 (132.2)	181	72.6 (121.7)	.020

*p-value calculated with ANCOVA (adjusted for gender and age).

The absolute values, and differences between the IS and CS at T2 compared with T1 are shown in Table 5, adjusted for gender and age, calculated with ANCOVA. All children improved their coordination at follow-up ($p < 0.001$). The increase was higher in the IS ($p < 0.001$). To quantify the effect of school type a multivariate regression analysis was added. The full model including age, gender and school type accounted for approx. 10% of the variation in the increase of lateral jumping. Within this analysis the mean increase was 6.3 jumps higher in the intervention schools than in the control schools ($p < 0.001$, $F = 24.953$) controlled for age and gender (Table 6).

The increase of lateral jumping according to the different BMI-classifications was significantly different in normal weight children (Table 7).

On examining the cross sectional data of children who were overweight or obese, they always achieved the lowest scores at T1 ($p = 0.001$) and T2 ($p < 0.001$) (Figure 1) and there was no difference between IS and CS at initial examination or at follow-up.

Six-minute run

At T1 and T2 the boys of the IS reached higher results in the six-minute run (T1 857.2 ± 113.0 versus 816.1 ± 99.7 m, $p \leq 0.001$; T2 959.2 ± 147.8 versus 891.5 ± 93.5 m, $p \leq 0.001$). The increase was higher in boys than in girls (104.5 ± 149.0 versus 72.2 ± 113.4 m, $p = 0.018$). Within the CS the boys reached higher results at both examinations than the girls (T1 870.5 ± 120.1 versus 810.8 ± 100.8 m, $p \leq 0.001$; T2 939.5 ± 118.8 versus 885.9 ± 101.3 m, $p = 0.002$). The increase did not differ significantly.

The results of the 6-minute run and differences between the IS and CS are shown in Table 5, adjusted for gender and age, calculated with ANCOVA. All children improved during follow-up ($p < 0,001$). The increase in the IS was higher than in the CS ($p = 0.020$). To quantify the effect of school type a multivariate regression was added. The full model including age, gender and school type accounted for approx. 2% of the variation in the increase of runned metres. Within this analysis the mean increase was 30.7 metres higher in the intervention schools than in the control schools ($p = 0.020$, $F = 3.346$) controlled for age and gender (Table 8).

The increase according to the different BMI-classifications was significantly different in underweight children (Table 9).

On examining the cross sectional data, overweight and obese children had lower scores at T1 and at T2 (each $p < 0.001$), adjusted for gender, age in both IS and CS (Figure 2).

DISCUSSION

Obesity and physical inactivity are increasing problems in childhood (AGA, 2004, Kavey et al., 2003). Schools can play a key role in encouraging a healthy lifestyle among children in order to counteract this development. In the current study, after 20.8 months of school-based intervention, no effect on the incidence of overweight and obesity

Table 6. Multivariate regression (independent variable: age at T1, gender and school type; SE= standard error).

		B	SE	Beta	T	p
modell	**constant**	19.843	5.862		3.385	.001
	gender	2.451	.743	.125	3.300	.001
	age (yrs.)	.276	.896	.013	.308	.758
	school type	-6.316	.925	.293	-6.828	<.001
a	dependent variable difference between lateral jumping T2 and T1					

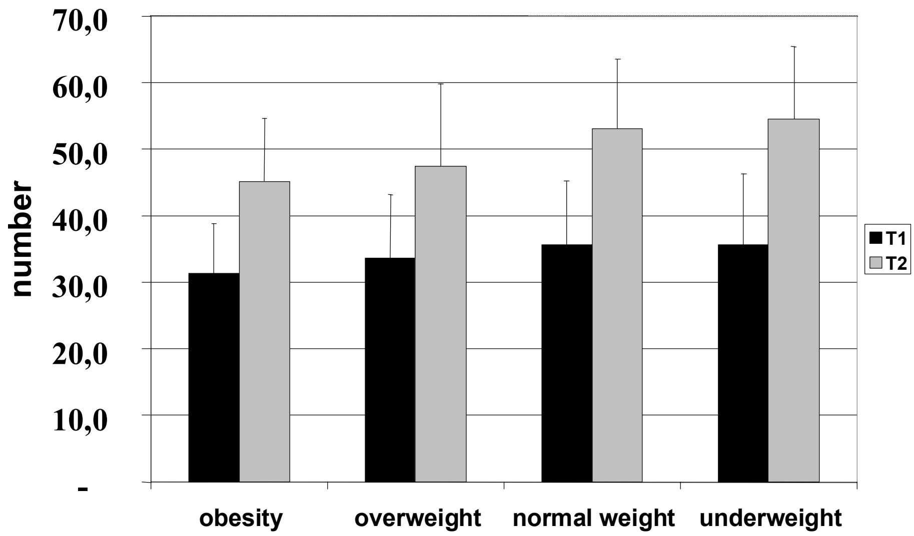

Figure 1. Results of the lateral jumping (number) at T1 and T2 according to the BMI classification. For p-values see text.

was found in the intervention group. There was however a clear improvement in motor abilities in the intervention schools. Sallis et al. (2003) found an increase in physical activity in boys, but not in girls after a 2-year intervention in middle schools (grades 6 to 8). In contrast, the "Move it Groove it" program in Australia showed a positive effect on motor abilities following optimized physical eduction lessons for both genders at ages 7 to 10 years (van Beurden et al., 2003). Regular participation in physical activity is associated with substantial health benefits for children and adolescents (Sallis and Patrick 1994). Furthermore, there is evidence that active children are more likely to become active adults (Kuh and Cooper 1992). Nevertheless, to reduce the incidence of overweight and obesity the involvement of the parents should be itensified. Manios et al. (1999; 2002) found a significantly reduced increase in BMI and an improved fitness in the intervention group after 3 and 6 years of school interventions in Crete at ages 6 to 9 and 12 years. Müller et al. (2001) showed a higher reduction of skinfold thickness after 1 year of a combined family- *and* school-based intervention.

Our follow-up data reveals that more than two thirds of the obese first graders stayed obese and less than 10% reach normal weight. On the other hand normal weight children had a <5% risk to become obese or overweight at follow-up. Although there was improvement in motor abilities for the entire population examined, and the intervention schools appeared to have a better motoric outcome, this effect was restricted to normal weight and underweight children. As with previously published studies (Graf et al., 2004a; 2004b) the overweight and obese children showed the poorest improvement in motor ability with time, and no significant differences between intervention and control schools for these subsets of children were found.

Table 7. Increase in lateral jumping between the different BMI-classification at T1 (BMI-T1) in both schooltypes (IS = intervention schools; CS = control schools).

BMI-T1		N	Means (±SD)
obesity	IS	30	15.7 (11.1)
	CS	17	11.7 (9.7)
overweight	IS	38	17.7 (10.2)
	CS	20	11.1 (9.3)
normal weight	IS	350	19.6 (9.1)***
	CS	132	12.6 (9.1)
underweight	IS	33	18.7 (10.4)
	CS	19	15.2 (10.2)

*** $p < 0.001$ compared with CS by ANCOVA (adjusted for gender and age).

Data concerning children's level of activity and its correlation with obesity are sparse and inconsistent (Bar-Or and Baranowski 1994; Bar-Or 2003; Ward and Evans 1995). However, poorer motoric abilities have been found in overweight and obese children in previous studies (Graf et al., 2004a; 2004b, Okely et al., 2004). Physical fitness is a powerful predictor of mortality among adults (Myers et al., 2002). Unfit lean men had a higher risk of all-cause and CVD mortality than did obese fit men (Lee et al., 1999). But there is a paucity of comparable studies among children and adolecents.

There are potential limitations to our study. We did not examine health knowledge after the intervention, nutrition habits, ethnic and socio-economic aspects of the children and their families.

Table 8. Multivariate regression (independent variable: age at T1, gender and school type; SE= standard error).

		B	SE	Beta	T	p
modell	**constant**	-41.531	83.147		-.499	.618
	gender	-18.697	10.619	-.072	-1.761	.079
	age (yrs.)	27.993	12.686	.103	2.207	.028
	school type	-30.730	13.122	-.110	-2.342	.020
a	dependent variable difference between runned metres T2 and T1					

These aspects will require further attention in future studies, as all of these cultural variables may affect the outcomes of any intervention. Knowledge of a healthy lifestyle and learning about the health benefits of preventive care, and appropriate personal behaviors should encourage pupils to protect their health over lifetime and have a better chance of remaining healthy throughout their lives.

Table 9. Increase in the result of the 6-min-run between the different BMI-classification at T1 (BMI-T1) in both schooltypes (IS = intervention schools; CS = control schools).

BMI-T1		N	Means (±SD)
obesity	**IS**	28	61.0 (138.6)
	CS	17	16.9 (86.63)
overweight	**IS**	35	70.9 (147.5)
	CS	20	82.2 (99.5)
normal weight	**IS**	321	87.1 (130.1)
	CS	126	78.3 (129.7)
underweight	**IS**	29	131.5 (120.8)***
	CS	18	74.1 (107.3)

*** p = 0.006 compared with CS by ANCOVA (adjusted for gender and age).

The assessments of motoric ability used in our study have been validated in field tests, but are not strictly comparable with exercise testing using VO_2max measurements. The association between fundamental movement skills and physical activity has not been extensively or prospectively studied. Differences in research designs have contributed to inconsistent findings. Okely et al. (2001) concluded that fundamental movement skills are associated with self-reported physical activity in adolescents, but predict only a part of it. The additional assessment of parameters according to body composition (waist circumferences, skinfold thickness etc.) could show a possible effect more clearly to differ between an increase in muscle or fat tissue.

CONCLUSIONS

Preventive intervention in primary schools offers a potentially effective means to improve motor skills in childhood and to break through the vicious circle physical inactivity – motor deficits – frustration – increasing inactivity possibly combined with an excess energy intake – weight gain. To prevent

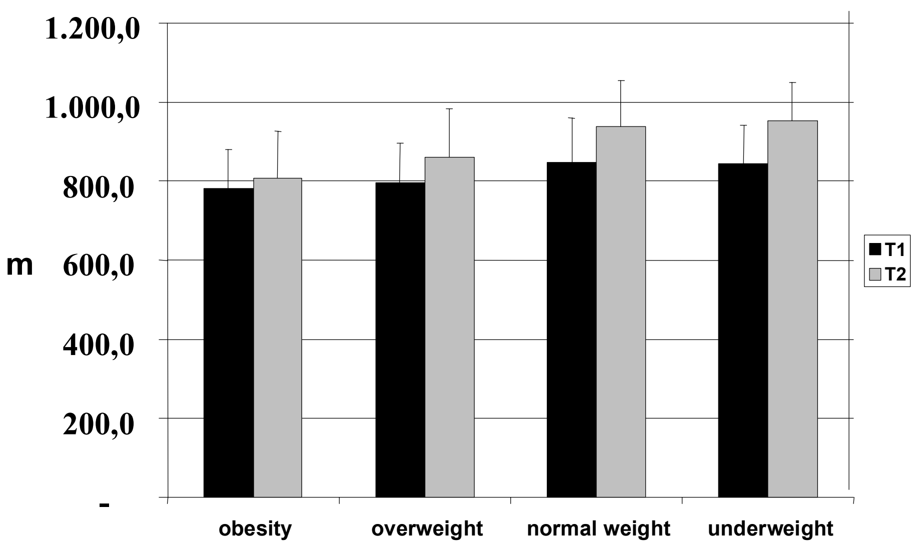

Figure 2. Results of the 6-minute run (in metres, m) at T1 and T2 according to the BMI classification. For p-values see text.

overweight and obesity these measures have to be intensified and parents need to be involved, although the less increase of BMI in the intervention schools is a remarkable step in the right way. Longer term follow-up studies to assess the effect of active parent involvement in school based intervention programs are clearly essential.

REFERENCES

Allison, D.B., Fontaine, K.R., Manson, J.E., Stevens, J. and VanItallie, T.B. (1999) Annual deaths attributable to obesity in the United States. *JAMA* **282,** 1530-1538.

AGA (2004) Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter Leitlinien. (Working group Obesity in childhood and adolescence. Guidelines) 10.9.2004 (in German). Avaliable from URL: hhtp://www.a-g-a.de

Bar-Or, O. and Baranowski, T. (1994) Physical activity, adiposity and obesity among adolescents. *Pediatric Exercise Science* **6,** 348-360.

Bar-Or, O., Foreyt, J., Bouchard, C., Brownell, K.D., Dietz, W.H., Ravussin, E., Salbe, A.D., Schwenger, S., St. Jeor, S. and Torun, B. (1998) Physical activity, genetic and nutritional consideration in childhood weight management. *Medicine & Science in Sports & Exercise* **30,** 2-10.

Bar-Or, O. (2003) Die Epidemie der Adipositas im Kindes- und Jugendalter (Epidemic of obesity in childhood and adolescence). *Sports Science Exchange* **2,** 1-8. (In German)

Beck, J. and Bös, K. (1995) *Normwerte der motorischen Leistungsfähigkeitsfähigkeit (Standardised values of motoric performance).* (In German) Sport und Buch Strauß; Köln 1995.

Bös, K. (2001) *Motorische Tests (motoric tests).* 2nd edition. Hogrefe Göttingen, Bern.

Campbell, K., Waters, E., O'Meara, S., Kelly, S. and Summerbell, C. (2002) Interventions for preventing obesity in childhood (Cochrane Review). *Cochrane Database Systematic Review* **3,** CD001871.

Cole T.J., Faith, M.S., Pietrobelli, A. and Heo, M. (2005) What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile? *European Jorunal of Clinical Nutrition* **59,** 419-425.

Dordel, S. and Rittershaußen, A. (1997) Bewegungsförderung als Entwicklungsförderung? (Promotion of physical activity for promotion of development?). *Haltung und Bewegung* **17,** 5-24. (In German)

Graf, C. (2003) Das CHILT-Projekt (The CHILT-Project). *Deutsche Zeitschrift für Sportmedizin* **54,** 247. (in German)

Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H.G. and Dordel, S. (2004a) Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project). *International Journal of Obesity* **28,** 22-26.

Graf, C, Koch, B., Dordel, S., Schindler-Marlow, S., Icks, A., Schüller, A., Bjarnason-Wehrens, B., Tokarski, W. and Predel, H.G. (2004b) Physical activity, leisure habits and obesity in first-grade children. *European Journal of Cardiovascular Prevention and Rehabilitation* **11,** 284-290.

Kavey, R.E.W., Daniels, S.R., Lauer, R.M., Atkins, D.L., Hayman, L.L. and Taubert, K. (2003) American Heart Association Guidelines for primary prevention of atherosclerotic Cardiovascular Disease beginning in childhood. *Circulation* **107,** 1562-1566.

Kromeyer-Hauschild, K., Wabitsch, M., Kunze, D., Geller, F., Geiss, H.C., Hesse, V., von Hippel, A., Jaeger, U., Johnson, D., Korte, W., Menner, K., Müller, G., Müller, J.M., Niemann-Pilatus, A., Remer, T., Schaefer, F., Wittchen, H.U., Zabrabnsky, S., Zellner, K., Ziegler, A. and Hebebrand, J. (2001) Percentile of body mass index in children and adolescence evaluated from different regional German studies. *Monatsschrift Kinderheilkunde* **8,** 807-818. (In German: English abstract).

Kuh, D.J.L. and Cooper, C. (1992) Physical activity at 36 years: patterns and childhood predictors in a longitudinal study. *Journal of Epidemiology and Community Health* **46,** 114-119.

Lee, C.D., Blair, S.N. and Jackson, A.S. (1999) Cardiorespiratory fitness, body composition, and all-cause and cardiovascular mortality in men. *American Journal of Clinical Nutrition* **69,** 373-380

Manios, Y., Moschandreas, J., Hatzis, C. and Kafatos, A. (1999) Evaluation of a health and nutrition education program in primary school children of Crete over a three-year period. *Preventive Medicine* **28,** 149-159.

Manios, Y., Moschandreas, J., Hatzis, C. and Kafatos, A. (2002) Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. *British Journal of Nutrition* **88,** 315-324.

Müller, M.J., Mast, M, Asbeck, I., Langnase, K. and Grund, A. (2001) Prevention of obesity--is it possible? *Obesity Review* **2,** 15-28.

Myers J., Prakash, M., Froelicher, V., Do, D., Partington, S. and Atwood, J.E. (2002) Exercise capacity and mortality among men referred for exercise testing. *New England Jorunal of Medicine* **346,** 793-801

Nader, P.R., Stone, E.J., Lytle, L.A., Perry, C.L., Osganian, S.K., Kelder, S., Webber, L.S., Elder, J.P., Montgomery, D., Feldman, H.A., Wu, M., Johnson, C., Parcel, G.S. and Luepker, R.V. (1999) Three-year maintenance of improved diet and physical activity: the CATCH cohort. Child and Adolescent Trial for Cardiovascular Health. *Archives of Pediatrics & Adolescent Medicine* **153,** 695-704.

Okely, A.D., Booth, M.L. and Chey, T. (2004) Relationship between body composition and fundamental movement skills among children and adolescents. *Research Quaterly for Exercise and Sport* **75,** 238-247.

Okely, A.D., Booth, M.L. and Patterson, J.W. (2001) Relationship of physical activity to fundamental movement skills among adolescents. *Medicine & Scence ni Sports & Exercise* **33,** 1899-1904.

Rowlands, A.V., Ingledew, D.K. and Eston, R.G. (2000) The effect of type of physical activity measure on the relationship between body fatness and habitual physical activity in children: a meta-analysis. *Annales of Human Biology* **27,** 479-497.

Sallis, J.F., McKenzie, T.L., Conway, T.L., Elder, J.P., Prochaska, J.J., Brown, M., Zive, M.M., Marshall, S.J. and Alcaraz, J.E. (2003) Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. *American Journal of Preventive Medicine* **24,** 209-217.

Sallis, J.F. and Patrick, K. (1994) Physical activity guidelines for adolescents: consensus statement. *Pediatric Exercise Science* **6,** 302-314.

Schilling, F. (1974) *Körperkoordinationstest für Kinder. KTK. Manual (body coordination test for children, KTK, manual).* Weinheim Beltz Test GmbH. 8-53. (In German)

Stone, E.J., McKenzie, T.L., Welk, G.J. and Booth, M.L. (1998) Effects of physical activity interventions in youth: review and synthesis. *American Journal of Preventive Medicine* **15,** 298-315.

van Beurden, E., Barnett, L.M., Zask, A., Dietrich, U.C., Brooks, L.O. and Beard, J. (2003) Can we skill and activate children through primary school physical education lessons? "Move it Groove it"--a collaborative health promotion intervention. *Preventive Medicine* **36,** 493-501.

Ward, D.S. and Evans, R.. (1995) Physical activity, aerobic fitness and obesity in children. *Medicine, Exercise, Nutrition, and Health* **4,** 3-16.

AUTHORS BIOGRAPHY

Christine GRAF
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
MD
Research Interests
Primary and secondary prevention, children and exercise, obesity and metabolism.
E-mail: C.Graf@dshs-koeln.de

Benjamin KOCH
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
Sport scientist

Gisa FALKOWSKI
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
Sport scientist

Stefanie JOUCK
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
Sport scientist

Hildegard CHRIST
Employment
Institute of Medical Statistics, Informatics and Epidemiology; University of Cologne

Kathrin STAUENMAIER
Employment
Institute of Medical Statistics, Informatics and Epidemiology; University of Cologne

Birna BJARNASON WEHRENS
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
PhD, Dr. Sportwiss.

Walter TOKARSKI
Employment
Institute for European Sport development and leisure studies
Degree
PhD, Dr. rer. pol.

Sigrid DORDEL
Employment
Institute of School Sport and Development; German Sport University Cologne
Degree
Dr. rer nat.

Hans-Georg PREDEL
Employment
Institute for Cardiology and Sportmedicine; German Sport University Cologne
Degree
PhD, MD

KEY POINTS

- School-based prevention improves motor abilities in primary school children.
- The incidence of obesity is not influenced by school-based intervention.
- To prevent obesity in early childhood the measures have to be intensified and parents should be included.

✉ **Dr. med. Dr. Sportwiss. Christine Graf**
Institute for Cardiology and Sportmedicine, German Sport University, Carl-Diem-Weg 6 50933 Cologne, Germany.