Journal of Sports Sciences
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713721847

School-based prevention: Effects on obesity and physical performance after 4 years

Christine Graf [a]; Benjamin Koch [a]; Gisa Falkowski [a]; Stefanie Jouck [a]; Hildegard Christ [b]; Kathrin Staudenmaier [b]; Walter Tokarski [c]; Andreas Gerber [d]; Hans-Georg Predel [a]; Sigrid Dordel [e]
[a] Institute of Cardiology and Sports Medicine, German Sport University Cologne, Cologne, Germany [b] Institute of Medical Statistics, Informatics and Epidemiology, University of Cologne, Cologne, Germany [c] Institute for European Sport Development and Leisure Research, German Sport University Cologne, Cologne, Germany [d] Institute for Health Economics and Clinical Epidemiology, University of Cologne, Cologne, Germany [e] Institute of School Sport and Development, German Sport University Cologne, Cologne, Germany

First Published:August2008

To cite this Article Graf, Christine, Koch, Benjamin, Falkowski, Gisa, Jouck, Stefanie, Christ, Hildegard, Staudenmaier, Kathrin, Tokarski, Walter, Gerber, Andreas, Predel, Hans-Georg and Dordel, Sigrid(2008)'School-based prevention: Effects on obesity and physical performance after 4 years',Journal of Sports Sciences,26:10,987 — 994

To link to this Article: DOI: 10.1080/02640410801930176

URL: http://dx.doi.org/10.1080/02640410801930176

Journal of Sports Sciences, August 2008; 26(10): 987–994

Routledge
Taylor & Francis Group

School-based prevention: Effects on obesity and physical performance after 4 years

CHRISTINE GRAF[1], BENJAMIN KOCH[1], GISA FALKOWSKI[1], STEFANIE JOUCK[1], HILDEGARD CHRIST[2], KATHRIN STAUDENMAIER[2], WALTER TOKARSKI[3], ANDREAS GERBER[4], HANS-GEORG PREDEL[1], & SIGRID DORDEL[5]

[1]*Institute of Cardiology and Sports Medicine, German Sport University Cologne, Cologne, Germany,* [2]*Institute of Medical Statistics, Informatics and Epidemiology, University of Cologne, Cologne, Germany,* [3]*Institute for European Sport Development and Leisure Research, German Sport University Cologne, Cologne, Germany,* [4]*Institute for Health Economics and Clinical Epidemiology, University of Cologne, Cologne, Germany, and* [5]*Institute of School Sport and Development, German Sport University Cologne, Cologne, Germany*

(Accepted 18 January 2008)

Abstract

Juvenile obesity is increasing worldwide. Preventive strategies are warranted. The school-based Children's Health Interventional Trial (the CHILT Project) combines health education and physical activity for children. The effect on obesity and physical performance was studied after four years in 12 primary schools compared with five control schools. Anthropometric data were recorded. Physical performance was measured by a coordination test for children (balancing backwards, one-legged obstacle jumping, lateral jumping, sideways movements) and a 6-min run (endurance). No difference in the prevalence and incidence of overweight and obesity was found between the intervention and control schools before and after the intervention. Remission of overweight was higher in the intervention schools (23.2 vs. 19.2%), but not significant. An increase in coordination related to lateral jumping and balancing backwards was apparent in the intervention schools (30.6, $s = 10.8$ vs. 26.1, $s = 10.8$, $P = 0.005$; 21.8, $s = 11.8$ vs. 19.4, $s = 11.7$, $P = 0.007$), and the increase in endurance performance tended to be higher in intervention schools (100.8, $s = 122.7$ vs. 92.8, $s = 126.0$, $P = 0.055$), adjusted for age, sex, baseline test result, and body mass index at final examination. Therefore, preventive intervention in primary school offers the possibility to improve physical performance in children. The prevalence and incidence of obesity were not affected.

Keywords: *Health education, children, obesity, inactivity, physical performance*

Introduction

The prevalence of obesity among children and adolescents in developed and developing countries is increasing (Allison, Fontaine, Manson, Stevens, & VanItallie, 1999; Kavey *et al.*, 2003). Excess weight gain is caused by an interaction of genetic and environmental factors, including metabolic and behavioural components. In particular, a lack of physical activity, together with an unhealthy diet, places children at risk for developing overweight and obesity (Working Group on Obesity in Childhood and Adolescence, 2004).

Overweight children are more likely to develop chronic diseases such as hypertension and glucose intolerance, as well as manifest diabetes mellitus type 2, orthopaedic and/or psychosocial disorders (Power, Lake, & Cole, 1997). In addition, obese children tend to become obese adults with all the associated co-morbidities (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). There is a need for counter-measures, therefore, but drawing up effective strategies to prevent children from developing overweight remains a challenge (Summerbell *et al.*, 2003, 2005).

School settings, in principle, are committed to providing measures to all children independent of their socio-economic status. Adequate interventions in primary schools may help to counteract the increase in physical inactivity and overweight at an early stage (Kavey *et al.*, 2003). But to date school-based programmes with an emphasis on a healthy lifestyle have produced inconsistent results (Müller, Mast, Asbeck, Langnäse, & Grund, 2001; Nader *et al.*, 1999; Stone, McKenzie, Welk, & Booth, 1998). In a recently published Cochrane review that included 22 studies, a minor but positive impact of chosen

Correspondence: C. Graf, Institute for Cardiology and Sports Medicine, German Sport University Cologne, Carl-Diem-Weg 6, D-50933 Cologne, Germany. E-mail: c.graf@dshs-koeln.de

ISSN 0264-0414 print/ISSN 1466-447X online © 2008 Taylor & Francis
DOI: 10.1080/02640410801930176

programmes was found on body mass index (BMI) and an improvement in diet or physical activity. Nevertheless, Summerbell *et al.* (2005) concluded that there are limited high-quality data proving the effectiveness of obesity prevention programmes because of different samples, interventions, and methods, and thus further research is required.

The CHILT Project is a professionally developed programme designed to promote a healthy lifestyle in primary schoolchildren (Graf, 2003). The primary aims of this intervention are to increase total energy expenditure via physical activity during lessons and breaks, to optimize physical education lessons, to enhance pupils' health knowledge, and to influence the prevalence of overweight and obesity.

Children from 12 primary schools took part in the intervention. Primary endpoints were to reveal the effects of the intervention on (1) the incidence of overweight and obesity and (2) motor abilities after nearly 4 years by comparing the results with those of children from five control schools. Additionally, potential effects within the intervention and control schools were analysed and differeniated according to several BMI classifications.

Methods

Sample and study

The study began in September 2001. Eighteen primary schools were randomly selected from schools in the Cologne area in Germany. Twelve schools (intervention schools) agreed to participate in the CHILT Project for cardiovascular and obesity prevention in primary schools, while six did not. Five control schools were randomly selected from the same region, all of them took part in the study. The examinations started in the children's first school year. Informed consent was obtained from the parents or guardians of the intervention and control children. An independent Ethics Committee from the German Sport University of Cologne approved this study.

Initial performance capacity and anthropometric data of the children were obtained in classes at the beginning of the school year 2001–2002 (baseline examination). Intermediate data were collected in June–July 2003, at which point the children were at the end of their second year (results not shown here). Final data were obtained in their fourth year in the spring/summer of 2005 (final examination).

Only those children who took part in the entrance and final examinations were included [314 boys (51.1%) and 301 girls (48.9%)]; 15 children were excluded because they took part in other programmes for overweight and obese primary school children (Graf *et al.*, 2005b). Therefore, 76.5% of the school population was enrolled in the study. At baseline the children had the following mean characteristics: age 6.8 years ($s = 0.4$), height 1.24 m ($s = 0.06$), body mass 25.0 kg ($s = 4.7$), BMI 16.3 kg · m^{-2} ($s = 2.2$). The anthropometric data of the children are shown in Table I.

Anthropometric data

Height and mass were measured using the same freestanding Seca stadiometer. We deducted 500 g for the sports clothing the children were wearing. The BMI was calculated as mass in kilograms per height in metres squared. Obesity was defined as body mass index $\geq 97^{th}$ percentile, using the definition of the International Task Force on Obesity in Childhood and population-specific data (Cole, Bellizzi, Flegal & Dietz, 2000). Overweight was defined as body mass index $\geq 90^{th}$ percentile, but $< 97^{th}$ percentile; normal weight as body mass index $\geq 10^{th}$ percentile, but $< 90^{th}$ percentile; and underweight as body mass index $< 10^{th}$ percentile (Kromeyer Hauschild *et al.*, 2001).

Motor tests

Six-minute run. The 6-min 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 & Bös, 1995; Bös, 2001). The children had to run around a standard volleyball court (54 m) in small groups of up to eight children for 6 min. The children were allowed to walk, but not to stop, if they were exhausted. The number of laps run was counted, the additional metres run added, and the exact distance covered by each child was determined in metres.

Procedure of the body coordination test for children

The body coordination test for children was used to examine gross motor development. It is valid for

Table I. Baseline anthropometric data.

Characteristic	Schools	*N*	Mean	*s*	*P*-value
Age (years)	Intervention	433	6.7	0.4	<0.001
	Control	178	7.2	0.4	
Height (m)	Intervention	414	1.23	0.05	<0.001
	Control	172	1.25	0.05	
Body mass (kg)	Intervention	414	24.5	4.5	0.001
	Control	172	25.9	4.8	
BMI (kg · m^{-2})	Intervention	414	16.2	2.2	N.S.
	Control	172	16.4	2.4	

5- to 14-year-old children (Schilling, 1974). The body coordination test for children consists of four items:

1. *Balancing backwards*. The children have to balance backwards on three different square edged beams (each 3.0 m long; width = 6.0, 4.5, and 3.0 cm). They perform this task three times on each beam and are awarded up to 8 points for each walk. The total points achieved are then calculated.
2. *One-legged obstacle jumping*. The children jump one-legged over rectangular foam panels (each 50 × 20 × 5 cm). The aim is to jump over the highest stack of panels, which are piled diagonally one on top of the other. The run-up distance is a constant 1.5 m, the starting height 5 cm. For each leg (left and right), the children are allowed three attempts at each height. For each succesful first attempt the child receives 3 points, for each succesful second attempt 2 points, and for each succesful third attempt 1 point.
3. *Lateral jumping*. The children jump sideways with both feet together over a strip of wood on a panel (measuring 60 × 100 × 0.8 cm) as often as possible within 15 s. Each child is allowed two attempts; each jump is awarded 1 point. Subsequently, the total points scored are calculated.
4. *Sideways movements*. The children stand on a board (measuring 25 × 25 cm; 3.7 cm high), and then have to place a second board next to the first one and step onto it. This exercise has to be repeated as often as possible within 20 s. For each repetition, 1 point is awarded.

The results of these four exercises are added together and an overall motor quotient, taking age and sex into consideration, is extrapolated. In this paper, the motor quotient and the raw values of the four items are reported.

Intervention

The intervention period lasted nearly 4 years and comprised sessions aimed at promoting health and physical activity. The theoretical model used as the basis of the intervention was a combination of the theory of planned behaviour and of the precaution adoption process model (Weinstein, Rothman, & Sutton, 1998). The teachers were asked to give one extra health education lesson per week (20–30 min). The main topics of the health education dealt with biological background, nutrition, and self-management. Additionally, physical activity breaks (5 min each) should be allowed during lessons once a morning. Furthermore, pupils were given physical activity opportunities during breaks and their physical education lessons were optimized by training the teachers. For this purpose, the teachers were instructed during an intensive entrance workshop and yearly follow-ups dealing with the topics covered. Ressources for learning lessions were evaluated internally by panels of teachers and by final reviewers. The detailed intervention is described in Graf *et al.* (2005b). In the first year, site visits were made to all schools to ensure that all aspects were being applied as designed. Intervention schools were described as being committed if they offered extra activities several times a week or held a health lesson at least once a month. Within the control schools, the normal school programme was adhered to.

Statistical analysis

Descriptive statistics for the anthropometric data and results of the motoric tests are provided [mean values plus standard deviations (s) and range (minimum, maximum)]. Time points were baseline and intervention year 4. Differences in the children's values between the intervention and control schools or between boys and girls were calculated using the unpaired t-test. A multivariate analysis of covariance (ANCOVA) was used to compare differences in individual characteristics in the groups (e.g. motoric test results in intervention vs. control schools). Sex, age, and pre-intervention value at baseline examination served as covariates and school type (intervention or control school) as a factor. Comparisons of frequencies were made using the χ^2 method (e.g. BMI classification in the different school types). All cited P-values are uncorrected according to multiple hypothesis tests, although P-values < 0.05 were considered statistically significant. All analyses were performed using the statistical software SPSS 14.0.

Results

Intervention

After the intervention, all teachers were asked to describe how intensively they fulfilled the programme. They reported that health education sessions lasting approximately 20–45 min were held at intervals from once per semester to twice a week. Physical activity during lessons took place at intervals from twice a week to three times per morning. The workshops were attended irregulary. The implementation of the whole programme decreased from the first to the fourth grade.

Anthropometric data

The anthropometric baseline data for the intervention and control schools are presented in Table I.

The children from the control schools were older, taller, and heavier than those from the intervention schools (all $P < 0.001$). These findings can be attributed to the fact that examinations started at a later date. Therefore, in the data analysis baseline values were considered as covariates. In the final examination, no differences were found. Body mass index did not differ at either examination (both $P > 0.05$). All anthropometric data increased significantly due to growth (all $P < 0.001$) during the period of follow-up (data not shown). The increase in all anthropometric data did not differ between the intervention and control schools, except the increase in BMI was higher in the intervention schools ($P < 0.001$; see Table II).

At the entrance examination, 6.6% of all children ($n = 37$) in the intervention and control schools were obese, 8.1% ($n = 45$) were overweight, 77.8% ($n = 434$) were normal weight, and 7.5% ($n = 42$) were underweight. At final examination, 7.4% ($n = 47$) were obese, 11.3% ($n = 63$) were overweight, 75.1% ($n = 419$) were normal weight, and 5.2% ($n = 29$) were underweight. No difference in the BMI classification was found between groups by the χ^2 method (entrance examination $P = 0.413$; final examination $P = 0.288$). The incidence of new-onset obesity in the normal and underweight populations during the study period was 2.0% ($n = 7$) in the intervention schools and 1.6% ($n = 2$) in the control schools. No difference was found by the χ^2 method ($P = 0.190$). In total, 23.2% (13/56) of obese and overweight children from the intervention schools reached normal weight at final examination, while 19.2% (5/26) of those in the control schools did ($P = 0.374$ by the χ^2 method).

Motor tests

The results of the motor tests at baseline and final examination, and changes in the performance, are shown in Tables III–VIII. The increase in endurance performance in the intervention group was higher ($P = 0.058$), adjusted for age at the entrance examination, and by sex, pre-intervention value at entrance, and BMI classification at final examination. Each item on the body coordination test for children was improved in the intervention group, adjusted for all co-variables, but this increase was only significant in balancing backwards and lateral jumping (see Tables III–VIII).

Subgroup analyses

Differences between overweight/obese vs. normal/underweight children. Subgroup analyses were performed

Table II. Mean BMI ($kg \cdot m^{-2}$) at baseline and follow-up (standard deviation in parentheses).

	Intervention schools ($n = 410$)	Control schools ($n = 170$)	Difference	P-value
Baseline	16.2 (2.2)	16.4 (2.4)	0.2	N.S.
Follow-up	18.3 (3.4)	17.9 (3.4)	0.4	N.S.
Change	2.1 (2.1)	1.5 (1.8)	0.6 (0.3 to 0.9)	0.001
ANCOVA			0.7 (0.3 to 1.1)	< 0.001*

*Adjusted for age, sex, and pre-intervention value.

Table III. Mean 6-min run performance (m) at baseline and follow-up (standard deviation in parentheses).

	Intervention schools ($n = 376$)	Control schools ($n = 171$)	Difference	P-value
Baseline	844.6 (110.1)	845.0 (113.8)	0.4	N.S.
Follow-up	946.1 (125.5)	938.5 (129.3)	7.5	N.S.
Change	100.8 (122.7)	92.8 (126.0)	8.0 (−14.4 to 30.3)	N.S.
ANCOVA			21.7 (−0.5 to 43.8)	0.055*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table IV. Mean motor quotient at baseline and follow-up (standard deviation in parentheses).

	Intervention schools ($n = 403$)	Control schools ($n = 168$)	Difference	P-value
Baseline	95.4 (14.6)	94.4 (15.0)	1.0	N.S.
Follow-up	105.9 (15.6)	105.2 (16.8)	0.7	N.S.
Change	10.5 (13.0)	10.8 (11.3)	0.3 (− 2.6 to 2.0)	N.S.
ANCOVA			0.3 (− 2.1 to 2.6)	N.S.*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table V. Mean balancing backwards performance at baseline and follow-up (standard deviation in parentheses).

	Intervention schools ($n = 410$)	Control schools ($n = 173$)	Difference	P-value
Baseline	29.8 (11.9)	29.6 (11.0)	0.2	N.S.
Follow-up	51.6 (13.1)	49.0 (13.8)	2.6	0.033
Change	21.8 (11.8)	19.4 (11.7)	2.4 (0.3 to 4.5)	0.024
ANCOVA			3.0 (0.9 to 5.3)	0.007*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table VI. Mean one-legged obstacle jumping performance at baseline and follow-up (standard deviation in parentheses).

	Intervention schools (*n* = 406)	Control schools (*n* = 173)	Difference	*P*-value
Baseline	27.2 (11.9)	29.7 (13.1)	2.5	0.024
Follow-up	55.6 (13.4)	55.2 (14.1)	0.4	N.S.
Change	28.4 (10.8)	25.5 (10.8)	2.9 (1.0 to 4.8)	0.003
ANCOVA			0.3 (−1.7 to 2.4)	N.S.*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table VII. Mean lateral jumping at baseline and follow-up (standard deviation in parentheses).

	Intervention schools (*n* = 409)	Control schools (*n* = 173)	Difference	*P*-value
Baseline	34.5 (9.3)	38.1 (10.1)	3.6	< 0.001
Follow-up	65.0 (11.1)	64.2 (12.1)	1.2	N.S.
Change	30.6 (10.8)	26.1 (10.8)	4.5 (2.6 to 6.4)	< 0.001
ANCOVA			3.1 (0.9 to 5.2)	0.005*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table VIII. Mean sideways movements at baseline and follow-up (standard deviation in parentheses).

	Intervention schools (*n* = 410)	Control schools (*n* = 170)	Difference	*P*-value
Baseline	32.6 (6.4)	33.6 (6.4)	1.0	N.S.
Follow-up	44.8 (7.1)	44.9 (7.8)	0.1	N.S.
Change	12.2 (7.7)	11.3 (7.3)	0.9 (−0.4 to 2.4)	N.S.
ANCOVA			1.0 (−0.4 to 2.4)	N.S.*

*Adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

regarding changes in anthropometric data and motor performance capacity within several BMI classifications. The overweight and obese children had the highest increase in BMI. This group also had the worst results for all motor tests in both the intervention and control schools and the lowest increase independent of participation in the intervention or control group (see Table IX).

Differences between intervention schools with low vs. high commitment. The increase in BMI measurements and the poor results from the motor tests in a comparison of the commited with the less commited schools are shown in Table X. The increase in BMI was more marked in the less committed schools; however, so was one-legged obstacle jumping (see Table V. There were no further differences.

Discussion

Obesity and physical inactivity are increasingly seen as a problem in childhood (Kavey *et al.*, 2003). Schools can play a key role in encouraging a healthy lifestyle among children to counteract this development (Kahn *et al.*, 2002). In the present study, after nearly 4 years of school-based intervention, no effect on the incidence of overweight and obesity was found in the intervention group. There was a slight trend in the intervention schools for more overweight and obese children to reach normal weight, although the most marked increase in BMI was found in intervention schools, especially the non-committed ones. Therefore, we hypothesize that a more intensive implementation of the programme together with parental integration could have a more positive influence on the anthropometric data. Manios and colleagues (Manios, Moschandreas, Hatzis, Kafatos 1999, 2002) found a significantly reduced increase in BMI and improved fitness in their intervention group after 3 and 6 years of school interventions in Crete at ages 6–9 and 12 years. Besides the school-based intervention, seminars were organized for parents to improve their health knowledge. In addition, Müller *et al.* (2001) reported a higher reduction in skinfold thickness after 1 year of a combined family- *and* school-based intervention.

In the present study, there was an improvement in some motor tasks in the intervention schools. The improvements in lateral jumping and balancing backwards were significantly higher than in the control schools; in all other tasks, advances were made, but were not statistically significant. Within the M-SPAN (Middle School Physical Activity and Nutrition) Project in sixth- to eighth-graders, the intervention significantly improved students' moderate to vigorous physical activity by 18% (McKenzie *et al.*, 2004). A positive effect on motor skills was supposed, but not examined. In contrast, the "Move it Groove it" programme in Australia showed a positive effect on motor abilities following optimized physical education lessons for both girls and boys at ages 7–10 years (van Beurden *et al.*, 2003). Regular participation in physical activity is associated with substantial health benefits for children and adolescents (Sallis, McKenzie, Alcaraz, 1993). Furthermore, intensive integration of parents could have a positive effect on physical activity promotion. Within the Framingham children's study, the children were 5.8 times more likely to be active when both parents

Table IX. Changes in BMI and test items (unadjusted means with standard deviation in parentheses).

Change in:	Schools	Obesity	Overweight	Normal weight	Underweight	Total	*P*-value*
BMI ($kg \cdot m^{-2}$)	Intervention	5.6 (2.5)	3.9 (1.6)	1.5 (1.4)	− 0.2 (0.9)	2.1 (2.1)	< 0.001
	Control	5.0 (1.2)	3.0 (1.9)	1.1 (1.2)	− 0.4 (1.0)	1.5 (1.8)	
Balancing backwards	Intervention	14.4 (11.6)	17.6 (11.5)	22.8 (11.4)	29.2 (10.6)	21.8 (11.8)	0.007
	Control	15.9 (11.6)	13.8 (10.0)	20.1 (11.7)	22.8 (14.9)	19.2 (11.9)	
One-legged obstacle jumping	Intervention	18.6 (8.8)	24.8 (11.3)	29.7 (10.1)	31.5 (15.5)	28.4 (10.8)	N.S.
	Control	21.4 (10.0)	20.7 (11.6)	27.5 (10.6)	28.5 (9.9)	26.2 (10.9)	
Lateral jumping	Intervention	26.6 (9.9)	30.6 (11.9)	30.9 (10.7)	32.2 (10.6)	30.6 (10.8)	0.005
	Control	21.9 (14.3)	27.3 (7.8)	26.1 (10.6)	25.8 (11.0)	25.9 (10.6)	
Sideways movements	Intervention	7.8 (7.6)	10.2 (8.4)	12.9 (7.5)	13.0 (6.9)	12.2 (7.7)	N.S.
	Control	9.8 (5.7)	8.5 (6.8)	10.8 (7.6)	15.8 (4.7)	10.8 (7.3)	
Motor quotient	Intervention	− 1.9 (9.9)	6.1 (14.6)	12.0 (12.3)	17.1 (11.5)	10.5 (13.0)	N.S.
	Control	4.0 (13.1)	4.4 (11.7)	12.0 (10.8)	16.7 (8.8)	10.7 (11.4)	
6-min-run	Intervention	3.8 (107.1)	88.8 (98.4)	112.5 (125.1)	128.7 (104.0)	100.6 (123.8)	N.S.
	Control	12.3 (146.3)	70.4 (126.2)	100.3 (118.9)	152.8 (165.4)	93.3 (128.9)	

Note: Multivariate analyses. **P*-value adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

Table X. Increase in BMI and test items (unadjusted means with standard deviation in parentheses).

Changes in:	Intervention schools	*N*	Mean (*s*)	*P*-value*
BMI ($kg \cdot m^{-2}$)	High commitment	292	1.9 (2.0)	0.002
	Low commitment	85	2.4 (2.3)	
6-min run (m)	High commitment	271	94.0 (124.5)	N.S.
	Low commitment	75	125.3 (112.6)	
Balancing backwards	High commitment	292	21.7 (11.6)	N.S.
	Low commitment	83	23.8 (11.5)	
One-legged obstacle jumping	High commitment	289	28.1 (11.0)	N.S.
	Low commitment	83	30.0 (9.7)	
Sideways movements	High commitment	292	11.8 (7.9)	0.021
	Low commitment	83	14.1 (6.7)	
Lateral jumping	High commitment	291	30.5 (10.9)	N.S.
	Low commitment	83	29.4 (10.9)	
Motor quotient	High commitment	288	10.0 (13.2)	N.S.
	Low commitment	81	12.7 (12.4)	

Note: Multivariate analyses. **P*-value adjusted for age, sex, pre-intervention value, and BMI classification at final examination.

were active (95% confidence interval = 1.9, 17.4) than children whose parents were both inactive (Moore *et al.*, 1991). Possible mechanisms for this relationship include the parents serving as role models, sharing of activities by family members, and enhancement and support by active parents of their children's participation in physical activity. Finally, genetically transmitted factors also help to determine to what extent a child performs physical activity.

Although there was an improvement in motor abilities for the entire population examined, and the intervention schools appeared to perform better than the control schools, this effect was restricted to normal weight and underweight children in the intervention schools. Overweight and obese children produced less good test results and markedly lower improvements in all tasks. Physical fitness is a powerful predictor of mortality among adults (Myers *et al.*, 2002). In the present study, overweight and obese children failed to increase their endurance performance capacity in contrast to those who were normal weight or underweight. As excessive childhood weight can lead to severe cardiovascular problems in adult life, a more active everyday life would be desirable. However, there is a paucity of comparable and longitudinal studies among children and adolescents.

In addition, it is extremely difficult for school-based programmes to encourage overweight and obese children in an adequate way to change their lifestyle. Faith and colleagues (Faith, Leone, Ayers, Moonseong, & Pietrobelli, 2002) reported that children who are the targets of weight criticism by peers have negative attitudes towards exercise and report reduced physical activity levels. This may result in increasing sedentary habits and motor deficits. To break this vicious circle, special programmes are needed, such as our programme for overweight and obese primary school children (Graf *et al.* 2005a, 2005b). The increased BMI of 40 overweight and obese primary school children was lower than in controls; a reduction in endurance performance was not detectable after the intervention (cooking and exercising twice a week for nearly 9 months).

There are potential limitations to our study. The schools were not randomly assigned to intervention and control groups. Therefore, existing baseline differences between the intervention and control group in selected parameters became evident. The measures were not implemented by the teachers as required, but whether this would lead to clearer results can only be speculated upon. We did not examine health knowledge after the intervention, or the nutritional habits of the children and their families. Knowledge of a healthy lifestyle and learning about the health benefits of preventive care, and appropriate personal behaviour, should encourage pupils to protect their health over a lifetime and therefore have a better chance of remaining healthy throughout their lives.

Conclusion

Preventive intervention in primary schools offers a potentially effective means to improve coordinative skills in childhood. The incidence of overweight and obesity was not affetcted. We speculate that by using adequate measures excessive weight gain in children can be prevented; the BMI increase was lower in intervention than control schools. However, such measures as those applied in the intervention in this study need to be intensified and the familiy environment, especially parents, has to be integrated to a greater extent.

Acknowledgements

We acknowledge the AOK Rheinland/Hamburg (Cologne Office), the Förderverein des Herzzentrums Köln, our students, the teachers, parents, and school children for all their support. We would also like to thank Steve Marlow and Christiane Klose for critically reviewing the manuscript.

References

Allison, D. B., Fontaine, K. R., Manson, J. E., Stevens, J., & VanItallie, T. B. (1999). Annual deaths attributable to obesity in the United States. *Journal of the American Medical Association*, *282*, 1530–1538.

Beck, J., & Bös, K. (1995). *Normwerte der motorischen Leistungsfähigkeitsfähigkeit (Standardized values of motoric performance)*. Cologne: Sport und Buch Strauß.

Bös, K. (2001). *Motorische Tests (Motoric tests)* (2nd ed.). Göttingen: Hogrefe.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, *320*, 1240–1243.

Faith, M. S., Leone, M. A., Ayers, T. S., Moonseong, H., & Pietrobelli, A. (2002). Weight criticism during physical activity, coping skills, and reported physical activity in children. *Pediatrics*, *110*, 1–8.

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

Graf, C., Koch, B., Falkowski, G., Jouck, S., Christ, H., Bjarnason-Wehrens, B. et al. (2005a). Effects of a school-based intervention on the BMI and motor abilities in childhood (mid point data of the CHILT-Project). *Journal of Sport Science and Medicine*, *4*, 291–229.

Graf, C., Rost, S. V., Koch, B., Heinen, S., Falkowski, G., Dordel, S. et al. (2005b). Data from the StEP TWO program showing the effect on blood pressure and different obesity parameters in primary school children. *Cardiology in the Young*, *15*, 291–298.

Kahn, E. B., Ramsey, L. T., Brownson, G., Heath, G. W., Howze, E. H., & Powell, K. E. (2002). The effectiveness of interventions to increase physical activity: A systematic review. *American Journal of Preventive Medicine*, *22*, 73–101.

Kavey, R. E. W., Daniels, S. R., Lauer, R. M., Atkins, D. L., Hayman, L. L., & 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. *et al.* (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).

Manios, Y., Moschandreas, J., Hatzis, C., & 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., & 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.

McKenzie, T. L., Sallis, J. F., Prochaska, J. J., Conway, T. L., Marshall, S. J., & Rosengard, P. (2004). Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Medicine and Science in Sports and Exercise*, *36*, 1382–1388.

Moore, L. L., Lombardi, D. A., White, M. J., Campbell, J. L., Oliveria, S. A., & Ellison, R. C. (1991). Influence of parents' physical activity levels on activity levels of young children. *Journal of Pediatrics*, *118*, 215–219.

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

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

Nader, P. R., Stone, E. J., Lytle, L. A., Perry, C. L., Osganian, S. K., Kelder, S. *et al.* (1999). Three-year maintenance of improved diet and physical activity: The CATCH cohort. Child and Adolescent Trial for Cardiovascular Health. *Archives of Pediatrics and Adolescent Medicine*, *153*, 695–704.

Power, C., Lake, J. K., & Cole, T. J. (1997). Measurement and long-term health risks of child and adolescent fatness. *International Journal of Obesity*, *21*, 507–526.

Sallis, J. F., McKenzie, T. L., & Alcaraz, J. E. (1993). Habitual physical activity and health-related physical fitness in fourth-grade children. *American Journal of Diseases of Children*, *147*, 890–896.

Schilling, F. (1974). *Körperkoordinationstest für Kinder. KTK Manual (Body coordination test for children. KTK Manual)* (pp. 8–53). Weinheim: Beltz Test GmbH (in German).

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

Summerbell, C. D., Ashton, V., Campbell, K. J., Edmunds, L., Kelly, S., & Waters, E. (2003). *Interventions for treating obesity on children.* Cochrane Library, Issue 3. Chichester, UK: Wiley.

Summerbell, C., Waters, E., Edmunds, L., Kelly, S., Brown, T., & Campbell, K. (2005). *Interventions for preventing obesity in children*. Cochrane Database Systematic Review (3): CD001871.

van Beurden, E., Barnett, L. M., Zask, A., Dietrich, U. C., Brooks, L. O., & 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.

Weinstein, N. D., Rothman, A. J., & Sutton, S. R. (1998). Stage theories of health behavior: Conceptual and methodological issues. *Health Psychology*, *17*, 290–299.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine*, *337*, 869–873.

Working Group on Obesity in Childhood and Adolescence (2004). *Guidelines* (Arbeitsgemeinschaft Adipositas im Kindes- und Jugendalter Leitlinien) (in German).