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RELATIONS BETWEEN SOCIAL INEQUALITIES AND EFFECTS OF INCREASED AVAILABILITY OF PHYSICAL EDUCATION ON CHILDREN´S HEALTH – A LONGITUDINAL STUDY OF ELEMENTARY SCHOOLS

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Abstract

The obesity crisis and health inequalities among children have directed the attention of policymakers to school-based interventions. Accordingly, the state government of North Rhine-Westphalia commissioned a pilot project amongst daily PE classes in primary schools. An evaluation study was conducted testing 520 children from seven project schools and 142 children from non-project schools over a four-year period. Body mass index (BMI) served as an indicator of the children's health status. Further health-related aspects were measured in terms of motoric capacities. Moreover, sports club participation was measured. The results suggest that the daily PE class does not represent a universal remedy for specific health deficits. However, disadvantaged children - in particular girls - might benefit from school-based interventions.

Key words: *School-based interventions, obesity, health, SES, primary schools, physical education, evaluation study, childhood*

Introduction

There is growing concern about the health status of children in developed societies. First, an obesity crisis among children, which appears to be linked to lack of physical activity, is likely to cause different diseases, premature mortality and long-term morbidity [31: 12]. Meta-analysis suggests that being overweight increases the risk of cardiovascular diseases among school-aged children [10].

Second, secular trends in living conditions, in particular a sedentary lifestyle, and social inequalities appear to result in a lack of physical activity, especially among children and adolescents with lower socioeconomic status (SES) [1; 2]. This is particularly detrimental since children's health benefits from physical activity in numerous ways [9; 17; 30].

Thus, policymakers have directed their attention to school-based interventions as they can involve every child in health-related interventions regardless of SES [32] and can use the superior infrastructure provided by the school setting [10]. However, the efficacy of these interventions is controversial. Thus, the research presented here reports on the evaluation of a school-based intervention initiated by the government of North Rhine-Westphalia. The results are particularly interesting because of the longitudinal quality of the data gathered and the character of North Rhine-Westphalia as one of the most densely and diversely populated German federal states.

Background

The impact of secular trends in living conditions and social inequalities on the health and physical activity of German children and youngsters has been controversially discussed [26]. Whereas participation rates in sports clubs have increased and new forms of physical activity have emerged [28], there seems to be a general lack of exercise, a decline in physical activity and motoric capabilities, which are likely to have detrimental health consequences [4].

In addition, the impact of SES on children's health, fitness and motoric capabilities is debated. SES correlates with children's motoric capabilities [19; 26;]. Moreover, sports club membership among children and youngsters in Germany persistently shows a strong middle-class bias [19; 21;], which is problematic because sports club membership correlates with better motoric capabilities [27]. These social inequalities have gained increasing attention because Germany is experiencing an obesity crisis leading to negative medical and psychosocial consequences [7; 12;]. Obesity is also more prevalent among children with a lower SES [cf. 24; 25].

Therefore, the German federal government has commissioned basic research [5; 22] and is pursuing a coordinated strategy to address children's health [6]. However, school education falls under the jurisdiction of the German federal states. Thus, the pilot project reported here was commissioned by the state government of North Rhine-Westphalia. The project aimed to increase the provision of methodically instructed exercise sessions and to help schools to establish an exercise-focused profile. Thus, between the school terms of 2004/05 and 2007/08, 25 pilot primary schools implemented a daily PE class.

Notwithstanding the good arguments in favour of school-based interventions, the evidence for their efficacy is ambiguous. An early meta-review suggested that school-based interventions are effective across diverse settings and target populations [18]. The same conclusion seems to apply to after-school programs [3]. The majority of studies on school-based interventions reported positive effects on motor performance, physical activity and knowledge of physical activity and suggested a positive impact on BMI [8; 20]. However, the effects of interventions appeared to be small to negligible [23]. Interventions had limited success in reducing BMI or body fat in children [13; 15]. Moreover, intervention effects appear to differ for target populations. Accordingly, girls benefit most but so too do participants with higher SES [10; 8; 16]. However, evidence on the effects on specific target populations is far from conclusive.

Thus, this study evaluates the effect of a daily PE class program on health status as well as on physical ability and activity. Thus, we hypothesise:

H#1: Children from primary schools participating in the 'daily PE class programme' experience an improvement in health status, motoric skills and physical activity as the program proceeds.

In accordance with previous research, we expect to find a gender effect:

H#2: Any improvement in health status, motoric skills and physical activity should be higher for girls.

Finally, as school-based interventions are intended to compensate for disadvantages resulting from low SES, we test the following hypothesis:

H#3: Any improvement in health status, motoric skills and physical activity should be higher for children with low SES.

Methods

Evaluation study

The daily PE program required the schools to start in the school term 2004/05. Each of the five PE classes per week had to fit into the PE curriculum for the respective grade. Since the schools enjoyed substantial leeway for implementing the daily PE class, the research presented here represents an evaluation but not an interventive study [28]. The evaluation team collected data in February and March 2005, again at the beginning of the third school year (September 2006) and in the fourth school year a few months before the end of the project in February and March 2008. Here, only a fraction of the conducted data is presented.

School sample

The original 25 participating primary schools were sampled to represent the variety in regional settings and primary schools in North Rhine-Westphalia. Factors that were systematically varied included location, SES, infrastructure and resources. After two schools had dropped out, seven of the remaining 23 schools were selected for an in-depth evaluation. In addition, a control group consisting of two non-participating schools was studied. Thus, the design of the evaluation study followed a longitudinal quasi-experimental logic [2].

Schools were required to assess the SES of their children by rating the share of immigrant children, parental income and the school's social neighbourhood on scales ranging between 1 ('low') and 6 ('high'). These variables were used to construct an index of the SES of a school's intake after the original scores had been recoded. The variables were combined as follows: A 'high SES' was coded when income and social environment were considered high and immigrant share low, a 'medium SES' was coded if all of the variables assumed medium values, and finally, a 'low SES' was coded if income and social neighbourhood were considered to be low and immigrant share to be high. Six of the 23 participating schools were considered as having an intake with a high SES, twelve as having a medium SES intake and five as having a low SES intake. The high and low SES groups show substantial homogeneity (cf. Table 1).

Table 1: Social background of participating and non-participating schools' intake

School ID	Partici-pation	included in evaluation study	Social background	Neighbourhood score (original)[a]	Neighbourhood score (recoded)[b]	Parental income score (original)[a]	Parental income score (recoded)[b]	Immigrant share score (original)[a]	Immigrant share score (recoded)[b]
14	yes	no	High	4	High	4	High	2	Low
21	yes	no	High	4	High	4	High	1	Low
24	yes	no	High	4	High	4	High	1	Low
17	yes	no	High	4	High	3	Medium	2	Low
27	yes	no	High	4	High	3	Medium	2	Low
5	yes	yes	High	4	High	3	Medium	1	Low
13	yes	no	Medium	3	Medium	3	Medium	6	High
16	yes	no	Medium	3	Medium	3	Medium	5	High
11	yes	no	Medium	3	Medium	3	Medium	4	Medium
12	yes	no	Medium	3	Medium	3	Medium	3	Medium
8	yes	yes	Medium	3	Medium	3	Medium	2	Low
26	yes	no	Medium	3	Medium	3	Medium	2	Low
3	yes	yes	Medium	3	Medium	3	Medium	1	Low
25	yes	no	Medium	3	Medium	3	Medium	1	Low
19	yes	no	Medium	3	Medium	2	Low	2	Low
20	yes	no	Medium	3	Medium	2	Low	2	Low
1	yes	yes	Medium	2	Low	2	Low	2	Low
22	yes	no	Medium	2	Medium	2	Low	2	Low
9	no	yes	Medium	3	Medium	3	Medium	2	Low
6	yes	yes	Low	3	Medium	2	Low	6	High
4	yes	yes	Low	2	Low	2	Low	6	High
18	yes	no	Low	2	Low	2	Low	5	High
7	yes	yes	Low	2	Low	2	Low	3	Medium
23	yes	no	Low	1	Low	1	Low	4	Medium
10	no	yes	Low	2	Low	2	Low	3	Medium

Note: a. Likert scale with 1 = 'Low' and 6 = 'High'. b. Recoding procedure is described in the text.

Study population

A total of 520 children from the seven project schools were tested over a four-year period; within the two non-participating schools a control group of 142 children were tested. Gender shares remained constant across all panel waves (girls = 49.77%, boys = 50.23%). The average age equalled at t_1 6.65 years (SD = 0.58), at t_2 8.33 years (SD = 0.52) and at t_3 9.75 years (SD = 0.61).

The body mass index (BMI) was used as an indicator of the children's health status. Since BMI cannot be treated as a continuous dependent variable, a binary variable was generated: *Normal BMI* assuming the value of '1' for all BMI values between the 10^{th} and 90^{th} percentile of the reference sample, and '0' for all BMI values outside this range. Thus, '0' indicates both underweight and overweight.

The coordinative performance of the children was measured by the Dortmund Coordinative Test for Primary School Pupils [29]. The test distinguishes the ability to coordinate under time pressure (*CuTP*) and the ability for exact motor control (*EMC*). The *CuTP* was measured by the time needed for directing a rubber ring through a slalom course and by the time needed to jump a distance of 20 metres while changing landing legs and direction. Since the mean values of the two tests did not differ significantly, the two values were summarized.

EMC was measured by Likert scales ranging from zero to five for assessing the children's performance in jumping into a standing position, where the children were required to jump into a hoop and to stand on the landing leg for 10 seconds. Furthermore, the children were required to jump rhythmically over a course while continuously switching from one-legged hopping to two-legged jumping. The point values achieved in the two tasks were summarized. Finally, sports club participation was measured by a survey item (*Club*).

The longitudinal quality of the data allowed the creation of a panel data set. Since only effects of the daily PE class program are of interest, we use fixed effect models for estimating the magnitude of causal factors, because these models are unbiased and consistent. Yet, time-invariant variables are excluded [14].

In the multivariate analyses performed, *BMI*, *CuTP, EMC* and *Club* served as dependent variables. The set of independent variables comprises dummy variables for schools participating in the daily PE class project (*Daily PE*), low social status background intake (*Low*) and sex (*Sex*) and a time period variable (*Time*).

Results

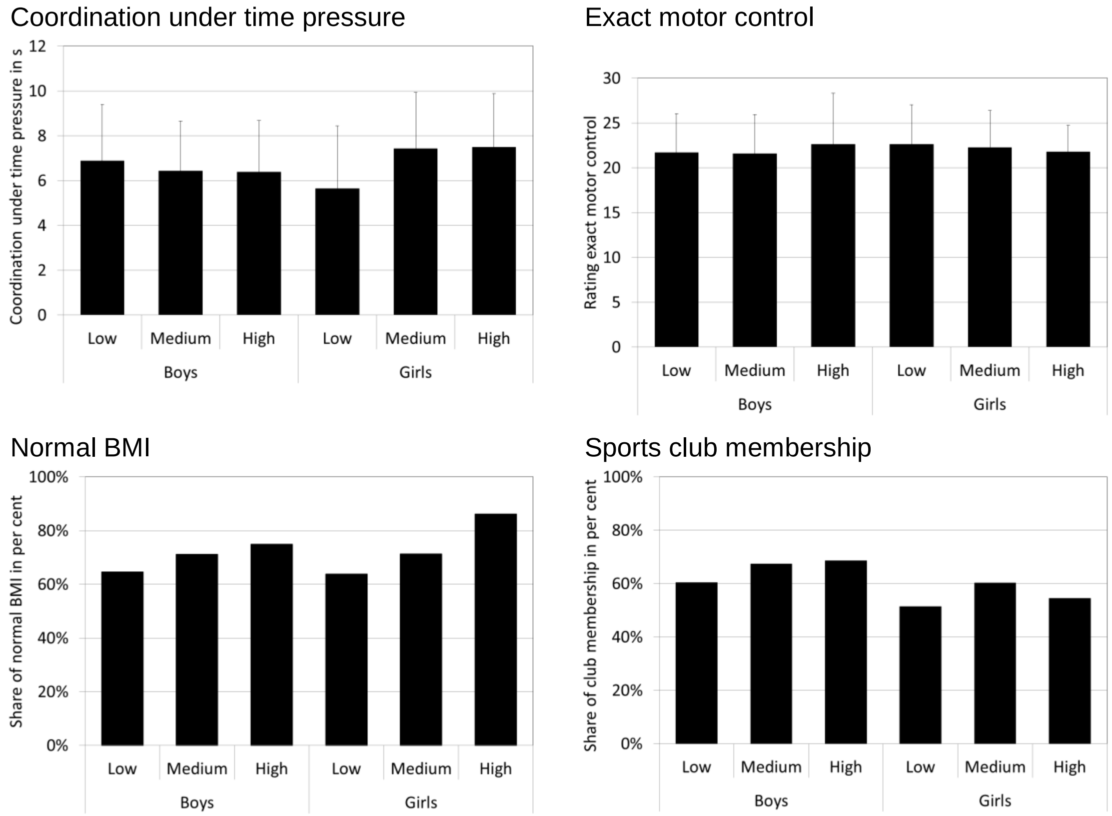
Descriptive analysis contradicts claims of an obesity crisis since children have increasingly reached normal weight. However, motoric capabilities have declined over time, although sports club participation has increased (cf. Table 2).

Table 2. Descriptive statistics for each panel wave

Variables	T_1	T_2	T_3
Age (in years)	6.65 ± 0.58	8.33 ± 0.52	9.75 ± 0.61
Sex (share)			
Girls	49.77	49.77	49.77
Boys	50.23	50.23	50.23
Socio-economic status			
Low	42.45	42.45	42.45
Medium	53.62	53.62	53.62
High	3.93	3.93	3.93
Coordination under time pressure	5.65 ± 2.38	7.11 ± 2.18	8.38 ± 1.87
Exact motor control	25.84 ± 4.33	21.18 ± 2.72	18.88 ± 2.12
Normal BMI (share)	63.22	71.60	71.12
Sports club membership (share)	41.73	68.60	69.81

Graphical depiction suggests that SES seems to influence coordination under time pressure (*CuTP*) for boys but not for girls. The ability for exact motor control (*EMC*) declines with higher SES for girls but not for boys. For both sexes, the likelihood of achieving normal weight increases with SES. Higher SES seems also to increase the likelihood of sports club membership for boys but not for girls (*Club*) (cf. Figure 1).

Figure 1. Motoric skills, normal BMI and sports club membership according to gender and SES



Note: Data from several panel waves were pooled, ‘low’, ‘medium’ and ‘high’ refer to SES.

Multivariate analyses with the pooled data set confirmed that there is a strong sex and age effect but no SES effect on *CuTP*; in contrast *EMC* is dependent on sex, age and SES. The likelihood of gaining normal *BMI* is dependent on SES and age but not on children’s sex, whilst for *Club* membership all three independent variables are relevant (cf. Table 3). Thus, children with higher SES perform better in every respect. Girls perform worse than boys in terms of coordination under time pressure but better in exact motor control and are less likely to be members of sports clubs. While motoric capabilities decrease with age, the likelihood of having normal weight and of being a sports club member increases with age.

Table 3. Multivariate analyses with the pooled dataset

Independent variables	**CuTP**[a]	**EMC**[a]	**BMI**[b]	**Club**[b]
Constant	0.468	38.378***	-0.181	-2.091***
	(0.356)	(0.559)	(0.360)	(0.341)
SES[c]	-0.167	-0.154***	0.351**	0.270**
	(0.100)	(0.157)	(0.103)	(0.098)
Sex[d]	0.886***	0.514**	0.055	-0.360**
	(0.113)	(0.177)	(0.114)	(0.110)
Age	0.762***	-2.019***	0.089*	0.312***
	(0.041)	(0.065)	(0.042)	(0.041)
N	1,424	1,419	1,426	1,463
Adjusted R^2 (Pseudo R^2)	0.216	0.407	0.009	0.041

Note: CuTP = Cooordination under time pressure, EMC = Exact motor control, BMI = Normal BMI, Club = Sports club membership. Standard errors in parentheses. a. OLM regression. b. Logistic regression. c. Socio-economic status, low SES=0, medium SES=1, high SES=2; d. Dummy variable, female=1, male=0.
*p < 0.05, **p < 0.01, ***p < 0.001.

Panel analyses are conducted in three steps: First, the models include only the variable *Time* and interactions with *Daily PE* (models a). Then, interactions with *Low SES* and *Sex* were added to account for conditional effects of the daily PE class program on children from a low social background and on girls (models b). Finally, the interaction term *Low SES×Sex* was included to account for the possibility that girls from a low social background would benefit most from the program (models c).

Table 4. Capacity for coordination under time pressure

Independent variables	Model 1a	Model1b	Model1c
Constant	4.374***	4.385***	4.384
	(0.129)	(0.129)	(0.129)
Time	1.353***	1.506***	1.741***
	(0.129)	(0.231)	(0.269)
Time×Daily PE	-0.022	-0.336	-0.556
	(0.147)	(0.257)	(0.297)
×Low SES			
Children from *non-participating* schools with low social background		0.128	-0.390
		(0.260)	(0.400)
Children from *participating* schools with low social background		0.166	0.127
		(0.143)	(0.203)
×Sex			
Girls from *non-participating* schools		-0.362	-0.762*
		(0.262)	(0.351)
Girls from *participating* schools		0.190	0.159
		(0.140)	(0.181)
×Low SES×Sex			
Girls from *non-participating* schools with low social background			0.895
			(0.526)
Girls from *participating* schools with low social background			0.077
			(0.286)
N	1,489	1,484	1,484
R^2_{Within}	0.363	0.367	0.370
$R^2_{Between}$	0.153	0.143	0.116
$R^2_{Overall}$	0.211	0.213	0.196

Note: Method is fixed effects regression using the xtreg command in STATA, standard errors in parentheses.
*p < 0.05, **p < 0.01, ***p < 0.001.

Since high values for *CuTP* indicate fewer coordinative skills, an improvement in children's performance by the daily PE class program would be reflected by a negative sign of the coefficient for *Time×Daily PE*. While children's performance decreases over time, none of the models strongly supports the idea of a significant improvement effect of the daily PE class. Only in the final model is the coefficient for the daily PE program negative and almost significant (*p*=0.061). Yet, the coefficient signs for the interaction terms for *Daily PE×Time×Low SES* and *Daily PE×Time×Sex* are at odds with theoretical expectations.

For *ECM*, where higher values denote better skills, the coefficient for the interaction *Daily PE×Time* should be positive and significant (cf. Table 5). Again, abilities decline over time, and evidence for a positive effect of the daily PE class is rather weak. The only significant effect found in the final model (model 2c) is that non-participating girls with low SES experience a decline in their ability for exact motor control. The positive effect of program participation on participating girls is almost significant (*p*=0.054). Thus, the daily PE class might have prevented a decline in the motoric skills of participating girls.

Table 5. Capacity for exact motor control

Independent variables	Model 1a	Model1b	Model1c
Constant	28.648***	28.655***	28.657***
	(0.163)	(0.161)	(0.161)
Time	-3.241***	-2.599***	-2.980***
	(0.164)	(0.289)	(0.334)
Time×Daily PE	-0.126	-0.679*	-0.383
	(0.186)	(0.321)	(0.369)
×Low SES			
Children from *non-participating* schools with low social background		-0.908**	-0.045
		(0.326)	(0.503)
Children from *participating* schools with low social background		-0.540**	-0.315
		(0.179)	(0.254)
×Sex			
Girls from *non-participating* schools		-0.409	0.250
		(0.329)	(0.440)
Girls from *participating* schools		0.257	0.434
		(0.175)	(0.225)
×Low SES×Sex			
Girls from *non-participating* schools with low social background			-1.484*
			(0.660)
Girls from *participating* schools with low social background			-0.444
			(0.356)
N	1,482	1,478	1,478
R^2_{Within}	0.693	0.700	0.702
$R^2_{Between}$	0.311	0.253	0.239
$R^2_{Overall}$	0.427	0.390	0.380

Note: Method is fixed effects regression using the xtreg command in STATA, standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

Table 6. Likelihood of normal BMI

Independent variables	Model 3a	Model 3b	Model 3c
Time	-0.406	-0.225	-0.000
	(0.279)	(0.429)	(0.463)
Time×Daily PE	0.844**	0.322	-0.037
	(0.300)	(0.463)	(0.501)
×Low SES			
Children from *non-participating* schools with low social background		-0.236	-0.840
		(0.570)	(0.784)
Children from *participating* schools with low social background		0.360	0.733*
		(0.230)	(0.329)
×Sex			
Girls from *non-participating* schools		-0.167	-0.892
		(0.578)	(0.878)
Girls from *participating* schools		0.388	0.725*
		(0.228)	(0.311)
×Low SES×Sex			
Girls from *non-participating* schools with low social background			1.441
			(1.213)
Girls from *participating* schools with low social background			-0.779
			(0.469)
N	477	477	477
MacFadden Pseudo R^2	0.054	0.072	0.085
Cox and Snell Pseudo R^2	0.038	0.051	0.060

Note: Method is fixed effects logistic regression using the xtlogit command in STATA, standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

For examining the program's effect on the likelihood of achieving normal weight (*BMI*), we conducted several logistic panel regressions, which required excluding cases without variation in weight status (cf. Table 6). According to the basic model, the probability of children having a normal BMI declines significantly over time while program participation increases the likelihood (model 3a). The final model suggests that the probability of gaining normal weight significantly increases for participating children with a low SES, and in particular girls (model 3c).

Table 7. Likelihood of sports club membership

Independent variables	Model 4a	Model 4b	Model 4c
Time	0.958***	0.365	0.113
	(0.231)	(0.425)	(0.478)
Time×Daily PE	0.093	0.875	0.971
	(0.261)	(0.479)	(0.535)
×Low SES			
Children from *non-participating* schools with low social background		0.335	0.781
		(0.481)	(0.651)
Children from *participating* schools with low social background		-0.208	0.130
		(0.246)	(0.373)
×Sex			
Girls from *non-participating* schools		0.814	1.300
		(0.483)	(0.687)
Girls from *participating* schools		-0.179	0.101
		(0.247)	(0.334)
×Low SES×Sex			
Girls from *non-participating* schools with low social background			-0.984
			(0.956)
Girls from *participating* schools with low social background			-0.609
			(0.498)
N	639	639	639
MacFadden Pseudo R²	0.250	0.259	0.264
Cox and Snell Pseudo R²	0.166	0.172	0.175

Note: Method is fixed effects logistic regression using the xtlogit command in STATA, standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Finally, the effect of the daily PE class on sports club membership was assessed. In short, the results contradict the idea that the program increased the probability of club membership (Table 7).

Discussion

Widespread concerns about a so-called obesity crisis, declining physical activity, deteriorating motoric capabilities among children and their detrimental long-term health effects have inspired policymakers to initiate school-based interventions in order to promote physical activity. Given the controversial efficacy of such programs, the research presented here evaluates the 'Daily PE Class' – a program initiated by the federal state of North Rhine-Westphalia.

First, the data cast doubts on the concept of an obesity crisis, although motoric capabilities seem to decline. The data support the idea that SES is relevant for children's health status, motoric capabilities and sports club participation. However, SES impact differs according to sex.

The study supports only to a limited extent optimism for school-based intervention programs. Consistent evidence for a positive impact of the daily PE program was found for the children's likelihood of achieving normal BMI. The idea that girls should particularly benefit from a school-based intervention received some support. According to the analyses, girls from participating schools had a higher likelihood of achieving normal weight. Other findings contradicted expectations concerning gender effects.

Finally, expectations of greater program benefits for children with a low SES received only very limited support. The program appears to have reduced the decrease of motoric skills among girls with a low SES. In addition, the likelihood of participating children with low SES achieving normal BMI increased.

Taken together, the findings support further scepticism regarding the efficacy of school-based intervention programs. The daily PE class did not result in significant improvements in motoric capabilities, health status or sports club participation across the entire population of participating children. However, specific target populations that are less likely to participate in sports clubs might benefit from school-based intervention programs.

Three methodological limitations have to be mentioned. First, leeway in implementation inevitably implied some uncontrolled variation between schools. Second, SES was only measured at the school and not at an individual level. Finally, the evaluation study did only focus on one dimension of motoric capabilities.

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