

PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENT IN NORWAY

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ABSTRACT

The present study investigates how physical activity (PA) in different arenas (organized sport, PA within school hours, general PA outside school) is related to academic achievement in Norwegian secondary schools. The study underscores the importance of separating those who participate in organized sport from those who have withdrawn and those who never have participated. Defining sport as a highly structured spare time activity, the study also controls for participation in alternative activities such as performing arts. Students in 9th, 11th and 12th grade were included in the study (N=1788); 48.42% were girls. Self-reported grades in three subjects, mathematics, language and physical education (PE), served as dependent variables in three separate multivariate regression analyses. Independent variables included different arenas of PA, performing arts, mothers' and fathers' educational level, living conditions, screen-time, homework, diet and BMI. All three multivariate regressions, for mathematics ($F=30.57, p<0.01, R^2=0.194$), language ($F=32.67, p<0.01, R^2=0.205$), and PE ($F=55.94, p<0.01, R^2=0.306$), were statistically significant with good explanatory power. There was a positive co-variation between participation in organised sport and grades in mathematics, language and PE for students who are successful in sport. Students who withdraw from sport, on the other hand, are not able to capitalize in terms of better grades. General PA outside school hours had no impact on grades in mathematics and language. However, there is a positive co-variation between PA conducted within school hours and grades in all three subjects. PA outside of school hours does not contribute to higher academic achievement. Still, there are qualities to organized sport and other spare time activities, together with social background and other life-style variables, that pay off in terms of higher academic achievement. Within school hours both PE and school meals are possible tools that can be utilized to improve academic achievement

Keywords: Academic achievement, physical activity, physical education, organized sport.

1. INTRODUCTION

In the Norwegian context it is well documented that school reproduces inequality in academic achievement. Girls achieve better compared to boys in most subjects, with the exception of PE, where boys receive better grades than girls (Ekren, Aanerud, & Tuhus, 2014; Steffensen & Ziade, 2009). Another general finding is that children with parents who have attained higher education/higher socioeconomic class have higher academic achievement (Andersen, 2009; Hægeland, Kirkebøen, Raaum, & Salvanes, 2013; Tuhus, 2013; Wiborg, Arnesen, Grøgaard, Støren, & Opheim, 2011). Family structure is also of importance, showing that children who lives with married parents receive better grades than children living with parents who are cohabitants. Children who live with only one parent have even poorer grades (Lauglo, 2008).

The reproduction of social inequality in this context implies that factors outside the school context are of importance, and that school political instruments, e.g. competence building of teachers, better teaching quality and learning environment, have limited impact (Wiborg et al.,

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2011). In recent years physical activity (PA), often in combination with diet, has received a lot of attention in large interventions studies throughout the western world; Scandinavia (Andersen and Froberg 2006; Ericsson and Karlsson 2014; Samdal et al. 2008), Canada (Shephard, 1997; Shephard, 1996), Australia (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001), and USA (Sallis et al., 1999). This paper will not go into depth on results of single studies. Rather it will concentrate on central findings in several newer review- and meta-studies. Keeley and Fox (2009), and Trudeau and Sheppard (2008), focus on physical education (PE) and concludes that there is no support for more hours of PE having a positive impact on academic achievement. Both reviews also underscore that there are no implications of more hours of PE leading to poorer grades in other subjects. Thereby lending support to more hours of PE providing relatively better grades pr. time-unit. The documentation of several other positive effects stemming from PE leads to the advice of more time allocated to PE. A report from the Department of Health and Human Services (CDC, 2010), points out that it is necessary to distinguish between different types of PA within the school context: PE, recess, in classes other than PE, and extracurricular PA. The report concludes that 51% of the studies show a positive relationship between academic achievement and PA, 48% show no relationship, and 1,5% show a negative relationship.

Two more recent reviews lend support to PA having a positive impact on academic achievement (Biddle & Asare, 2011; Singh, Uijtdewilligen, Twisk, van Mechelen, & Chinapaw, 2012). However, it is noted that there are few studies of high quality, the relationship is often weak and inconsistent, and therefore conclusions should be tentative. It is also noted that most studies in the reviews deals with PA within the school context, and that there is less knowledge about the impact of PA on other arenas. The newest large review includes studies in the time period 1954 to 2012 (Howie & Pate, 2012). The review highlight that the quality of research has become better the last five years. The review concludes that a majority of studies argues for a positive relationship between PA and academic achievement. Authors still underscore that findings across studies are inconsistent and to a certain degree contradictory. Despite weak, contradictory findings, positive results are most often accentuated, leading to a word of caution in terms of possible bias.

This short literature review show that most studies report a positive relationship between PA, of some sort, and academic achievement. The relationship is weak and inconsistent, and there are warnings concerning weak designs and bias in how results are reported. Because of the “No child left behind” studies in USA have focused on uncovering possible negative effects of allocating more time to PE. So far studies have revealed no such negative effects, concluding that one can safely increase time in PE in order to harvest other positive effects (especially health effects), without resulting in a negative impact on academic achievement in other subjects. There is no standard measure of PA or academic achievement, underscoring problems with comparing results across studies due to different measures. Cross sectional studies often report a weak positive relationship between PA and academic achievement but cannot conclude about the causality in the relationship. Few studies consider PA outside the school context and lack a more nuanced understanding of organized sport in terms of participation and withdrawal. A more comprehensive understanding of PA conducted in different arenas is considered an important contribution to the literature. First, we can separate between PA within and outside of the school context. Second, within the school context we distinguish between PE, break time and PA in school hours other than PE (CDC, 2010). Third, outside of the school context we distinguish between organized sport, exercise outside organized sport (self-organized exercise, fitness centers and similar), and general PA level (Howie & Pate, 2012).

It is common to control for socioeconomic background, diet, BMI, and time spent on homework and sedentary activities (e.g. screen activities). Equivalent variables are included in this

study. Few studies control for young people's participation in other spare time activities that can function as an alternative to organized sport. According to Fredricks and Eccles (2006), it is relevant to control for other activities when investigating academic achievement, and in this study participation in the municipal School of Performing Arts (TKK) is included. This research paper investigated specifically how PA in- and outside the school context impacts academic achievement in terms of grades in mathematics, language and PE.

2. METHODS AND MATERIALS

2.1 Participants

This study uses data from the "Young in Trondheim" study (UngHit), a collaboration between Trondheim municipal authority, Sør-Trøndelag county authority, Sør-Trøndelag University College (HiST), and The Norwegian University of Science and Technology (NTNU). 9th, 11th and 12th grade of all public schools in Trondheim municipal participated in the survey. Only those respondents who answered all the questions relevant for the analysis were retained, providing a sample of N=1788 (48.42 percent girls), distributed with 337 students in 9th grade (51 percent girls), 669 students in 11th grade (49.60 percent girls), and 783 students in 12th grade (46.60 percent girls). In the analysis gender was coded girl=0 and boy=1. Because of large dropout all grades are collapsed in the analysis.

2.2 Procedure

The UngHit project has been approved by the Regional committee for medical and health related research ethics (REC). All 11 public high schools in Trondheim municipal participated in the study, and all students were invited to complete a self-report questionnaire, administered online through Questback. The questionnaire was made available within school hours for all students between weeks 40-44 in 2009. Each and every school made sure that there was sufficient time to complete the questionnaire. The survey was voluntary, and students could decline to take part. Students below 16 years of age needed parental consent to participate.

2.3 Criterion Measures

The survey included a range of items intended to measure different arenas of PA. Means and standard deviations of all measures used in the analysis are presented in Table 1.

2.3.1 Grades/academic Achievement: The adolescents reported their grades in three subjects: Norwegian, mathematics, and PE, where 1 is the worst possible and 6 is the best possible grade.

2.3.2 Educational Attainment and Living Conditions: Parents' educational attainment was measure on a 5-point scale: 1) less than high school, 2) high school, vocational subjects, 3) high school, general education, 4) College undergraduate, 5) College graduate. The question about living conditions was a yes/no question about living with both mother and father, with no coded as the reference (0).

2.3.3 Sport Participation and School of Performing Arts (TKK): Students were asked "*Are you or have you participated in one or more of the following clubs, prosocial activities or teams?*" Organized sport and TKK was two of several possible answers. The measure included three possible answers; 1) No, never participated, 2) Yes, I have participated but quit, and 3) Yes, I am still participating. The measure was dummy-coded with "No, never participated" as the reference (0).

2.3.4 General Physical Activity and Physical Activity at School: To measure general PA students were asked the following question: “*Outside school hours: how many hours a week do you take part in sports or exercise in a way that makes you out of breath and/or sweating?*” The item was rated on a 6-point scale: 1) none, 2) about 30 minutes, 3) about 1-1,5 hours, 4)2-3 hours, 5) 4-6 hours, 6) 7 hours or more. PA within the school context was measured on the same scale, asking the students: “*In classes and recess at school: how many hours a week do you take part in sports or exercise in a way that makes you out of breath and/or sweating?*”

2.3.5 Homework and Screen Related Activity: Students were asked how much time they spent on homework and screen activities during a day, responding on a 7-point scale: 1) less than 30 minutes, 2) 30-59 minutes, 3) 1-2 hours, 4) 3-4 hours, 5) 5-6 hours, 6) 7-10 hours, 7) more than 10 hours. Homework was measured with a single item: “Homework”. Whereas screen-time was constructed using three items: a) “watch TV (movies, series, and similar)”, b) “PC for chatting, games, video, and similar)”, and c) “Videogames (Xbox, Playstation, Nintendo, and similar)”. Entering the three variables in a principal component analysis produced a one-component solution with an eigenvalue of 1.28, explaining 42.57 percent of the variance. All three variables loaded above .6 on the component. The three variables were added together, and divided by the number of variables, to construct the variable screen-time

2.3.6 Diet and Body Mass Index (BMI): Diet was measure by asking students “How often do you eat lunch”, with four alternatives 1) never/rarely, 2) 1-3 days a week, 3) 4-6 days a week, 4) every day. The variable was dummy-coded with not every day as reference (0), and every day as comparison (1). BMI is measured through self-reported height and weight, entered in the formula of weight/height².

3. RESULTS

Table 1: Mean and (SD) for central variables (N=1788)

Variable [min-max-values]	9 th Grade		11 th Grade		12 th Grade		Total	
	Girls (N=172)	Boys (N=165)	Girls (N=331)	Boys (N=337)	Girls (N=365)	Boys (N=418)	Girls (N=868)	Boys (N=920)
Mathematics	4.35	4.36	3.94	3.74	3.91	3.81	4.01	3.88
[1-6]	(.97)	(1.00)	(1.18)	(1.21)	(1.15)	(1.22)	(1.14)	(1.20)
Language	4.31	3.99	4.50	3.96	4.28	3.91	4.37	3.94
[1-6]	(.79)	(.84)	(.92)	(.98)	(.77)	(.90)	(.84)	(.92)
Physical education	4.38	4.68	4.41	4.67	4.22	4.50	4.33	4.60
[1-6]	(.68)	(.68)	(.98)	(1.02)	(.82)	(.89)	(.86)	(.91)
Mothers' education	3.59	3.69	3.40	3.48	3.32	3.24	3.41	3.41
[1-5]	(1.07)	(1.00)	(1.11)	(1.00)	(1.16)	(1.15)	(1.13)	(1.08)
Fathers' education	3.70	3.76	3.44	3.44	3.35	3.25	3.45	3.41
[1-5]	(1.18)	(1.28)	(1.31)	(1.28)	(1.34)	(1.33)	(1.30)	(1.31)
PA Outside school	4.06	4.59	3.84	4.16	3.79	4.05	3.86	4.19
hours [1-6]	(1.46)	(1.36)	(1.46)	(1.65)	(1.59)	(1.63)	(1.52)	(1.60)
PA in school hours	2.80	3.03	2.79	2.82	2.71	2.74	2.76	2.82
[1-6]	(1.18)	(1.28)	(1.17)	(1.32)	(1.25)	(1.34)	(1.21)	(1.33)
Homework	2.98	2.61	2.57	2.03	2.52	1.95	2.63	2.10
[1-7]	(1.18)	(1.08)	(1.04)	(1.04)	(1.11)	(1.06)	(1.11)	(1.08)
Screen-time	2.32	2.74	2.33	2.76	2.31	2.84	2.32	2.79
[1-7]	(.71)	(.85)	(.72)	(.93)	(.69)	(.92)	(.71)	(.91)
BMI	19.30	19.43	21.02	21.54	21.47	22.09	20.87	21.41
	(2.24)	(2.33)	(2.56)	(2.70)	(2.86)	(2.75)	(2.75)	(2.83)

Table 1 show mean and standard deviation (SD) for variables entered as continuous variables in the analysis. Because there are only three grades included in the sample, and thus little variation concerning age, the three grades are collapsed in the following analysis.

Table 2: Correlations (N=1788)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Mathematics																
2. Language	.53*															
3. Physical education	.39*	.35*														
4. Gender	-.05*	-.24*	.15*													
5. Mothers' education	.26*	.28*	.18*	.00												
6. Fathers' education	.28*	.26*	.18*	-.02	.54*											
7. Living conditions	.16*	.10*	.14*	.05	.16*	.21*										
8. Withdrawn from sport	-.16*	-.06*	-.29*	-.07*	-.09*	-.10*	-.17*									
9. Participate in sport	.21*	.10*	.43*	.13*	.14*	.13*	.18*	-.79*								
10. Withdrawn from TKK	.06*	.13*	-.01	-.17*	.08*	.11*	.01	.03	-.01							
11. Participate in TKK	.12*	.11*	-.01	-.03	.12*	.15*	.08*	.03	-.07*	-.25*						
12. PA outside school hours	.17*	.13*	.43*	.11*	.16*	.16*	.14*	-.36*	.53*	.01	-.11*					
13. PA within school hours	.16*	.14*	.26*	.03	.12*	.10*	.08*	-.20*	.23*	-.00	.02	.31*				
14. Homework	.21*	.22*	.14*	-.24*	.16*	.21*	.11*	-.06*	.06*	.04	.14*	.09*	.09*			
15. Screen-activities	-.21*	-.22*	-.10*	.28*	-.14*	-.15*	-.08*	.03	-.04	-.08*	-.10	-.10*	-.08*	-.12*		
16. Lunch	.17*	.16*	.19*	-.03	.13*	.14*	.09*	-.07*	.11*	.01	-.01	.16*	.09*	.13*	-.14*	
17. BMI	-.16*	-.13	-.10*	.10*	-.12*	-.11*	-.06*	.04	-.06*	-.01	-.06*	.00	-.05*	-.07*	.09*	-.05*

* $p < .05$

Table 2 show mostly weak correlations between academic achievement and other variables. However, because the sample is relatively large the correlations are mostly statistically significant. Some of the strongest correlations are found between grades (math, language, PE), indicating that students either have good or bad grades in several subjects.

Table 3: Multiple regression models with grades in mathematics, language and PE as dependent variables (N=1788)

	Mathematics		Language		PE	
	B	Beta	B	Beta	B	Beta
Gender (girl=0)	.01	.004	-.34	-.19**	.25	.14**
Mothers' education	.11	.10**	.12	.15**	.02	.03
Fathers' education	.10	.11**	.06	.09**	.03	.05
Living conditions	.12	.05*	.03	.01	.02	.01
Organized sport (never participated=0):						
Withdrawn from sport	.07	.03	.11	.06	.15	.08*
Participate in sport	.39	.17**	.16	.09*	.55	.30**
TKK (never participated=0)						
Withdrawn from TKK	.12	.05*	.17	.08**	-.006	-.003
Participate in TKK	.27	.08**	.20	.08**	-.01	-.004
PA outside school hours	.002	.003	.03	.04	.12	.22**
PA during school hours	.06	.07**	.05	.07**	.08	.11**
Homework	.11	.11**	.07	.09**	.08	.10**
Screen-activities	-.18	-.13**	-.08	-.08**	-.06	-.06**
Lunch (not every day=0)	.18	.07**	.15	.08**	.15	.08**
BMI	-.04	-.10**	-.02	-.06**	-.02	-.08**
Constant	3.63	**	3.60	**	3.51	**
R ²	.194		.205		.306	
F	30.57**		32.67**		55.94**	

* $p < .05$, ** $p < .01$

Table 3 show results of separate regression analysis that include the three different grades as DV. For mathematics, the model explains 19.4% of the variance ($F=30.57$, $p < 0.01$), for language 20.5% ($F=32.67$, $p < 0.01$), and for PE and astonishing 30.6% of the variance ($F=55.94$, $p < 0.01$).

4. DISCUSSION

Results in the present study supports findings in previous studies showing that school reproduces inequality in academic achievement resulting from gender and social background (Bakken, Borg,

Hegna, & Backe-Hansen, 2008; Bakken & Elstad, 2012; Ekren et al., 2014; Hægeland et al., 2013; Steffensen & Ziade, 2009; Tuhus, 2013; Wiborg et al., 2011). Even though there are no gender differences concerning grades in mathematics, there are relatively strong differences in grades of language and PE, where girls have better grades in language and boys have better grades in PE. There is also a clear relationship between parents' level of education and grades in mathematics and language – higher level of education goes together with better grades. Clearly, academic achievement is related to variables outside the school context.

Does PA contribute to higher academic achievement? The answer to this question is not a simple yes or no. First, results show that general PA outside school hours is not related to grades in mathematics and language. However, we also need to consider that PA within school hours have a positive co-variation with grades in all subjects. These results could imply that PA conducted closely in time with theoretical subjects could contribute positively. Results are promising in terms of PA within school hours could serve as a tool to better academic achievement (Biddle & Asare, 2011; Singh et al., 2012).

How can we explain the consistent and relatively strong co-variation between organized sport and academic achievement? The first step towards an explanation starts with highlighting that the positive relationship only applies to students taking part in organized sport at the time of the survey. Students who have participated at an earlier time, and for some reason have decided to withdraw, do not have better grades in mathematics and language compared to students who have never participated in organized sport. This is interpreted in favor of the need to succeed in sport in order to harvest benefits in terms of academic achievement. Considering the large drop-out from organized sport during secondary and high- school (Seippel, Strandbu, & Sletten, 2011), relatively few students actually succeed in sports, and caution should be taken before displaying participation in sport as a favorable path towards higher academic achievement.

The second step towards an explanation involves understanding organized sport as something more than PA. Herein learning to work towards a long-term achievement goal and having to organize daily life in an efficient way in order to deal with school, organized sport, and other interests. Put differently, results could be interpreted in support of the executive functioning hypothesis, where organized sport have a positive impact in terms of choosing, organizing and initiate goal-directed behavior (Best, 2010; Tomporowski, Davis, Miller, & Naglieri, 2008). Such an interpretation could be connected to the positive co-variation between academic achievement and participation in TKK. Viewed this way PA is not the common denominator of performing well when playing an instrument or football, but concentrated practice and working towards a goal over time. Furthermore, there is a third step towards an explanation, but first we need to discuss some particularities concerning grades in PE and time-use outside school hours.

Results concerning grades in PE display a somewhat different pattern compared to mathematics and language. First, parents' level of education seems to have no importance, and second PA both inside and outside of the school context display a relatively strong co-variation with grades in PE. The higher level of PA for students inside and outside the school context, the better grades they receive in PE. This is interpreted in support of previous studies showing that PE is adapted in favor of students participating in organized sport, and boys in particular (Ingebrigtsen & Mehus, 2006). However, students who have withdrawn from organized sport receive better grades in PE when compared to students who have never participated, showing that previous participation in organized sport produce gains in terms of better grades.

Results show a clear positive co-variation between time spent on homework and grades in all subjects. Time-use on screen activities goes in the opposite direction - students who spend a lot of time on TV, video-games and social media get worse grades. Descriptive statistics in Table 1 show that girls spend more time doing homework and less time on screen-activities compared to boys. Table 1 also show that time-use on homework reaches its peak in 9th grade, before

descending during high school. In the included sample, girls in 9th grade spend most time on homework and the least time on screen activities. This might indicate that screen activities replace homework to a certain degree during adolescence, which could impact academic achievement negatively.

Following Farb and Matjasko (2012), controlling for more than one organized spare time activity, in terms of TKK, has been an important issue in this study. TKK and organized sport are highly structured, controlled by adults, and performance focused (Mahoney, Eccles, & Larson, 2004). Results show that participation in TKK have positive co-variation with grades in mathematics and language. The positive relationship also applies to students withdrawing from the activity, which contrasts with findings related to organized sport. These findings are highlighted because it is well documented that organized sport is not able to provide an offer suited for all children and youth (Ingebrigtsen & Mehus, 2006; Seippel et al., 2011). It is of value to show that there are alternative spare time activities that impacts academic achievement in a positive way - especially for those young people who can't succeed in sport.

How, then, can we explain that young people who withdraw from sport are not collecting benefits in terms of better grades in mathematics and language when this is the case for students who have participated in TKK? One possible explanation is related to different content in the activities with organized sport focusing on win/lose. It is plausible that students not succeeding in sport are left with a stronger feeling of being unsuccessful and a weakened sense of self assessment, compared to students who withdraw from TKK. Data in the present study does not allow for a closer investigation of this hypothesis, but would be interesting to follow up in later studies. Another possible explanation concerns recruitment, specifically skewness in recruitment and withdrawal. Over 90 percent of students in this sample have experiences from organized sport, supporting the fact that organized sport in Norway recruits almost all children and youth across social background (Ingebrigtsen & Aspvik, 2010). Correlations (Table 2), show a negative relationship between parents' educational level and withdrawal from sport. This is interpreted in terms of wide sport recruitment, and that students from families without higher education withdraw at a higher rate. On the other hand, there is a positive correlation between parents' educational level and withdrawal from TKK. TKK recruit fewer students, and mostly students from families with higher education, and in the end these students withdraw. The point being that TKK recruits with a larger skewness compared to organized sport, and that better grades in mathematics and language not necessarily is about participation in a concrete activity. This line of thought leads us to the third step of explaining why participation in organized sport leads to higher academic achievement.

In addition to time use on spare time activities analyses have included variables measuring diet and BMI. Results are in support of previous Norwegian studies showing that diet is of importance for academic achievement (Stea & Torstveit, 2014; Øverby, Lüdemann, & Høigaard, 2013). BMI is included in the analysis with the assumption of a possible relationship between PA, diet and BMI. Correlations (Table 2) are very weak between BMI, PA within and outside of school hours, and regular intake of lunch. Still, high BMI is related to lower academic achievement. By interpreting diet and BMI in context with other independent variables a relatively clear pattern emerges, in which parents' educational level correlates with numerous other variables. Attainment of higher education correlates with higher academic achievement, participation in organized sport and TKK, higher level of PA, more time spent on homework, less screen-time, lower BMI, and regular intake of lunch. We therefore need to ask the question to what extent individual variables impact academic achievement, or if the better strategy is to consider a more comprehensive picture indicating that higher education corresponds with a lifestyle that is beneficial to academic achievement. In other words, the third step of the

explanation is that organized sport, together with TKK, contributes to the reproduction of social inequality of academic achievement.

5. CONCLUSION

To conclude, PA outside of school hours does not contribute to higher academic achievement. Still, there are qualities to organized sport and other spare time activities, together with social background and other life-style variables, that pay off in terms of higher academic achievement. Within school hours both PA and school meals are possible tools that can be utilized to improve academic achievement.

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