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A Sustainable Swedish School Intervention with Extra Aerobic Exercise—Its Organization and Effects on Physical Fitness and Academic Achievement

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Abstract: A large majority of Swedish children do not reach the recommended daily activity level. Some, but not all, studies show that extra physical activity may have positive effects on children's school performance, physical fitness and health. The present purpose was to offer pupils from the 7th to the 8th grade extra aerobic exercise led by physical education teachers and to evaluate the effects on aerobic fitness, muscle strength, school grades and health. The hypothesis was that extra aerobic exercise would improve physical fitness, school grades and health. In the two-year project, 122 pupils aged 13–14 years from three schools constituted an aerobic group with 30 min extra exercise sessions (≥70% maximal heart rate) twice weekly. A control group of 26 pupils was included. All 148 pupils also had regular 60 min physical education lessons (2/week). A moderate to large significant effect size (via partial eta-squared) of the interaction effect for the aerobic group compared to the control group over time was generally seen for aerobic fitness, the muscle strength test with push-ups, school grades in Swedish, English and physical education, and in average school grade for four school subjects combined, thus also including mathematics. Within the aerobic group, significant improvements were also shown for aerobic fitness, endurance and strength of abdominal and leg muscles, and the total physical test index during the two-year project. The control group showed no corresponding improvement in these parameters. Improvements in school grades were generally seen among both sexes in the aerobic group, whereas improvements in physical capacity were distinctly more pronounced among boys and seldom among girls. A similar pattern with significant improvement in several school grades was noted in all three intervention schools, although one of the schools had a distinctly larger proportion of children who immigrated to Sweden. The aerobic group showed significantly higher ratings (with a small to moderate effect size) on several questions about physical self-perception than the control group at the end of the 8th grade. This teacher-led school intervention generated a sustainable project with improvements in physical fitness and school grades. The project might act as an inspiration for other schools to increase physical activity to improve physical fitness and possibly school grades.

Keywords: physical activity; physical education; school; teachers; academic achievements; fitness

1. Introduction

Few longitudinal interventions with extra aerobic exercise for school children include tests of muscle strength and aerobic capacity as evaluation tools while monitoring changes in academic performance and health. A large review offers strong evidence for a positive association between aerobic fitness and cluster of physical fitness (PF) with academic performance (AP) for cross-sectional youth studies [1]. There is also evidence from longitudinal studies of a positive association between cluster of PF and AP, whereas the relationship between muscular strength and AP remains uncertain [1].

Regular physical activity and its importance for health and well-being have received strong scientific support during the past decade [2–4]. These and several other studies show positive effects of regular physical activity on both physical and psychological health.

Compared to the other Nordic countries, Sweden has the fewest physical education lessons per week. According to the Lancet [5], Swedish pupils exhibit the lowest rate of self-reported daily physical activity in the Scandinavian countries and 85 percent do not reach the recommended daily activity level. Many adolescents worldwide do not meet current physical activity guidelines. Effective policies, investment and management at all levels are needed to counteract differences in physical activity levels between genders and socioeconomic groups, as well as low participation in physical activity in general among children and adolescents. Such input will improve the health of this and future generations and help realize the 2030 Sustainable Development Goals [5].

School is where most children can be reached. Whether increased daily school activity can improve pupils' mental function such as cognition, executive function and even academic results is an ongoing discussion. According to the WHO, children and adolescents aged 5–17 years should be physically active for an average of 60 min per day at moderate to high intensity [3]. The WHO further recommends that high-intensity aerobic activities, as well as bone- and muscle-strengthening activities, should be performed at least three days a week [3].

Results from the WHO report based on 21 systematic reviews form the basis for the recommendations [4]. The report describes pronounced evidence that greater amounts and higher intensities of physical activity and different types of physical activity (i.e., aerobic and muscle- and bone-strengthening activities) are associated with improved health outcomes. There is also evidence for recommendations on limiting sedentary behaviors. Physical activity is associated with several positive health outcomes, including muscle strength and skeletal, cardiometabolic and mental health. Further, physical activity reduces the risk of depression, and reduces depressive symptoms in children and adolescents irrespective of diagnosed major depression. Physical activity is also favorably associated with reduced obesity in children and adolescents. Lately, physical activity has been shown to have positive effects on cognitive function and academic outcomes (e.g., school performance, memory and executive function) in children and adolescents [4]. This is confirmed by another large report which states that some, but not all, studies have shown that extra physical activity may have positive effects on children's school performance [6,7].

Correlations between academic achievement (assessed by a standardized test and school grades), fitness and physical activity were investigated in a cross-sectional study in overweight/obese 10-year-old children [8]. Field-based aerobic fitness was associated with language skills. Further, field-based muscular strength was associated with grade point average, natural and social science, foreign language and mathematics skills. However, that study noted that physical activity showed no significant links with academic achievement. Overall, the significant associations observed for muscular strength and speed/agility were attenuated and often disappeared after additional adjustments for body mass index and cardiorespiratory fitness, indicating that these associations are interdependent. Cadenas-Sanchez et al. (2020) [8] stated, however, that other fitness components than cardiorespiratory fitness, such as muscular strength and speed-agility, are positively associated with academic achievement. Accordingly, public health strategies should focus on improving many aspects of fitness as an effective approach to enhance academic achievement in children and future interventions are therefore needed to verify these results [8].

Considering the above literature, we introduced a study called "the Movement for Better Health and Learning". The study has since been incorporated in a broader scientific project intended to document practical research in physical education. The purpose of this broader initiative by the Swedish School of Sport and Health Sciences was to develop models of practice-based research where teachers and researchers meet on an equal footing to prioritize problems or challenges that, by extension, could contribute to a stronger scientific foundation and bridge the gap between school, higher education and research. This indicates the outline for the present study: a joint action where teachers met with researchers to discuss the data and pedagogical aspects of the intervention.

The aim of the two-year school intervention was to offer pupils in years 7 and 8 twice-weekly extra aerobic physical activity led by physical education (PE) teachers during the school day, and to evaluate the effects on aerobic fitness, muscle strength, school grades in mathematics, language and physical education as well as health. The hypothesis was that extra aerobic exercise during the school day would result in improved aerobic fitness, muscular strength, school grades and health.

2. Material and Methods

2.1. Setting

This two-year project was undertaken within the national Education, Learning and Research initiative called for by the Swedish government. This initiative seeks to stimulate practice-based research to develop a stronger scientific foundation and bridge the gap between schools and universities. The initiative consists of practical research in which local schools collaborate and develop new knowledge together with university scholars. The present collaboration included planning the project's structure, discussions, seminars, relevant data analyses and presentation of results in relation to scientific evidence. The project was well rooted among school leaders, administration and politicians.

2.2. Material

One hundred and fort-eight students were included in the whole two-year school intervention from autumn 2018 to spring 2020. Data were collected for all 148 participants regarding physical fitness tests and health questions (see below) at the beginning of the 7th grade (week 38) and at the end of the 8th grade (week 22). Informed permission to start and conduct the intervention was given by the principals and informed consent from the children and parents was obtained before study start.

One hundred and twenty-two individuals (64 girls, 58 boys) aged 13–14 years were randomly selected to participate from three schools (A, B and C) in an area of high socioeconomic diversity (see below). Pupils performed twice-weekly extra aerobic training (approximately 30 min, $\geq$70% maximal heart rate) led by their PE teachers. A control group consisting of 26 pupils (13 girls, 13 boys) was randomly selected from school A. These received extra aerobic training.

In total, there were 122 participants—48 (23 girls, 25 boys) from school A, 29 (15 girls, 14 boys) from school B, and 45 (26 girls, 19 boys) from school C. The three schools are situated outside Stockholm, Sweden, in an area with a high percentage of children born abroad or with parents born abroad. School B had the largest proportion of immigrant pupils. In this area, families generally came from a lower socioeconomic status. In school A, a draw (via lottery) was made among the total of six classes in the 7th grade, so that two classes could form an intervention group with extra aerobic exercise twice a week and one class could form a control group. In school B, all pupils in the 7th grade were included in a group with extra aerobic exercise twice a week. Out of a total of seven classes in the 7th grade in school C, two classes were drawn (via lottery) in a group that received extra aerobic training twice a week. In the three schools, there was great interest from all classes to be part of the intervention. Therefore, a draw (via lottery) was held among the classes in schools A and C. In addition, there were no special inclusion and exclusion criteria for pupils in the three schools.

All but four participants in school B completed the project to the end of year 8. One main reason for the non-completers is that several pupils in school B moved schools.

2.3. Intervention

Extra aerobic (i.e., pulse-raising) activities were carried out twice per week (30 min) for pupils in the three schools in the academic years 2018/2019 and 2019/2020, i.e., in grades 7 and 8. Their regular physical education lessons were supplemented with two more days of 30 min heart rate-boosting activities (Table 1). The sessions were led by three PE teachers, one at each school.

Table 1. Schedule for which months the various included *measures* were made for all students in both the aerobic group and the control group during the four semesters of the project. The number of *regular PE lessons* for both groups as well as *extra aerobic exercise sessions* for students in the aerobics group during the two-year project are also presented in the table.

	Autumn Year 7	Spring Year 7	Autumn Year 8	Spring Year 8
AEROBIC GROUP + CONTROL GROUP:				
Fitness tests	early Sep			late May
The WHO Five Well-Being Index	early Sep			late May
School grades	late Dec			early Jun
Physical self-perception questions				late May
Some physical activity questions				late May
Regular PE lessons 60 min 2/week	Sep–Dec regular teaching	Jan–early Jun regular teaching	Sep–Dec regular teaching	Jan–early Jun regular teaching
AEROBIC GROUP:				
Extra aerobic exercise 30 min 2/week	Sep–Dec	Jan–early Jun	Sep–Dec	Jan–early Jun

To ensure that the different extra aerobic exercise sessions were as equal as possible between the three schools, the three PE teachers met once a week on Fridays to go through the different upcoming training sessions (see typical examples below). The PE teachers had been allocated 10% of their service time during the two-year period for the organization and execution of the two extra weekly sessions with aerobic exercise and including the fitness tests with pupils (see below).

The session goal was for pupils to reach at least 70 percent of maximum heart rate. To ensure this, pupils performed activities at high but not very high intensity as reflected in the Borg Rate of Perceived Exertion (RPE) scale [9]. Here, a given RPE of 15 corresponds to an intensity that is rated as high/hard/strenuous, while a value of 17 corresponds to an intensity that is rated as very high/hard/strenuous.

Initially, pupils were shown how to perform the various aerobic exercises, and how a score of 15 on Borg's rating scale corresponds to high/hard/strenuous effort. During the project, at different points per session, pupils were asked whether they reached an RPE of $\geq$15. Each 30 min training session was constructed so that, for 80% of the time, pupils exercised at an intensity corresponding to rating of RPE of $\geq$15. The remaining 20% of time was allocated to warm-up tasks and rest between interval exercises. Before the start of the two-year project, pupils in school A (n = 48) wore heart rate monitors during many different training exercises to ensure that a high intensity level of $\geq$70 percent of their maximum heart rate is consistent with a simultaneous rating of $\geq$15 on the RPE scale.

Every month, in the two-year project, two new 30 min exercise sessions were created by the PE teachers. The exercise sessions were similar across schools. These exercise sessions were performed each week for the whole month. For every following month, two new exercise sessions were created and performed.

Examples of the content in typical exercise sessions were: (i) various intense ball games in small groups of pupils, e.g., a group of three pupils against another group of three other pupils playing soccer, basketball, handball, and drop ball games; (ii) Tabata interval training 5 $\times$ 4 min (an exercise performed for 20 s followed by 10 s of rest, repeated 7 more times, a total of 8 times and 4 min), exercising different large muscle groups; (iii) different obstacle courses in the gymnastics hall, where pupils had to run and jump over different high gymnastic plinths, sprint hurdles and other gymnastic equipment (four-minute intervals); (iv) running outdoors on a 500 m track at intervals, alternating from 90 s at a very high intensity (RPE of $\geq$18) to by 90 s of rest while walking for a total of eight repetitions (90 s + 90 s); (v) jogging for 20–25 min at an RPE of $\geq$15; (vi) station training/circle training for intervals of 45 s (and moving to the next station for 15 s) at 12 stations, performed in two rounds. Here, exercises were performed at a high intensity for various large muscle groups in the legs, back, abdomen and arms including different heart rate-boosting activities, e.g., leg bends without and with jumps and "jumping jacks".

A more detailed example of an exercise session with *Tabata training* included five blocks, each for four minutes, with one minute rest between the blocks. Each block required two exercises (a + b) to be repeated four times—20 s of work and 10 s of rest. Block 1—warm-up: (a) *High knee lifts* (work rhythmically with high knees and arms); (b) *Mountain climber* (start in a push-up position and keep your abdomen and back stable while pulling your knees up to your elbows). Block 2—(a) *Jumping jacks* (stand on the floor with your legs together and your arms at your sides, then jump to a wide leg position while moving straight arms to the side and up over the head, jump back to the starting position while lowering your arms and then repeat the exercise); (b) *Jumping squat forward* (start in a standing position, take charge and jump forward with maximum force from the starting position and dampen the landing by bending slightly at the knees). Block 3—(a) *Alternating leg jumps* (take a big step forward and bend your front knee slightly, swap places between front and back leg alternately by jumping and move both your arms back and forth alternately); (b) *Toe jumps on the spot* (stand with parallel feet, keep your arms at your hips and jump rhythmically up and down on your forefoot with straight knees). Block 4—(a) *Burpees* (start by bending your knees and putting your hands on the floor, stretch your legs behind your body and lower your body in a controlled but fast manner to the floor while moving your feet quickly under your body; from there, jump up from a deep squat position and clap your hands; (b) *Bearcrawl* forward (start in a push-up position and walk forward with your right foot and left arm to start, then move your left foot and right arm forward; repeat backwards, with your foot and arm work diagonally). Block 5—*Each of the above exercises is performed for 20 s.*

Several of the different examples of heart rate-boosting activities, created especially for the present study, are described and illustrated by the PE teachers in a newly published book [10] and on a website [11].

Theoretical lessons in mathematics, Swedish and English were scheduled in direct connection with the extra aerobic training sessions. Thus, each extra aerobic session was performed just before a theoretical lesson in either Swedish, English or mathematics. The sessions were voluntary and took place within the normal school timetable (Table 1).

2.4. Physical Fitness Tests

The five physical fitness tests were the beep test, strength tests for the arm, leg and abdominal muscles, and a jump test. This study reports the results of measurements taken initially in the autumn term of 2018 (when pupils started in year 7) and at the end of the spring term in 2020 (end of year 8). The tests were administrated by each school's PE teacher.

Aerobic capacity was tested using the well-known beep test, also called the "20 m shuttle run test". This has good test–retest reliability and validity for young people aged 13–15 years, with strong evidence that it reflects maximum oxygen uptake (cardiovascular fitness) in children and adolescents [12–18]. The beep test involves running between two markers that are 20 m apart, following audio cues which dictate the running speed required. At regular intervals, the required running speed increases. The test continues until participants are no longer able to keep up with the required pace. The number of successfully completed lengths was noted.

Endurance and strength tests *for the upper body* in the form of push-ups were performed. The body was prone and approximately 15 cm from the floor (to a fixed marking) with hands shoulder-width apart at chest level and toes on the floor [19]. Push-ups were performed at a metronome speed of 60 until proper movement and pace could no longer be maintained. The number of successful repetitions was noted. Good test–retest reliability has been shown for this test (repetitions) in adolescents in year 9 of secondary school (ICC 0.90) [20] and in adults aged 18–45 years (ICC 0.87) [21,22]. Push-up scores have been found to be significantly correlated with strength (related to body weight) in one repetition maximum (1RM) during bench press among individuals with a mean age of 20 years [20].

An endurance and strength test for the *abdominal and hip flexor muscles* in the form of sit-ups was performed, starting with the subject supine, shoulders touching the floor. With knee joints at 90 degrees the subject's feet were anchored to the floor, with hands at ear level. The subject raised their trunk to a sitting position with elbows touching thighs, before returning to the supine position with shoulders touching the floor again. The subject performed as many complete repetitions as possible for 60 s [19,23,24], and the number of repetitions was noted. Good test–retest reliability (ICC 0.83) has been shown for the number of sit-ups performed in adults with a mean age of 19 years [25]. The sit-up test has been used in other major field test contexts and has also been validated with electromyography, showing similar activity patterns between subjects in several abdominal and hip flexor muscles [19,23,24,26,27]. In such dynamic sit-ups, the activation level has been validated to be approximately 40–50% of maximal activation levels (in maximal voluntary contractions, MVC) in both abdominal synergy muscles and hip flexor synergy muscles among individuals aged 20–30 years [24,25].

In the *leg test*, static endurance and strength was tested with the subject's hip and knee joints flexed at 90 degrees, and their entire back held against the wall, also called the wall squat test. Hands were kept crossed over their chest. The subject loaded both legs equally and maintained the position for as long as possible. The number of seconds in the correct position was recorded. Good test–retest reliability has been shown for number of seconds in the wall squat test among adolescents in year 9 of secondary school (ICC 0.88) [20]. The wall squat test has been validated in terms of how many of the various quadricep (approximately 40–50% of max) and hamstring muscles (approximately 10–35% of max) are activated among men aged 20–30 years [28].

Jump test: A maximum vertical jump was performed [19]. This jump test began with the subject standing with one side of the body in contact with a wall. Initially, the arms were raised straight up above the head and the subject held a pencil in the hand closest to the wall. Before jumping, the subject drew a line with the pencil as far up the wall as possible. Then, a maximum vertical jump was performed, starting from an upright position bending the knees, with a jump directly after, also called a counter movement jump. At the highest point in the jump, another line was made on the wall with a pencil. It was important to maintain the same grip on the pencil throughout the test. The subject was allowed to swing their arms during the jump. The distance between the two markings was measured. The best of three trials was registered. Excellent test–retest reliability and validity has generally been shown for such jumps (ICC $\geq$ 0.94) among individuals with a mean age of 23 years [29]. Assessing jump height is useful in the context of public health physical fitness examination in adolescents, according to a large review in youth [30].

Pupils were instructed to perform each test at maximum effort and to not stop until they absolutely could not take any more. The test leaders provided encouragement.

For all physical tests, the PE teachers constructed a physical test index using a grading scale from 10 (highest) to 0 (lowest), agreed in advance, indicating the absolute values of each physical test. For the total of five physical tests performed, a sum was then calculated for each pupil who performed all five physical tests (the total physical test index). The constructed index table can be obtained from the authors upon request.

2.5. Academic Achievements

Grades in the four school subjects—mathematics, Swedish, English and physical education (PE)—were monitored during this period, during the autumn term in the 7th grade and the spring term in the 8th grade. Grades are presented in terms of merit from A to F—A = 20, B = 17.5, C = 15, D = 12, 5, E = 10 and F = 7.5. Thus, grade data are reported here for autumn 2018 (year 7) and spring 2020 (year 8) as a reflection of change during the two years for all three schools.

2.6. The WHO Five Well-Being Index

The WHO Five Well-Being Index was used to follow up on pupils' well-being [31]. The five questions were graded from 0 to 5 and covered the following feelings: (1) "I have felt cheerful and in good spirits", (2) "I have felt calm and relaxed", (3) "I have felt active and vigorous", (4) "I woke up feeling fresh and rested", and (5) "My daily life has been filled with things that interested me". Alternative answers are: "All the time" (5), "Most of the time" (4), "More than half of the time" (3), "Less than half of the time" (2), "Some of the time" (1) or "At no time" (0). Finally, the total sum of the answers is added and multiplied by 4, for a value between 0 and 100, where values below 50 indicate that the student feels less well.

In the present report, questionnaire responses are presented for two occasions: at the beginning and at the end of the two-year project for all three schools.

2.7. Physical Self-Perception, Physical Activity Habits and Well-Being Questions

2.7.1. Physical Self-Perception

To evaluate pupils' physical self-perception, the Children and Youth Physical Self-Perception Profile (CT-PSPP) was used [30,31] at the end of 8th grade. This survey has 36 questions about domains of physical self-perception. It was included in the final stage of the project because the teachers and researchers saw value in assessing pupils' physical self-perception. Thus, a comparison could be made here between those who received extra aerobic training and the control group regarding these issues. The six domains are Sport Competence, Physical Condition, Body Attractiveness, Physical Strength, Physical Self-Worth and Global Self-Esteem. Additionally, the Total Sum for all six sub-domains combined is assessed. Answers from this questionnaire were obtained only from school A and school C. Thus, the present survey contained a total of 36 questions (6 questions per sub-domain, graded 1–4 per question) [32,33].

2.7.2. Physical Activity Habits and Well-Being Questions

Only at the end of the 8th grade were questions answered regarding physical activity patterns and well-being. See the Results section for the different questions and results.

2.8. Sessions with Extra Aerobic Training

To achieve maximum benefit from the extra aerobic sessions, pupils entered an intensity zone of approximately 70% of maximum heart rate for at least 20 min (and mostly up to 30 min). During the sessions, it was emphasized that the purpose was not to carry out any form of high-intensity training, but for pupils to feel sweaty and breathless but not exhausted. The sessions were scheduled in the morning with theoretical lessons direct following, with the intention being to achieve the best cognitive effect via, among other things, the increased blood flow to the brain from training.

One aim of the extra aerobic sessions was fun-filled fitness exercises with games, group exercises, and obstacle courses. For each month, two "Sessions of the Month" were planned. Pupils performed these different programs during the following four weeks.

Further examples of training elements are reported in the book "Heart rate boosting activities" by Seger and Eklund (2020) [10] and on the SISU Idrottsböcker (2020 website) [11].

Together, the three experienced PE teachers were responsible for the implementation and organization of the sessions. They designed new sessions each month, assembling a bank of aerobic activities. One teacher wrote a bachelor thesis during implementation of the project [34] as part of a career development initiative. Thus, the increased knowledge and design of workouts during this project has also led to collaboration with a publisher.

2.9. Statistics

Statistical analyses were performed with Statistica 13.5 (TIBO Software Inc, Paulo Alto, CA, USA) and the SPSS Statistics 27.0 Software package (SPSS Inc Chicago, IL, USA). Data are generally reported as the mean and standard deviation (±SD); and as the mean and confidence interval (CI) in figures.

Fitness test results, school grades, and results concerning health via the WHO Five Well-Being Index were normally distributed (examined according to the Kolmogorov–Smirnov test or the current relationship between skewness and standard error skewness).

To detect significant differences in different physical fitness test results, school grades and results concerning health via the WHO Five Well-Being Index between the control class and pupils who received extra heart rate training a repeated-measures (RM)-ANOVA with Fisher's LSD post hoc test was performed. The effect size of the interaction effect between the aerobic group and the control group over time in the RM-ANOVA analyses was measured with partial eta-squared (where 0.01 indicates a small effect, 0.06 a moderate effect and 0.14 a large effect).

For the physical self-perception survey and questions about physical activity habits and well-being, the Mann–Whitney U test was used to detect differences between the control class and the extra aerobic training group. These surveys were only performed once, at the end of year 8. The effect size (while using the Mann–Whitney U test) for the aerobic group versus the control group was calculated ($ES = Z/\sqrt{n}$) for this questionnaire regarding physical perception (where <0.3 is a small effect, 0.3–0.5 a medium effect and >0.5 a large effect). In the Results section, a significant difference is generally marked with a star * when $p < 0.05$.

3. Results

3.1. Change in Physical Fitness during the Two-Year Period

3.1.1. Combined Aerobic Group versus Controls

From the beginning of year 7 to the end of year 8, a significant improvement was observed in four of the five assessed fitness tests—beep (+11%), sit-up (+11%), leg (+29%) and jump tests (+19%)—but not in the arm test, for all pupils combined ($n = 122$) from schools A + B + C who received extra aerobic training (i.e., the aerobic group), with data expressed in absolute values (Table 2A). On the other hand, the control group ($n = 26$) showed a significant decrease in the arm test (−24%), and a significant improvement only in the jump test (+19%), while the control group showed no significant change during the period in the three remaining fitness tests (Table 2B).

For the beep test and the arm test, the effect size was significant and moderate (measured with partial eta-squared regarding) regarding the interaction effect for the combined aerobic group compared to the control group over time (Table 2B).

At baseline, significantly lower values only in the beep test and significantly higher values in the jump test (of the five fitness tests) were seen for the combined aerobic group compared to the control group. At the end of the two-year project, no significant differences between the aerobic group and the controls for these two or any other tests were noted.

Somewhat similar results were found for the fitness tests expressed as index values (estimated from 1 to 10 per test) (Table 3B). Here, the combined aerobic group ($n = 122$) showed no significant improvement in the arm and leg tests, but in the beep, sit-up, and jump tests and in the total physical test index (for all five fitness tests added together, Table 3B). For the control group, there was a significant decrease in the arm test and a significant improvement in the jump test, while the three remaining physical tests showed no significant change—nor did the total physical test index (Table 3B).

Table 2. Results in *absolute numbers* with mean values (±SD), change in percent (%) and *p*-value for fitness tests performed initially in the autumn term in the 7th grade and at the end of the spring term in the 8th grade: for (**A**) the extra aerobic training group in all three schools (n = 122) (2 sessions/w for 30 min), and (**B**) for the control group (n = 26). Significant difference (via RM-ANOVA analyses) is marked with *, $p1 < 0.05$. The *p1*-value indicates significant changes within each group. The effect size of the interaction effect between the combined aerobic group and the control group over time was measured with partial eta-squared shown with significance level (*p2*-value) in the lower part of the table (after the results for the control group).

Fitness	**(A). Three Schools—Extra Aerobic Training**			
	Autumn—7th	**Spring—8th**	**%**	***p1*/Partial Eta-Squared, *p2***
Beep test (*n*)	6.17 (8.0)	6.84 (2.28)	+11% *	$p1 < 0.001$
Arm test (*n*)	17.0 (10.4)	17.8 (10.4)	+5%	$p1 = 0.27$
Sit-up test (*n*)	36.0 (9.5)	40.1 (11.7)	+11% *	$p1 < 0.001$
Leg test (s)	195 (165)	252 (292)	+2% *	$p1 = 0.039$
Jump test (cm)	32.4 (5.7)	38.4 (9.2)	+19% *	$p1 < 0.001$
(B). Control Group				
Beep test (*n*)	7.75 (2.20)	6.93 (1.91)	−11%	$p1 = 0.24/0.070$, $p2 = 0.007$
Arm test (*n*)	18.4 (7.7)	13.9 (8.1)	−24% *↓	$p1 = 0.011/0.069$, $p2 = 0.006$
Sit-up test (*n*)	39.2 (7.4)	42.5 (10.8)	+8%	$p1 = 0.14/0.001$, $p2 = 0.775$
Leg test (s)	134 (109)	164 (139)	+24%	$p1 = 0.61/0.002$, $p2 = 0.684$
Jump test (cm)	28.2 (5.8)	35.5 (9.5)	+19% *	$p1 < 0.001/0.005$, $p2 = 0.469$

For the beep test and the arm test the effect size was significant and moderate (measured with partial eta-squared) regarding the interaction effect for the combined aerobic group compared to the control group over time (see Table 3B. Control group).

At baseline, significantly lower values only in the beep test and significantly higher values in the jump test (of the five fitness tests) were seen for the aerobic group compared to the control group. At the end of the project no significant differences between the aerobic group and the controls for these two or any other tests were noted.

3.1.2. Aerobic Groups in Each School versus the Control Group

The change for *each school* regarding each fitness test during the two-year period is presented below in Table 4 (in absolute values) and in Table 5 (index values), including the control group.

The extra aerobic training group in school A showed significant improvement in the beep (+15%), leg (+74%) and jump tests (+19%) and in the total physical test index (+17%). The aerobic group in *school B* showed a significant improvement only in the jump test (+21%) and in the total physical test index (+17%). The aerobic group in *school C* showed a significant improvement in the beep (+15%), sit-up (+24%) and jump tests (+16%) and for the total physical test index (+41%). The control group showed a significant improvement only in the jump test (+19%), while a significant decrease was seen (−24%) for the arm test, as mentioned above. For the other fitness tests, no significant difference was seen in the controls (Table 4).

For the beep test and the arm test, the effect size was significant and moderate to large (measured with partial eta-squared) regarding the interaction effect for the aerobic group compared to the control group over time for all of the three schools, except for the beep test in school B (absolute values shown in Table 4, and index values in Table 5).

Table 3. Results are expressed as *index values* (estimated from 1 to 10 per fitness test) with mean values (± SD), change in percent (%) and *p*-value for the different fitness tests performed initially in the autumn term in the 7th grade and at the end of the spring term in the 8th grade: for (A) the extra aerobic training group in all three schools (n = 122) (2 sessions/w for 30 min), and (B) for the control group (n = 26). Significant difference (via RM-ANOVA analyses) is marked with *, $p < 0.05$. The *p1*-value indicates significant changes within each group. The effect size of the interaction effect between the combined aerobic group and the control group over time was measured with partial eta-squared shown with significance level (*p2*-value) in the lower part of the table (placed after the results for the control group).

Fitness	**(A). Three Schools—Extra Aerobic Training**			
Index	**Autumn—7th**	**Spring—8th**	**%**	***p1*/Partial Eta-Squared, *p2***
Beep test	4.64 (2.26)	5.44 (2.27)	+17% *	*p1* < 0.001
Arm test	4.58 (2.99)	4.77 (3.04)	+ 4%	*p1* = 0.43
Sit-up test	4.61 (2.08)	5.35 (2.31)	+16% *	*p1* < 0.001
Leg test	3.51 (2.57)	3.94 (2.60)	+12%	*p1* = 0.10
Jump test	4.48 (1.92)	6.26 (2.82)	+40% *	*p1* < 0.001
Total physical test index	22.3 (8.4)	26.6 (9.8)	+19% *	*p1* < 0.001
	(B). Control Group			
Beep test	6.36 (2.31)	5.71 (2.13)	−10%	*p1* = 0.11/0.057, *p2* = 0.017
Arm test	4.94 (2.55)	3.67 (2.63)	−26% *↓	*p1* = 0.017/0.057, *p2* = 0.013
Sit-up test	5.37 (1.64)	6.00 (2.11)	+12%	*p1* = 0.16/0.000, *p2* = 0.816
Leg test	2.53 (1.81)	3.06 (2.14)	+21%	*p1* = 0.39/0.000, *p2* = 0.885
Jump test	3.21 (1.72)	5.68 (2.87)	+77% *	*p1* < 0.001/0.013, *p2* = 0.232
Total physical test index	22.5 (6.2)	23.6 (7.7)	+ 5%	*p1* = 0.51/0.028, *p2* = 0.106

At the start and the end, the *aerobic group* presented a significant difference (compared to the control group) for a few tests (in absolute values, Table 4); in school A, with higher values in the leg test at start and in the arm and jump tests at the end; in school B, with higher values in the jump test at start and lower in the sit up test and higher in the leg test at the end; in school C, with lower values in the beep, arm, sit-up and jump tests at the start.

3.1.3. Girls and Boys in the Aerobic Groups versus Controls

It was notable that boys, and not girls, generally presented significant improvements in all five fitness tests from the beginning of year 7 to the end of year 8. The *boys* (n = 58) who received *extra aerobic training* (in all three schools combined) showed significant improvements in all five fitness tests after two years. This was also true for the total fitness test index (+26%, Table 6).

On the other hand, in the *extra aerobic training* group (n = 64 in all three schools combined), a significant improvement was seen only on the jump test (+29%) among girls. In addition, a strong trend towards improvement was noted for girls in the sit-up test (+7%, p = 0.054). Other physical tests and the total physical test index showed no statistically significant change for girls.

For *boys* in the *control group* (n = 13), there was a significant improvement in the sit-up (+22%) and vertical jump (+34%) tests, and a significant decrease in the beep test (−23%), while no significant change was seen in the other physical tests separately and the total physical test index. Among *girls* in the *control group* (n = 13), a significant decrease was noted only in the arm test by −23%. Other tests, including the total physical test index, showed no significant changes for this group of girls after two years.

The effect size for the beep test and the arm test was significant and moderate (measured with partial eta-squared) only for the boys regarding the interaction effect for the combined aerobic group compared to the control group over time (Table 6).

Looking at the start and the end of the intervention, among the absolute fitness tests results for both sexes (Table 6), the *aerobic group* presented only a few significant differences (compared to the control group) in the five tests; for girls, with lower values in the beep test at start and higher values in jump test both at the start and at the end; for boys, with higher values in the arm test at the end.

Table 4. Results in *absolute numbers* with mean values (± SD), change in percent (%) and *p*-value for the fitness tests performed initially in the autumn term in the 7th grade and at the end of the spring term in the 8th grade: for (A) the extra aerobic training group in school A (n = 48), school B (n = 29) and school C (n = 45) (2 sessions/w for 30 min), and (B) for the control group (n = 26). Significant difference (via RM-ANOVA analyses) is marked with *, $p < 0.05$. The *p1*-value indicates significant changes within each group. The effect size of the interaction effect between the aerobic group and the control group over time was measured with partial eta-squared shown with significance level (*p2*-value) to the right in the table.

Fitness	**Schools A, B and C—Extra Aerobic Training Pupils**			
	Autumn—7th	**Spring—8th**	**%**	**p1/Partial Eta-Squared, p2**
		School—A		
Beep test (*n*)	6.62 (2.26)	7.63 (2.27)	+15% *	*p1* = 0.006/0.154, *p2* = 0.006
Arm test (*n*)	23.5 (10.2)	23.0 (9.4)	−2%	*p1* = 0.650/0.093, *p2* = 0.028
Sit-up test (*n*)	40.9 (9.2)	43.1 (8.3)	+ 5%	*p1* = 0.096/0.006, *p2* = 0.582
Leg test (s)	175 (145)	308 (295)	+74% *	*p1* = 0.001/0.044, *p2* = 0.139
Jump test (cm)	32.5 (6.4)	38.8 (8.1)	+19% *	*p1* < 0.001/0.006, *p2* = 0.604
		School—B		
Beep test (*n*)	6.65 (1.62)	6.69 (1.97)	+ 1%	*p1* = 0.934/0.043, *p2* = 0.216
Arm test (*n*)	16.8 (9.2)	18.9 (9.6)	+13%	*p1* = 0.141/0.207, *p2* = 0.003
Sit-up test (*n*)	34.7 (7.0)	35.9 (10.3)	+ 3%	*p1* = 0.504/0.018, *p2* = 0.401
Leg test (s)	242 (155)	356 (359)	+47%	*p1* = 0.166/0.009, *p2* = 0.559
Jump test (cm)	33.0 (5.7)	40.0 (8.3)	+21% *	*p1* < 0.001/0.001, *p2* = 0.849
		School—C		
Beep test (*n*)	5.41 (1.99)	6.20 (2.31)	+15% *	*p1* = 0.040/0.106, *p2* = 0.024
Arm test (*n*)	10.9 (7.0)	12.2 (8.3)	+12%	*p1* = 0.321/0.110, *p2* = 0.015
Sit-up test (*n*)	32.1 (8.1)	39.7 (15.0)	+24% *	*p1* < 0.001/0.032, *p2* = 0.190
Leg test (s)	184 (169)	149 (127)	+23% *	*p1* = 0.259/0.030, *p2* = 0.220
Jump test (cm)	32.1 (5.7)	37.2 (10.9)	+16% *	*p1* < 0.001/0.015, *p2* = 0.374
		Control Group		
Beep test (*n*)	7.75 (2.20)	6.93 (1.91)	−11%	*p1* = 0.240
Arm test (*n*)	18.4 (7.7)	13.9 (8.1)	−24% *↓	*p1* = 0.011
Sit-up test (*n*)	39.2 (7.4)	42.5 (10.8)	+8%	*p1* = 0.140
Leg test (s)	134 (109)	164 (139)	+24%	*p1* = 0.610
Jump test (cm)	28.2 (5.8)	35.5 (9.5)	+19% *	*p1* < 0.001

Table 5. Results are expressed as *index values* (estimated from 1 to 10 per fitness test) and are given here with mean values (± SD), change in percent (%) and *p*-value for the different fitness tests performed initially in the autumn term in the 7th grade and at the end of the spring term in the 8th grade: for (A) the extra aerobic training group in school A (n = 48), school B (n = 29) and school C (n = 45) (2 sessions/w for 30 min), and (B) for the control group (n = 26). Significant difference (via RM-ANOVA analyses) is marked with *, $p < 0.05$. The *p1*-value indicates significant changes within each group. The effect size of the interaction effect between the aerobic group and the control group over time was measured with partial eta-squared shown with significance level (*p2*-value) to the right in the table.

Fitness	**Schools A, B and C—Extra Aerobic Training Pupils**			
Index	**Autumn—7th**	**Spring—8th**	**%**	**p1/Partial Eta-Squared, p2**
		School—A		
Beep test	5.12 (2.34)	6.06 (2.25)	+18% *	$p1$ = 0.020/0.098, $p2$ = 0.032
Arm test	6.41 (2.94)	6.15 (2.77)	−4%	$p1$ = 0.451/0.055, $p2$ = 0.093
Sit-up test	5.71 (2.13)	6.14 (1.92)	+8%	$p1$ = 0.130/0.004, $p2$ = 0.667
Leg test	3.21 (2.31)	4.56 (2.77)	+42% *	$p1$ = 0.001/0.029, $p2$ = 0.233
Jump test	4.58 (2.05)	6.39 (2.54)	+40% *	$p1$ < 0.001/0.024, $p2$ = 0.274
Total physical test index	25.3 (8.8)	29.6 (9.5)	+17% *	$p1$ < 0.001/0.066, $p2$ = 0.084
		School—B		
Beep test	5.04 (1.50)	5.35 (2.05)	+ 6%	$p1$ = 0.461/0.055, $p2$ = 0.162
Arm test	4.76 (2.68)	5.29 (2.84)	+11%	$p1$ = 0.274/0.013, $p2$ = 0.154
Sit-up test	4.27 (1.48)	4.45 (2.17)	+ 4%	$p1$ = 0.614/0.018, $p2$ = 0.387
Leg test	4.23 (2.49)	4.59 (2.59)	+ 9%	$p1$ = 0.498/0.001, $p2$ = 0.838
Jump test	4.50 (1.97)	6.86 (2.65)	+52% *	$p1$ < 0.001/0.001, $p2$ = 0.877
Total physical test index	23.2 (6.9)	27.1 (9.2)	+17% *	$p1$ = 0.012/0.043, $p2$ = 0.239
		School—C		
Beep test	3.91 (2.22)	4.91 (2.38)	+26% *	$p1$ = 0.012/0.105, $p2$ = 0.024
Arm test	2.69 (1.81)	3.11 (2.47)	+16%	$p1$ = 0.290/0.108, $p2$ = 0.016
Sit-up test	3.76 (1.64)	5.14 (2.74)	+37% *	$p1$ < 0.001/0.029, $p2$ = 0.208
Leg test	3.35 (2.61)	2.91 (1.97)	−13%	$p1$ = 0.337/0.030, $p2$ = 0.224
Jump test	4.38 (1.95)	5.78 (3.28)	+32% *	$p1$ = 0.002/0.030, $p2$ = 0.224
Total physical test index	18.2 (8.1)	25.6 (9.5)	+41% *	$p1$ = 0.002/0.030, $p2$ = 0.178
		Control Group		
Beep test	6.36 (2.31)	5.71 (2.13)	−10%	$p1$ = 0.110
Arm test	4.94 (2.55)	3.67 (2.63)	−26% *↓	$p1$ = 0.017
Sit-up test	5.37 (1.64)	6.00 (2.11)	+12%	$p1$ = 0.160
Leg test	2.53 (1.81)	3.06 (2.14)	+21%	$p1$ = 0.390
Jump test	3.21 (1.72)	5.68 (2.87)	+77%*	$p1$ < 0.001
Total physical test index	22.5 (6.2)	23.6 (7.7)	+ 5%	$p1$ = 0.510

Table 6. Results in *absolute numbers* with mean values (± SD), change in percent (%) and *p*-value for the fitness tests performed initially in the autumn term in the 7th grade and at the end of the spring term in the 8th grade: for (A) the extra aerobic training group in all three schools combined (n = 122, 64 girls and 58 boys) (2 sessions/w for 30 min), and (B) for the control group (n = 26, 13 girls and 13 boys). Significant difference (via RM-ANOVA analyses) is marked with *, $p < 0.05$. Here, data for the *total physical test index* are shown for those who completed all five fitness tests. The *p1*-value indicates significant changes within each group. The effect size of the interaction effect between the combined aerobic group and the control group over time for each sex was measured with partial eta-squared shown with significance level (*p2*-value) to the right of the table after the mean results for the combined aerobic group.

Fitness		**Girls/Boys A. Three Schools—Extra Aerobic Training**			
		Autumn—7th	**Spring—8th**	**%**	**p1/Partial Eta-Squared, p2**
Beep test (*n*)	♀	5.74 (1.86)	5.89 (2.05)	+3%	*p1* = 0.530/0.008, *p2* = 0.523
	♂	6.56 (2.23)	7.73 (2.19)	+18% *	*p1* < 0.001/0.170, *p2* = 0.002
Arm test (*n*)	♀	13.7 (9.3)	12.3 (7.0)	−10%	*p1* = 0.234/0.064, *p2* = 0.072
	♂	20.1 (10.5)	23.0 (10.3)	+10% *	*p1* = 0.005/0.107, *p2* = 0.012
Sit-up test (*n*)	♀	34.3 (8.3)	36.8 (12.6)	+7%	*p1* = 0.054/0.069, *p2* = 0.056
	♂	37.6 (10.0)	43.1 (10.3)	+15% *	*p1* < 0.001/0.013, *p2* = 0.390
Leg test(*s*)	♀	219 (182)	253 (299)	+16%	*p1* = 0.415/0.001, *p2* = 0.840
	♂	172 (129)	251 (259)	+46% *	*p1* = 0.022/0.003, *p2* = 0.663
Jump test (cm)	♀	31.3 (5.0)	33.4 (7.4)	+7% *	*p1* = 0.014/0.002, *p2* = 0.753
	♂	33.6 (6.7)	43.2 (8.7)	+29%*	*p1* < 0.001/0.003, *p2* = 0.684
Total physical test index	♀	20.0 (7.2)	21.6 (7.5)	+8%	*p1* = 0.116/0.012, p2 = 0.470
	♂	24.3 (8.9)	30.7 (9.6)	+26% *	*p1* < 0.001/0.045, *p2* = 0.138
			B. Control Group		
Beep test (*n*)	♀	7.28 (1.93)	7.08 (2.37)	− 3%	*p1* = 0.695
	♂	8.60 (2.63)	6.66 (2.65)	−23% *↓	*p1* = 0.040
Arm test (*n*)	♀	19.3 (8.8)	12.4 (6.6)	−36% *↓	*p1* = 0.018
	♂	17.8 (7.2)	14.9 (9.0)	−16%	*p1* = 0.156
Sit-up test (*n*)	♀	39.3 (7.2)	35.5 (8.1)	−10%	*p1* = 0.216
	♂	39.1 (7.4)	47.6 (10.2)	+22% *	*p1* = 0.009
Leg test (*s*)	♀	174 (150)	186 (173)	+7%	*p1* = 0.910
	♂	105 (60)	149 (88)	+42%	*p1* = 0.545
Jump test (cm)	♀	25.0 (5.0)	27.9 (5.6)	+12%	*p1* = 0.164
	♂	30.5 (5.0)	41.0 (7.8)	+34% *	*p1* < 0.001
Total physical test index	♀	21.6 (7.6)	21.3 (5.7)	−1%	*p1* = 0.902
	♂	23.4 (4.8)	26.0 (9.2)	+10%	*p1* = 0.276

3.2. Changes in Academic Achievements during the Two-Year Period

Below, changes in grades from autumn in the 7th grade to spring in the 8th grade are described.

3.2.1. Average School Grades for the Aerobic Group versus Controls

All Three Schools Combined

A significant improvement from 13.2 to 14.5 was seen in the average school grade (mathematics, Swedish, English and physical education) for the combined extra aerobic training group (n = 122) during the two-year period (Figure 1). The control group showed a decrease from 14.9 to 14.6, which was not statistically significant (n = 26, Figure 1). The effect size was significant and large, measured with partial eta-squared (0.142, $p < 0.001$) regarding the interaction effect for the combined aerobic group compared to the control group over time.

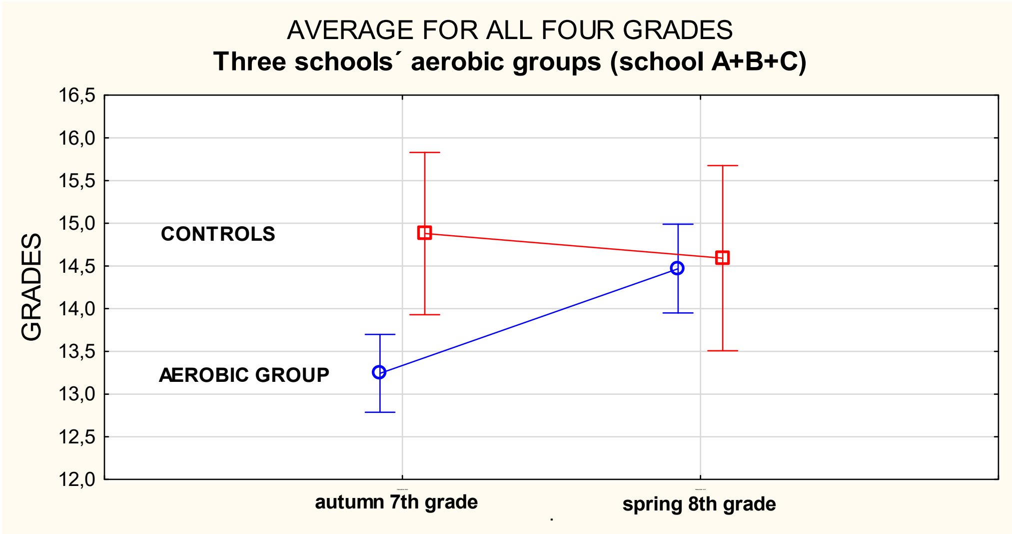

Figure 1. Average grades (±95% CI) for all four subjects combined (mathematics, Swedish, English and physical education) from autumn in year 7 to spring in year 8 for the control group (n = 26) and for all aerobic training pupils combined from all three schools (n = 122) during the period.

The average grade for autumn in year 7 for the aerobic group was significantly lower (13.2) than for the control group (14.9), but this was not so at the end of year 8 (14.5 vs. 14.6).

*Changes for genders***.** A significant improvement in average school grade was seen in the combined aerobic training groups for both *girls* (from 13.7 to 15.2, n = 64) and *boys* (from 12.8 to 13.7, n = 58) during this two-year period.

In the control group, a non-significant decrease in average school grade was seen for both girls (from 15.3 to 14.6, n = 13) and boys (from 14.8 to 14.6, n = 13). The effect size was significant here for both sexes, in terms of the interaction effects for the aerobic group compared to the control group over time, measured with partial eta-squared, indicating a large effect for the girls 0.249 ($p < 0.001$) and a small to moderate effect for the boys 0.059 ($p = 0.048$).

Average school grade for autumn in year 7 for the aerobic group was significantly lower both for girls (13.7) and boys (12.8) than control group girls (15.3) and boys (14.5). This was not so at the end of year 8 (aerobic group girls 15.2 and boys 13.7; control group 14.6).

Changes for Each School

A significant improvement in average school grade was seen in the aerobic groups for all schools during the period: school A from 13.5 to 14.8 (n = 48), school B from 11.8 to 13.4 (n = 29), and school C from 13.7 to 14.7 (n = 45). The control group showed a non-significant decrease here, from 14.9 to 14.6 (n = 26). The effect size was significant and large for all three schools, in terms of the interaction effects for the aerobic group compared to the control group over time, measured with partial eta-squared—school A 0.190 ($p < 0.001$), school B 0.316 ($p < 0.001$), and school C 0.158 ($p = 0.001$).

In year 7 (autumn), the aerobic group in schools A and B (but not school C) had a significantly lower average school grade than the control group. At the end of the last term, spring year 8, no significant difference was seen for any of the three schools versus the controls.

*Changes for genders***.** In the aerobic group for all three schools separately, a significant improvement in average school grade was seen for both sexes—school A *girls* (from 13.4 to 15.1, *n* = 23) and school A *boys* (from 13.6 to 14.7, *n* = 25); school B *girls* (from 12.6 to 14.7, *n* = 15) and school B *boys* (from 11.1 to 12.5, *n* = 14); school C *girls* (from 14.1 to 15.6, *n* = 26) and school C *boys* (from 13.6 to 14.6, *n* = 19).

The effect size was generally significant and large here for both sexes in all of the three schools, in terms of the interaction effects for the aerobic group compared to the control group over time (measured with partial eta-squared), except for the boys in school A (0.081, $p = 0.092$). The other values were for the girls in school A 0.331 ($p < 0.001$); for the girls and boys in school B 0.444 ($p < 0.001$) and 0.257 ($p = 0.011$), respectively; and for the girls and boys in school C 0.218 ($p = 0.005$) and 0.316 ($p = 0.001$), respectively.

For the aerobic group girls, a significantly lower average school grade than for the controls was seen in the autumn of year 7 for school A only in Swedish, for school B in Swedish and physical education, but not for school C in any of the four school subjects. At the end of year 8, no significant differences were seen among girls between the aerobic group versus the controls in the four school subjects, except that school C girls showed higher grades in Swedish and English than the control group.

3.2.2. Grades in Each School Subject—Aerobic Group versus Controls

A significant improvement in grades in Swedish, English and physical education emerged for the aerobic group in all three schools combined, and the aerobic groups in schools A, B and C separately. Some improvement, although not significant, was noted for the mean mathematics grades. The mean values for each grade and group are shown in Table 7.

Table 7. Mean values (±SD) for grades in Ma—mathematics, Sw—Swedish, Eng—English and Phys.ed—physical education in the autumn in the 7th grade (year 7) to spring in the 8th grade (year 8) for all the extra aerobic training groups—all three schools combined (*n* = 122), school A (*n* = 48), B (*n* = 29) and C (*n* = 45) (2 sessions/w for 30 min), and also for the control group (*n* = 26). Significant difference (via RM-ANOVA analyses) from the 7th to the 8th grade is marked with a star * (=$p1 <$ 0.05). The effect size (ES) of the interaction effect for the aerobic group versus the control group over time, measured with partial eta-squared with significance level (*p2*-value) presented below average school grade in the end of year 8.

	Grades in Each School Subject Significant Change * ↑ from Autumn 7th Grade to Spring 8th Grade				
	All Three Schools	**School A**	**School B**	**School C**	**Controls**
Ma_7th gr	13.0 ± 3.1	13.2 ± 2.3	13.0 ± 4.3	12.7 ± 3.3	13.3 ± 4.0
Ma_8th gr Ma-ES (via partial eta-squared) and *p2*-value	13.5 ± 3.8 0.000 *p2* = 0.922	13.6 ± 3.6 0.000 *p2* = 0.912	13.0 ± 4.8 0.001 *p2* = 0.831	13.3 ± 3.3 0.001 *p2* = 0.827	13.8 ± 4.1
Sw_7th gr	12.7 ± 3.4	12.5 ± 2.8	9.8 ± 2.6	14.6 ± 3.1	15.1 ± 3.0
Sw_8th gr Sw-ES (via partial eta-squared) and *p2*-value	14.2 ± 3.8 * 0.182 *p2* < 0.001	14.4 ± 3.5 * 0.287 *p2* < 0.001	11.8 ± 3.6 * 0.376 *p2* < 0.001	15.2 ± 3.5 * 0.166 *p2* = 0.001	14.0 ± 2.8 *↓
Eng_7th gr	13.7 ± 3.5	13.6 ± 3.5	12.5 ± 4.6	14,4 ± 2.6	14.5 ± 2.8
Eng_8th gr Eng-ES (via partial eta-squared) and *p2*-value	15.2 ± 3.8 * 0.153 *p2* < 0.001	15.2 ± 3.4 * 0.240 *p2* < 0.001	13.7 ± 4.8 * 0.176 *p2* = 0.003	15.9 ± 3.1 * 0.283 *p2* < 0.001	13.8 ± 3.0
Phys.ed_7th gr	13.7 ± 2.9	14.9 ± 2.3	11.7 ± 3.0	13.5 ± 3.0	16.6 ± 2.6
Phys.ed_8th PE-ES (via partial eta-squared) and *p2*-value	15.0 ± 3.4 * 0.037 *p2* = 0.022	16.1 ± 2.8 * 0.063 *p2* = 0.034	14.5 ± 3.9 * 0.188 *p2* = 0.002	14.3 ± 3.4 * 0.020 *p2* = 0.235	16.8 ± 3.5

On the other hand, the control group showed a decrease in grades in Swedish and English, significant in Swedish (Table 7). For the two remaining subjects, no statistical difference was seen for controls during this two-year period.

The effect size was generally significant and large for all three schools regarding grades in Swedish, English and physical education (PE), in terms of the interaction effects for the aerobic group compared to the control group over time (measured with partial eta-squared, Table 7). This was also true for the combined aerobic group. No such significant effect size was seen for grades in mathematics in any of the three schools separately or combined, neither for PE grades in school C.

Grades for Girls and Boys in Each School Subject—The Aerobic Groups and Control

Tables 8 and 9, for girls and boys, respectively, present grade changes from autumn in year 7 to spring in year 8.

Table 8. For *girls* in each school (A, B and C), mean values (±SD) are presented for grades in Ma—mathematics, Sw—Swedish, Eng—English and Phys.ed—physical education from autumn in the 7th grade to spring in the 8th grade for all the extra aerobic training pupils (2 sessions/w for 30 min) —and also for the control group. Significant difference (via RM-ANOVA analyses) from the 7th to the 8th grade is marked with a star * (=$p1 < 0.05$). The effect size (ES) of the interaction effect for the aerobic group versus the control group over time, measured with partial eta-squared with significance level ($p2$-value) presented below average school grade in the end of year 8.

Girls—Mean Values—Grades in Each School Subject Significant Change * ↑ from Autumn 7th Grade to Spring 8th Grade					
	All Three Schools ***n* = 64 ♀**	**School A** ***n* = 23 ♀**	**School B** ***n* = 15 ♀**	**School C** ***n* = 26 ♀**	**Controls** ***n* = 13 ♀**
Ma_7th gr	13.2	13.2	14.3	12.9	13.8
Ma_8th gr	13.8	13.5	14.2	13.5	13.8
Ma-ES (partial eta-squared) and $p2$-value	0.007 $p2 = 0.476$	0.001 $p2 = 0.842$	0.046 $p2 = 0.327$	0.011 $p2 = 0.512$	
Sw_7th gr	13.8	12.9	10.3	16.0	16.5
Sw_8th gr	15.7 *	15.1 *	13.5 *	17.1 *	14.8 *↓
Sw-ES (partial eta-squared) and $p2$-value	0.328 $p2 < 0.001$	0.455 $p2 < 0.001$	0.674 $p2 < 0.001$	0.364 $p2 < 0.001$	
Eng_7th gr	13.9	12.6	14.5	14.7	14.2
Eng_8th gr	15.4 *	15.0 *	14.3	16.3 *	13.3
Eng-ES (partial eta-squared) and $p2$-value	0.162 $p2 = 0.001$	0.374 $p2 < 0.001$	0.028 $p2 = 0.447$	0.248 $p2 = 0.001$	
Phys.ed_7th gr	14.3	15.2	11.3	14.4	16.5
Phys.ed_8th	16.0 *	16.7 *	15.3 *	15.5 *	16.5
PE-ES (partial eta-squared) and $p2$-value	0.072 $p2 = 0.025$	0.066 $p2 = 0.102$	0.309 $p2 = 0.006$	0.052 $p2 = 0.157$	

Both genders in the aerobic groups in the combined aerobic group and in all three schools generally showed significant improvement in grades in Swedish, English and physical education (Tables 8 and 9). Exceptions were girls in school B for English. No significant changes were seen for the mathematics grade. No pupils in the control group showed significant improvement in any of the four subjects during this period between autumn in year 7 and spring in year 8. On the contrary, girls in the control group showed a significant decrease in Swedish (Table 8).

Table 9. For *boys* in each school (A, B and C), mean values (±SD) are presented for grades in Ma—mathematics, Sw—Swedish, Eng—English and Phys.ed—physical education from autumn in the 7th grade to spring in the 8th grade for all extra aerobic training pupils (2 sessions/w for 30 min)—and also for the control group. Significant difference (via RM-ANOVA analyses) from the 7th to the 8th grade is marked with a star * (=$p1 < 0.05$). The effect size (ES) of the interaction effect for the aerobic group versus the control group over time, measured with partial eta-squared with significance level ($p2$-value) presented below average school grade in the end of year 8.

Boys—Mean Values—Grades in Each School Subject Significant Change * ↑ from Autumn 7th Grade to Spring 8th Grade					
	All Three Schools ***n* = 58 ♂**	**School A** ***n* = 25 ♂**	**School B** ***n* = 14 ♂**	**School C** ***n* = 19 ♂**	**Controls** ***n* = 13 ♂**
Ma_7th gr	12.7	13.2	12.1	13.2	12.7
Ma_8th gr	13.2	13.7	12.1	13.7	13.7
Ma-ES (partial eta-squared) and *p2*-value	0.008 *p2* = 0.467	0.006 *p2* = 0.663	0.006 *p2* = 0.197	0.006 *p2* = 0.663	
Sw_7th gr	11.6	12.2	9.4	12.2	13.6
Sw_8th gr	12.6 *	13.8 *	10.6 *	13.8 *	13.3
Sw-ES (partial eta-squared) and *p2*-value	0.069 *p2* = 0.032	0.149 *p2* = 0.020	0.142 *p2* = 0.058	0.149 *p2* = 0.020	
Eng_7th gr	13.5	14.4	10.9	14.4	14.8
Eng_8th gr	15.0 *	15.4 *	13.3 *	15.4 *	14.2
Eng-ES (partial eta-squared) and *p2*-value	0.145 *p2* = 0.001	0.138 *p2* = 0.024	0.395 *p2* = 0.001	0.138 *p2* = 0.024	
Phys.ed_7th gr	13.1	14.6	12.1	14.6	16.7
Phys.ed_8th	14.1 *	15.5 *	13.8*	15.5 *	17.1
Partial eta-squared and *p*-value	0.011 *p2* = 0.383	0.030 *p2* = 0.305	0.103 *p2* = 0.016	0.030 *p2* = 0.305	

The effect size for both sexes was often significant and large for all three schools combined and separately for grades in Swedish, English and physical education (PE), in terms of the interaction effects for the aerobic group compared to the control group over time (measured with partial eta-squared, Tables 8 and 9). No such significant effect size for either sex was seen for grades in mathematics in any of the three schools separately or combined, neither for PE grades in schools A and C. Nor was any such significant effect seen among girls in English and boys in Swedish in school B and for PE grades among boys in the combined aerobic group (see Tables 8 and 9).

3.3. WHO Well-Being Index—The Aerobic Group and Controls

A decrease was seen from autumn in the 7th grade to the end of the 8th grade for the WHO Five Well-Being Index by 14% for the aerobic group (from 67 to 58 points) and by 7% for the control group (from 71 to 66 points, Figure 2). The change was significant only for the aerobic group. No significant difference emerged between the groups either in autumn in the 7th grade nor at the end of the 8th grade. The effect size showed no significant difference (measured with partial eta-squared 0.006 $p = 0.442$) regarding the interaction effect for the combined aerobic group compared to the control group over time for the WHO Five Well-Being Index, nor for separate schools (school A 0.004 $p = 0.660$, school B 0.045 $p = 0.181$, and school C 0.002 $p = 0.734$). Thus, each aerobic group showed a similar pattern, with a reduction for school A by 10% from 71 to 64 points ($p = 0.019$), for school B by 19% from 74 to 59 points ($p = 0.004$), and for school C by 12% from 59 to 51 points ($p = 0.058$). No significant difference was seen between the aerobic group and the control group either in autumn in the 7th grade or at end of the 8th grade for school A or B, but only for school C and then solely at the end of the 8th grade.

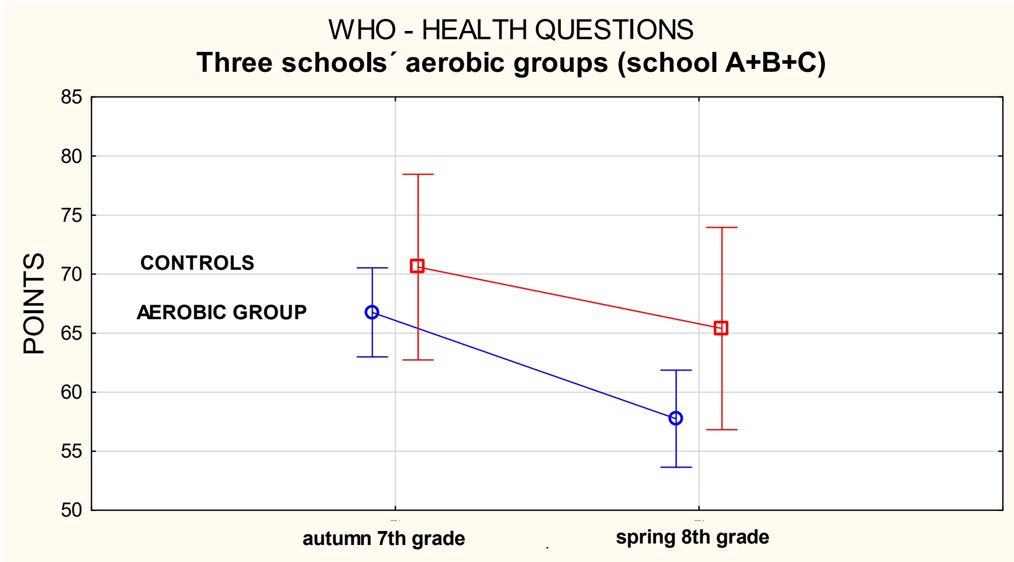

Figure 2. Average well-being values (±95% CI) for the WHO Five Well-Being Index summarized from the autumn semester in the 7th grade to the spring semester in the 8th grade for the control group (n = 26) and for all pupils in a combined extra aerobic training group from all three schools (n = 122) (2 sessions/week for 30 min) during the two-year period.

For the total score on the WHO Five Well-Being Index, a significant decrease by −17% (from mean 63.0 to 52.6 points) was seen for the extra aerobic training group girls (n = 64) and by −10% (from 71.2 to 63.8 points) for boys (n = 58) from all three schools combined during the period. Additionally, for the control group girls a decrease of 15% appeared during this period, which was not significant (from 73.6 to 62.8 points), while these values were relatively unchanged (from 67.6 to 68.0 points) for boys in the control group. The effect size showed no significant changes for either sex, measured with partial eta-squared (0.006 p = 0.442) regarding the interaction effect for the combined aerobic group compared to the control group over time for the WHO Five Well-Being Index (girls <0.001 p = 0.954 and boys 0.033 p = 0.206).

3.4. Physical Self-Perception in the Aerobic Group Compared to Controls Only in Year 8

At the end of the spring term in year 8, school A and C pupils answered a questionnaire about physical self-perception.

A significant difference was seen between the control group and the combined extra aerobic training group for questionnaire responses regarding sub-domains "*Physical Condition*", "*Physical Strength*", "*Physical Self- Worth*" and "*Total Sum*" (Table 10). In these four parameters, the significant effect size was small to moderate for the aerobic group compared to the control group. No significant difference was found for the sub-domains "Sport Competence", "Body Attractiveness" or "Global Self-Esteem".

Physical Self-Perception among Girls Compared to Boys, Year 8 Only

In the aerobic group with pupils from schools A and C, girls showed significantly lower values than boys on the sub-domains *"Sport Competence"* (15.5 vs. 17.9), *"Physical Condition"* (16.1 vs. 18.0), *"Body Attractiveness"* (14.7 vs. 16.2) and *"Total Sum"* for all sub-domains combined (96.0 vs. 105.8, see Table 11). In these four parameters, the significant effect size was small to moderate for the boys compared to the girls in the this combined aerobic group.

Table 10. Mean values (±SD) for each sub-domain in a questionnaire about physical self-perception performed at the end of the 8th grade by the control group and the combined aerobic group from schools A and C. Significant difference (via Mann–Whitney analyses) between the controls and the combined aerobic group is marked with *, $p < 0.05$. The effect size (ES = $Z/\sqrt{n}$, via the Mann–Whitney U test) for the aerobic group versus the control group is given to the right in the table.

Physical Self-Perception Only Spring 8th Grade	**Aerobic Groups in Schools A+C versus Controls**			
Six Sub-Domains + Sum	**Mean Value**	**Median**	**Std.Dev**	***p*-Value/ES**
Sport Competence				
AEROBIC gr	16.5	16	3.5	$p = 0.112/0.20$
CONTROL gr	14.7	15	3.8	
Physical Condition				
AEROBIC gr	16.9 *	17	3.6	$p = 0.035$ */0.26
CONTROL gr	14.6	15	4.6	
Body Attractiveness				
AEROBIC gr	15.3	15	2.5	$p = 0.364/0.11$
CONTROL gr	14.6	15	2.4	
Physical Strength				
AEROBIC gr	15.7 *	16	3.5	$p = 0.010$ */0.32
CONTROL gr	13.5	12	2.9	
Physical Self-Worth				
AEROBIC gr	17.0 *	18	3.6	$p = 0.048$ */0.25
CONTROL gr	14.9	14	3.7	
Global Self-Esteem				
AEROBIC gr	18.1	18	3.6	$p = 0.511/0.08$
CONTROL gr	17.4	18	3.6	
Total Sum				
AEROBIC gr	100.0 *	101	16.6	$p = 0.015$ */0.32
CONTROL gr	89.6	84	15.7	

The same pattern was seen in this group for the other three categories, although the differences were not significant—"Physical Strength" (15.2 vs. 16.3), "Physical Self-Worth" (16.3 vs. 18.0) and "Global Self-Esteem (17.6 vs. 18.7).

In the *control group*, girls showed lower self-rating values than boys in the sub-domains "Sport Competence" (14.1 vs. 15.6), "Physical Condition" (14.0 vs. 15.4), and "Body Attractiveness" (14.1 vs. 15.3). Girls in the control group had a slightly higher rating than boys for the sub-domain "Global Self-Esteem" (18.5 vs. 17.6), whereas a relatively equal estimation between the sexes in the control group emerged for "Physical Strength" (13.7 vs. 13.3), "Physical Self-Worth" (14.8 vs. 15.0) and "Total Sum" for all sub-domains combined (89.0 vs. 90.4). However, none of these gender comparisons were statistically significant ($p < 0.05$).

Table 11. For girls and the boys in the combined aerobic group from schools A and C, the mean values (±SD) for each sub-domain in the physical self-perception questionnaire performed only at the end of the 8th grade. Significant difference (via Mann–Whitney analyses) between the girls compared to the boys is marked with *, $p < 0.05$. The effect size (ES = $Z/\sqrt{n}$, via the Mann–Whitney U test) for the girls versus the boys in the combined aerobic group is given to the right in the table.

Physical Self-Perception Only Spring 8th Grade	Girls Compared to Boys Aerobic Groups in Schools A+C			
Six Sub-Domains + Sum	**Mean Value**	**Median**	**Std.Dev**	***p*-Value/ES**
Sport Competence				
GIRLS	15.5 *	15.5	3.5	p = 0.009 */0.33
BOYS	17.9	18	3.1	
Physical Condition				
GIRLS	16.1 *	16.5	4.1	p = 0.044 */0.25
BOYS	18.0	18	2.6	
Body Attractiveness				
GIRLS	14.7 *	15	2.5	p = 0.028 */0.28
BOYS	16.2	16	2.0	
Physical Strength				
GIRLS	15.2	16	3.6	p = 0.356/0.12
BOYS	16.3	16	3.3	
Physical Self-Worth				
GIRLS	16.3	17	3.4	p = 0.084/0.22
BOYS	18.0	18	3.7	
Global Self-Esteem				
GIRLS	17.6	18	3.9	p = 0.343/0.12
BOYS	18.7	18	3.0	
Total Sum				
GIRLS	96.0 *	99.5	16.6	p = 0.036 */0.27
BOYS	105.8	108	15.1	

3.5. Physical Activity and Well-Being Questions in the Aerobic Group Compared to Controls Only in Year 8

At the end of spring in year 8, a questionnaire about physical activity patterns and well-being was answered. No significant difference was found between the control group compared to the aerobic groups (combined or separately at each school) for any of all the following questions given below. Thus, similar self-reported values were found in the controls and the aerobic groups regarding physical activity at different intensities and durations, sedentary behavior, sleep habits and perceived health.

The questions were: *(i) "How many times a week do you exercise for more than 30 min in your free time?"* with the following possible answers: (4) five times or more, (3) 3–4 times, (2) 1–2 times, and (1) never. All combined and separate aerobic groups and the control group had a mean value between 2.78 ± 0.85 and 3.03 ± 0–70. *(ii) "How do you appreciate your physical exercise habits?"* with the following possible the answers: (4) Very good, (3) Good, (2) Pretty good, and (1) Bad. All combined and separate aerobic groups and the control group had a mean value here between 2.74 ± 0.81 and 3.05 ± 0.78. *(iii) "How much time do you spend a regular week doing physical exercise, which makes you breathless, e.g., running, exercise gymnastics, ball sports? Add up all the time (with a sum for 7 days)"* with the following possible answers: (1) zero minutes/no time, (2) up to 30 min, (3) 0.5–1 h, (4) 1–1.5 h, (5) 1.5–2 h, and

(6) at least 2 h. All combined and separate aerobic groups and the control group had a mean value here between 4.63 ± 2.01 and 5.47 ± 1.16. *(iv) "How long time per week do you do strength training exercise in total?"* with the following possible answers: (7) over 2.5 h, (6) up to 2.5 h (5) up to 2 h, (4) up to 1.5 h, (3) up to 1 h, (2) up to 0.5 h, and (1) 0 min. All combined and separate aerobic groups and the control group had a mean value here between 3.65 ± 2.16 and 4.53 ± 1.78. *(v) "How much do you sit in total during a normal day if you subtract sleep?"* with the following possible answers: (1) Almost all day, (2) 13–15 h (3) 10–12 h (4) 7–9 h, (5) 4–6 h, (6) 1–3 h, and (7) Never. All combined and separate aerobic groups and the control group had a mean value here between 4.36 ± 1.10 and 4.95 ± 0.91. *(vi) "How much do you sit in front of a screen during a normal day if you exclude sleep (not watching TV)?"* with the following possible answers: (1) Almost all day, (2) 13–15 h, (3) 10–12 h, (4) 7–9 h, (5) 4–6 h, and (6) 1–3 h, (7) Never. All combined and separate aerobic groups and the control group had a mean value here between 4.68 ± 1.29 and 4.96 ± 1.18. *(vii) "How do you feel at school?"* with the following possible answers: (4) Very good, (3) Pretty good, (2) Less good, and (1) Not good. *(viii) "How important do you feel it is to have many friends at school?"* with the following possible answers: (4) Very important, (3) Quite important, (2) Less important, and (1) Not important. In the two latter questions (iii and iv), all combined and separate aerobic groups and the control group had a mean value here between 2.95 ± 0.69 and 3.26 ± 0.92. *(ix) How satisfied are you with your life as a whole?"* with the following possible answers: (5) Very satisfied, (4) Fairly satisfied, (3) Satisfied, (2) Little dissatisfied, and (1) Dissatisfied. All combined and separate aerobic groups and the control group had a mean value here between 3.75 ± 1.00 and 4.19 ± 0.79. *(x) "How do you experience your physical health?"* with the following possible answers: (6) Very satisfactory, (5) Satisfactory, (4) Fairly satisfactory, (3) Quite unsatisfactory, (2) Unsatisfactory, and (1) Very unsatisfactory. All combined and separate aerobic groups and the control group had a mean value here between 4.39 ± 0.92 and 4.70 ± 1.21. *(x) "How do you feel in general?"* with the following possible answers: (5) Very good, (4) Good, (3) Neither good nor bad, (2) Bad, and (1) Very bad. All combined and separate aerobic groups and the control group had a mean value here between 3.64 ± 0.95 and 4.08 ± 0.80. *(xi) "How often do you experience that you wake up rested?"* with the following possible answers: (7) Always, (6) Often, (5) Quite often, (4) Occasionally, (3) Quite rarely, (2) Rarely, and (1) Never. All combined and separate aerobic groups and the control group had a mean value here between 3.92 ± 1.53 and 4.40 ± 1.24. *(xii) "How often do you experience a good night's sleep?"* with the answers (7) Always, (6) Often, (5) Quite often, (4) Occasionally, (3) Quite rarely, (2) Rarely, and (1) Never. All combined and separate aerobic groups and the control group had a mean value here between 4.31 ± 1.18 and 5.03 ± 1.23.

Consequently, in all these senses, the control group and the aerobic groups showed similar answers at the end of year 8. That was also true for three more questions, with the exception of only one school in each of those three questions. *(xiii) "How much time do you spend a regular week doing everyday physical exercise, such as walking, cycling? Add up all the time (with a sum for 7 days)"* with the following possible answers: (1) zero minutes/No time, (2) up to 30 min, (3) 0.5–1 h, (4) 1–1.5 h, (5) 1.5–2.5 h, (6) 2.5–5 h, and (7) at least 5 h. All combined and separate aerobic groups and the control group had a mean value here between 4.62 ± 1.60 and 5.25 ± 1.45, with the exception that only the aerobic group in school A had a significantly lower mean value (4.33 ± 1.39, p = 0.020) than the control group (5.25 ± 1.45). *(xiv) How many hours on a typical day do you estimate you move at light intensity, i.e., total time for all normal daily movements (but not time when you become somewhat short of breath or sweaty)?"* with the following possible answers: (7) 14–16 h, (6) 10–13 h, (5) 7–9 h, (4) 5–6 h, (3) 3–4 h, (2) 1–2 h, and (1) 0 h. All combined and separate aerobic groups and the control group had a mean value here between 3.52 ± 1.53 and 3.92 ± 1.32, with the exception that only the aerobic group in school C had a significantly lower mean value (3.18 ± 1.55, p = 0.034) than the control group (3.84 ± 1.34). **(***xv) "How do you experience your mental health?"* with the following possible answers: (6) Very satisfactory, (5) Satisfactory, (4) Fairly satisfactory, (3) Quite unsatisfactory, (2) Unsatisfactory, and (1) Very unsatisfactory.

All combined and separate aerobic groups and the control group had a mean value here between 4.42 ± 1.18 and 4.84 ± 0.90, with the exception that only the aerobic group in school B had a significantly lower mean value (4.10 ± 1.08, $p = 0.021$) than the control group (4.84 ± 0.90).

Since pupils only completed this questionnaire at the end of 8th grade, answers may be particular to self-rated lifestyle at that time. The mean results of these answers appeared to be rather similar between the control group compared to the combined aerobic group and separate aerobic groups in all three schools.

4. Discussion

4.1. Main Findings

There were several positive findings in the present study during the two-year project with extra aerobic exercise twice weekly for 30 min for pupils aged 13–14 years. A significant improvement from the autumn term in year 7 to the spring term in year 8 was found in the combined aerobic group (schools A, B and C) regarding aerobic capacity, endurance and strength of abdominal and leg muscles, the total physical test index, and average school grade for all four school subjects combined and individual grades in Swedish, English and PE. The control group showed no significant improvement in any of these parameters. A significant effect size of the interaction effect for the aerobic group compared to the control group over time was seen for aerobic fitness, the muscle strength test with push-ups, grades in Swedish, English and physical education and in average school grade for all four school subjects.

Improvements in school grades were generally seen among both sexes in the aerobic group, whereas improvements in physical capacity were distinctly more pronounced among boys than girls.

Compared to controls, the aerobic group scored significantly higher (with a small to moderate effect size) in the survey on physical self-perception in the three sub-domains (6 questions) "Physical Condition", "Physical Strength", and Physical Self-Worth" as well as in "Total Sum" for all 36 questions (answered only at the end of the 8th grade).

A high participation rate was established, and positive experiences were reported among pupils in the extra aerobic training groups. All who performed the initial test battery at the beginning of year 7 completed the whole two-year project, except for four pupils in school B, who moved schools. Pupils regularly expressed their appreciation for extra aerobic training to the PE teachers. Thus, project organization with PE teachers engaged in the intervention led to a sustainable project with improvements in physical fitness and school grades.

A new cross-sectional study conducted in 32 Swedish schools, including pupils aged 13–14 ($n = 1139$), found that boys showed somewhat higher levels than girls of moderate-to-high-intensity physical activity (MVPA) and light intensity of physical activity (LIPA), using accelerometer assessments [35]. They also found higher aerobic fitness for the boys compared to girls. Among the same group of Swedish schoolchildren (13–14 years), another new cross-sectional study reported that only approximately one-third complied with, and more boys (37%) than girls (25%) reached, recommendations for activity levels [36]. That survey also showed that boys were generally more physically active during the school day. If this is also true for our assessed pupils, this might partly explain why we found that boys in the extra aerobic exercise groups improved their physical fitness more often than girls. These gender differences were somewhat surprising, and this must be considered when planning further interventions. However, both sexes in the aerobic group generally improved their assessed grades similarly from year 7 to year 8.

Another challenge in the present work was the multicultural nature of the area studied. Girls with an immigrant background generally participate in club sports significantly less than boys and girls with a Swedish background. Moreover, it has been reported that adolescents (13–14 years) born in Sweden showed significantly higher aerobic fitness compared to children born outside Sweden and this finding only remained significant in girls, but not boys, when stratified by gender [35]. Thus, most probably, special considerations could be needed in planning and performing similar future exercise interventions in such multicultural areas, where children may have less experience of physical exercise. This is important to consider when trying to reach all children in the most optimal way possible. On the other hand, the aerobic group in school B (located in a lower socioeconomic area and with a larger proportion of families with multicultural backgrounds) presented several positive results regarding improved grades similar to those of the aerobic groups in the other two intervention schools. Grades in Swedish, English and PE, as well as average school grade, also significantly improved in school B at the end of the two-year project for both sexes, except in English for the girls.

4.2. Previous Research on the Acute and Intervention Effects of Physical Activity

Many studies show the immediate and long-term effects of physical activity on academic performance and cognitive function in school children. However, several reports show no such effects.

According to a meta-analysis [37], both acute and chronic physical activity (PA) interventions might be a promising way to improve several cognitive outcomes and language skills in adolescents and young adults. The positive effects of physical activity on executive function, attention and academic performance have been found in a meta-analysis in preadolescent children (6–12 years) [38]. The study states that the largest effects are expected for interventions that aim for continuous regular physical activity over several weeks. Thus, the positive outcomes of physical activity on cognitive function and/or academic achievement have been shown for both adolescents and young adults and for younger children (6–12 years; see also below) [1,37,38].

High-intensity cardiovascular exercise might be a feasible alternative for acute cognitive gains according to another meta-analysis of all ages, including youth [39]. Participation in high-intensity interval training can improve cognitive function, with a moderate effect in acute studies and a small significant effect in chronic interventions, according to a meta-analysis with children and adolescents only [40]. Regarding the positive effect on cognitive function directly after physical activity found in previous studies, the extra aerobic sessions in the present intervention were intentionally scheduled in connection with theoretical lessons in mathematics, Swedish and English in the present study. Thus, the timetable for the two school days was organized so the extra aerobic session was performed just before a theoretical lesson in either Swedish, English or Mathematics. Further, in all three schools, extra fruit or breakfast was often given in connection with the extra training sessions. Eating habits may also contribute to learning state and general well-being.

In a recent meta-analysis on pupils aged 5–18 years, it was shown that cognitive performance, principally mathematics-related skills, was increased by quality-based PE interventions, i.e., increasing pupils' participation in physical activity during PE [41]. Moreover, they found that increasing the amount of curriculum time allocated to PE, i.e., quantity-based PE interventions had a very small and non-significant effect on academic performance. These authors also reported that there were no differences between the three PE interventions (i.e., quantity, quality, and combined PE interventions) in regard to academic performance. On the contrary, in our intervention, we found a significant improvement in grades in Swedish, English and physical education, but not in mathematics, in pupils that performed extra aerobic exercise twice weekly (in addition to regular PE lessons) during scheduled school time.

Sports participation during school hours has been shown to be more beneficial for academic performance compared with sport participation outside school hours according to a meta-analysis [42]. These authors found some evidence that sport participation at a moderate dose and at school could positively affect academic performance in children and adolescents. They further reported that sports participation was most beneficial for academic performance when it was at a moderate dose (i.e., 1–2 h·wk-1), compared with no sport or a high dose of sport (3 + h·wk-1).

Álvarez-Bueno et al. (2017) showed in a meta-analysis [43] that physical activity and PE benefits might affect several aspects of academic achievement, particularly mathematics-related skills, reading, and summed scores in youth (4–13 years). Other authors also found that most physical activity interventions have significant positive effects on academic performance when led by practitioners with higher qualifications in PE and exercise science. This is related to the practitioner's ability to mediate higher physical activity intensities in their given interventions [44]. The meta-analysis (including children aged 6–16 years) also emphasized that future PA intervention studies should focus on the importance of PA intensity and include measures of physical fitness as objective indicators to enable more reliable analyses to establish the influence of PA on academic performance.

Advantages of the present study are that PE teachers led all the extra aerobic exercise sessions and also at a level of a relatively high intensity (≥70% maximal heart rate). These teachers likewise performed the physical fitness tests. That various fitness tests of both aerobic fitness and muscle strength were assessed as evaluation tools in the intervention is another strength of our study.

As mentioned, the present extra aerobic exercise group showed a significant improvement in grades in Swedish, English and PE and in average school grade from autumn in year 7 to spring in year 8 for, a fact not seen for the control group. The extra physical activity might have been a contributing factor for this outcome. The relatively lower grades in Swedish for pupils in school B may be due to a larger proportion of immigrant pupils (cf. Table 6). However, grades in Swedish increased significantly for all extra aerobic exercise groups in all three schools combined, whereas grades in Swedish for the control group significantly decreased during this two-year period.

In our Nordic neighbor countries, school PE time has been increased. A recently published Danish study, based on the results from children aged 7–12 years, advocates increased school physical activity, not only for physical health but also to support academic achievement [45]. Corresponding results have been published from a Norwegian intervention, where 14-year-old pupils had 120 min extra physical activity during the school week for nine months. An intervention group showed better results regarding reading and mathematical ability compared to a control group, even though the effect was small. However, the authors, Solberg et al. (2021) believe that intervention studies are a feasible method for increasing young people's academic achievement [46].

Not all improvements found with physical exercise may persist post-intervention. In a Danish study of 1300 pupils, PE teaching was increased from 90 to 270 min/w for school years 3–7 for an intervention group. In school years 7–9, pupils returned to 90 min of teaching PE a week. The results showed no significant differences between the intervention group and the control group (90 min/v) in terms of grades (year 9) in any of the examined school subjects (Danish, English, mathematics, and science) [47]. These differing results could be explained by the fact that the effects of physical activity need to be maintained over a longer period. It would be interesting to follow up on the youth in the present study to see how various parameters are influenced by a post-intervention.

A cross-sectional study on children (6–11 years) shows a direct association between physical activity and academic performance and an independent relationship between physical activity and cognition [48]. These authors emphasize that future longitudinal studies are needed to determine whether increased physical activity can improve cognition and academic performance, including analyses of factors such as gender, socioeconomic status and ethnicity. Our longitudinal study with extra aerobic exercise included analyses of both boys and girls as well as schools with various socioeconomic status and multicultural backgrounds.

A large, rigorously conducted cluster RCT study in 10-year-old children in Norway supports the notion that there is still inadequate evidence that increased physical activity in school enhances academic achievement in all children [49]. However, the authors state that combining physical activity and learning seems a feasible model to stimulate learning in the academically weakest schoolchildren. We did not analyze the differences within each group between pupils with high and low grades. During the two-year period, however, significantly improved grades were noted for school subjects Swedish, English and PE and average school grade in all of the three schools, including school B with pupils with a more multicultural background and lower socioeconomic status than those in schools A and C (see also above).

An article entitled "Be smart exercise your heart: effects on brain and cognition" summarizes the effects of physical activity on cognition and brain function at different levels in the brain, with results for children and adolescents [50]. Data are also presented on a positive relation between physical activity and cognitive performance in school-aged children in several measurement categories (perceptual skills, intelligence quotient, achievement, verbal tests, mathematic tests, memory, developmental level/academic readiness and other).

Thus, many, but not all, such studies show the acute and chronic positive effects of physical activity on academic performance and cognitive function.

4.3. Fitness Tests and Academic Performance

Some physical activity studies in schoolchildren have measured and compared changes in academic performance and physical fitness tests, and then most often aerobic capacity tests. Changes in aerobic fitness between the 6th and 8th grades were positively related to changes in academic achievement in standardized tests regarding reading and mathematics [51]. The authors claim that changes in aerobic fitness may modulate changes in academic achievement and that these findings highlight the importance of physical activity; their outcomes have broad relevance for educational systems and policies. We found a significant effect size of the interaction effect for the aerobic group compared to the control group over time for aerobic fitness and the muscle strength test with push-ups, as well as for grades in Swedish, English and physical education and in average school grade for all four school subjects. Within the aerobic group we also found an improvement in the endurance and strength of abdominal and leg muscles over the two-year project. Tests of muscle strength have very rarely or not been measured before in such school interventions.

A one-year intervention showed no improvement in aerobic fitness, cognitive tests and health with high-intensity interval training (HIIT) 10 min (71–85% of max heart-rate) twice weekly during regular school PE for pupils aged 12–13 years [52]. Moreover, they found no significant moderation of intervention effects by sex, socioeconomic status or baseline fitness levels. Wassenaar et al. concluded that their findings should be interpreted with caution given low implementation fidelity and high drop out. In addition, they proposed that further well-controlled, school-based trials that examine the effectiveness of HIIT-style interventions to enhance cognitive and mental health outcomes are warranted [52]. In our study, we had more time for extra aerobic exercise. We also had high implementation fidelity and low drop out as a result of the sustainable design of the project with close interaction between PE teachers and pupils.

Better performance in various cognitive tests has been shown in children aged 9–10 years with higher aerobic fitness than less fit children [53]. This cross-sectional study suggests that childhood aerobic fitness and basal ganglia volumes relate to cognitive function at the time of fitness testing and may play a role in future cognitive performance. The authors hoped that their research results would encourage public health and educational changes to promote a physically active lifestyle in children. Further, aerobic fitness is also associated with greater hippocampal cerebral blood flow in children aged 7–9 years [54]. The hippocampus is an important area for memory.

Another cross-sectional study of 10-year-old overweight/obese children showed that other fitness components such as muscular and speed-agility fitness may contribute to better academic performance, yet these associations depend on body mass index and cardiorespiratory fitness [8]. The authors found no relationship between physical activity and academic achievement. Accordingly, they state that public health strategies should focus on improving multiple aspects of fitness as an effective approach to enhance academic achievement in children. Further randomized controlled trials are needed to verify these results [8]. That we, in our study, measured physical capacity both regarding aerobic fitness and strength in several muscles follows suggestions in the latter study.

Moreover, a large review of cross-sectional youth studies reports strong evidence of a positive association between aerobic fitness and cluster of physical fitness (PF) and academic performance (AP) [1]. The authors also present evidence from longitudinal studies for a positive association between cluster of PF and AP, whereas the relationship between muscular strength and AP remains uncertain. In our longitudinal study, an increase in PF and improvements in school grades were found in connection with extra aerobic exercise.

We used the well-known and validated Beep test [12–18]. A significant improvement was observed for the extra aerobic exercise group in schools A and C, but not in school B. Rather similar values were noted between the start and the end of the period for school B. The reason for this unclear. The control group, on the other hand, showed a non-significant decrease between the start and the end of the project in the Beep test.

Comparing fitness levels at the study start for the aerobic group compared to controls, only the Beep test (of the five fitness tests) showed significantly lower values, and only the jump test showed significantly higher values. At the end of the two-year project, no significant differences between the groups were noted in any of the five fitness tests.

For the control group, a significant improvement among all fitness tests was seen only in jumping ability. Puberty development can affect various fitness test results and can possibly be a contributing factor for this test. However, this intervention did not examine pubertal development. Notably, the control group showed a significant decrease in the arm test during this two-year period. The reason for this result is unclear.

Thus, there is a lack of previous longitudinal studies with extra physical exercise for school children with evaluation of both academic performance and health as well as aerobic fitness and muscle strength in different muscles.

4.4. Physical Self-Esteem and Well-Being

We found significantly higher values (with a small to moderate effect size) for the aerobic group than for the control group for questionnaire responses regarding the sub-domains (each containing six questions) "*Physical Condition*", "*Physical Strength*", "*Physical Self-Worth*" and "*Total Sum*" at the end of the two-year project. Such questionnaires have been used previously in different reports [32,33].

A study shows that at ages 12 and 15 years, boys' and girls' "Physical Condition" and "Physical Strength" as well as "Body Attractiveness" and "Physical Strength", respectively, have the strongest correlations to physical self-esteem [55]. Those authors showed that the impact of a sub-domain upon physical self-esteem varies during adolescence and early adulthood. Such information may be useful when creating physical activity programs that support and develop physical self-esteem according to these authors.

We found that in the *extra aerobic training group*, girls scored significantly lower than boys (with a small to moderate effect size) for sub-domains "Sport Competence", "Physical Condition", and "Body Attractiveness" and for "Total Sum" for all six sub-domains combined. No significant changes were seen between the sexes in the control group, although the tendencies were generally similar to those mentioned for the aerobic group.

The WHO Five Well-Being Index showed some reduction in both our aerobic group and control group, although this was significant only for the former, from the autumn term in the 7th grade to the spring term in the 8th grade. However, the effect size showed no significant changes regarding the interaction effect for the aerobic group compared to the control group over time for the WHO Five Well-Being Index. The reason for the pattern of reduced health according to the WHO Five Well-Being Index for both groups during this two-year project is unclear. One contributing factor could be the start of the COVID-19 pandemic during the last term of year 8. This might have affected perceived health, though no significant difference was found between the aerobic group and the controls at the start of year 7, nor at the end of year 8 for the WHO Five Well-Being Index. In a meta-analysis [56,57], clinically elevated signs of self-reported depression and anxiety were shown during the COVID-19 pandemic for 80,000 children and adolescents from several continents worldwide, and the main victims were girls and young teenagers. Another study showed that self-rated physical activity habits often decreased among university students during the lockdown due to the COVID-19 pandemic compared to before the lockdown [58]. Such lifestyle changes may influence general well-being. In the present study, children's physical habits outside school time were not assessed from the beginning of year 7 to the end of year 8.

The positive influence of physical activity on general state of health, and not only on learning, in children and adolescents has been shown in a large WHO report, based on 21 systematic reviews [4]. Physical activity, for example, improves cardiometabolic, skeletal and mental health, and reduces the risk of depression in youth. Sports also affect the health of competitive athletes. Intensive and continuous physical exercise is known to activate the immune system and induce metabolic adaptations, which can be monitored via alteration of many biochemical parameters, for example in serum [58]. These authors declare that such biomarkers can be followed during different stages of a sport season to protect the health of competitive elite athletes and also to prevent overtraining conditions that might result in various diseases and injuries such as infection, inflammation, and muscle injury [59]. Thus, physical activity can both promote health and well-being and in excessive amounts also reduce health and well-being, which should be considered by everyone who engages in various physical exercise regimes and by responsible leaders.

4.5. Practice Related Research or Applied Research—A Meaningful Approach to the Professionalization of PE

The present project was managed by three experienced PE teachers, handling regular PE lessons as well as the aerobic intervention. They were involved professionally in planning, setting up and forming research questions and carrying out the methods, tests, etc. The entire research process was thus a valuable learning experience for them, enabling them to start other PE interventions in the future. In addition to being co-researchers, the PE teachers also noted additional positive effects from the project, for example that pupils were more independent and were able to guide younger pupils in aerobic exercises. Further, after a while in the two-year period, there was a tendency for the aerobic group of pupils to take part in more spontaneous sport activities and athletic club sports outside school. The PE teachers observed that self-confidence among pupils, especially among girls, increased markedly during the two-year period. The project also particularly affected participation in spontaneous sports and club life (i.e., both during breaks at school and outside school) among girls. Finally, improved relationships between PE teachers and guardians/parents of pupils were noted.

When the school intervention also became part of the larger project collaboration with university scholars, teachers and researchers sat together and analyzed the results, what could be learned from the intervention, changes of content, etc. This created a common understanding of what had made the project sustainable in terms of pedagogical strategies, routines, and knowledge of pupils.

A main limitation of this study is that the control group was restricted to only one class with 26 pupils, although they all completed the whole two-year project. This group was randomly selected via lottery from one of the schools. Further, not all school staff were involved in the project at the school. It would have been optimal if we had included all the questionnaires from the beginning in the 7th grade. In addition, it would have been of value if we had continuously, during the two-year period, measured their physical activity habits in a diary and/or had assessed their physical activity patterns with accelerometers at baseline and at the end of intervention. We measured lifestyle habits and their well-being with a questionnaire, but only at the end of year 8. It is known that people generally overestimate their physical activity habits and underestimate their sedentary behavior in questionnaires. However, among these questions, there were generally no significant differences between the control group and the aerobic group combined or the separate aerobic groups at each school (A, B and C). Thus, there was a certain similarity between the groups in this respect. Puberty may play a role in differences in fitness tests over time. However, it was not accounted for in this study. Another limitation is that we did not use assessment tools with more advanced laboratory equipment to monitor aerobic fitness and strength in different muscle groups. Actually, one of the main purposes of our project was to use field tests. They are simple and cost effective to utilize in such contexts. A factor that effects fitness tests is motivation. Pupils were instructed to perform each test with maximum effort. Encouragement was given in all tests. The field tests selected in the present study are relatively common and, within the Methods section, various examples of references are given that have shown relatively good reliability and validity for such measurements.

It can be argued that just paying attention to getting extra aerobic exercise can be one explanation for our positive results in the intervention group compared to the control group. However, our study was designed so that the aerobic group and the control group would perform several aerobic and strength tests as well as different questionnaires pre- and post-intervention. Thus, both groups received the same attention in these respects. Our primary intention was to compare a group that performed two extra 30 min aerobic sessions with a group that did not. Therefore, two alternative weekly activities for 30 min were not created for the control group in the present study.

A strength of the project may have been that the extra sessions of aerobic training were voluntary and that they fell within the schools' timetables. Other strengths are that the project was well anchored among school management, that three schools were involved and that the school intervention was led by the ordinary PE teachers whom pupils knew and met at other times during the school day. Strengths also include that evaluations employed several different fitness tests of aerobic capacity and muscle strength, as well as school grades and perceived health; and that various positive outcomes were obtained among these parameters. Further strengths are that comparisons were made with a control group and that high sustainability was found regarding the participation rate in the two-year project. Moreover, comparisons were also made between genders and the schools (located in different socioeconomic areas and with varying ethnicity). These constituted factors that sometimes could affect the outcomes. Another strength is the longitudinal design of this study.

5. Conclusions

This was a sustainable project design involving PE teachers in an extra aerobic exercise intervention. In the aerobic group there were significant improvements from the autumn term in year 7 to the spring term in year 8 in grades in Swedish, English, physical education, and in average school grade for four school subjects combined, thus also including mathematics for these pupils aged 13–14 years. There were also significant improvements in aerobic fitness, endurance strength of abdominal and leg muscles as well as the total physical test index. The control group showed no significant improvement in any of these parameters. Improvements in school grades were generally seen among both sexes in the aerobic group, whereas improvements in physical capacity were distinctly more pronounced among boys and seldom among girls. Such facts may be considered in future similar physical exercise projects. A similar pattern with significant improvement in several school grades was noted in all three intervention schools, although one of the schools had a distinctly larger proportion of children who immigrated to Sweden.

A moderate to large significant effect size of the interaction effect for the aerobic group compared to the control group over time was generally seen for aerobic fitness, the muscle strength test with push-ups, grades in Swedish, English and physical education and in average school grade for all four school subjects.

Involving PE teachers in the intervention led to a sustainable project with improvements in physical fitness and school grades. Previously, such longitudinal physical exercise interventions in school settings have rarely or not at all included both aerobic fitness tests and different muscle strength tests for pupils. A special advantage from a sustainability point of view was the high levels of continuity among pupils who participated voluntarily in this two-year project with timetabled extra aerobic training. Such interventions might be of special value in schools with a high proportion of pupils with lower participation in organized sports, of multicultural backgrounds and from a lower socioeconomic status. Another strength from a sustainability perspective was that the project was well rooted in school management and at each local school. The positive outcomes indicate that the project organized by PE teachers might inspire other schools aiming at introducing extra physical activity to improve physical fitness from a lifelong perspective and possibly school grades for their pupils.

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