Scandinavian Journal of Public Health, 1–7

ORIGINAL ARTICLE

The effect of physical-activity intervention on children's health-related quality of life

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Abstract

Aims: We investigated the effect of a school-based physical-activity intervention on children's health-related quality of life (HRQoL) and the potential influence of moderate to vigorous physical activity (MVPA). *Methods:* A randomised, controlled trial (Active School) involving fifth-grade children was conducted during the 2014/15 school year. The sample included 435 children (10–11 years old) at five intervention schools and four control schools. The weekly interventions concerned two 45 min of physically active lessons, five 10 min of physically active breaks and five 10 min of physically active homework. The children's HRQoL was measured using KIDSCREEN-27 and a self-report questionnaire, while physical activity was measured using accelerometers. *Results:* The results of multilevel analysis showed a significant effect on psychological wellbeing ($p = 0.005$), social support and peers ($p = 0.005$) and school environment ($p = 0.013$). No gender differences were observed. Children's MVPA did not influence their KIDSCREEN-27 score. ***Conclusions:*** **The school-based physical-activity intervention (Active School) shows positive effects on children's self-reported psychological wellbeing, social support and peers, and school environment.**

Keywords: *Physical activity, social interactions, wellbeing, multilevel analysis*

Background

Health-related quality of life (HRQOL) is a multidimensional concept commonly used to examine the impact of health status on quality of life [1]. It is a useful indicator of overall health, encompassing the physical, emotional, mental, social and behavioural components of wellbeing [1,2]. Physical activity is important for maintaining and improving mental and physical health [3].

It is of concern that 50% of adolescents in Norway do not meet the minimum physical-activity recommendations for the achievement of health benefits [4]. The link between physical activity and HRQoL has demonstrated positive relationships for various subgroups of the adult population [5]. Among adolescents, cross-sectional results show that, over a five-year period, physically active young people (particularly those engaging in outdoor activity) have a higher HRQoL than their less active peers – a result primarily driven by better physical and social performance [6]. Improving cardiorespiratory fitness might be especially useful in enhancing HRQoL in children. Recent studies demonstrate the positive association of aerobic fitness and muscular strength with wellbeing in younger children [7,8], and this supports the hypothesis that aerobic fitness may be beneficial to improving children's wellbeing. Nevertheless, the underlying mechanism explaining changes in HRQoL as a result of changes in physical-activity levels remains unclear. A number of interacting neurobiological, psychological and social mechanisms are thought to be involved [3]. However, it is claimed that the activity alone (e.g. sitting in front of a screen or being physically active)

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Date received 10 May 2019; reviewed 29 November 2019; 18 May 2020; 17 August 2020; 5 October 2020; accepted 14 October 2020

DOI: 10.1177/1403494820971493
journals.sagepub.com/home/sjp
SAGE

cannot explain this mechanism; the results can easily be linked to the way the physical activity is organised and the context in which it occurs [9]. Recent research indicates that physical activity must be organised to ensure that social belonging affects mental health [10,11] and learning outcomes [12].

Finding the significant effects that school-based physical-activity interventions have on HRQoL in children has proven to be a challenge. In a review by Rafferty et al. [13], eight of the 11 studies report a significant increase in physical activity, and only one of those studies reports a significant increase in an indicator of wellbeing. Another recent RCT study focusing on increased physical activity in primary school (fifth grade) found no significant effect on HRQoL [2]. However, the major limitation of this cluster RCT study was the non-significant difference in physical activity between the intervention and control groups during the intervention.

It has been suggested that mixed findings in the literature might be explained by inconsistent measurement of children's wellbeing. Studies have captured the multidimensional nature of wellbeing, but the indicators chosen may not fully reflect how children perceive their own wellbeing. Moreover, measures of physical activity may impact the results; the use of an objective measure of physical activity, for example an accelerometer, is highly recommended [13]. The sensitivity of the KIDSCREEN-27 tool, as regards to reflecting change related to physical activity in studies, remains undocumented. It is recommended that future physical-activity interventions include a measure of wellbeing developed from the child's perspective, and that future reviews narrow the search to interventions that have successfully increased physical activity before exploring the effects of wellbeing [13]. Based on current knowledge, the objective of this study is (a) to determine the effect of a school-based physical-activity intervention on children's self-reported HRQoL and (b) to examine whether moderate to vigorous physical activity (MVPA) is positively related to children's HRQoL.

Methods

The present study uses data from the 'Active School' study – a randomised and controlled trial conducted in Stavanger, Norway between August 2014 and June 2015. The main purpose of the intervention study was to investigate whether increased physical activity at school affected fifth-graders' aerobic fitness and self-regulation. A more thorough description of the study is presented in Kvalø et al. [14]. The intervention was led by teachers at the intervention schools and consisted of one primary component (physically active lessons) and two secondary components (physically active homework and physically active recess). In relation to classroom teaching, physically active lessons were conducted outdoors (e.g. in the schoolyard), which provided children an opportunity to move and interact with one another while working on academic tasks. The intention of having physically active lessons was to distribute knowledge amongst children through group work with each of them contributing different knowledge and skills of both an academic and physical nature. In addition, the interaction between children may contribute to the development of a strong and positive social environment that stimulates the children's experience of belonging in the school environment.

Power calculations were based on executive function (the main outcome of the intervention) as a means to detect an effect size (Cohen's *d*) of 0.3 (equals Cohens $f = 0.15$). For example, a total of 250 children would provide a power of $\beta = 0.80$ to detect relevant changes (repeated measures) in children in the intervention and control groups. Overall, nine schools were divided into two groups and stratified according to the number of children participating in extracurricular sports, the living conditions in the surrounding school area, and the size and level of participation in the 'Physical Activity Leader Program' (a separate programme that focuses on increasing physical activity and preventing bullying during recess periods). The computer program 'Researcher Randomizer' [15] was used to select the five intervention schools (227 children) and four control schools (231 children) based on the above criteria. Parental consent was obtained, and the children provided verbal consent before testing (449 children). Norwegian Research Data (Project No. 38509) approved the study, which is registered at clinicaltrial.gov (ID identifier: NCT03436355). Figure 1 shows the flow model for the Active School procedures and measures in KIDSCREEN. Missing data – due to a lack of time to respond, sickness or vacation – was at pre-test 26–29% in the intervention group and 15–21% in the control group. At post-test, this decreased to 3–9% in both groups. In addition, 16 children dropped out during the intervention period due to sickness, cancellation of participation or their having moved away from the school district.

Intervention

The weekly interventions consisted of two 45 min of physically active lessons, five 10 min of physically active breaks and five 10 min of physically active homework. We estimate that intervention schools

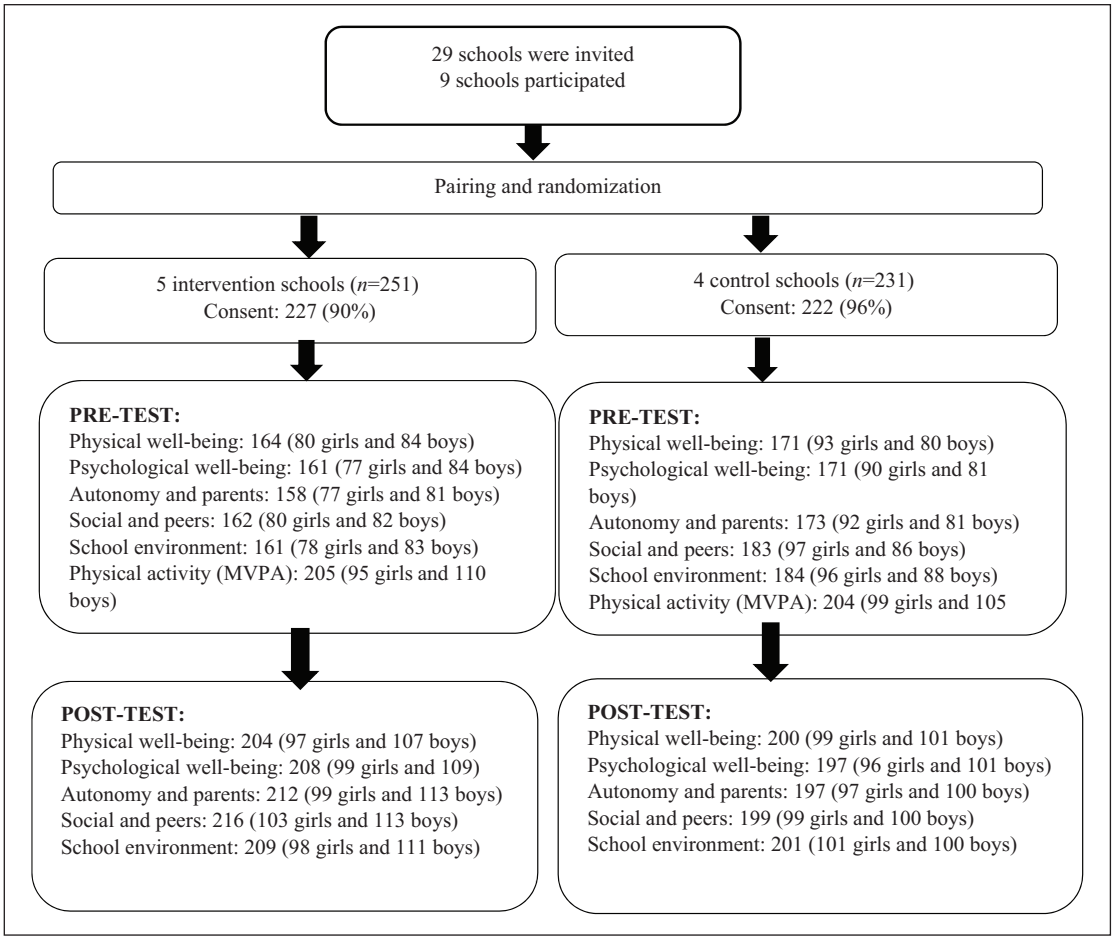

Figure 1. Flow model of the Active School intervention, KIDSCREEN measures and baseline physical activity (moderate to vigorous physical activity, MVPA).

should conduct 325 min of physical activity every week. Control schools followed the regular national curriculum, providing 135 min of physical activity (physical education and regular physical activity) every week. In total, teachers at the intervention schools reported an average of 292 min of physical activity every week, whilst control schools reported 104 min.

Previous results from the Active School study

The effect on the intervention's main outcomes (executive function and aerobic fitness) was a non-significant improvement in aerobic fitness and executive function in children at intervention schools versus those at control schools (mixed ANCOVA repeated measures). Moreover, a positive tendency ($p = 0.057$) – expressed by a small effect size (0.21 Cohens d) – was found for executive function, indicating a bigger improvement in children at intervention schools compared to those at control schools [14]. In addition, ANCOVA repeated measures of objectively physical activity (measured with accelerometers) were also performed and showed a significant improvement for the intervention group $F(1,364) = 11.02$, $p < 0.001$ (Cohens $d = 0.34$) and regarding aerobic fitness in the least fit children $F(1,122) = 6.2$, $p = 0.01$ (Cohens $d = 0.46$) [16].

Measures

In this study, the KIDSCREEN-27 instrument was used to measure health-related quality of life (HRQoL). The Norwegian version was translated and ready for use in 2006 [17] and demonstrates good reliability and validity [18]. The questionnaire measures HRQoL across five dimensions: physical wellbeing (five items), psychological wellbeing (seven items), autonomy and parent relations (seven items), social support and peers (four items), and school environment (four items). The KIDSCREEN-27 self-report version requires respondents to answer the 27 items on a five-point Likert scale ranging from never/not at all to always/extremely (1 = never/not at all, 2 = seldom/slightly, 3 = quite often/moderately,

4 = very often/very, 5 = always/extremely). Certain items are reversed when scoring the questionnaire. For each dimension, a scoring algorithm is used to calculate *T*-scores scaled with a mean of 50 and a standard deviation of 10 [19]. Scoring the instrument does not result in an overall HRQoL score, but rather a total score for each of the five dimensions, where higher scores indicate better HRQoL. The scores can be used to make comparisons with age-specific norm-referenced data [19]. Completing the KIDSCREEN-27 only took 10–15 min and was administered to the schoolchildren via a pen-and-paper self-report process. All children in the participating classes were invited to take part.

Physical activity was measured using accelerometers (ActiGraph GT1M/GT3X/GT3X+, LLC, Pensacola, Florida, USA). The collection of baseline accelerometer data was conducted before the intervention started (August 2014). Data were considered valid if a child had at least two days with a wear time of ⩾ 480 min/day accumulated between 06:00 and 24:00 [16]. In this study, outcomes for PA levels were MVPA min/day (⩾ 2296 cpm), and Evenson cut-points were used. All accelerometers were analysed using ActiLife, v. 6.12.0 (ActiGraph Corporation, LLC, Pensacola, FL, USA).

Statistical analyses

Test–re-test reliability was assessed by intraclass correlation coefficients (ICC) using a two-way mixed model with an absolute agreement definition; ICC values ⩾ 0.6 were considered satisfactory [1]. ICCs ranged from 0.69 to 0.80, which is consistent with Ravens-Sieberer [19], where ICCs ranged from 0.61 to 0.74 for the different KIDSCREEN-27 dimensions. Means and SD were used to illustrate children's baseline characteristics. Missing data were imputed from relevant variables by multiple imputations using Markov Chain Monte Carlo. Missing data were interpreted as random. The effect of the intervention on HRQoL was assessed using five separate mixed-effect analyses, with the post-scores of the various KIDSCREEN variable scores as the outcome. The independent variable was group (intervention versus control schools) adjusted for the pre-test KIDSCREEN variable scores. Due to the clustered nature of the data, schools were included as random effects, and maximum likelihood approximation was used. Effect sizes (ES) were calculated by dividing the adjusted group difference in HRQoL between groups (intervention and control schools) by a value of 10, which is the standard way of calculating effect size in KIDSCREEN-27 [19]. The following effect-size criteria were used: trivial (< 0.2 ES), small (0.2–0.5 ES), moderate (0.5–0.8 ES) and large (> 0.8 ES). Previous studies using KIDSCREEN indicate that girls have lower HRQoL scores than boys, and the proportion increases into adolescence [20,21]. Gender was entered in the analysis as a factor for testing of the gender effect. A second analysis included MVPA in the multilevel model to estimate whether physical activity might affect results in the five KIDSCREEN-27 dimensions. PROCESS analysis with 5000 bootstraps was used to investigate the potential mediation effect of MVPA (mediator) in the relationship between group (intervention versus control groups) as an independent variable and the five different KIDSCREEN-27 dimensions (using difference scores) as dependent variables. All statistical analyses were performed using SPSS 21 (IBM Corporation, Somers, NY, USA).

Results

A total of 310–324 children were included in the multilevel analysis (69–72% response rate). Children's pre-test HRQoL characteristics and MVPA scores are presented in Table I.

In terms of the first research question, the effects of the intervention were determined using the multilevel model, including the random intercept of school to account for the multilevel structure of the data. The results (Table II) show a significant effect on children's self-reported psychological wellbeing 2.85 (95% confidence interval (CI), 0.9–5.1), $p = 0.005$, $n = 310$; social support & peers 2.84 (95% CI, 0.8–4.6), $p = 0.005$, $n = 327$; and school environment 2.5 (95% CI, 0.5–4.3), $p = 0.013$, $n = 324$. Gender had no significant effect in the multilevel model.

To answer the second research question, baseline MVPA was included in the multilevel model. Results from the multilevel model as confirmed by PROCESS analysis show that children's MVPA does not affect HRQoL scores: physical well-being 0.01 (95% CI, –0.02–0.06) $p = 0.415$; psychological wellbeing 0.014 (95% CI, –0.03–0.06), $p = 0.544$; autonomy and parents 0.027(95% CI, –0.03–0.06), $p = 0.210$; social support and peers: 0.001 (95% CI –0.03–0.05) $p = 0.604$; and school environment 0.005 (95% CI, –0.6–0.04), $p = 0.809$. Estimates indicate no influence of MVPA on children's HRQoL in intervention schools.

Discussion

The main findings from this study show a significant effect for psychological wellbeing, social support and peers, and school environment. Although only9 schools were included in the intervention, variation within the schools concerning the intervention versus

Table I. Study children's baseline characteristics.

	Intervention schools (five schools)		Control schools (four schools)	
Variables	***n***	**Mean ±SD**	***n***	**Mean ±SD**
Physical well-being (five items)	167	53.8 ±9.3	173	51.3 ±9.6
Psychological well-being (seven items)	161	55 ±9.6	171	53.5 ±9.2
Autonomy and parents (seven items)	158	53.4 ±10.8	173	50.7 ±8.9
Social support and peers (four items)	162	54.2 ±10.1	183	54.4 ±8.6
School environment (four items)	161	57.4 ±9.6	184	54.1 ±9.5
Moderate to vigorous physical activity (MVPA)	205	61 ±19.25	204	69.5 ±25.8

Table II. Results of multilevel linear model analysis of KIDSCREEN-27 scores.

Domain	Intervention schools Mean (95% CI)	Control schools Mean (95% CI)	Group difference (95% CI) (*p*-value)	ES
Physical well-being (n = 314)	52.10 (50.79–53.41)	52.15 (50.82–53.49)	0.065 (–1.8–1.9) (0.953)	0.0
Psychological well-being (n = 310)	56.52 (55.03–58.99)	53.5 (52.05–54.94)	2.85 (0.9–5.1) (0.005)	0.28
Autonomy & parents (n = 312)	55.8 (54.37–57.24)	55.05 (53.61–56.39)	0.80 (–1.2–2.8) (0.432)	0.0
Social support & peers (n = 327)	54.5 (53.14–55.86)	51.76 (50.44 -53.08)	2.84 (0.8–4.6) (0.005)	0.28
School environment (n = 324)	57.15 (55.79–58.51)	54.76 (53.48–56.04)	2.50 (0.5–4.3) (0.013)	0.25

CI, confidence intervals; ES, effect size.

control group may have contributed to the present effect. Including baseline MVPA in the multivariate model indicates that physical activity had no influence on children's perceptions of the various KIDSCREEN-27 dimensions, contradicting recent findings that concluded that aerobic fitness might be beneficial for improving HRQoL [7,8].

One possible explanation of the present effects may be that physically active lessons in the schoolyard affect children's mood and enjoyment, experience of school and relationship with teachers. The variety of teaching methods and an innovative approach seem positive with respect to children's satisfaction at school, and this may motivate them to work harder academically during lessons. In this context, physical activity is about teamwork and social belonging, which is in turn an important factor regarding participation in physical activities [22]. Children prefer to move about when they feel that their peers are inviting and welcoming and they have contributed and helped their team [23]. This confirms the findings of Dyrstad et al. [24], where children in the intervention group experienced better friendship with their peers as a result of participating in the Active School intervention study.

A review study by Rafferty et al. [13] concluded that determining the effects of school-based interventions on wellbeing should include physical-activity measures. Previous results from the Active School study showed significant improvement in objectively measured physical activity and increased aerobic fitness in the least active children in the intervention schools [16]. Although children in the intervention group received 135 min more physical activity (38%) than those at control schools, they did not report any improvement in physical wellbeing. This result contrasts with findings in Lubans et al. [25] that physical activity can improve physical self-perception. In addition, the non-significant findings of MVPA raise the question of how much physical activity is sufficient to influence children's HRQoL. Previous research suggests that as much as 1.2 SD of extra physical activity (331 counts/min) might be needed to improve the KIDSCREEN-27 domain of physical wellbeing [7]. Another study claims that a difference of 300 m in a 10-min running test is expected to yield a difference of 3 points in wellbeing [8]. With these results in mind, it is possible that considering what is required to improve self-reported physical wellbeing in KIDSCREEN-27, the children in the Active School study were not sufficiently engaged in physical activity. Moreover, research emphasises that higher intensity (vigorous) activity may better contribute to physical and mental health benefits than moderate intensity [26]. Insufficient intensity in physical activities might have affected the non-influence of MVPA in this study. Moreover, previous research has reported that gender differences in HRQoL tend to emerge around the ages of 11–14 [26], thus our sample may have been too young (9–10 years old) to observe this phenomenon.

Strengths and limitations

Use of an RCT design is a strength of the current study; it provided empirical evidence of the intervention efficacy and is necessary for valid analysis of the result of the intervention. It is important to bear in mind the multiple mechanisms that can influence children's HRQoL when doing research in 'real-world settings' such as schools. The strength of the KIDSCREEN-27 questionnaire is that it provides clarity on the specific aspects of a child's environment that may be salient to the promotion of health and wellbeing. Previous studies have demonstrated that younger children may be unable to accurately report their perceptions using negatively worded items [18,27]. With this perspective in mind, there may be methodological reasons why the current literature reports little or no effect on HRQoL [13]. Several studies have found KIDSCREEN-27 to be applicable to different populations across different countries [18,19,27,28]. A lack of consistent results may be the result of language issues, a difference in cultural adaptions or other factors and should be examined in further studies.

This study has several limitations. First, a relatively low sample response rate in KIDSCREEN-27 raises issues of power and representativeness. However, an advantage of this multilevel model is that it uses the entire data set. Second, our assessments relied on information obtained from the children and did not include information from parents and teachers. However, studies that have investigated relationships between children's and parents' responses have found a small correlation between them [8,27,28]. Third, the data are missing at random, and this can cause unbiased estimates of each of the means. That being said, the parameters are estimated using Maximum Likelihood, which provides asymptotically unbiased estimates. Fourth, lack of prospective MVPA data in this study prevents us from establishing a causal relationship between KIDSCREEN scores and MVPA.

Conclusions

In conclusion, our findings indicate that participating in a school-based physical-activity intervention study may be beneficial for children's self-reporting psychological wellbeing, social relationships and the school environment. Physical activity expressed by MVPA did not predict children's self-reported wellbeing. There is reason to believe that implementing physically active lessons at school might influence children's health in multiple ways: (a) their objectively measured MVPA, which influences physical health (even though they do not report it), helps achieve the recommended 60 min of daily moderate to vigorous physical activity; (b) their perception of the importance of positive relations with peers and teachers improves; and (c) they experience positive effects (enjoyment and happiness) that may influence their mental health. Emphasising social belonging in physical activities seems important and meaningful to children. Further analysis should emphasise how and why physical-activity interventions can increase wellbeing in children. Overall, these findings should encourage schools to implement physically active lessons in their daily school curriculum.

Acknowledgements

The authors wish to thank all the testers for their data-collection work. This study was funded by the University of Stavanger, Stavanger Municipality, Rogaland County Council and the Regional Research Fund, Norway.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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