Effects of a School-Based Physical Activity Program on Physical and Psychosocial Quality of Life in Elementary School Children: A Cluster-Randomized Trial

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The present study tested the effect of a school-based physical activity (PA) program on quality of life (QoL) in 540 elementary school children. First and fifth graders were randomly assigned to a PA program or a no-PA control condition during one academic year. QoL was assessed by the Child Health Questionnaire at baseline and postintervention. Based on mixed linear model analyses, physical QoL in first graders and physical and psychosocial QoL in fifth graders were not affected by the intervention. In first graders, the PA intervention had a positive impact on psychosocial QoL (effect size [d], 0.32; \( p < .05 \)). Subpopulation analyses revealed that this effect was caused by an effect in urban (effect size [d], 0.38; \( p < .05 \)) and overweight first graders (effect size [d], 0.45; \( p < .05 \)). In conclusion, a school-based PA intervention had little effect on QoL in elementary school children.

Chronic diseases like obesity, as well as mental disorders are an increasingly prevalent public health problem in children and young adolescents (38, 40). Restricted activities, teasing of peers, decreased (motor) competences and general worries as a result of such chronic conditions can adversely affect a child’s quality of life (QoL; 17). The later includes “individuals’ subjective evaluation of their physical health, mental health, and social functioning” (10). It extends traditional

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objective measures of health and has been increasingly recognized as providing an important marker of health outcome for children in the general population (17).

Searching for ways to enhance QoL, physical activity (PA) has been found to be a promising option. In adult populations PA interventions have shown to improve physical and psychological QoL (1,5). The mechanisms by which these improvements occur are not fully understood, but improvements in psychological factors, such as body image or perceptions of physical fitness, as well as more physiological changes, such as sympathetic nervous system activity, may play an important role (5). In children, the impact of PA on QoL has mainly been examined in clinical populations. Positive intervention effects on QoL were found in children with rheumatic diseases (28) and asthmatic children (2,19). To our knowledge, in the general population of healthy children no intervention studies have determined whether PA leads to an improvement of QoL.

To overcome this existing gap in research, we conducted a randomized controlled trial to determine whether PA affected QoL in elementary school children. Based on data obtained in adult populations, we hypothesized that our intervention would improve both physical and psychosocial QoL. We further aimed to find out whether our intervention had a distinct effect on subpopulations with potentially low QoL. We based our selection of study variables on cross-sectional studies, which had demonstrated lower QoL for children from families with lower socioeconomic status (32), pubertal children (41), urban children (37) and overweight children (21,46,52).

Our empirical data were drawn from a school-based PA program over one academic year aiming at improving body composition, fitness, PA, QoL and also cardiovascular health in elementary school children (“Kinder-Sportstudie KISS”).

Method

Study Design and Participants

The study was performed in two provinces of Switzerland with a total of 919 elementary schools. Of these, 95 fulfilled our stratification criteria, i.e., a clear rural or urban localization and a prevalence of 10-30% children from ethnic minorities. These strata were chosen to be representative for the Swiss population. Recruitment of participating schools (i.e., cluster randomization) was based on the willingness of these 95 elementary schools to be randomized either to an intervention group with a PA curriculum or a control group. Fifteen schools with a total of 27 classes were randomized by a random-number table. Sixteen classes in nine schools located in six communities were randomized to the intervention group (INT), and 11 classes in 6 schools in other communities of the same provinces were randomized to the control group (CON). A higher number of schools in the INT than in the CON group were chosen to gain more experience with the intervention. In summary, 540 children were assessed at baseline; 242 were in first grade (6–8 years) and 298 were in fifth grade (10–12 years). Gender was evenly distributed.

Informed consent for the questionnaires and all measurements was necessary for all participants and was given by the children and a parent. The study was approved by the Ethics Committees of the University of Basel, the University of Zürich, as well as by the cantonal ethical committee of Aargau, Switzerland. All evaluation measures were developed as defined in the CONSORT guidelines (9).
Data Collection

All questionnaires were completed at baseline (August 05) and then again after one academic year (June 06). The Child Health Questionnaire (CHQ-PF50) and a sociodemographic questionnaire were distributed to the children at school in coded envelopes. The parents filled in the answers at home. The questionnaires were brought back to school some days later and collected by the teachers. Weight and height were measured at the schools. All procedures were completed by the staff of the Institute of Exercise and Health Sciences from the University of Basel.

Measures

Quality of Life (QoL). QOL was measured by using the German version of the Child Health Questionnaire (CHQ-PF50; 33). The CHQ-PF50 is a validated 50-item multidomain questionnaire for children aged 5–18 years evaluating children’s quality of life from a parent’s view. It assesses physical, emotional, social, and school functioning in the context of their family and social environments, from which physical and psychological health summary scores are derived. Thirteen domains of children’s functioning are assessed. These include (1) limitations in performing physical activities (6 items), (2) limitations in school work or activities with friends as a result of physical health (2 items), (3) global health of child (6 items), (4) child’s pain (2 items), (5) limitations of family activities due to child’s health (6 items), (6) limitations in school work or activities with friends as a result of emotional or behavioral problems (3 items), (7) limitations of parent’s time due to child’s physical and psychological health (3 items), (8) parent’s experience for emotional stress and worry due to child’s physical and psychological health (3 items), (9) child’s satisfaction with abilities, looks, family/peer relationships and life (6 items), (10) child’s feelings of anxiety and depression (5 items), (11) exhibition of aggressive, immature and delinquent behavior (6 items), (12) family’s ability to get along (1 item), and (13) changes in health (1 item) compared with one year ago. Based on the manual (32), the raw score for each domain was transformed on a 0–100 scale with higher scores indicating better QoL. In a next step, the 13 domains were converted into a physical and a psychosocial summary score to provide a summary of the child’s health-related QoL. The internal consistency of the German Version of the CHQ-PF50 has proven to be higher than .70 in all hypothesized domains in child populations (50). Similar findings were achieved within the current study, except for the domain of general health.

Pubertal Stages. Parents of fifth graders received a sheet with the Tanner stages on which the children with the help of their parents had to rate the pubertal stage of the child. Children were then categorized into prepubertal (stage 1) and pubertal (stages 2–5; 16). Studies report correlations between parent and health professional ratings of Tanner stages ranging from 0.75 to 0.87 (8,15).

Anthropometry and Body Composition. Body Mass Index (BMI) was calculated with the individual’s bodyweight divided by the square of his or her height. Standing height was measured by a wall-mounted stadiometer (Seca, Basel, Switzerland, accuracy 0.2 cm) and body weight was determined using an electronic scale (Seca, Basel, Switzerland, accuracy 0.05 g). Using Swiss national percentiles (42), overweight and obese are defined as a BMI exceeding the 90th and 97th percentiles, respectively. We grouped the children into a normal weight group and overweight/obese group.
**Sociodemographic Variables.** Age, sex and living area were assessed. Parental education was categorized on two levels: high (university diploma) vs. low (no university diploma) and used to refer to the family’s socioeconomic status.

**PA Intervention**

Detailed information concerning the Kinder-Sportstudie KISS has been published (54). Briefly, the intervention took place over one academic year. It included daily physical education classes (two additional lessons of 45 min. per week, each given by physical education teachers), several short activity breaks per day during academic lessons, PA homework and adaptation of playgrounds to encourage activities during school breaks. The three regular physical education classes were given by the classroom teachers, but the content of the lessons was prepared by a physical education expert. The two additional physical education classes were given by physical education teachers. The CON group continued to follow their usual school curriculum including three physical education lessons per week (45 min. each), but did not have any of the above mentioned elements of the intervention.

**Statistical Analysis**

Unpaired \( t \) tests and chi-squared test were used in drop-out analyses. Stepwise linear regression models were used to compare the relationship of QoL with independent variables like sociodemographic parameters and weight status in cross-sectional analysis. For the intervention analyses, accounting for the clustered study design, we used a mixed linear model comparing QoL delta scores between the INT and CON group with group, gender and living area as fixed effects and school as the random effect. We included QoL scores at baseline, gender, living area, parental education, weight status and pubertal stage (for fifth graders) as covariates in the model. Corresponding analyses were performed within different subpopulations (i.e., gender, living area, parental education, weight status and pubertal stage).

Results were considered significant at \( p < .05 \). Effect sizes (11) were interpreted as small (0.2–0.49), moderate (0.5–0.79) and large (≥ 0.8).

**Results**

**Descriptive Data**

Twenty-eight classes in 15 schools totalling up to 540 children entered the study. 456 (84%) children provided QoL baseline data. Chi-squared tests were conducted to analyze the associations between participation at baseline and data available for both participants (\( n = 456 \)) and nonparticipants (\( n = 84 \)). Nonparticipation was associated with male sex (\( \chi^2 [1, N = 540] = 4.66, p < .05 \)), urban living area (\( \chi^2 [1, N = 540] = 10.57, p < .001 \)) and low parental education (\( \chi^2 [1, N = 540] = 5.67, p < .05 \)). Of the 456 who had participated at baseline, 411 (90%) had valid postintervention data. Table 1 shows baseline sociodemographic characteristics for those 411 children. There were no significant differences between study groups except for a higher percentage of first graders living in an urban area in the intervention group compared with the control group, \( \chi^2 (1, N = 180) = 6.15, p < .01 \). QoL scores at baseline did not differ by study group (see Table 2).
### Table 1  Study Population Characteristics According to Group and Grade

<table>
<thead>
<tr>
<th></th>
<th>1st grade</th>
<th></th>
<th>5th grade</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td>Number</td>
<td>111</td>
<td>69</td>
<td>146</td>
<td>85</td>
</tr>
<tr>
<td>Girls</td>
<td>50%</td>
<td>54%</td>
<td>57%</td>
<td>48%</td>
</tr>
<tr>
<td>Age—mean ± SD</td>
<td>6.9 ± 0.3</td>
<td>6.9 ± 0.3</td>
<td>11.0 ± 0.5</td>
<td>11.3 ± 0.6</td>
</tr>
<tr>
<td>Pubertal stage(^1)</td>
<td>0%</td>
<td>0%</td>
<td>51%</td>
<td>50%</td>
</tr>
<tr>
<td>Parents without university diploma</td>
<td>49%</td>
<td>49%</td>
<td>49%</td>
<td>48%</td>
</tr>
<tr>
<td>Urban living area</td>
<td>52%</td>
<td>33%</td>
<td>55%</td>
<td>45%</td>
</tr>
<tr>
<td>Overweight and/or obese(^2)</td>
<td>26%</td>
<td>25%</td>
<td>25%</td>
<td>26%</td>
</tr>
</tbody>
</table>

\(^1\)Tanner stages = 2–5  
\(^2\)Swiss national percentiles

### Table 2  Intervention Effects on Psychosocial and Physical Quality of Life (QoL) in First and Fifth Graders

<table>
<thead>
<tr>
<th>Grade</th>
<th>Variable</th>
<th>Condition</th>
<th>n</th>
<th>Pre Mean ± SD</th>
<th>Post Mean ± SD</th>
<th>F condition</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Psychosocial QoL</td>
<td>Intervention</td>
<td>111</td>
<td>53.2 (5.9)</td>
<td>53.6 (6.0)</td>
<td>4.1 *</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>69</td>
<td>53.3 (6.0)</td>
<td>51.7 (7.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical QoL</td>
<td>Intervention</td>
<td>111</td>
<td>54.4 (7.2)</td>
<td>54.3 (6.5)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>69</td>
<td>53.9 (6.6)</td>
<td>54.0 (4.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th grade</td>
<td>Psychosocial QoL</td>
<td>Intervention</td>
<td>146</td>
<td>52.0 (7.5)</td>
<td>51.3 (8.6)</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>85</td>
<td>52.7 (6.9)</td>
<td>52.2 (7.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical QoL</td>
<td>Intervention</td>
<td>146</td>
<td>52.6 (10.0)</td>
<td>53.2 (10.0)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>85</td>
<td>52.6 (8.6)</td>
<td>53.9 (7.6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Results are from a mixed-model analysis. Group, gender and living area were designed as fixed effects, school as random effect. QoL scores at baseline, parental education, BMI and pubertal stage were included as covariates.

\* p< .05.
Drop-out Analyses

By means of chi-squared tests we compared the 411 children, who had valid pre- and postintervention data to those 45, who had pre- but no postintervention data. Children who did not have postintervention data were more likely to have parents with a lower education, $c^2 (1, \, N = 449) = 7.11$, $p = .01$. Otherwise, there were no differences between those two groups.

Cross-sectional Analyses

Based on stepwise linear regression models, nonacademic parental education was associated with impaired physical QoL in first graders, $b = -.19$, $t(196) = -2.70$, $p < .01$, and impaired psychosocial QoL in fifth graders, $b = -.13$, $t(241) = -2.06$, $p < .05$. Gender, living area, pubertal stage and weight status were not related to QoL.

Intervention Effects

QoL before and after the intervention is presented in Table 2. Physical QoL in first graders as well as physical and psychosocial QoL in fifth graders were not affected by the intervention. There was a statistically significant intervention effect for psychosocial QoL in first graders. The effect was mainly caused by a decrease in QoL in the controls.

Additional mixed model analyses compared the intervention group to the controls within different subpopulations. Thereby the PA intervention had a positive, statistically significant effect on psychosocial QoL in overweight first graders, $F(1, \, 45) = 3.22$, $p < .05$, $d = .45$, and urban first graders, $F(1, \, 78) = 3.14$, $p < .05$, $d = .38$. There were no intervention effects in children of parents with lower education or in pubertal children.

Discussion

We hypothesized that a school-based PA program would positively influence physical and psychosocial QoL in first and fifth graders. Our data provided little support for these hypothesis. No statistically significant intervention effect was found for physical QoL in first graders and for physical and psychosocial QoL in fifth graders. Yet, psychosocial QoL in first graders was positively affected by our intervention.

The present intervention effect on first graders’ psychosocial QoL coincides with previous findings in adults (1). Our outcome was mainly caused by a decrease of psychosocial QoL in the controls while no change occurred in the intervention group. This indicates that PA prevented a decrease of psychosocial QoL in the intervention group. The decrease observed in controls, may be related to age-related challenges posed by social environment (3), commonly referred to as developmental tasks (23). From pre- to posttesting, first graders were confronted with various changes related to school entry. A change in social environment (e.g., new teachers and classmates), adapting to new rules, less free time, dealing with school-related tasks (e.g., homework, exams), getting up earlier and an increased separation time from the parents may have had a critical impact on psychosocial QoL. In the intervention group, mechanisms, which are said to explain the positive influence of exercise on psychological stress, depression and anxiety, might have compensated
a environmentally induced decrease of psychosocial QoL. Experimental evidence in adult populations points out that exercise can lead to mood enhancement by a down-regulation of certain central serotonergic receptors (7). Psychological mechanisms, which are frequently proposed for the antidepressant effect of exercise (34), could also explain why our PA intervention affected psychosocial QoL positively. Meta-analytic findings support exercise to be an important measure in enhancing children’s self-esteem (18). Furthermore, cognitive-behavioral mechanisms like mastery of a difficult skill, increased self-efficacy, feeling successful or an increased internal locus of control as well as social mechanisms could play an important role (39). Especially the latter, referring to positive social group interaction, pleasure or the personal attention subjects receive while exercising, could have had a positive influence on class climate and consequently on psychosocial QoL of the class members.

The mechanisms discussed above might help to explain the different effect between first and fifth graders. In comparison with first grade controls, fifth grade controls did not show a decrease in psychosocial QoL which may be related to the fact that they were more used to coping with school-related tasks. Social mechanisms, especially improvement of class climate by daily PA, may play a stronger role in a new group (i.e., first graders) than in a group, which has already been together for four years (i.e., fifth graders). In the current study, a higher school enjoyment by these joyful daily intervention tasks may have acted as moderator variable between PA and psychosocial QoL. Thus, first graders, which are expected to have higher school enjoyment than fifth graders (13) might be more receptive to a school-based intervention and its potential positive effect on psychosocial QoL. Alternatively, the spontaneous decrease in PA with age (12,45) might be an indication that PA per se becomes less attractive for older children and therefore may have a smaller impact on their psychosocial QoL. However, clear underlying mechanisms, which led to the differential intervention effects in first and fifth graders, remain poorly understood.

Our intervention had a positive influence on physical fitness, adiposity and cardiovascular risk factors (30). In contrast to these objective measures of physical health, our intervention did not affect overall subjective evaluations of physical health (i.e., physical QoL). A possible explanation for this finding might be a ceiling effect with a small variation of high physical QoL scores at baseline indicating that most subjects did not perceive bodily pain or discomfort and did not experience physical limitations during leisure or school activities. In turn, clinical populations with initially low physical QoL scores and restricted ability to cope with daily tasks have been shown to demonstrate higher QoL after an exercise program (28). Nevertheless, QoL is dependent on so many other influences and a simple PA intervention by itself might not be sufficient to improve well-being in a population that is “well” already.

Cross-sectional analyses in the current study revealed that lower parental education was associated with impaired physical QoL in first graders and with impaired psychosocial QoL in fifth graders for which large numbers of explanatory factors (psychosocial, behavioral, material) have been discussed (49). A recent Canadian study (31) with a clinical population of children revealed, that despite a costless national health care system, socioeconomic disparities remain important determinants of QoL. This suggests that the impact of socioeconomic factors is related to issues other than access to health care. Insufficient parental knowledge
on health-related topics, impaired living conditions, stigmatization as well as the perception of relative social position that may impact family stress, self-esteem, empowerment and life control might negatively influence dimensions of QoL (47).

Our cross-sectional data indicate that there is a particular need for enhancing the decreased physical QoL in children with nonacademic parental education. Unfortunately, our subpopulation analyses did not reveal corresponding intervention effects which is compatible with the theory that other factors may play a much more important role in affecting QoL in this population. In contrast, our PA intervention positively influenced psychosocial QoL in overweight first graders, which interestingly, and contrary to a recent study in older children (25) did not report a decreased QoL in the cross-sectional analysis. Thus, the present intervention effect in young children may be important from a preventive point of view and help to avoid a decrease in psychosocial QoL later on during childhood. As in adults (20) it can be seen as an important finding considering the increasing prevalence of obesity (40,55).

Our subpopulation analysis revealed a positive intervention effect on psychosocial QoL in urban first graders. Previous studies have shown urban children to be less physically active than rural children (27,29,35). Urban children seem to prefer outdoor playing activities to indoor activities (e.g., watching television or playing computer games), but are often forced to stay at home due to environmental factors (limited access to playgrounds, unsafe neighborhood; 24). With regard to this dilemma, urban children may be highly receptive to a PA program and consequently report greater changes in psychosocial QoL.

Highlighting the influence of a school-based PA intervention on QoL, the current study addressed an innovative and important research topic. To our knowledge this is the first randomized controlled trial to focus on this matter. A strength of the current study was the use of a multivariate model controlling for the effect of a PA intervention on different subpopulations, e.g., overweight children. In this context, our study links to a recent research recommendation by Shoup et al. (46). Based on their cross-sectional associations between impaired QoL, overweight and low PA in children, Shoup et al. state that “the examination of changes in weight and physical activity status as predictors of changes in QoL would be a logical next step in this research” (p. 411). While our study focused on the general population of children, future trials on PA and QoL should be conducted with obese children during treatment. In contrast to our study sample, which mainly consisted of normal or slightly overweight subjects, PA interventions with obese children might also have an influence on physical dimensions of QoL.

Limitations of the current study should be recognized and addressed in future studies. First, the statistical significant intervention effect on first graders’ psychosocial QoL needs to be considered with caution. A review article (53) points out that statistically significant differences in QoL are not synonymous with clinically meaningful changes and therefore p-values should be accompanied by alternative measures. In line with this claim we calculated effect sizes. Based on Cohen’s classification standards of effect sizes (11), the present intervention effect can be considered as small (0.2–0.49). A main goal of the KISS-study was to increase PA in elementary school children. Measurement of PA was obtained by accelerometers and is described elsewhere (54). Although overall daily PA did not change in the intervention compared with the control group, total PA and moderate-vigorous PA
in school, as well as moderate-vigorous PA over the whole day was significantly improved in favor of the intervention (30). As shown by others (14), it seems that the increase in PA during school was partially compensated during the time out-of-school. It is, nevertheless, possible that a significant increase in overall PA would have led to greater improvements in QoL or that QoL was at the ceiling level even before the intervention. Our assessment of QoL only consisted of parent proxy ratings and therefore should be interpreted with caution. Correlations between parent and child responses to QoL assessments are at best moderate and are normally greater for sick compared with healthy children (17). Thus, future studies should incorporate both, parent proxy ratings and self-ratings of QoL. Furthermore, inclusion of additional measures of well-being (i.e., self-esteem, school enjoyment or social self-concept could help detect underlying mechanisms explaining the relationship between PA and QoL. From a methodological point of view a selection bias cannot be excluded. Male sex, urban living area and low parental education were overrepresented in children who did not participate in baseline testings, a common finding in health-related research in adults (22,36,44). The lack of QoL improvement in the current study might be related to a limited ability of the CHQ-PF50 to detect changes in QoL especially at the high end of summary scores. Originally the CHQ-PF50 was developed and validated as a discriminative instrument for disability, and not as outcome for effect studies (32). Nowadays, its use is controversial. While some authors Boyd and Hays (6) suggest the CHQ-PF50 as outcome measure in clinical trials, others question its ability to detect changes in health status in clinical populations (4,48) and especially in a generally healthy population (43). A final limitation may be related to the test-retest reliability of the CHQ-PF50. While no data are available in the originally published U.S. population on which the questionnaire was established (32), a comparable Australian study (51) with 5414 parents of children aged 5–18 years showed that two week-test-retest reliability was positive, moderately high and even for all scales (ICC range: 0.49–0.78, Spearman range:0.54–0.73). However, a recent review (26) including a clinical population revealed limited test-retest reliability for the CHQ-PF50. Nevertheless, our results may be the consequence of moderate test-retest reliability of the CHQ-PF50.

In conclusion, a school-based PA program during one academic year had little influence on QoL in elementary school children. Physical QoL in first graders and physical and psychosocial QoL in fifth graders were not affected by the intervention. There was a small positive intervention effect on psychosocial QoL in first graders. Subpopulation analyses demonstrated that this effect was mainly caused by positive changes in overweight children and in children from urban living areas. While our data indicates that a PA intervention had limited impact on QoL in a population of healthy elementary school children where QoL is generally high, future research should clarify if corresponding trials lead to positive QoL changes in other age groups and populations where QoL at baseline is compromised.

Acknowledgments

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References


