

# A school-based physical activity intervention on psychosocial health outcomes among 11- and 12-year-olds – HOPP-project

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The purpose was to investigate the effect of a school-based physical activity (PA)-intervention among 11- and 12-year-olds (6th- and 7th graders) across 4 years. Seven primary schools in Horten municipality in Norway received 45 min daily extra PA as part of the curriculum. The intervention started in 2015 with follow-up in 2016–2019. The effect was measured after 1–4 years of participation, among the same children (6th to 7th grade) and among new children starting in 6th grade. Two control schools received no additional PA beyond the regular PA at school. The Self-reported Strength and Difficulties Questionnaire (SDQ-S) focusing on internalizing and externalizing difficulties were administered. A statistical model for repeated measurements was used and adjusted for parents' educational level, sex, age, and waist-to-height ratio (WHtR). The significance level was  $p \leq 0.01$ . In total, 1221 children completed the SDQ-S. SDQ-S scores were stable, and difficulties were relatively low. The control group had significantly lower SDQ-S scores than the intervention group at start, indicating fewer difficulties. The adjusted effect within the intervention schools showed a borderline significant increase in total difficulty scores between 2018 and 2019 (mean difference: 1.02, 95% CI:  $-1.82, -0.23$ ,  $p \leq 0.01$ ). Educational level showed a weak negative correlation with total difficulty score ( $r = -0.1$ ). No significant change was reported within the control schools. Few psychosocial health problems among 11- and 12-year-olds were detected. The borderline increase in total difficulty score that was seen for the intervention schools, is believed to be of limited clinical relevance.

## KEYWORDS

children, externalizing problems, internalizing problems, physical activity, psychosocial, school-based intervention, SDQ

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## 1 | INTRODUCTION

Children and adolescents in Norway are generally satisfied with life and happy with who they are.<sup>1,2</sup> However, there seems to be an increasing trend in feelings of both loneliness and sadness among adolescents, and 18% of this age-group have reported being unsatisfied with their own health.<sup>2</sup>

Schools have the potential to make a difference in the prevention of psychosocial health problems, since they can facilitate activities at no extra cost. Moreover, school-based physical activity (PA) interventions are increasingly studied for their potential to reach the young where they are.<sup>3</sup> School-based PA interventions have also shown to be favorable over family-based, clinic-based, and detention facility-based interventions for their effect on psychosocial health problems.<sup>4</sup> The rationale for providing PA for psychosocial health problems are numerous and includes increased well-being, increased self-concept, and a decrease in internalizing- and externalizing problems.<sup>5,6</sup> A newly published systematic review and meta-analysis concluded that PA as part of a school program could have beneficial effects on children's mental health and anxiety, well-being, and resilience.<sup>3</sup> However, the beneficial effect reported in this review was concluded to be small. In addition, the included studies showed considerable heterogeneity, making the interpretation of results challenging. These conclusions were supported by another systematic review assessing the effect of PA on mental health among children and adolescents in general.<sup>7</sup> This review found a small increase in psychological well-being and a reduction in psychological ill-being. However, relatively small sample sizes had been studied, alongside relatively short follow-up times in the included intervention studies.

Few interventional studies have investigated the relationship between PA and associated health outcomes over a longer period.<sup>8</sup> Furthermore, studies including detailed descriptions about the implementation of the intervention are warranted to provide a better understanding of the relationship between PA and psychosocial health.<sup>3,7</sup>

The aim of the present study was therefore to assess the effect of a school-based PA intervention program on psychosocial health outcomes among 11- and 12-year-old in Norway, over a four-year period between 2015 and 2019. We hypothesized that participating in school-based PA reduces psychosocial problems among children.

## 2 | MATERIALS AND METHODS

### 2.1 | Participants

In 2015, all children from seven elementary schools in Horten municipality, Norway, were included in a planned

6-year controlled longitudinal school-based PA intervention program called "The Health Oriented Pedagogical Project" (HOPP), as part of the compulsory and implemented pedagogical platform. The idea behind HOPP was that the educational program represented a shift from passive to active learning. In Norway, organized PA in elementary school consists of 90 min of weekly physical education lessons. The children included in the HOPP program received an additional 45 min of activity each day, replacing ordinary desk learning with physical tasks. Hence, the school-based PA program involved an additional 225 min/week of PA.

Before the start of the HOPP project in 2015, Kristiania University College was invited with the aim to assess the effect of the compulsory school-based PA intervention. The research group sent out an invitation to participate in the HOPP research project, and oral and written information was given at school meetings.<sup>9</sup> Two control schools from Viken County, Norway, were recruited based on estimated socioeconomic levels, using a centralized Norwegian program for systematic quality work in schools and kindergartens. The control schools received no information about the school-based PA program and upheld their 90 min/week according to the curriculum.

All parents gave written consent on behalf of their children to participate. All identifiable data collected were replaced by a unique identification code and were transferred digitally to a secure database during annual testing. Thus, during analysis, all identifiable personal data were deleted. The project is approved by the Regional Committees for Medical and Health Research Ethics (2014/2064/REK sør-øst) and is registered in [ClinicalTrials.gov](https://clinicaltrials.gov) (Identifier: NCT02495714). The current study is conducted according to the World Health Medical Association Declaration of Helsinki and followed the recommended CONSORT extension reporting guidelines.<sup>10</sup>

### 2.2 | Outcomes

The participating children underwent annual testing from January until June during the longitudinal intervention, starting in 2015 and ending when they graduated from 7th grade.<sup>9</sup> No testing took place in 2020 and 2021 due to the Covid-19 pandemic. Thus, 2019 was the last year of follow-up for this study. In 2016, the Self-reported Strength and Difficulties Questionnaire (SDQ-S) was included in HOPP to assess levels of internalizing and externalizing psychopathology among 11- and 12-year-old (6th and 7th graders, respectively).<sup>11,12</sup> Since the intervention started in 2015, 2016 represents children being 1 year in the intervention whereas 2019 represents children being 4 years in the intervention.

The Norwegian translated SDQ-S was administered digitally to children aged 11- and 12-year-olds, using Questback running on a computer. The SDQ-S includes 25 items, across 5 scales of 5 items: emotional problems, conduct problems, hyperactivity, peer problems, and pro-social behavior. Responses to the SDQ-S items were converted into scores 0, 1, and 2, corresponding to “not true”, “somewhat true”, and “certainly true”, respectively. Scores for each of the five scales were calculated, and the total difficulty score combined sub-scores for emotional problems, conduct problems, hyperactivity, and peer problems. The total difficulty score ranges from 0 to 40.<sup>11</sup>

As recommended, externalizing and internalizing SDQ-S scores were calculated for this sample.<sup>13</sup> Both externalizing and internalizing scores range from 0 to 20. Externalizing scores is the sum of the conduct and hyperactivity scales, whereas internalizing scores is the sum of the emotional and peer problems scales. The SDQ-S has shown to be valid and reliable for completion by 11–16 year old,<sup>14</sup> also in the Norwegians.<sup>12,15</sup>

## 2.3 | Intervention

A working group of 14 experienced teachers (two from each intervention school) in Horten municipality, with special interest in education and experience in health promotion, PA, and pedagogics, were included in planning the interventional program. A large library of activities emphasizing theoretical learning while being physically active were inspired from Aktivitetskassen<sup>16</sup> and Active Smarter Kids (ASKs),<sup>17</sup> in addition to the teachers' own ideas from other elementary schools with experience in active learning. The activities were adapted to various subjects such as language and mathematics within the framework for academic learning for grades 1–7. The suggested activities, including suggestions for progression, were then made available in each classroom. After an eight-month planning and development period from 2014 to 2015 all teachers ( $n = 210$ ) in Horten municipality were trained in the new pedagogical platform during a two-day course. Two teachers from the working group held additional follow-up courses at each school during spring 2015 and before the start of the intervention. In addition, a full-time employee, specifically trained for this purpose, was responsible to oversee all intervention schools during the project period.

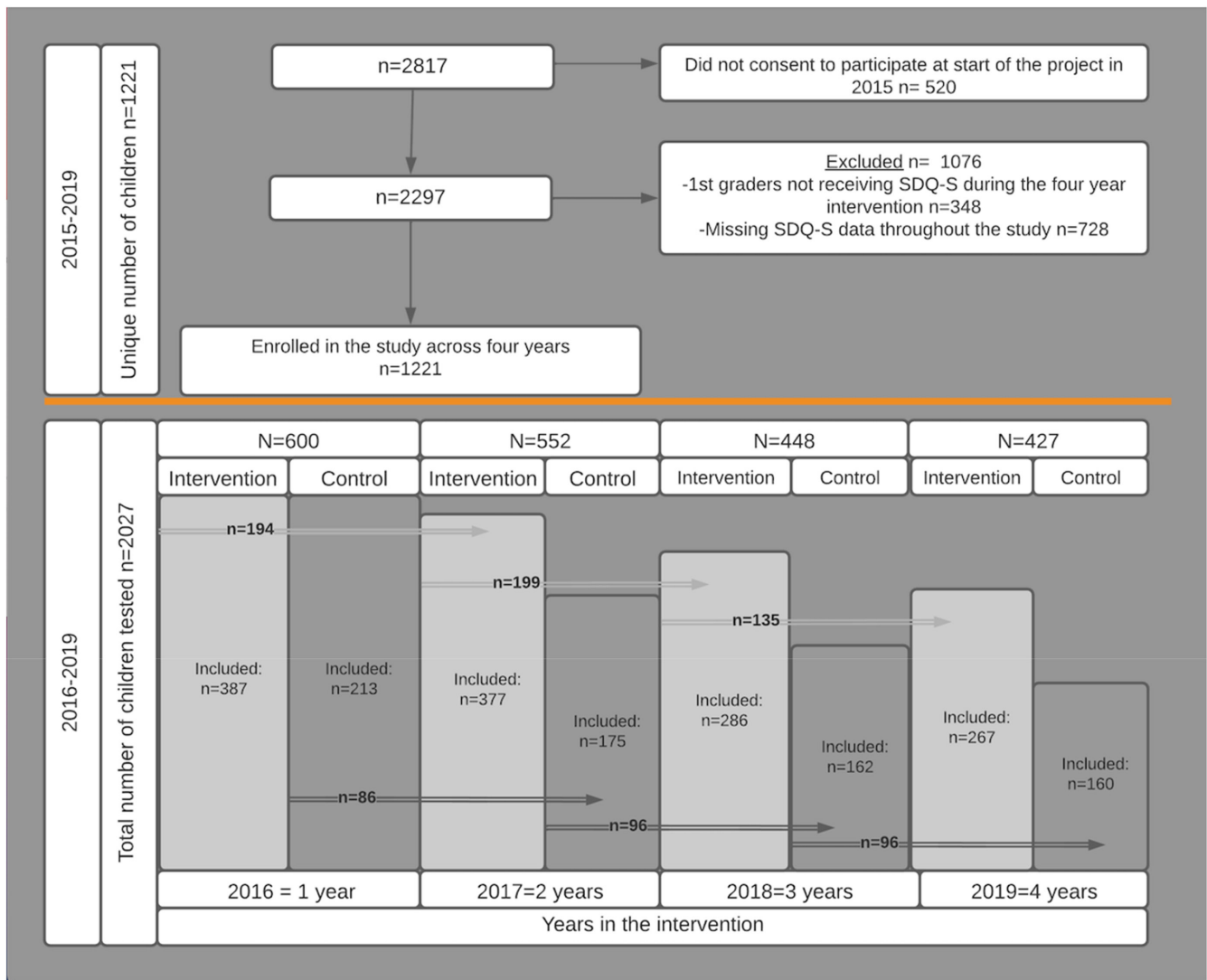
Based on the available activities, the teachers had the autonomy to choose when and how to conduct the activity lessons. For example, a typical lesson could consist of 45 min of theory in the classroom, then 45 min of active learning. The activities were performed in the schoolyard, gymnasium, or in school halls. No individual reporting of

the children's participation in the intervention was done. However, the teacher completed a questionnaire daily regarding the number of minutes of activity and intensity level for each class, which was collected by project team members twice each year. The activities were adjusted to fit the various age groups and aimed to produce moderate-to-high intensity levels, with 25%–30% of the time at a vigorous activity level.

## 2.4 | Data analysis

Data were analyzed using SPSS, version 28 (SPSS, Inc., Armonk, NY, USA). Background variables for the study participants measured each year in the intervention are presented with frequencies ( $n$ ) and percentages or means with standard deviations (SDs) and range. Parental education was used as a proxy for socioeconomic status (SES). Based on the parent with the highest education in the family, SES levels were categorized into low education (primary school and high school), and higher education (>4 years of higher education at university). We chose to report on waist-to-height ratio (WHtR) as an indicator of general fitness.<sup>18</sup> To report PA levels, the children used an activity monitor (Actigraph wGt3X-BT, ActiGraph LLC, Pensacola, Florida, USA) that was attached to the hip and worn for six consecutive days. Moderate to vigorous PA (MVPA) was calculated by summing minutes in moderate and vigorous intensity domains divided by the number of valid days.<sup>9</sup> Normality tests showed that SDQ-S scores were slightly right-skewed; total difficulty score (skewness 1.03 and Kurtosis 1.65); internalizing score (skewness 1.24 and Kurtosis 1.93) and for externalizing scores (skewness 0.67 and Kurtosis 0.56).

To assess the effect of the PA intervention on SDQ-S a mixed linear model was used. This method was chosen to adjust for the repeated measures for the children in the study. In Norway, primary schools run from 1st to 7th grade, where 7th graders leave for secondary school. This means that the children recruited in 6th grade were followed until 7th grade and were assessed in two different study years (Figure 1). Crude estimates between the intervention- and control groups were calculated for each dependent variable with interaction terms: intervention/control by years in the intervention. Adjusted effects for each dependent variable were also calculated including age, sex, WHtR, and parental education level. Due to the non-randomized design of the PA intervention, both the between-groups effect and within-groups effect were calculated. Spearman's Rank Order Correlation (Spearman's rho) was used to explain the strength of the association using Cohen's  $d$ : weak association:  $r = 0.10$ – $0.29$ , moderate association



**FIGURE 1** Flowchart of the study participants eligible and included from 2015–2019. Numbers above the solid line represent unique number of children, while numbers below the solid line represent number of tests performed. Light gray boxes are intervention schools including 6th and 7th graders while dark gray boxes are control schools including 6th and 7th graders. Each year illustrates time spent in the intervention. Children in 6th grade are followed for 1 year, and number of children going from 6th to 7th grade are shown with arrows for both intervention schools (light gray) and control schools (dark gray). The children in 7th grade moves on to secondary school. This explains the annual decline in number of children. SDQ-S, Self-reported Strengths and Difficulties Questionnaire

$r = 0.30$ – $0.49$  and a strong association:  $r = 0.50$ – $1.0$ . Subgroup analyses using independent sample  $t$ -tests were performed for covariates significantly associated with SDQ-S in the mixed model analysis. A Bonferroni correction was calculated and  $p$ -values  $\leq 0.01$  were considered statistically significant.

### 3 | RESULTS

A total number of 1221 children were included in this 4-year intervention study (Figure 1). However, due to the same children being followed and tested from 6th to 7th

grade, a total of 2027 tests were performed (Figure 1). Characteristics of the 600 children recruited in 2016 are presented in Table 1. The intervention schools showed significantly higher values for SDQ-S and WHtR, and lower values for MVPA and parental educational level as compared with the control schools (Table 1).

Results from the effect of the PA intervention between the intervention- and control schools are shown in Figure 2 and Tables S1 and S2. In general, SDQ-S scores were stable throughout the intervention period. The crude estimate showed that the mean SDQ-S scores were higher in the intervention schools compared to the control schools, although not all time points

TABLE 1 Baseline characteristics of the study population  $n = 600$ 

	Total, $n = 600$ numbers with (%), (SD) or range	Intervention schools <sup>a</sup> , $n = 387$ numbers with (%) or (SD)	Control schools <sup>b</sup> , $n = 213$ numbers (%) or (SD)	Difference between intervention- and control schools, $p$ -value (95% CI)
11 year-olds	280 (46.7%)	194 (32.3%)	86 (14.3%)	n.a
12 year-olds	320 (53.3%)	193 (32.2%)	127 (21.2%)	
Boys	293 (48.8%)	194 (32.3%)	99 (16.5%)	0.39
Girls	307 (51.2%)	193 (32.2%)	114 (19%)	
Waist-to-height ratio (WHtR)	0.44 (SD 0.05) Range: 0.35–0.68	0.45 (SD 0.05)	0.43 (SD 0.04)	<0.001 (0.01, 0.03) <sup>c</sup>
Parental numbers with >4 years higher education	128 (29.1%)	42 (32.8%)	86 (67.2%)	<0.001 <sup>c</sup>
MVPA min/day	77.73 (SD 28.37) Range: 16–190	73.60 (SD 27.06)	85.25 (SD 29.21)	<0.001 (–16.43, –6.88) <sup>c</sup>
SDQ Total difficulty score	8.12 (SD 4.88) Range: 0–31	8.61 (SD 5.08)	7.23 (SD 4.36)	0.001 (0.61, 2.16) <sup>c</sup>
SDQ Internalizing score	3.49 (SD 2.84) Range: 0–17	3.75 (SD 2.98)	3.03 (SD 2.49)	0.003 (0.25, 1.19) <sup>c</sup>
SDQ Externalizing score	4.63 (SD 2.88) Range: 0–15	4.86 (SD 2.95)	4.20 (SD 2.70)	0.06 (0.19, 1.13) <sup>c</sup>

<sup>a</sup>Seven intervention schools.

<sup>b</sup>Two control schools.

<sup>c</sup> $p \leq 0.01$ . Higher education means >4 years of higher education at University. Total difficulty score is the sum of four scales; emotional problems, conduct problems, hyperactivity and peer problems. Externalizing scores is the sum of the conduct and hyperactivity scales, whereas internalizing scores is the sum of the emotional and peer problems scales. Background data are measured at the commencement of the study in 2016 were SDQ was included. Missing data: parental education  $n = 160$ .

Abbreviations: CI, confidence interval; MVPA, moderate to vigorous physical activity; SD, standard deviation; SDQ, strengths and difficulties questionnaire; WHtR, waist to height ratio.

reached statistical significance in the adjusted analysis (Figure 2A–C and Table S2). The strength of these associations was weak ( $r < 0.03$ ).

Results for the within-group effects are shown in Tables S1 and S2. In the adjusted analysis, no significant difference within intervention- or control schools on SDQ-S was found, except between 2018–2019 where the adjusted effect showed that the intervention schools had borderline higher total difficulty score (mean change: 1.02, 95% CI:  $-1.82, -0.23$ ,  $p 0.01$ ) versus (mean change:  $-0.21$ , 95% CI:  $-0.71, 1.13$ ,  $p 0.65$ ), respectively) (Figure 2A and Table S2).

Parental educational level was the only variable significantly associated with total difficulty score in the adjusted analysis ( $p < 0.01$ ), and a weak negative correlation was found ( $r = -0.2$ ). A sub-group analysis was performed among children whose parents had low-educational level and among those with high-educational level, and total difficulty scores to explain the significant within-group effect seen in the intervention schools. The results showed that among those with low-educational level ( $n = 79$ ) significantly higher total difficulty score was found as compared to those with high-educational level ( $n = 206$ ): 9.70 versus 8.08, respectively (95% CI: 0.48, 2.75,  $p = 0.006$ ).

## 4 | DISCUSSION

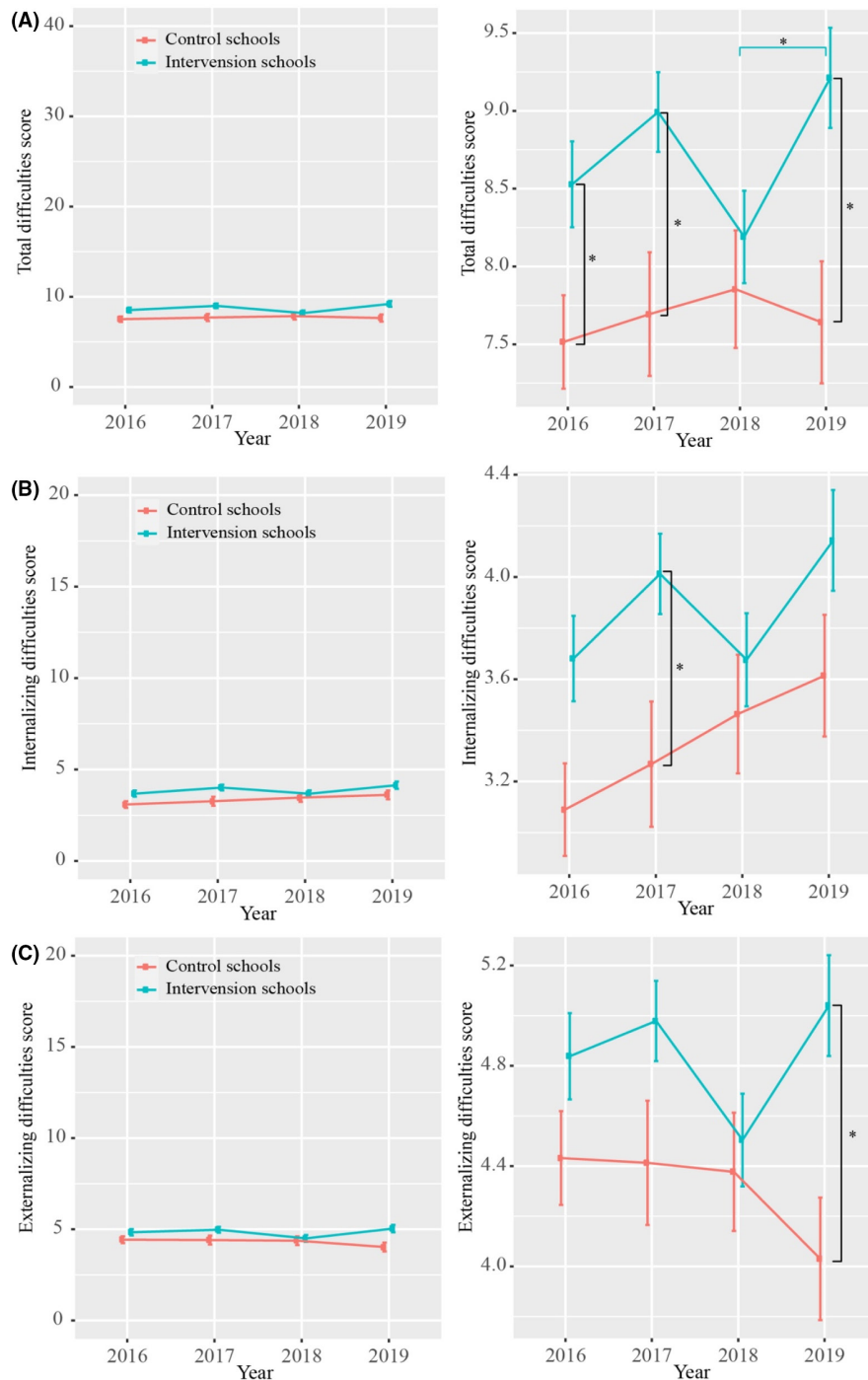
This study showed that psychosocial difficulties, focusing on internalizing and externalizing problems, were relatively low and stable throughout the study. Between-group analysis showed that the control schools had lower scores for SDQ-S each year in the intervention. Within-group analysis for the intervention schools, also showed a

slight increase in total difficulties score after an intervention period of 4 years. This is contrary to our hypothesis that school-based PA was expected to lower psychosocial problems among children.

Updated guidelines for PA in children and adolescents conclude that PA has a critical role for the treatment and prevention of mental health disorders such as depression and anxiety, whereas the effect of PA on psychosocial health problems is less convincing.<sup>19</sup> Recent systematic reviews and meta-analysis have been published concluding with a beneficial effect of PA on psychosocial health outcomes.<sup>3–5,7</sup> However, effect sizes are concluded small, and the clinical relevance may be questionable. Beneficial effects on internalizing and externalizing problems specifically have also been shown.<sup>5</sup> The results from the latter review were based on clinical- and community samples, not limited to the school setting, which makes direct comparison with this present study challenging. An effect of PA on internalizing and externalizing problems could perhaps have been seen if our sample had more severe or clinical cases.<sup>5</sup>

An important conclusion from this study is that the SDQ-S scores were relatively low and that total difficulty scores are within the category as low risk of developing psychosocial health problems.<sup>12,15</sup> To our knowledge, there are no published cut-off values for internalizing and externalizing SDQ-S scores. However, comparing the subscale-scores that compromise internalizing and externalizing SDQ-S scores from previously published literature with that reported in the current study, internalizing and externalizing SDQ-S scores are within the low risk or slightly raised risk of developing psychosocial health problems as seen for total difficulty scores.<sup>12,15</sup> The small, yet significant, the difference in total difficulties, externalizing and

**FIGURE 2** Effect of a school based physical activity intervention showing adjusted means and adjusted effects— between and within-groups comparison. Mixed liner model showing adjusted effects between-groups and within-groups. Mean difference for the between-group analysis is calculated between intervention and control group each year in the study. Mean difference for the within-group analysis is calculated as the change from year to year (e.g., data representing 2017 is the change in scores from 2016–2017). Data were adjusted for sex, age, parental educational level, and Waist-to-height ratio. (A) Total difficulty scores. Red line illustrates control schools and green lines illustrated intervention schools. Total difficulty scores are calculated as the mean difference between groups with error bars showing SEM (standard error of the mean). Left panel show total difficulties ranging from 0–40 points. Right panel is an enlarged format with vertical black bars indicating significant between-group differences and green horizontal green bars indicating within-group differences.  $p$ -Values  $\leq 0.01$  were considered statistically significant and marked by an asterisk. Total difficulty score is the sum of four scales; emotional problems, conduct problems, hyperactivity, and peer problems. (B) Internalizing difficulty scores. Red line illustrates control schools and green lines illustrated intervention schools. Internalizing difficulty scores are calculated as the mean difference between groups with error bars showing SEM (standard error of the mean). Left panel show internalizing difficulty scores ranging from 0 to 20 points. Right panel is an enlarged format with vertical black bars indicating significant between-group differences.  $p$ -Values  $\leq 0.01$  were considered statistically significant and marked by an asterisk. Internalizing difficulty scores is the sum of the emotional and peer problems scales. (C) Externalizing difficulty scores. Red line illustrates control schools and green lines illustrated intervention schools. Externalizing difficulty scores are calculated as the mean difference between groups with error bars showing SEM (standard error of the mean). Left panel show externalizing difficulty scores ranging from 0 to 20 points. Right panel is an enlarged format with vertical black bars indicating significant between-group differences.  $p$ -Values  $\leq 0.01$  were considered statistically significant and marked by an asterisk. Externalizing difficulty scores is the sum of the conduct and hyperactivity scales.



internalizing problems among the intervention schools compared to the control schools, are probably of little clinical relevance. A Bonferroni correction was done due to multiple analysis. Still, the between- and within-group differences may indicate a Type-I error.

Another important explanation for the lack of effect from this present study may be explained by a ceiling effect. The relatively low-SDQ-S scores, and with that a healthy sample of children included, may prevent the children from improving the already few problems they encounter. To adjust for this potential effect, we could

have categorized the SDQ-S scores into high- and low-risk groups for developing psychosocial health problems. However, we would then risk losing statistical power and valuable information from the children included.<sup>20</sup>

Although the available theory on possible mechanisms of PA for mental health has been described as favorable,<sup>6</sup> opposite findings have been proposed.<sup>21</sup> A study among female high-school students showed that if the students did not gain physical competence, like increased strength, improved general health and appearance, and increased sports competence, by participating in sports and PA

this could undermine self-esteem.<sup>21</sup> Having higher perceived motor competence in early childhood years has also shown to be important for participation in PA in late childhood.<sup>22</sup> Unfortunately, no questions covering physical competence was included. Valid conclusions on the impact of physical competence on psychosocial health problems can therefore not be drawn.

The strengths of this study are the assessment of the effect of PA on psychosocial health outcomes over the course of 4 years. In addition, the intervention was low of cost and feasible as HOPP was a mandatory part of the everyday school program. Another strength is the use of SDQ-S as a valid and reliable outcome measure. Lastly, the study included a relatively large sample of children, and the analysis allowed for repeated measures of the same children in the one-year follow-up. However, we excluded 728 children due to missing SDQ-S data. Although a Type-2 error may explain the lack of effect from the PA-intervention, the below-described limitations are important to consider when interpreting the results from this study.

First, the intervention was not randomized. Although control schools were chosen to best match the SES-levels of the intervention schools, control schools had lower SDQ-S scores and WHtR, while higher parental educational level and levels of MVPA. Higher levels of parental education could predict higher levels of PA in children and adolescents,<sup>23</sup> which in turn could be favorable toward decreasing mental health problems in this group.<sup>7</sup> Internalizing problems, including peer problems, has also previously been associated with overweight among children.<sup>24,25</sup> The subgroup analysis showed that the children of parents with low education had more total difficulties than the children of parents with higher education. However, the correlation was weak, and interpretation must be taken with caution. A further limitation is that it is only 1-year follow-up data from each child included. The few longitudinal studies (up to 2.5 years intervention) on PA in children and adolescents that have been published show significant reduction of both externalizing<sup>26,27</sup> and internalizing<sup>26</sup> problems. One-year follow-up from 6th to 7th grade may therefore have been too short to see an effect of the present intervention. Too short interventional periods could also explain the weak overall effect on psychosocial health problems from previous school-based interventions,<sup>3</sup> or the lack of effect from a recent Danish school-based PA intervention.<sup>28</sup> Another important factor is that the intervention was teacher led. Although all teachers involved were taught and supervised throughout the intervention, no details on the individual child's PA intensity level were monitored. In addition, a range of activities was available with different intensity levels. It could also be that the duration of the daily PA differed somewhat

between children and classes. This means that both the intensity and the duration of the implemented PA intervention could be too low. At last, no information is available on the cause or background of non-respondents. We included data from one municipality that may not cover the range of SES levels seen in Norway. Therefore, we have no insight on potential systematic selection among participants and can only assume the representativeness of the current sample and their reports on psychosocial health outcomes.<sup>29,30</sup>

In conclusion, no effect after a 4-year school-based PA intervention was found for psychosocial health problems among 11- and 12-year-old children in this study. Importantly, the SDQ-S scores were relatively low and in the category of low risk to slightly raised risk of developing psychosocial health problems. The significant increase in total difficulty score seen in the intervention schools is therefore probably of little clinical relevance. Due to low SDQ-S scores, a ceiling effect may also explain the lack of effect from the PA intervention.

## 5 | PERSPECTIVES

A worry to consider is that there has been a decline in PA levels for children between the age of six and seven<sup>31</sup> and further up to the age of 15.<sup>32</sup> At the same time PA in childhood may protect the development of psychosocial health problems in adolescents and early adulthood.<sup>33,34</sup> Positive attitudes toward own motor competence are important to establish in early childhood as it may be critical for further motivation to participate in sports and PA.<sup>22</sup> This present study assessed the effect of a school-based PA intervention among 11- and 12-year-old children on psychosocial health problems. However, no effect was found. Perhaps, the results could have been different in samples with more severe cases, or if the intervention had started in early childhood.<sup>22</sup> Schools and kindergartens are in an important position to support healthy behavior and potentially reduce the risk of developing psychosocial health problems. Future school-based PA interventions should therefore aim for longitudinal designs starting in early childhood in more diverse samples to assess the effect on psychosocial health problems over time.

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## CONFLICT OF INTEREST

No conflicts of interest to declare.

## DATA AVAILABILITY STATEMENT

The data that supports the findings of the study are available from the contact author upon reasonable request.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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