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The effect of active learning on academic performance in a Norwegian primary school setting–the Health Oriented Pedagogical Project (HOPP)

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Background: Numerous systematic reviews, with varying degrees of certainty, have suggested a beneficial link between physical activity and academic achievement.

Methods: The Health Oriented Pedagogical Project (HOPP) in Horten, Norway, integrates active learning in seven elementary schools' curricula (n = 1,545), aiming to merge physical activity with academic instruction. The control group consisted of two schools from Akershus County, doing standard teaching (n = 752). The data were collected from 2015 to 2019.

Results: The results highlight the active learning potential to complement traditional teaching methods and foster overall academic success in elementary education. Active learning, partially replacing traditional classroom methods with physical tasks, yielded significant academic benefits. Secular trends for national tests in 5th-grade intervention school students across five years showed improvement compared to control schools in English, arithmetic, and reading. Both intervention and control schools displayed a significant change in slope across the study period. Compared to national median results, the intervention schools also revealed an improvement.

Conclusion: HOPP's findings underscore the effectiveness of active learning in enhancing academic performance, with intervention schools surpassing national medians after four years of intervention.

KEYWORDS

physical activity, active learning, academic performance, elementary school children, education

Introduction

Systematic reviews suggest a beneficial link between physical activity and academic achievements (Donnelly et al., 2016; Rasberry et al., 2011; Trudeau and Shephard, 2008). A 2022 systematic review of 54 studies concluded that "physically active academic lessons improve the total time engaged in physical activity, motor skills, and/or academic

performance" in primary school children frontiersin.org. a comprehensive 2023 meta-analysis (92 randomized trials) found *no overall adverse effect* on academic achievement physical activity programs *integrated with academic instruction* (lasting ~6–10 weeks at moderate-to-vigorous intensity) led to improved mathematics test performance, and cognitively enriched active programs improved language arts outcomeslink.springer.com. The effect varied due to differences in physical activity characteristics and research designs (Donnelly et al., 2016). The biological benefits of physical activity contribute to promoting neural growth for synaptic plasticity (Singh et al., 2012). There is a balance between the educational benefits gained from physical activity and the reduction in academic learning time it may require (Trudeau and Shephard, 2008). The health benefits of physical activity for children are well-documented, and WHO advocates 60 min of daily physical activity for children (Jiménez-Pavón et al., 2013; Biddle and Asare, 2011; Langford et al., 2014; World Health Organization, 2016).

Recognition of educational benefits of physical activity has prompted school-based interventions. Studies show moderate health benefits, but a critical factor identified was that interventions often resulted in limited physical activity engagement (Metcalf et al., 2013). The issue was not the effectiveness of physical activity intervention programs, but identifying interventions leading to increased physical activity, as these gave positive educational outcomes. Physical activity separated from academic teaching reduced the time allocated for educational activities, potentially impacting learning outcomes. However, a study suggested that 60 min of physical activity per day did not negatively impact learning outcomes (Norris et al., 2015). The advantage of active learning programs is integrating education with organized physical activity so that time devoted to physical activity does not detract from educational time. The effect of physical activity on different subjects may differ, as they require different cognitive abilities (Singh et al., 2019; Macedonia, 2019; Jensen et al., 2025; Mao et al., 2024).

Norris et al. (2015) indicate that active learning boosted physical activity and positively impacted academic performance, but call for more research for conclusive evidence. The study designs varied from cross-sectional to RCTs research (Bartholomew and Jowers, 2011; Donnelly et al., 2009; Stewart et al., 2004). An interview-based Norwegian case study reported more active and engaging school days with active learning (Dyrstad et al., 2018), and a large randomized controlled trial (Active Smarter Kids) using active learning was conducted in Norway (Resaland et al., 2015).

The sedentary nature of traditional classroom settings may contribute to various health issues in children (Kuzik et al., 2022; Dang et al., 2024). The static environment of typical classrooms *may thus* potentially hinder pupils' cognitive and emotional development (Zeng et al., 2017). Active learning initiatives aim to create a dynamic, engaging learning environment that stimulates body and mind. The effectiveness and longevity of active learning programs may be linked since their duration plays a significant role in determining their impact. The longevity of active learning may be a key to the cumulative advantages of physical activity, including better concentration, enhanced memory retention, improved classroom behavior, and superior academic performance overall.

The Health Oriented Pedagogical Project (HOPP) is a school-based active learning intervention program conducted in Norway, blending physical activity with academic teaching (Fredriksen et al., 2017). HOPP addresses growing concerns about inactivity among children and explores the potential cognitive and academic benefits of incorporating active learning. Active learning as a daily routine encourages the development of beneficial habits and attitudes toward physical activity from a young age. This proactive approach can instigate a paradigm shift in how we perceive the role of physical activity in children's lives, extending beyond school. This aligns with the Norwegian school curriculum, emphasizing that pupils should be encouraged to live an active lifestyle (The Norwegian Directorate for Education and Training, 2024).

HOPP aims to explore the impacts of active learning, emphasizing the importance of the duration and consistency of active learning programs as studies suggest the traditional classroom setting's sedentary nature contributes to adverse and potentially hinders cognitive and emotional development (Bartholomew and Jowers, 2011; Donnelly et al., 2009; Stewart et al., 2004). Findings from this study may contribute to the evidence supporting integrating physical activity into educational frameworks as a modern pedagogy. The main research question is how long-term active learning integration affects elementary school academic outcomes.

Materials and methods

HOPP is a school-based physical activity program initiated by the municipality of Horten in Southeastern Norway for all seven elementary schools there. To evaluate the program, two control schools were chosen by Kristiania University College. To be selected, the Control schools had to be within a reasonable distance from Oslo and have approximately the same level of parental education (as a proxy for socioeconomic status). The Control schools had no additional physical activity programs beyond compulsory physical education. At baseline, HOPP included 2,297 pupils, aged 6–12 years, from both intervention schools (n = 1,545) and two control schools (n = 752). Reaching children from all socioeconomic layers was decisive. Parents were informed both in writing and orally, providing the basis for written informed consent.

HOPP was initiated in 2015 as a seven-year longitudinal, large-scale controlled intervention focused on public health, cardiometabolic risk factors, and academic performance. The intervention was cut one year short in 2020 due to the pandemic, and the latest national test results were recorded in 2019. The school restrictions due to the COVID-19 pandemic made it impossible for us to visit the schools to collect data. Otherwise, the schools functioned as normally as possible. HOPP also included tests of anthropometric status, cardiovascular status, physical activity level, physical fitness level, several blood tests, executive functions, quality of life, and friendship, all omitted in this paper but can be studied in the published study protocol (Fredriksen et al., 2017).

Intervention

The main aim of the HOPP study was to use the children's natural potential for physical activity to enhance academic skills

by introducing active learning into the educational program. The HOPP intervention consisted of 45 min/day (225 min/week) of active learning where traditional classroom teaching was replaced with physical tasks conducted in the schoolyard, gymnasium, or school halls. In addition, pupils had 90 min/week of compulsory physical education teaching. The project was mandatory for both students and teachers, but the evaluation and yearly testing required written informed consent from parents and children. During testing, a child could opt out without giving any reason. The consent was given using Satchel Post, a message folder for parents in the pupil's backpack. Before the intervention, the parents were able to attend a school meeting with the municipality and school authorities. Children aged 12 or older gave informed consent in addition to their parents.

Two experienced teachers from each school, 14 teachers in total, formed a working group that planned the content of the intervention based on Harter's Competence Motivation Theory and Bandura's social learning theory. These theories are based on performance motivation; the more children succeed in mastering, the more they are encouraged to try other tasks.

The working group created a library of activities that replaced traditional language, arithmetic, and English teaching methods. These activities were a mixture of their ideas and inspiration from The Norwegian Directorate for Education and Training (udir.no) and Trudvang Elementary School, Sogndal, Norway, and the ASK study. For examples of activities with descriptions in English, see https://www.activesmarterkids.com/physicallyactivelessons. The criterion was that pupils at all levels should have moderate to high intensity during various exercises and be at a vigorous activity level for 25–30% of the time. "Activity boxes" were developed and located in each classroom as a result of an 8-month-long test period. In spring 2015, 210 teachers in Horten municipality were taught how children can work with their academic skills in language, arithmetic, and English and simultaneously be physically active. The intervention schools were followed up weekly by a specially trained teacher employed by the municipality.

In the intervention schools, it was the teachers' responsibility to integrate physical activity into the school day and to implement the curriculum accordingly. Teachers were provided with a comprehensive set of tools and resources designed to support active learning, including lesson plans, equipment, and guidance on movement-based pedagogy. However, within this framework, they maintained complete academic freedom and professional discretion to choose how, when, and to what extent these tools were applied. This approach ensured flexibility in adapting the intervention to suit individual teaching styles and classroom dynamics, while maintaining the overarching goal of promoting increased physical activity throughout the school day.

The teachers decided how and when the period of active learning should occur, and the number of minutes and intensity level were documented through a daily questionnaire that the teachers answered. While teacher diaries were initially considered to document daily activities, compliance was limited, and the diaries were designed to capture class-level—not individual-level—data. Given the high workload for teachers and the limited precision for tracking individual activity across 2,300 children over five years, we concluded that the diaries were not a reliable data source. Instead, we prioritized objective activity measurements using accelerometers, which provided higher-quality and individual-level data.

There was no individual follow-up on pupils' participation in the intervention.

From mid-January, each school was visited and tested according to the test plan in a set manner (Fredriksen et al., 2017). This included testing at the school's venue and seven days of wearing an accelerometer.

National academic tests

The Norwegian Directorate for Education and Training annually conduct compulsory tests that provide information on reading, arithmetic, and English skills. The tests are held during autumn, shortly after the pupils have started in the 5th, 8th, and 9th grades. National tests will vary in type of tasks and degree of difficulty, and the scores may be difficult to compare directly between different tests. To solve this problem, the samples are linked together using so-called anchor tasks. A small and random sample of pupils nationally completes a test version containing both regular and anchor tasks, which are otherwise at the same level. In this way, a connection is established between two different samples using an Item Response Theory (IRT-model) (Zegota et al., 2022). The IRT-model is a testing theory for designing and scoring tests that measure abilities, attitudes, and other variables. It uses statistical models to represent item and test characteristics and considers the difficulty of each item when scaling them. IRT does not assume that all items are equally challenging. Pupils' results can now be converted into scale points, and the same score will describe the same skill, regardless of the results are from different tests and years. The results from national tests are published on a scale with a mean value of 50 points (SD = 10 points), together with the number of pupils at each mastery level. Since 2015, the results in arithmetic and English have been set on the same scale yearly, and the limits for each level have been fixed. The same is the case for the reading tests from 2017 onward. Hence, results from national tests can be used as a basis for measuring development over time. In this longitudinal study, the results from six years of national tests permit the extraction of individual information of each pupil and reporting secular trends, both from the intervention and control schools.

HOPP has collected results from national tests for 5th-grade pupils, beginning in the fall of 2014 with children born in 2004 until 2019 when the last 5th graders, born in 2008, completed their national tests.

Statistics

The mean (± 95 CI) of individual pupils' scores was compared for the Intervention and Control groups with a Gosset Independent *t*-test. Linear regression was performed between the Intervention and Control groups, as well as between the Intervention and Norwegian mean scores, to determine whether the scores improved non-significantly. Years in project and Intervention/Control group were independent variables, and Grades were dependent variables. In our analysis, we did not include age as a separate covariate because the "Testyear" variable functions as a proxy for age,

reflecting the progression and time each child has spent in the study. Socioeconomic status (SES) was also excluded from the models because of a strong correlation (Pearson's $r > 0.8$) with the intervention-control group distinction. Including both variables would introduce multicollinearity and compromise the interpretability of the results. Regarding sex, initial analyses showed minimal variation between boys and girls in the academic outcome measures. To increase statistical power and simplify interpretation, we therefore included both sexes in the same model without stratification. A p-value of 0.05 was considered statistically significant, and Bonferroni correction was applied to the analysis of the three outcomes. Stata 18.0, StataCorp LLC, College Station, TX, USA, was used as the statistical program.

Ethics

Informed consent was acquired from all parents prior to inclusion in the study. The study was conducted according to the Helsinki Declaration and The Regional Committee for Medical and Health Research Unit approved the study (reference number 2014/2064/REK sør-øst). The study is registered in Clinical trials (ClinicalTrials.gov Identifier: NCT02495714) as of 20 June—2015, retrospectively registered. The trial registration process was initiated prior to data collection; however, due to administrative delays, the formal registration on ClinicalTrials.gov was finalized retrospectively. Given the need to conduct baseline measurements before the intervention and the logistical demands of testing a large sample over an extended period, it was necessary to begin data collection before the registration was completed. Importantly, no deviations from the original study protocol occurred prior to registration. The collection of baseline values was initiated in mid-January 2015.

Results

HOPP project's distinct attribute has been its large sample size and duration, a factor that is postulated to be a critical contributor to its results. Data for academic performance were collected from 2015 to 2019 through the 5th grade national tests in Norwegian reading, English and arithmetic, and the project ended in March 2020, before the national tests of that year were conducted.

Table 1 shows the results for the Control and Intervention schools. The results for English (Figure 1) show that the Control schools had a declining trend, with the last year's scores significantly lower than the baseline measurements, but still significantly better than those of the Intervention schools ($p < 0.05$), except for the last year, when there was no significant difference in scores between the groups. For the Intervention schools, the scores improved non-significantly from the first to the second measurement ($p = 0.65$). They stayed elevated for the rest of the period at a level equal to the national median.

The Arithmetic scores in Figure 2 were declining for the Control schools throughout the project period. The score in the fourth year was significantly lower than in the first year ($p < 0.01$). The Intervention schools did not perform as well as the Control schools but showed an increased performance throughout the project.

In Figure 3, the Norwegian Reading scores are presented. The Control schools always performed better than the Intervention schools ($p < 0.05$). The results from the third year of the project were significantly better ($p < 0.05$) than those from the other years for the Controls. The intervention schools improved their performance from the baseline measurements (0 years into the project) to the next year and maintained this improvement throughout the project ($p < 0.05$).

This improvement is noteworthy, as reading is a foundational skill that influences all areas of learning. The HOPP project's approach facilitates better concentration and information retention, enhancing reading comprehension.

National average

The noticeable improvement in Norwegian Reading proficiency among the intervention schools reveals that active learning strategies can effectively complement and enhance traditional literacy teaching methods.

Sub group analysis

Among students who were initially low-performing (i.e., in the bottom quartile of baseline test scores), those in the intervention group showed a measurable improvement in test scores by the end of the study. In contrast, their peers in the control group did not. In practical terms, the proportion of students remaining in the lowest performance quartile at follow-up was lower in the intervention

TABLE 1 Average grade scores on the national tests from 2015 to 2019 for the control schools and the Intervention schools.

Subject group		2015			2016			2017			2018			2019		
		n	Mean	SD	*n*	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*	mean	SD
Arithmetic	Control	81	59.9	11.9	149	57.1	8.8	96	59.6	10.1	98	56.5	10.1	142	52.9	9.7
	Intervention	292	47.8	9.1	214	47.9	8.7	472	43.5	15.4	221	49.0	9.0	187	50.0	9.2
English	Control	78	55.7	9.0	150	54.2	9.3	92	55.6	10.2	97	53.5	9.2	141	50.9	9.4
	Intervention	294	49.3	10.0	269	47.9	9.2	239	49.5	9.5	217	49.6	8.3	189	50.3	9.7
Reading	Control	79	55.8	9.4	153	52.8	8.8	96	57.2	10.5	98	55.1	8.3	140	52.6	9.3
	Intervention	293	48.6	9.7	271	47.9	9.7	469	48.2	13.0	218	49.0	7.8	190	49.2	9.5

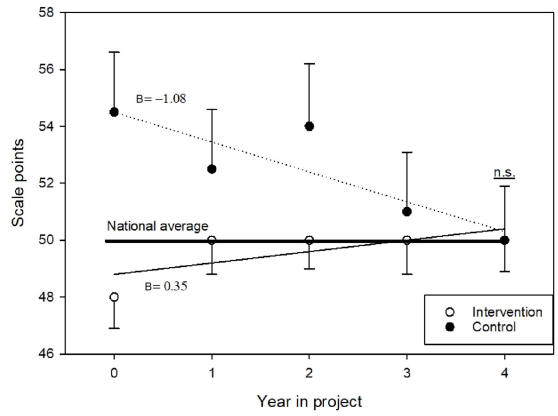

FIGURE 1
Results for national tests in the English language. Results are the mean and standard deviation. The thick horizontal line is the national average. The Scale point scale is constructed so that the national average is 50. Numbers larger than this are better than average. B is the regression coefficient for English scale points and time (year in project). n.s, not significant difference between control and intervention groups, else difference is significant, $p < 0.05$. Changes from baseline measurement for the *Intervention* schools are not statistically significant.

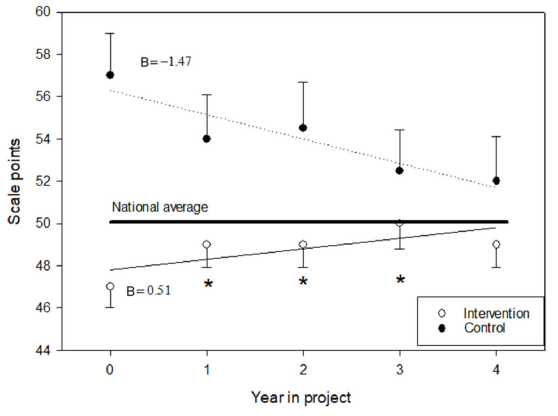

FIGURE 2
Results for national tests in Arithmetic. Results are the mean and standard deviation. The thick horizontal line is the national average. The Scale point scale is constructed so that the national average is 50. Numbers larger than this are better than average. B is the regression coefficient for Arithmetic scale points and time (year in project). Differences between control and intervention groups are all significant, $p < 0.05$. * indicates a statistically significant difference between the baseline year (0) and years 1,2,3 of the *Intervention* group.

schools than in the control schools. This suggests that long-term exposure to active learning may help reduce the number of students who perform poorly.

Discussion

HOPP focused on examining the impacts of active learning on academic performance, particularly emphasizing the importance of duration and consistency. Our findings contribute to a growing body of evidence underscoring the need for a systemic integration of physical activity into the educational framework, not just as a fleeting initiative but as a cornerstone of modern pedagogy. An increase of, for instance, two scale points—from 48 to 50—may seem minor at the individual level, but when such improvement is seen across an entire municipality of children, it reflects a considerable gain in overall academic performance. This is particularly noteworthy given the relatively modest nature

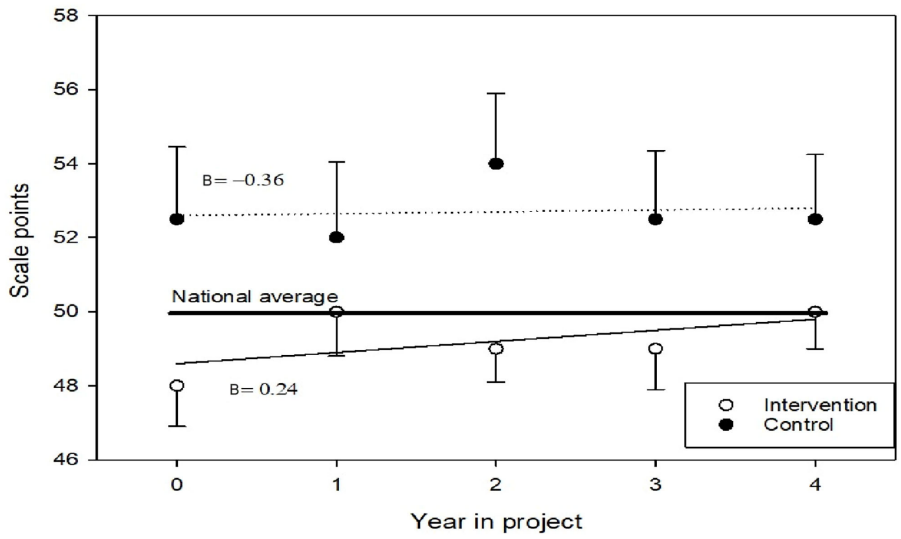

FIGURE 3
Results for national tests in Norwegian Reading. Results are the mean and standard deviation. The thick horizontal line is the national average. The Scale point scale is constructed so that the national average is 50. Numbers larger than this are better than average. B is the regression coefficient for Norwegian Reading scale points and time (year in project). Differences between control and intervention groups are all significant, $p < 0.05$. Changes from baseline measurement for the *Intervention* schools are not statistically significant.

of the intervention, which consisted of approximately 45 min of additional physical activity per school day, integrated into regular teaching. Such a scalable, low-cost intervention leading to measurable improvements in standardized academic outcomes should not be underestimated. If a similar effect size had been achieved through theoretical instruction or an academic enrichment program, it would likely have been regarded as a noteworthy success in the educational field. Therefore, while the effect sizes may be small in statistical terms, the public health and pedagogical implications are significant, particularly when applied at a population level. These findings suggest that even modest gains, if broadly distributed and sustainably implemented, can contribute meaningfully to educational equity and overall academic progress.

The trend observed in HOPP aligns with the broader literature, suggesting a positive association between physical activity and academic performance (Donnelly et al., 2016; Rasberry et al., 2011; Trudeau and Shephard, 2008; Singh et al., 2012; Macedonia, 2019; Jensen et al., 2025; Mao et al., 2024). The study's results, which reflect improvements in national English, Arithmetic, and Norwegian Reading test scores over six years, indicate the benefits of a sustained active learning approach. This evidence is particularly compelling given the long-term nature of the intervention, which is significant for enduring cognitive and academic outcomes.

The results for English (Figure 1) show that the Control schools had a declining curve, with the last year significantly lower than the baseline measurements, but still significantly better than the Intervention schools ($p < 0.05$), excluding the last year when there was no significant difference in scores between the groups. For the Intervention schools, the scores improved non-significantly from the first to the second measurement. They stayed elevated for the rest of the period at a level equal to the national median.

The Arithmetic scores in Figure 2 were declining for the Control schools throughout the project period. The score in the fourth year was significantly lower than in the first year ($p < 0.01$). The Intervention schools did not perform as well as the Control schools, except for in the fourth year in the project, indicating an upward trend in their scoring.

In Figure 3, the Norwegian reading scores are presented. The Control schools always performed better than the Intervention schools ($p < 0.05$). The result from the third year of the project was significantly better ($p < 0.05$) than the results from the other years for the Controls. The intervention schools significantly improved their performance from the baseline measurements (0 years in the project) to the next year and remained stable throughout the project ($p < 0.05$).

This aligns with WHO's recommendations for daily physical activity and the growing body of research emphasizing the importance of integrating physical activity into the curriculum (Trudeau and Shephard, 2008; Langford et al., 2014).

The HOPP approach, embedding physical activity into the educational process rather than viewing it as a separate entity, appears to have mitigated the trade-off between physical activity and academic teaching time. This model may represent a promising step toward pedagogical innovation in education, with potential implications for future practice if further supported by policy and sustained implementation. It is worth recognizing that while the increments in performance might appear modest, they are notable when considering the context. In a relatively brief period and with no other interventions besides HOPP, there has been a notable rise in test scores for children covering a whole municipality. This is particularly meaningful given that the intervention constitutes a minor portion of the children's total daily activities, adding just ~45 min of extra physical activity each day. From this perspective, the impact of such a seemingly minor addition is quite substantial. The positive outcomes in the intervention schools support the hypothesis that active learning can be successfully implemented without detracting from educational time, thereby offering a model for future educational interventions.

Notably, the HOPP project involved actual teachers in the intervention, addressing a gap highlighted in the Norris et al. (2015) review where the effectiveness of programs post-research intervention remained untested due to limited teacher involvement. By incorporating teachers into the process, the HOPP study provides a more realistic and scalable model of active learning that can be adopted in educational settings beyond the research context.

One may consider the impact of the pandemic lockdown to be negative for the other measurements but not the national tests. However, schools were partially kept open during this period. Additional active learning was implemented during the lockdown when the schools were still accessible. Schools in Horten municipality were better prepared than many other schools in Norway to perform outdoor teaching as they were already trained in active learning and had equipment ready to be used.

Educational challenges

Norwegian students have a concerning decline in academic performance, especially in Norwegian Reading, arithmetic, and science, as demonstrated by the PISA results in 2022 (Jensen et al., 2023). The significant decline in performance in these areas, with an increase in the number of low-performing students, underscores the need for measures to enhance learning and skill development among pupils. Active learning, which promotes engagement, critical thinking, and practical application of knowledge, can be crucial in addressing academic challenges among Norwegian school pupils. While our study was not originally designed to evaluate performance at the lower end of the achievement distribution specifically, we agree this is a meaningful question. Using national norms, we have conducted additional subgroup analyses by categorizing students into performance percentiles. Specifically, we analyzed the proportion of students in the lowest quartile of test scores at follow-up, comparing intervention and control groups and adjusting for baseline scores and relevant covariates. These analyses support the hypothesis that long-term exposure to active learning may be associated with a reduction in the proportion of low-performing students (not presented due to space limitations).

Strengths and limitations

A large sample size, with the analyses performed on an individual level, and six years of intervention underline the strength of the present results. The arithmetic variable revealed that 24 pupils had artificially low values in 2015. These were considered

input errors and deleted. While our approach did not allow for randomized participant selection, combining real-world settings, substantial participant numbers, and a case-control methodology was expected to yield a more robust knowledge base than smaller-scale RCT studies.

The intervention was designed to incorporate moderate to vigorous physical activity during active learning. Hence, the teachers implemented active learning with teaching assignments that theoretically would provide high enough intensity to achieve adequate physical intensity. The research group attempted to measure the intensity daily using a formula for teachers to fill out. However, it was futile as no teacher could keep track of all of the pupils in a class of 25–30. The only method for measuring physical activity was the accelerometer test, measured during a fixed week each year. This implies that perhaps several children did not reach the estimated level of intensity during active learning. Also, there were several obstacles for teachers to complete the intended active learning activity on all days, both in length and intensity. This may be due to weather, sick leave for teachers, limited access to areas intended for active learning due to too many classes doing active learning simultaneously, etc. However, this makes the results perhaps even more impressive, as less activity than intended has been given. Also variations in school-level factors such as teacher motivation and engagement could have impacted the fidelity and quality of intervention implementation. While all teachers received the same resources and training, individual enthusiasm and commitment to integrating physical activity into the curriculum may have varied. Second, although the core curriculum remained consistent across schools, differences in how it was delivered—particularly in the integration of active learning methods—could have influenced academic outcomes. Third, several unmeasured variables, including parental involvement, home learning environment, and screen time, may also have contributed to variations in student performance. These factors were not controlled for in the current study and should be considered when interpreting the results. Future research may benefit from including these variables to better isolate the effects of the intervention. Despite this, convincing results are displayed in favor of using active learning in the curriculum for improved academic achievement and perhaps with a simultaneously positive effect on health.

Over time, development is subjected to regression to the mean: High results will be substituted with lower results, and vice versa. This development may be seen in both the intervention and control groups. Especially the control schools did perform very well in the first years and would thus be exposed to a diminishing of the results.

The Flynn effect (Massey, 1995), states that the intelligence quotient (IQ) is rising from one generation to the next. Using Norwegian data from conscripts, Sundet, Barlaug and Torjussen found a leveling off of IQ scores after the mid-1990s (Sundet et al., 2004). A *decrease* in scores from the control schools may be viewed as such an effect. The *increase* in the scores of the national assessments for the intervention group may thus be the result of increased physical activity, which nullified the reduction in IQ and helped enhance academic performance.

A notable challenge during the implementation of the HOPP project was the coinciding widespread introduction of screen-based teaching tools, such as iPads, in Norwegian elementary schools. This shift in pedagogy has sparked considerable debate about the potential adverse effects of these tools on children's concentration and learning abilities, and described by some as an uncontrolled and non-consensual pedagogical experiment. Preliminary local studies have suggested that screen-based tools may have negatively influenced educational outcomes. Despite this potential limitation, a significant strength of the HOPP intervention is its apparent ability to counteract these adverse effects. The intervention schools participating in HOPP not only maintained national test performance levels but also demonstrated improvements. This indicates that the active learning approach, emphasizing physical activity and engagement, may have mitigated or even reversed the negative impact of screen-based tools on learning outcomes.

Conclusion

HOPP substantiates the significant role of sustained active learning in improving academic performance. TheHOPP study show the feasibility of integrating physical activity into the curriculum. This project emphasizes the need for a shift in educational approaches, integrating physical activity as a core teaching element to promote both cognitive development.

Considering these findings, the following implications may be drawn (1) The integration of active learning within the curriculum should be considered a viable approach to enhance academic outcomes. (2) Long-term interventions, as demonstrated by the HOPP project, are critical for realizing the full benefits of active learning. (3) Teacher involvement in developing and implementing active learning interventions is crucial for the practical and sustainable integration of such programs into the school curriculum.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Regional Committee for Medical and Health Research Unit (reference number 2014/2064/REK sør-øst). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

PF: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization,

Writing – original draft, Writing – review and editing. TB: Formal Analysis, Methodology, Writing – original draft, Writing – review and editing. AM: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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