Est. 1841 | YORK ST JOHN UNIVERSITY

Cimenti, Chiara, Thøgersen-Ntoumani, Cecilie, Larsen, Malte Nejst, Tarantino, Giampiero, Koch, Sofie, Eckert, Caroline, Meiner, Christina Birch, Prisak, Camilla, Krustrup, Peter and Ntoumanis, Nikos (2026) One-Year Effects of the FIT FIRST 20 High-Intensity and Multisport Physical Education Program on Physical Fitness and Psychological Outcomes in Early Adolescents: A Cluster-Randomized Controlled Trial. Scandinavian Journal of Medicine & Science in Sports, 36 (10).

Downloaded from: https://ray.yorksj.ac.uk/id/eprint/15888/

The version presented here may differ from the published version or version of record. If you intend to cite from the work you are advised to consult the publisher's version: https://doi.org/10.1111/sms.70374

Research at York St John (RaY) is an institutional repository. It supports the principles of open access by making the research outputs of the University available in digital form. Copyright of the items stored in RaY reside with the authors and/or other copyright owners. Users may access full text items free of charge, and may download a copy for private study or non-commercial research. For further reuse terms, see licence terms governing individual outputs. Institutional Repositories Policy Statement

RaY

Research at the University of York St John

For more information please contact RaY at ray@yorksj.ac.uk

Check for updates

Scandinavian Journal of Medicine & Science in Sports

WILEY

ORIGINAL ARTICLE OPEN ACCESS

One-Year Effects of the FIT FIRST 20 High-Intensity and Multisport Physical Education Program on Physical Fitness and Psychological Outcomes in Early Adolescents: A Cluster-Randomized Controlled Trial

Chiara Cimenti[1] | Cecilie Thøgersen-Ntoumani[1,2] | Malte Nejst Larsen[3] | Giampiero Tarantino[1,2] | Sofie Koch[4,5] | Caroline Eckert[3] | Christina Birch Meiner[1] | Camilla Prisak[3] | Peter Krustrup[3,6] | Nikos Ntoumanis[1,2,7]

[1]Danish Centre for Motivation and Behaviour Science (DRIVEN), Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark | [2]School of Sport, Exercise, and Rehabilitation Sciences, University of Birmingham, Birmingham, UK | [3]Sport and Health Sciences Cluster, Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark | [4]Research Unit for Active Living, Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark | [5]Research and Implementation Centre for Human Movement and Learning, Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark | [6]Sport and Health Sciences, University of Exeter, Exeter, UK | [7]School of Education, Language and Psychology, York St. John University, York, UK

Correspondence: Chiara Cimenti (ccimenti@health.sdu.dk)

Received: 15 January 2026 | **Revised:** 16 September 2026 | **Accepted:** 21 September 2026

Keywords: adolescents | cluster-randomized controlled trial | motivation | physical education | physical fitness

ABSTRACT

We evaluated the 1-year effectiveness of FIT FIRST 20, a high-intensity multisport physical education (PE) program, on physical fitness and psychological outcomes in 4–6 grade schoolchildren (10–13 years). A cluster-randomized controlled trial was conducted across 82 classes from 30 Danish schools ($n = 1652$ pupils; 49% girls). Schools were allocated to either three weekly 40-min FIT FIRST 20 sessions (intervention) or standard curriculum PE (control) over approximately 40 weeks. Outcomes were assessed at baseline and post-intervention; 2-year follow-up results will be reported separately. The primary outcome was cardiorespiratory fitness, assessed using the Yo-Yo Intermittent Recovery Test Level 1 (children's version). Secondary outcomes included agility, lower-body muscular power, postural balance, handgrip strength, body composition, blood pressure, resting heart rate, health-related quality of life, physical self-concept, motivation for physical activity, and satisfaction of basic psychological needs. Intervention effects were analyzed using linear mixed-effects models adjusted for sex, baseline sport participation, age, body mass and height. The latter two were excluded from models predicting psychological outcomes. Compared with the control, the intervention arm showed significantly greater improvements in cardiorespiratory fitness (54.90 m, 95% CI [8.35, 101.40], $p = 0.021$), along with significant gains in agility and lower-body muscular power. No interaction effects were observed for other physical fitness and psychological outcomes, although significant overall effects of time were observed for several outcomes. Overall, FIT FIRST 20 appears to be a feasible school-based strategy for improving selected physical fitness outcomes in 10–13-year-olds. Further modifications may be needed to strengthen the effects on psychological outcomes.

Clinical Trial Registration: ISRCTN14624515

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2026 The Author(s). *Scandinavian Journal of Medicine & Science In Sports* published by John Wiley & Sons Ltd.

1 | Introduction

Globally, most adolescents do not meet the recommended levels of physical activity (PA) [1]. Longitudinal evidence further shows that PA declines earlier than commonly assumed, beginning around the age of 7 and accelerating during preadolescence and early puberty (approximately ages 9–12) [2]. Similar patterns are observed in Denmark, where the proportion of youth achieving the recommended 60 min of daily PA sharply decreases with age, from 46% at 11 years to 23% at 15 years [3]. This developmental period (9–14 years) therefore represents a critical window for intervention, as early PA declines are associated with reduced physical fitness, lower motivation, and adverse long-term health trajectories [2, 4].

Schools are widely acknowledged as key settings for PA promotion because they reach nearly all children and account for a substantial proportion of their waking hours [5]. Despite this potential, school-based PA interventions have shown limited or inconsistent effects on key health-related outcomes [6].

A key explanation for these modest effects is the narrow fitness focus of most physical education (PE) and school-based PA interventions, which primarily target aerobic activity or moderate-to-vigorous PA (MVPA) [6]. However, evidence indicates that different exercise modalities exert domain-specific effects: for example, high-intensity interval training (HIIT) and aerobic training are most effective for improving cardiorespiratory fitness, whereas resistance training preferentially enhances musculoskeletal fitness [7]. Despite a large body of school-based PA research, few interventions are designed to simultaneously target metabolic, cardiorespiratory, and musculoskeletal fitness, with the latter particularly being underrepresented [6, 8, 9]. These limitations are compounded by a persistent gap between evidence-based recommendations and everyday PE practice; the latter often provides limited time at MVPA intensities and remains largely performance-oriented [10, 11]. This structural deficiency often means traditional PE alone is insufficient to address global physical inactivity trends. Nevertheless, appropriately designed PE can positively influence psychological outcomes beyond fitness. By supporting psychological need satisfaction through need-supportive teaching, PE can potentially promote autonomous motivation associated with greater engagement, well-being, higher MVPA levels, and stronger intentions to be physically active beyond school [12].

In response to these challenges, the FIT FIRST FOR ALL (Frequent Intense Training through Football, Interval Running, and Strength Training) program was developed in Denmark in 2018, informed by extensive research and recommendations [13, 14]. The program integrates HIIT, endurance, and strength-based activities to concurrently target metabolic, cardiorespiratory, and musculoskeletal fitness. Drawing on a wide range of sports, FF20 adapts sport-specific games into short, high-intensity PE activities designed to promote pupil behavioral engagement and time spent in MVPA. To support implementation within school settings, the program includes lesson plans, a teacher manual, and teacher training, enabling delivery by teachers regardless of their PE experience. The program has since been tailored to three age-specific versions within the Danish school system: (1) FIT FIRST 10 (FF10) (2–3 grade; approximately 7–11 years), evaluated in a recent three-arm dose–response trial [15], (2) FIT FIRST 20 (FF20) (4–6 grade; approximately 10–13 years), the focus of the present study, and (3) FIT FIRST TEEN (FFT) (7–9 grade; approximately 13–15 years), evaluated in a parallel cluster-randomized trial.

The present study evaluates FF20, the version developed for Danish 4–6 grades. The FF20 effectiveness trial spans two academic school years and commenced in August 2023. It compares an intervention arm with a control arm on physical fitness and psychological outcomes. The primary aim of this paper is to assess the post-intervention effects of FF20, following the first school year, relative to the control arm. Data collection for the second year of the program was ongoing in many of the schools at the time of submitting this paper.

2 | Materials and Methods

This study adheres to the Consolidated Standards of Reporting Trials (CONSORT) 2025 guidelines [16] and the extension for cluster-randomized trials [17] (see Supporting Information 1). The trial was prospectively registered on ISRCTN (ISRCTN14624515).

2.1 | Patients and Public Involvement

No patients were involved, as the study population comprised schoolchildren. Participants (schoolchildren) and stakeholders (teachers and other school personnel) were not involved in the design or dissemination planning. Study findings were shared with participating schools via email and communicated to relevant stakeholders (e.g., school staff and parents) through seminars and press releases.

2.2 | Study Design

A two-arm, cluster-randomized, parallel-group superiority trial was conducted in Danish primary schools over approximately 40 weeks, implemented in two cohorts (the first cohort was recruited in 2023 and the second cohort in 2024) using identical procedures. Cluster randomization was selected to minimize contamination between pupils within the same school. Schools were allocated to (i) a control arm receiving standard curriculum PE, or (ii) an intervention arm (FF20) consisting of three weekly FF20 lessons. After all schools completed the 40-week program, they remained in the study for an additional school year, during which one-third of the schools received a booster intervention addressing a separate research question (further details are in the protocol). In this manuscript, we report the 1-year effects of FF20 at the end of the 40 weeks.

2.3 | Ethical Procedures

The study complied with the Declaration of Helsinki. The Health Research Ethics Committee of the Region of Southern

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Denmark deemed the project exempt from formal review due to its minimal risk to participants (ID 11.806). Written informed parental consent was sought after randomization and obtained for all pupils whose data were included in the analyses. Verbal assent was obtained from the pupils, who were reminded at each data collection point that participation was voluntary. Although adverse effects were not anticipated, the research team monitored them through ongoing communication with schools and observation during data collection, pausing or stopping measurements whenever concerns arose.

2.4 | Participants and Recruitment

All public and private schools in Denmark were eligible to participate in the study, except those specializing in special-needs education or located in municipalities with targeted child-movement initiatives. Recruitment occurred via email, telephone, social media, online advertisement, blog posts, and the Danish Sports Confederation. After contacting about 85% of Danish schools, 30 schools consented to participate. Of these, 10 commenced in August 2023 and completed the 1-year intervention in June 2024, while 20 commenced in August 2024 and completed it in June 2025. Participants were pupils in 4–6 grade at the time of recruitment (approximately 10–13 years of age). All students in the selected classes were eligible; no individual exclusion criteria were applied.

2.5 | Randomization and Blinding

Schools were randomly allocated in a 2:1 ratio (intervention: control) using block randomization in Excel, stratified by the number of participating classes to ensure comparable distributions of cluster sizes across arms. The unequal allocation was chosen because the trial is embedded within a larger research program including a second-year booster delivered to a subset of intervention schools, while the remaining intervention schools and control schools receive no additional intervention.

The allocation sequence was generated by a blinded member of the research team (M.N.L.), who then enrolled schools and assigned them according to trial arms. Recruitment and enrolment of schools were completed prior to allocation disclosure to minimize selection bias. Because allocation occurred at school level and assignment was known to school staff prior to intervention delivery, allocation concealment was not feasible. Due to the nature of the study, whereby teachers delivered the intervention to students, blinding of teachers and pupils was not feasible. Outcome assessors and data analysts were not blinded because the same personnel were responsible for recruitment, communication with schools, data collection, and data analysis.

2.6 | Intervention and Control Arms

FF20 is a high-intensity and multisport PE program comprising three weekly 40-min sessions. These are delivered during school hours, replacing regular PE and additional school lessons. Sessions were based on 120 standardized lessons developed collaboratively by the University of (removed for blinding), the Danish Sports Confederation, Team Denmark (Denmark's national elite sports organization), and 24 national sports federations. Lessons were designed to elicit a high physiological load (mean intensity ≥ 75% of maximal heart rate) and included elements of sprinting, strength training, and bone-loading activities. Lesson content consisted primarily of small-sided games, interval-based play, relays, and partner exercises, emphasizing MVPA with minimal technical complexity. Activities were inspired by a wide range of sports, including ball games, athletics, and martial arts (e.g., badminton, football, handball, judo, rugby, taekwondo, and volleyball). Sessions required minimal equipment and were feasible both indoors and outdoors.

Teachers in intervention schools completed a 1-day training course combining theoretical and practical instruction. FF20 schools received a comprehensive manual containing all lesson plans and sport equipment (e.g., balls, cones, vests). Intervention fidelity was monitored through teacher logs and ongoing correspondence with the research team; the results will be reported in a future paper. The FF20 teacher manual is publicly available online in Danish (available at: https://www.dif.dk/raadgivning-og-stoette/mere-idraet-i-folkeskolen/fit-first).

Control schools continued their usual curriculum-based PE provision and did not receive FF20 materials, teacher training, or implementation support. Most control schools provided two weekly PE lessons. Usual PE was expected to follow the Danish national curriculum guidelines, "Fælles Mål", which include broad activity domains such as ball games, dance and expression, running, jumping and throwing, body-based activities, water activities, cooperation and responsibility, sport culture, health, well-being, and basic physical training principles [18]. Detailed information on the specific PE content delivered in control schools was not collected.

2.7 | Measures

All outcomes were administered by trained assessors following standardized protocols. Psychological outcomes were measured using validated questionnaires. Details of the testing procedures and measurement instruments for the primary and secondary outcomes are presented in Table 1, with corresponding references provided in Supporting Information 2.

2.7.1 | Primary Outcome

The primary outcome was cardiorespiratory fitness (CRF), assessed using the Yo-Yo Intermittent Recovery Test Level 1, children's version (YYIR1C). Cardiorespiratory fitness was quantified as the total distance (m) achieved on the YYIR1C.

2.7.2 | Secondary Physical Fitness Outcomes

Secondary physical fitness outcomes included agility, lower-body muscular power, postural balance, handgrip strength, body composition, blood pressure, resting heart rate, and mean arterial pressure. Further details of the testing procedures and measurement instruments are found in Table 1.

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | Procedure and instruments used to measure outcomes.

Outcome (unit of measurement)	Instrument	Data collection procedure	Data processing
Cardiorespiratory fitness (m)	Yo-Yo Intermittent Recovery Level 1 test for children and adolescents (YYIR1C)	YYIR1C consisted of 16-m shuttle runs at progressively increasing speed interspersed with 10 s recovery periods. Participants were first asked to perform two slow familiarization shuttles with adult guidance. An adult paced the children through the early stages up to level 12.2	The YYIR1C level reported for each participant was converted into meters according to the YYIR1C guidelines
Agility (s)	Arrowhead Agility Test (AAT)	From a sprint stance behind the line, participants ran to the center cone, turned right around the side cone, circled the far cone, and completed the test by crossing the start/finish line. Participants completed two trials at maximal speed	The best performance was retained for analysis
Lower-body muscular power (cm)	Standing Long Jump (SLJ)	Participants adopted a quarter-squat position, held for 2 s, and on command performed a jump with feet together and hands on the hips. Each participant performed two trials	The best performance was retained for analysis
Handgrip strength (kg)	Smedley hand dynamometer (Scandidact, Kvistgård, Denmark)	Participants were asked to stand with their back against a wall, hold the dynamometer in their dominant hand, with the elbow flexed at a 90-degree angle and kept close to the torso, and apply maximal force for 5 s. Each participant performed two trials	The best performance was retained for analysis
Postural balance (s)	Stork Balance Test	Participants balanced barefoot on one leg, placing the foot of the non-supporting leg against the inner thigh of the supporting leg, for as long as possible. Three trials were performed on each leg	For each leg, the best performance was retained, and the mean of the two best values was calculated
Height (cm)	Leicester Height Measure Mk II (Tanita Europe BV, Amsterdam, the Netherlands)	Participants stood barefoot with a straight back against the measurement instrument until the measurement was completed	
Body composition (body weight: kg; body fat percentage: %; muscle mass: kg; body mass index: kg/m^2)	InBody270 (InBody Co. Ltd., Seoul, Republic of Korea)	Body weight, body fat percentage, and muscle mass were measured with participants standing barefoot and wearing light clothing on the InBody for approximately 1 min	Fat mass (kg) was estimated by multiplying body weight by body fat percentage and dividing by 100. Fat mass index (kg/m^2) was derived by dividing fat mass by height squared. Body mass index (BMI) was estimated by dividing the weight (kg) by the height squared (m)

(Continues)

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | (Continued)

Outcome (unit of measurement)	Instrument	Data collection procedure	Data processing
Blood pressure (mmHg) and resting heart rate (beats·min^{-1})	OMRON M6 blood pressure monitor (HEM-7223-E; Omron Healthcare Co. Ltd., Kyoto, Japan) using a 17–22 cm cuff size	Following an initial 8-min supine rest, three blood pressure measurements were obtained at 1-min intervals using a monitor placed on the left upper arm over light clothing	The mean of three measurements was used, unless the first measurement exceeded the subsequent measurements by more than 10 mmHg for both systolic and diastolic blood pressure, in which case the average of the final two measurements was calculated. Mean arterial pressure (MAP) was derived as 1/3 systolic blood pressure plus 2/3 diastolic blood pressure, reflecting the relative duration of the cardiac cycle at rest
Participation in leisure-time sport clubs	Survey questions: (1) "Do you practice any sports in your spare time?", (2) "Which sports do you practice in your spare time?", (3) "How many times a week do you practice sports in your spare time?"	The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads	
Health-related quality of life	KIDSCREEN-27, self-report version	The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads	
Physical self-concept	Physical Self-Inventory, Very Short-Form	The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads	
Motivation for participation in PE	Perceived Locus of Causality Questionnaire	The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads	
Satisfaction of basic psychological needs	Psychological Need States in Sport (adapted to PE) Scale	The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads	

2.7.3 | Secondary Psychological Outcomes

Health-related quality of life was assessed using the KIDSCREEN-27; physical self-concept using the Physical Self-Inventory—Very Short Form (PSI-VS); motivation to move using the Perceived Locus of Causality Questionnaire (PLC), and satisfaction of basic psychological needs using the Psychological Need States in Sport (adapted to PE) Scale (PNSS-S). Items followed instrument-specific 5–7-point Likert response scales and were aggregated into composite scores, with higher values indicating greater functioning. All instruments possess strong construct validity and reliability in children and adolescents.

2.8 | Sample Size

Power calculations were performed using the National Institutes of Health Sample Size Calculator [19]. Input parameters were based on data from a prior pilot study [20]. The

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

power calculation was conducted for the overall 2-year trial and was powered to detect an effect size of $d = 0.20$ for the primary outcome at the 24-month follow-up, with a significance level of $\alpha = 0.05$ and 90% power. Given the longitudinal, cluster-randomized design, the power calculation model incorporated variance at both the pupil and class levels. An intraclass correlation coefficient (ICC) of 0.05 was specified, consistent with values reported in comparable school-based studies (interquartile range: 0.024–0.10) [21]. Longitudinal parameters included a standard deviation of 1.00 and an autocorrelation of 0.50 across repeated measures. Based on these assumptions and an expected average class size of 25 pupils, the model yielded a target of 33 classes, corresponding to a total recruitment sample of 1085 pupils, after accounting for a potential 25% individual-level attrition rate and lack of parental consent. The present manuscript reports analyses of the pre-specified 1-year post-intervention outcomes, which were not independently powered.

2.9 | Statistical Analysis

Means and standard deviations (SD) were calculated for all outcomes for both arms at baseline and post-intervention. For physiological outcomes, extreme outlier values (i.e., values > ±3 SD) were excluded prior to analysis. Questionnaire subscale scores were computed when at least ≥ 50% or ≥ 60% of items were completed, depending on whether the subscale contained an even or odd number of items. No imputation was performed for missing outcome data. Distributional assumptions were inspected using Q–Q plots, skewness and kurtosis indices, and Shapiro–Wilk and Shapiro–Francia tests.

Intervention effects were examined using linear mixed-effects models in jamovi (v2.6.44), investigating the mean difference between the intervention and control arms with respect to the primary and secondary outcomes, while accounting for clustering (pupils, classes, and schools). Time (0 = baseline, 1 = post-intervention) and arm (0 = control, 1 = FF20) were categorical predictors, coded using GAMLj's default centered ("simple") contrast scheme in jamovi. Hence, the fixed effect of time represents the estimated average change from baseline to post-intervention across the two arms. Two models were fitted as a sensitivity check. First, the "raw" model included the arm × time interaction only as a fixed effect, and pupil, class, and school as random-effect intercepts. Second, the "full" model was adjusted for sex (0 = male), baseline sport participation (0 = no participation), baseline age, and baseline height and body mass, as these covariates were selected a priori based on previous literature on correlates of PA in children and adolescents and their plausible relevance to the outcomes under study [22]. Height and body mass were excluded from the models predicting psychological outcomes, as these variables are not hypothesized to directly influence such outcomes. All continuous covariates were group-mean centered in line with recommendations for estimating pupil-level intervention effects [23]. Linear mixed-effects models were estimated using all available observations. Thus, participants with data at only one assessment could contribute their available measurement. Statistical significance was defined as $\alpha = 0.05$ for all outcomes. No formal correction for multiple comparisons was applied across secondary outcomes. Therefore, findings for secondary physical fitness and psychological outcomes should be interpreted as exploratory and hypothesis-generating. Primary inference is based on adjusted multilevel models.

3 | Results

3.1 | Participant Characteristics

The flow diagram of schools and participants is presented in Figure 1.

Eighty-two classes from 30 schools, comprising 1652 pupils, were randomized. Parental consent was obtained for 1195 pupils (72%), who were included in the primary analyses. This included 387 pupils in the control arm (75.4% consent) and 808 pupils in the intervention arm (70.9% consent). The mean age at baseline was 10.6 years (SD = 0.9; range = 9–13 years), and the sex distribution was balanced (49% girls). Table 2 presents baseline participant characteristics whereas Table 3 shows descriptive statistics for primary and secondary outcomes at baseline and post-intervention.

3.2 | Primary Outcome

A significant time effect (estimate = 115.76 m, 95% CI [92.48, 139.00], $p < 0.001$) and arm × time interaction were observed for CRF (estimate = 54.90 m, 95% CI [8.35, 101.40], $p = 0.021$). This indicates that CRF improved on average across the two arms, and this improvement was larger in FF20 than in the control arm. In practical terms, after adjustment for covariates, pupils allocated to FF20 improved, on average, by approximately 55 m more than those in the control arm on the YYIR1C from pre- to post-test. This difference corresponds to a small, standardized effect size ($d = 0.24$, 95% CI [0.04, 0.45]).

In the adjusted model, sex, baseline age, height, body mass, and sport participation were significantly associated with CRF (see Supporting Information 3). The pupil-level ICC was 0.59, compared with 0.02 at the class level and 0.11 at the school level. Full model specifications and variance components are reported in Supporting Information 3.

3.3 | Secondary Physical Fitness Outcomes

For lower-body muscular power (SLJ), a significant time effect (estimate = 4.75 cm, 95% CI [3.68, 5.83], $p < 0.001$) and arm × time interaction revealed improvements over time for both arms, with significantly greater gains in FF20 relative to the control (estimate = 4.09 cm, 95% CI [1.95, 6.24], $p < 0.001$). Agility performance (AAT) demonstrated a significant arm × time interaction favoring FF20, reflected by larger reductions in completion time relative to the control arm (estimate = −0.36 s, 95% CI [−0.50, −0.22], $p < 0.001$). For AAT, the average change across arms was not significant (estimate = −0.03 s, 95% CI [−0.10, 0.04], $p = 0.442$), reflecting opposing trajectories in the two arms (Supporting Information 3). In other words, completion time decreased in FF20 and increased in the control arm.

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

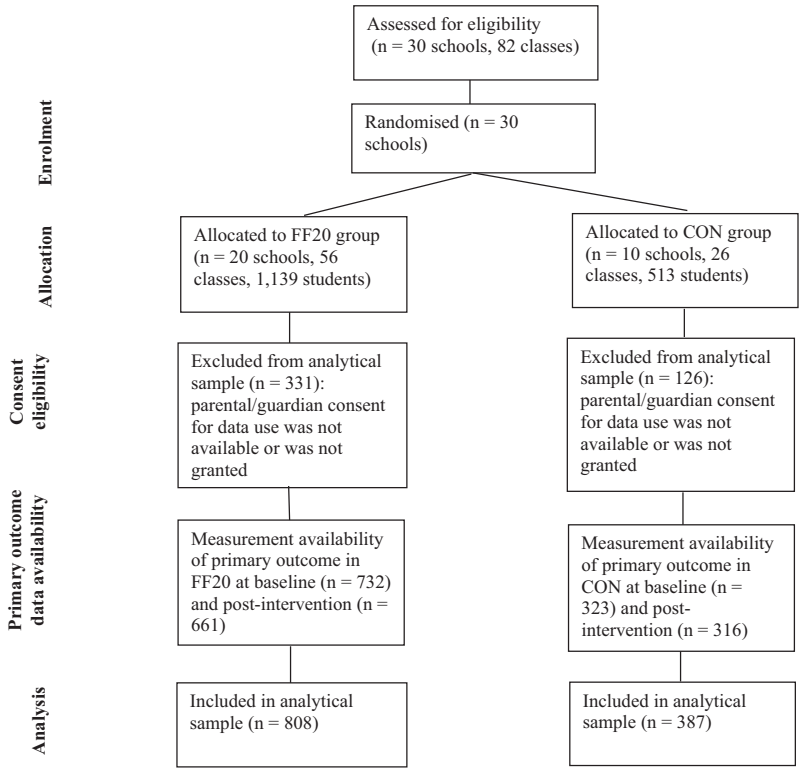


FIGURE 1 | CONSORT diagram showing the flow of schools and participants through each stage of the cluster-randomized trial. The connecting lines between boxes indicate participant flow and should not be interpreted as sequential subtraction at every stage. Inclusion in the analytical sample required parental/guardian consent for data use. The availability of the primary outcome at baseline and post-intervention is reported among participants included in the analytical sample. Linear mixed models used all available observations. Therefore, participants with data at baseline only, post-intervention only, or both time points could contribute to outcome-specific analyses, provided that parental/guardian consent for data use had been granted. Total analytical sample: $N = 1195$ (FF20, $n = 808$; CON, $n = 387$). CON, control arm; FF20, FIT FIRST 20.

Furthermore, in the adjusted models, sex, baseline age, height, body mass, and sport participation were significantly associated with SLJ and AAT, with the exception of age for AAT ($p = 0.057$). For both outcomes, the pupil-level ICC was the largest (SLJ: ICC = 0.59; AAT: ICC = 0.46).

No significant arm × time interactions were observed for the remaining secondary physical fitness outcomes in the adjusted models. However, significant main effects of time were found for several variables, indicating improvements in postural balance and handgrip strength, increases in body mass, muscle mass, fat mass, fat mass index, BMI, and systolic blood pressure, and a decrease in diastolic blood pressure.

The pattern of significant covariate effects varied across outcomes; for example, all covariates were significantly associated with fat mass index, whereas only age and body mass were associated with postural balance (see Supporting Information 3).

3.4 | Secondary Psychological Outcomes

Analyses of psychological outcomes reveal no statistically significant arm × time interactions in the adjusted models, with effect estimates generally small and confidence intervals overlapping zero. Significant main effects of time were, however, observed for several outcomes. Autonomy and parent relations improved over time, whereas general self-worth, physical self-worth, balance (Physical Self-Inventory—Very Short Form), introjected regulation, identified regulation, and intrinsic motivation declined over time. These changes were similar between arms, indicating comparable temporal trajectories.

In adjusted models, the contribution of covariates differed by outcome. For example, sex and sport participation were significantly associated with physical well-being, whereas sex was the only significant covariate for psychological well-being.

4 | Discussion

This study evaluated the 1-year effects of FF20, a high-intensity and multisport PE program, on physical fitness and psychological outcomes in schoolchildren aged approximately 10–13 years. Compared with standard curriculum PE, FF20 produced significantly greater improvements in CRF. Greater benefits for FF20, relative to the control, were also observed for lower-body muscular power and agility. For other physical fitness and psychological outcomes, there were no consistent between-arm differences in change, although several outcomes showed significant overall effects of time. To contextualize these findings, after adjustment for covariates, the additional between-arm effect of FF20 (~55 m; $d = 0.24$) was small and below the moderate pooled effects reported in meta-analyses of school-based interventions targeting CRF [24]. Nonetheless, this magnitude is consistent with broader evidence showing that school-based PA

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | Participant characteristics at baseline.

	CON	FF20
Number of participants (*n*)	387 (32.4%)	808 (67.6%)
Sex, boys (*n*)	153/344 (44.5%)	378/746 (50.7%)
Age (years)	10.3 ± 0.9 (*n* = 331)	10.7 ± 0.9 (*n* = 723)
Grade, 4	248/387 (64.1%)	279/808 (34.5%)
Grade, 5	81/387 (20.9%)	315/808 (39.0%)
Grade, 6	58/387 (15.0%)	214/808 (26.5%)
Body mass (kg)	40.5 ± 10.1 (*n* = 340)	42.2 ± 10.6 (*n* = 734)
Height (cm)	147.7 ± 8.7 (*n* = 339)	150.1 ± 8.5 (*n* = 730)
Active in leisure-time sports, yes	274/337 (81.3%)	627/746 (84.0%)
Weekly attendance in sport clubs		
No sessions per week	46/329 (14.0%)	91/732 (12.4%)
1–2 sessions per week	176/329 (53.5%)	397/732 (54.2%)
3–4 sessions per week	87/329 (26.4%)	203/732 (27.7%)
≥ 5 sessions per week	20/329 (6.1%)	41/732 (5.6%)
Sports		
Football	94/312 (30.1%)	243/733 (33.2%)
Handball	15/312 (4.8%)	80/733 (10.9%)
Tennis	7/312 (2.2%)	7/733 (1.0%)
Dance	19/312 (6.1%)	40/733 (5.5%)
Volleyball	1/312 (0.3%)	2/733 (0.3%)
Basketball	13/312 (4.2%)	21/733 (2.9%)
Gymnastics	46/312 (14.7%)	133/733 (18.1%)
Another sport	117/312 (37.5%)	240/733 (32.7%)

Note: Continuous variables are shown as mean ± SD, with n indicating the number of pupils with available data. Categorical variables are presented as *n*/*N* (%), where *N* is the number of pupils with valid data for the relevant variable; thus, denominators may vary across variables. The denominator is reported in every cell. Percentages in the first row are of the 1195 pupils with parental consent included in the analytical sample. Weekly attendance is reported among pupils with a valid response to the attendance item, including those reporting no sessions, so the four attendance categories sum to 100%. Sport type is reported among pupils who selected at least one sport. Because pupils could select more than one sport, these percentages are not expected to sum to 100%. A small number of pupils provided responses that were not fully consistent across the three items, specifically by reporting weekly sessions without answering "yes" to the participation item (CON *n* = 9; FF20 *n* = 14).
Abbreviations: CON, control arm; FF20, intervention arm.

programs often yield minimal to non-significant effects on adolescent physical fitness [6]. Of note, even small improvements may be relevant for public health, given robust associations between higher youth CRF and more favorable cardiometabolic health trajectories later in life [25]. However, no validated minimal clinically important difference exists for the YYIR1C, and the clinical significance of the present effect size cannot be determined from these data. Beyond cardiometabolic health, CRF has also been identified as a potential mediator of the association between PA and academic achievement in youth [26]. The relevance of CRF as a summative health marker in pediatric populations is further supported by an overview of meta-analyses representing over 125 000 observations across 33 health outcomes [27]. Taken together, the observed gains are encouraging in light of the well-documented global declines in youth CRF since the 1970s [28].

Several features of FF20 may explain its greater effects on CRF compared with standard curriculum PE. These include its combined aerobic and resistance-based approach, higher weekly lesson frequency, and emphasis on MVPA [24]. These characteristics align with meta-analytic evidence identifying HIIT as an effective exercise modality for improving VO_2max in children and adolescents [7]. However, the relative contribution of these factors cannot be determined, particularly because lesson intensity and detailed content were not objectively monitored in control schools.

To note, the FF10 dose–response trial found no CRF benefit at either a moderate (1.5 weekly FF10 sessions) or high (3 weekly FF10 sessions) dose over 4 months in 7–11-year-olds [15]. Nonetheless, this null result may be partly linked to implementation shortfalls, as delivery did not fully align with the intended

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 | Descriptives for outcome variables before (baseline) and after (follow-up) by arm.

	CON				FF20			
	Baseline		Follow-up		Baseline		Follow-up	
Outcome variables	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**
Primary outcome								
YYIR1C distance (m)	323	502.9 (372.3)	316	573.1 (442.7)	732	512.4 (370.9)	661	668.0 (473.3)
Secondary physical fitness outcomes								
SLJ performance (cm)	329	117.0 (18.5)	326	119.1 (21.2)	735	118.7 (18.4)	679	126.3 (19.6)
AAT performance (s)	316	10.8 (1.0)	324	11.0 (1.3)	734	10.8 (1.0)	676	10.6 (1.0)
Postural balance (s)	341	4.1 (3.2)	339	4.1 (3.6)	745	4.0 (3.2)	702	4.4 (3.2)
Handgrip strength (kg)	344	17.2 (4.1)	340	18.7 (4.7)	744	17.8 (4.3)	700	19.1 (4.6)
Body mass (kg)	340	40.5 (10.1)	336	43.6 (10.7)	734	42.2 (10.6)	685	45.5 (11.0)
Muscle mass (kg)	341	16.4 (3.6)	336	17.9 (3.7)	744	17.3 (3.6)	693	18.9 (4.0)
Fat mass (kg)	340	9.4 (5.9)	335	10.0 (6.1)	732	9.7 (6.3)	681	10.2 (6.5)
Fat mass index (kg/m^2)	335	4.3 (2.5)	333	4.3 (2.4)	722	4.2 (2.5)	677	4.2 (2.6)
Body mass index (kg/m^2)	335	18.4 (3.3)	334	18.6 (3.3)	723	18.5 (3.3)	681	18.8 (3.4)
Systolic blood pressure (mmHg)	340	96.8 (9.2)	335	99.2 (9.7)	730	99.0 (9.2)	688	101.0 (9.6)
Diastolic blood pressure (mmHg)	340	64.7 (7.3)	335	64.1 (7.0)	730	65.4 (7.2)	688	64.1 (7.5)
Mean arterial pressure (mmHg)	340	75.4 (7.1)	335	75.8 (7.0)	730	76.6 (7.0)	688	76.5 (7.1)
Resting heart rate (bpm)	340	73.0 (9.9)	335	72.5 (10.4)	730	73.2 (10.7)	688	72.5 (10.4)
Secondary psychological outcomes								
Physical well-being	337	51.3 (8.6)	338	51.9 (9.8)	745	51.4 (8.8)	696	51.7 (8.4)
Psychological well-being	133	49.7 (10.7)	338	50.5 (10.4)	624	50.3 (9.3)	696	50.6 (9.0)
Autonomy and parent relations	337	52.1 (10.2)	338	52.5 (10.2)	746	51.3 (9.4)	696	52.6 (9.7)
Peers and social support	337	51.0 (8.9)	338	51.1 (9.5)	746	50.9 (9.4)	696	51.0 (9.0)
School environment	337	52.1 (9.2)	338	51.4 (9.6)	746	51.7 (8.8)	696	51.5 (8.7)
General self-worth	285	5.0 (1.1)	330	4.9 (1.1)	708	5.0 (1.1)	674	5.0 (1.1)
Physical self-worth	282	4.9 (1.1)	327	4.8 (1.3)	697	4.9 (1.2)	673	4.9 (1.1)
Physical strength	301	4.3 (1.1)	310	4.4 (1.0)	685	4.4 (1.1)	649	4.5 (1.1)
Physical appearance	243	4.2 (1.1)	298	4.2 (1.2)	643	4.1 (1.2)	606	4.2 (1.2)
Physical condition	284	4.0 (1.3)	332	4.1 (1.3)	700	4.1 (1.3)	667	4.2 (1.3)
Flexibility	270	4.2 (1.2)	311	4.3 (1.2)	653	4.3 (1.1)	647	4.2 (1.2)
Balance	283	4.3 (1.1)	331	4.1 (1.1)	707	4.3 (1.1)	682	4.2 (1.1)
Speed	315	4.4 (1.2)	337	4.5 (1.2)	715	4.6 (1.1)	685	4.6 (1.2)
Autonomy satisfaction	337	5.1 (1.3)	338	5.2 (1.3)	746	5.1 (1.3)	695	5.1 (1.3)
Competence satisfaction	320	5.6 (1.1)	338	5.6 (1.2)	722	5.6 (1.1)	695	5.7 (1.1)
Relatedness satisfaction	320	5.6 (1.1)	338	5.6 (1.2)	722	5.6 (1.1)	695	5.6 (1.1)
Amotivation	336	3.0 (1.4)	338	3.1 (1.5)	744	2.9 (1.4)	694	2.9 (1.5)
External regulation	296	4.0 (1.4)	338	4.1 (1.4)	721	4.0 (1.3)	694	3.9 (1.4)
Introjected regulation	320	4.0 (1.5)	338	3.8 (1.5)	721	3.9 (1.4)	694	3.8 (1.4)

(Continues)

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 | (Continued)

	CON				FF20			
	Baseline		Follow-up		Baseline		Follow-up	
Outcome variables	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**	***n***	**Mean (SD)**
Identified regulation	320	5.2 (1.3)	338	4.9 (1.4)	721	5.2 (1.3)	694	5.1 (1.3)
Intrinsic motivation	296	5.2 (1.6)	338	5.1 (1.6)	721	5.4 (1.5)	694	5.3 (1.6)

Note: Mean (SD) and sample sizes for outcome variables before (baseline) and after (follow-up) the 40-week FF20 intervention for each of the two arms. Descriptive statistics are based on the analyzed dataset after exclusion of extreme values, as described in the Statistical Analysis section.
Abbreviations: AAT, Arrowhead Agility Test; CON, control; FF20, intervention arm; SLJ, standing long jump; YYIR1C, Yo-Yo Intermittent Recovery Test Level 1 for Children.

protocol. Overall, it remains unclear based on the available evidence whether the FIT FIRST program has consistent effects across age groups, whether its effects depend on the dose delivered, or whether differences in implementation fidelity contribute to the observed variation across trials. Finally, improvements in field-based CRF tests may also partly reflect changes in body composition, particularly reductions in fat mass [29]. But this mechanism is unlikely to explain the present findings, as body-composition indicators changed similarly across arms and no arm × time interactions were observed.

Beyond CRF, FF20 demonstrated more favorable changes over time in muscular power and agility compared to the control arm. These findings may be relevant, given that agility predicts sport participation in girls, while both agility and SLJ performance predict participation in boys [30]. The greater improvement in muscular power observed in the FF20 arm is consistent with evidence showing that school-based exercise interventions can enhance muscular fitness when strength-oriented activities are included [7]. Similarly, fundamental movement skills, including agility, have been shown to respond well to diversified school-based interventions delivered at a sufficient dose [31]. This evidence may partly explain the favorable effect of FF20, which combined a variety of PA providing different training stimuli within each lesson delivered three times per week [31]. In addition to the significant interaction, there were some time-specific effects. Muscular power showed a significant overall increase over time across the two arms, together with a significant arm × time interaction. This pattern was therefore consistent with an ordinal interaction, similar to that observed for CRF. For other physical fitness outcomes, significant overall changes over time were observed without clear intervention-specific advantages. Several factors may account for this pattern. Changes in physical fitness and body composition observed across the study period may, partly, reflect the growth and maturation processes characteristic of early adolescence [32]. Variation in the implementation of FF20 delivery may have also reduced the intended differentiation between FF20 and standard curriculum PE. This is a common challenge in school-based interventions constrained by scheduling demands and teacher workload [6]. This interpretation aligns with meta-analytic evidence indicating that null or minimal intervention effects on blood pressure and BMI are common and often attributable to insufficient intervention dose and limited adherence [6, 33]. It is also plausible that FF20 did not differ sufficiently from standard curriculum PE in the overall physical training stimulus required to produce distinct effects on these secondary physical fitness outcomes.

Furthermore, the absence of intervention-specific gains in handgrip strength may reflect the principle of training specificity rather than the limited relevance of handgrip strength as an outcome. Handgrip strength is in fact widely used as a marker of overall muscular fitness in pediatric populations [8]. At the same time, FF20 primarily consisted of high-intensity, sport-based activities involving running, jumping, changes of direction, and intermittent aerobic and lower-body muscular demands. Thus, the non-significant effect on handgrip strength may indicate that parts of the FIT FIRST 20 PE program did not provide a sufficient progressive upper-body resistance-training stimulus to develop overall upper-body muscular strength. Consistent with this interpretation, meta-analytic evidence shows that school-based exercise interventions do not consistently improve handgrip strength, and that meaningful gains in muscular strength and power may require higher-frequency and more targeted upper-body strength-oriented protocols within PE settings [8].

In contrast to the physical fitness outcomes, multiple psychological variables exhibited significant changes over time; yet none demonstrated intervention-specific effects. The concurrent declines in identified regulation and intrinsic motivation suggest a reduction in more autonomous forms of motivation over the school year, while the decline in introjected regulation indicates a simultaneous reduction in this more controlled form of motivation. Declines were also observed in self-perception outcomes (general self-worth, physical self-worth, and balance), consistent with longitudinal evidence of declining physical self-perceptions during adolescence [34]. As these changes occurred similarly in both arms, they are unlikely to reflect FF20 specifically and may instead reflect broader developmental or school-year influences. Health-related quality of life may decline during this developmental stage, consistent with longitudinal evidence showing moderate decreases across adolescence that coincide with pubertal development [35].

Of note, the concurrent decline in intrinsic motivation and increase in CRF raise questions about whether the observed fitness gains are likely to be sustained. Previous evidence indicates that self-determined motivation and enjoyment in PE are positively associated with PA in youth and with MVPA during PE lessons [36, 37]. Enjoyment has also been shown to predict CRF 1 year later in adolescents [38]. Therefore, if motivational

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

processes decline, the level of MVPA required to maintain improvements in CRF may be difficult to sustain, raising uncertainty about whether the observed gains would persist beyond the intervention period. Additional factors may account for the absence of between-arm differences in psychological outcomes. For example, the effects of PE-based interventions on autonomous motivation often rely on need-supportive pedagogy and targeted teacher training, features insufficiently emphasized in FF20 [12]. Improvements in physical self-concept may also require longer exposure or complementary intervention components beyond increased PA alone [39].

Finally, associations between outcomes and covariates such as sex, age, anthropometry, and sport participation reflected expected developmental and PA-related influences and did not attenuate the observed intervention effects. Across most outcomes, the pupil-level ICC was substantially larger than the class- and school-level ICCs. This is consistent with the associations we observed between the outcomes and pupil-level characteristics such as sex, age, and anthropometry.

4.1 | Strengths and Limitations

This study has several methodological strengths. First, the 40-week intervention period is substantially longer than that of most school-based interventions, which typically last fewer than 12 weeks [7]. This extended duration allowed us to evaluate the effects following sustained, medium-term exposure to the intervention. Achieving such a duration can be challenging in school settings due to time constraints and competing priorities among school staff. Second, recruitment was conducted over many months using different strategies. This resulted in the inclusion of schools from all regions of Denmark and ensured representation from both rural and urban areas. Third, data were collected using a wide range of devices and self-reported measures from physiology, anthropometry, and psychology. Finally, the study benefited from a large number of clusters and pupils (82 classes and 1195 pupils), exceeding the sample size specified in the power calculation.

Several limitations should also be noted. First, in line with reporting standards for cluster-randomized trials, blinding was not feasible. While this is unlikely to have substantially influenced teaching quality, it remains a recognized limitation of school-based intervention studies. Second, objective measures of activity dose such as heart-rate monitoring across sessions were not feasible within the constraints of a large-scale school-based trial. Third, the device used for blood pressure measurement has not yet been validated in pediatric populations, and the measurement protocol did not fully adhere to standardized procedures (e.g., measurement on a bare arm and in a seated position). These factors represent important limitations when interpreting blood pressure findings. Additionally, baseline psychological well-being data were missing for a subset of pupils, unevenly distributed between study arms, most likely due to a technical problem in the survey platform. Although the linear mixed-effects models used all available observations, inference for this outcome relies on the missing-at-random assumption. Finally, because no formal correction for multiple comparisons was applied across secondary outcomes, significant findings beyond the primary outcome should be interpreted cautiously as exploratory.

5 | Perspective

As progress towards the WHO target of reducing physical inactivity by 2030 remains insufficient, identifying effective and sustainable approaches to support PA and fitness in children and adolescents is increasingly important [5]. Schools, and PE in particular, provide an important setting for such efforts [5]. By evaluating FF20 in approximately 10–13-year-olds, the present study extends the evidence base for structured, high-intensity multisport PE and supports the potential contribution of school-based programs to broader efforts to improve youth fitness. Future research should determine which FF20 characteristics, including frequency, intensity, content, and duration, drive specific fitness adaptations, supported by objective assessment of exercise intensity, implementation fidelity, and delivered dose. Longer-term studies should establish whether effects are sustained and whether program refinement can extend benefits to body composition and psychological outcomes. Beyond physical health, FF20 may also have educational relevance, as improvements in CRF may partly mediate associations between PA and academic achievement [26, 40].

Author Contributions

P.K., C.T.-N., and N.N. conceived the study and secured funding. C.C., P.K., M.N.L., C.E., S.K., C.B.M., and C.P. contributed to school recruitment. C.C. coordinated the project, collected and analyzed data, and led the drafting of the manuscript. P.K., M.N.L., C.C., C.E., and C.B.M. contributed to teacher training. N.N. performed the sample size calculations, and M.N.L. conducted the cluster randomization. G.T., M.N.L., S.K., C.E., C.B.M., and C.P. assisted with data collection. G.T. and N.N. assisted with the statistical analysis and interpretation of findings. All authors critically revised the manuscript for important intellectual content and approved the final version.

Acknowledgments

The authors thank the pupils, teachers, and pedagogues from the participating schools for their valuable involvement. We are also grateful for the students and research staff's support in the data collection.

Funding

This work was supported by Novo Nordisk Fonden (NNF22SH0077612).

Consent

Written informed parental consent was requested for all eligible pupils, and verbal pupil assent was obtained at each data collection point. Only data from pupils with returned parental consent for data use were included in the analyses.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Datasets will be available from the corresponding author upon reasonable request for research purposes only, after the completion of the project (1 July 2026).

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

References

1. R. Guthold, G. A. Stevens, L. M. Riley, and F. C. Bull, "Global Trends in Insufficient Physical Activity Among Adolescents: A Pooled Analysis of 298 Population-Based Surveys With 1·6 Million Participants," *Lancet Child & Adolescent Health* 4, no. 1 (2020): 23–35.

2. J. D. D. Habyarimana, E. Tugirumukiza, H. Sun, A. Pathirana, and K. Zhou, "From Active Play to Sedentary Lifestyles: Understanding the Decline in Physical Activity From Childhood Through Adolescence—A Systematic Review," *Frontiers in Public Health* 13 (2025): 1636891.

3. M. Toftager, L. B. Christiansen, T. Baagø-Rasmussen, et al., *Active Healthy Kids Danmark 2026* (Syddansk Universitet, 2026).

4. V. Sember, G. Jurak, M. Kovač, S. Đurić, and G. Starc, "Decline of Physical Activity in Early Adolescence: A 3-Year Cohort Study," *PLoS One* 15, no. 3 (2020): e0229305.

5. World Health Organization, *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World* (World Health Organization, 2018).

6. S. E. Neil-Sztramko, H. Caldwell, and M. Dobbins, "School-Based Physical Activity Programs for Promoting Physical Activity and Fitness in Children and Adolescents Aged 6 to 18," *Cochrane Database of Systematic Reviews* 9 (2021): CD007651.

7. J. Wu, Y. Yang, H. Yu, L. Li, Y. Chen, and Y. Sun, "Comparative Effectiveness of School-Based Exercise Interventions on Physical Fitness in Children and Adolescents: A Systematic Review and Network Meta-Analysis," *Frontiers in Public Health* 11 (2023): 1194779.

8. E. Villa-González, Y. Barranco-Ruiz, A. García-Hermoso, and A. D. Faigenbaum, "Efficacy of School-Based Interventions for Improving Muscular Fitness Outcomes in Children: A Systematic Review and Meta-Analysis," *European Journal of Sport Science* 23, no. 3 (2023): 444–459.

9. H. S. Yuksel, F. N. Şahin, N. Maksimovic, P. Drid, and A. Bianco, "School-Based Intervention Programs for Preventing Obesity and Promoting Physical Activity and Fitness: A Systematic Review," *International Journal of Environmental Research and Public Health* 17, no. 1 (2020): 347.

10. UNESCO and Loughborough University, *The Global State of Play: Report and Recommendations on Quality Physical Education* (UNESCO, 2024).

11. J. L. Hollis, R. Sutherland, A. J. Williams, et al., "A Systematic Review and Meta-Analysis of Moderate-to-Vigorous Physical Activity Levels in Secondary School Physical Education Lessons," *International Journal of Behavioral Nutrition and Physical Activity* 14, no. 1 (2017): 52.

12. D. Vasconcellos, P. D. Parker, T. Hilland, et al., "Self-Determination Theory Applied to Physical Education: A Systematic Review and Meta-Analysis," *Journal of Educational Psychology* 112, no. 7 (2020): 1444–1469.

13. A.-M. Elbe, J. M. Wikman, M. Zheng, M. N. Larsen, G. Nielsen, and P. Krustrup, "The Importance of Cohesion and Enjoyment for the Fitness Improvement of 8–10-Year-Old Children Participating in a Team and Individual Sport School-Based Physical Activity Intervention," *European Journal of Sport Science* 17, no. 3 (2017): 343–350.

14. M. N. Larsen, C. M. Nielsen, E. W. Helge, et al., "Positive Effects on Bone Mineralisation and Muscular Fitness After 10 Months of Intense School-Based Physical Training for Children Aged 8–10 Years: The FIT FIRST Randomised Controlled Trial," *British Journal of Sports Medicine* 52, no. 4 (2018): 254–260.

15. C. Eckert, C. Thøgersen-Ntoumani, M. N. Larsen, et al., "Dose–Response Effects of a 4-Month FIT FIRST 10 School-Based Multisport Programme on Physical Fitness and Psychosocial Well-Being in Children Aged 7–11: A Three-Arm Cluster-Randomized Controlled Trial," *Scandinavian Journal of Medicine & Science in Sports* 36, no. 6 (2026): e70311.

16. S. Hopewell, A.-W. Chan, G. S. Collins, et al., "CONSORT 2025 Statement: Updated Guideline for Reporting Randomised Trials," *Lancet* 405, no. 10489 (2025): 1633–1640.

17. M. K. Campbell, G. Piaggio, D. R. Elbourne, D. G. Altman, and for the CONSORT Group, "CONSORT 2010 Statement: Extension to Cluster Randomised Trials," *BMJ* 345 (2012): e5661.

18. Børne- og Undervisningsministeriet, *Fælles Mål: Idræt* (*Børne- og Undervisningsministeriet*, 2019).

19. National Institutes of Health, "Parallel Group-Randomized Trial (GRT) Sample Size Calculator," accessed September 16, 2026.

20. M. N. Larsen, C. M. Nielsen, C. Ørntoft, et al., "Fitness Effects of 10-Month Frequent Low-Volume Ball Game Training or Interval Running for 8–10-Year-Old School Children," *BioMed Research International* 2017 (2017): 2719752.

21. K. Parker, M. Nunns, Z. Xiao, T. Ford, and O. C. Ukoumunne, "Intracluster Correlation Coefficients From School-Based Cluster Randomized Trials of Interventions for Improving Health Outcomes in Pupils," *Journal of Clinical Epidemiology* 158 (2023): 18–26.

22. J. F. Sallis, J. J. Prochaska, and W. C. Taylor, "A Review of Correlates of Physical Activity of Children and Adolescents," *Medicine & Science in Sports & Exercise* 32, no. 5 (2000): 963–975.

23. C. K. Enders and D. Tofighi, "Centering Predictor Variables in Cross-Sectional Multilevel Models: A New Look at an Old Issue," *Psychological Methods* 12, no. 2 (2007): 121–138.

24. G. Minatto, V. C. Barbosa Filho, J. Berria, and E. L. Petroski, "School-Based Interventions to Improve Cardiorespiratory Fitness in Adolescents: Systematic Review With Meta-Analysis," *Sports Medicine* 46, no. 9 (2016): 1273–1292.

25. S. Mintjens, M. D. Menting, J. G. Daams, M. N. M. van Poppel, T. J. Roseboom, and R. J. B. J. Gemke, "Cardiorespiratory Fitness in Childhood and Adolescence Affects Future Cardiovascular Risk Factors: A Systematic Review of Longitudinal Studies," *Sports Medicine* 48, no. 11 (2018): 2577–2605.

26. M. E. Visier-Alfonso, M. Sánchez-López, C. Álvarez-Bueno, A. Ruiz-Hermosa, M. Nieto-López, and V. Martínez-Vizcaíno, "Mediators Between Physical Activity and Academic Achievement: A Systematic Review," *Scandinavian Journal of Medicine & Science in Sports* 32, no. 3 (2022): 452–464.

27. I. Demchenko, S. A. Prince, K. Merucci, et al., "Cardiorespiratory Fitness and Health in Children and Adolescents: An Overview of Systematic Reviews With Meta-Analyses Representing Over 125 000 Observations Covering 33 Health-Related Outcomes," *British Journal of Sports Medicine* 59, no. 12 (2025): 856–865.

28. T. Fühner, R. Kliegl, F. Arntz, S. Kriemler, and U. Granacher, "An Update on Secular Trends in Physical Fitness of Children and Adolescents From 1972 to 2015: A Systematic Review," *Sports Medicine* 51, no. 2 (2021): 303–320.

29. L. Lai, L. Cai, W. Tan, et al., "Adiposity Mediates the Association of Objectively Measured Physical Activity With Cardiorespiratory Fitness in Children," *Childhood Obesity* 16, no. 8 (2020): 554–563.

30. R. A. Battista, E. D. Bouldin, K. A. Pfeiffer, et al., "Childhood Physical Fitness and Performance as Predictors of High School Sport Participation," *Measurement in Physical Education and Exercise Science* 25, no. 1 (2021): 43–52.

31. X. Yin, D. Zhang, Y. Shen, Y. Wang, Z. Wang, and Y. Liu, "Effectiveness of School-Based Interventions on Fundamental Movement Skills in Children: A Systematic Review and Meta-Analysis," *BMC Public Health* 25, no. 1 (2025): 1522.

32. S. Bchini, D. Moussaoui, A. K. Tabnjh, A. Bouassida, N. Hammami, and F. H. Yagin, "Longitudinal Change and Tracking of Health-Related Physical Fitness in Adolescents Aged 12–16 Years: A Structured Narrative Review," *Children* 13, no. 9 (2026): 1208.

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

33. H. Yuan, W. Shao, Y. Ren, M. Jiang, J. Kong, and F. Jing, "Non-Linear Effect of Physical Activity Intervention on Blood Pressure in Children and Adolescents: A Systematic Review and Dose-Response Meta-Analysis," *BMC Public Health* 25, no. 1 (2025): 3366.

34. J. Inchley, J. Kirby, and C. Currie, "Longitudinal Changes in Physical Self-Perceptions and Associations With Physical Activity During Adolescence," *Pediatric Exercise Science* 23, no. 2 (2011): 237–249.

35. J. A. Palacio-Vieira, E. Villalonga-Olives, J. M. Valderas, et al., "Changes in Health-Related Quality of Life (HRQoL) in a Population-Based Sample of Children and Adolescents After 3 Years of Follow-Up," *Quality of Life Research* 17, no. 10 (2008): 1207–1215.

36. Y. Zhou and L. Wang, "Correlates of Physical Activity of Students in Secondary School Physical Education: A Systematic Review of Literature," *BioMed Research International* 2019 (2019): 4563484.

37. K. B. Owen, J. Smith, D. R. Lubans, J. Y. Y. Ng, and C. Lonsdale, "Self-Determined Motivation and Physical Activity in Children and Adolescents: A Systematic Review and Meta-Analysis," *Preventive Medicine* 67 (2014): 270–279.

38. S. Costigan, A. Gråstén, M. Huhtiniemi, I. Kolunsarka, D. R. Lubans, and T. Jaakkola, "Longitudinal Associations Between Enjoyment of Physical Education, Cardiorespiratory Fitness, and Muscular Fitness Among Finnish Adolescents," *Scandinavian Journal of Medicine & Science in Sports* 34, no. 6 (2024): e14678.

39. M. Liu, L. Wu, and Q. Ming, "How Does Physical Activity Intervention Improve Self-Esteem and Self-Concept in Children and Adolescents? Evidence From a Meta-Analysis," *PLoS One* 10, no. 8 (2015): e0134804.

40. F. Vasilopoulos, H. Jeffrey, Y. Wu, and I. Dumontheil, "Multi-Level Meta-Analysis of Physical Activity Interventions During Childhood: Effects of Physical Activity on Cognition and Academic Achievement," *Educational Psychology Review* 35 (2023): 59.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Supporting Information: 1** CONSORT 2025 reporting checklist. **Supporting Information: 2** References associated with measurement instruments. **Supporting Information: 3** Tables and figures related to the results of the multilevel modeling.

16000838, 2026, 10, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.70374 by York St John University, Wiley Online Library on [05/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License