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# Effects of the FIT FIRST Teen Multisport Program on Adolescents' Physical Fitness and Well-Being: A Cluster Randomized Controlled Trial

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**Running Title**: FIT FIRST EFFECTS ON FITNESS AND WELL-BEING

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**ABSTRACT**

**Purpose**: School-based physical education (PE) can counter declines in fitness in adolescence, yet scalable, curriculum-embedded fitness programmes are scarce. We evaluated the implementation of FIT FIRST Teen (FFT), a teacher-delivered, high-intensity multisport programme across one school year. **Methods**: A cluster randomised controlled trial was conducted in 22 Danish schools (FFT, n=517; Control, n=860). Teachers in FFT were trained via a 1-day course and a manual and delivered three 40-minute lessons/week. The primary outcome was cardiorespiratory fitness, assessed via the Yo-Yo Intermittent Recovery Level 1 Children's test (YYIR1C). Secondary outcomes included handgrip strength, agility, balance, body composition, resting heart rate, and well-being. Multilevel modelling assessed the effectiveness of FFT, and exploratory latent transition analysis (LTA) was used to uncover latent fitness profiles and transitions over time in the two arms. **Results**: Compared with controls, adolescents allocated to FFT showed greater improvements in cardiorespiratory fitness, with a mean pre–post difference in YYIR1C distance of 106 m (p=0·009). In terms of secondary outcomes FFT showed greater gains in handgrip strength (~0.81 kg; p=0·012), and muscle mass (~0·44 kg; p<0.001). No intervention effects were observed in terms of well-being. Exploratory LTA supported a four-profile solution (high-fit, moderately-high-fit, moderately-low-fit, low-fit) and suggested that adolescents in the FFT group were more likely to remain in high-fit profile membership over time, compared to the control arm participants who tended to transition towards worse fitness profiles. **Conclusions:** Compared to the control arm, a 40-wk intervention with FFT improved cardiovascular fitness, handgrip strength, and muscle mass. FFT offers an alternative to PE curricula to improve adolescents' physical fitness. **Key Words**:

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CARDIORESPIRATORY FITNESS, WELL-BEING, PHYSICAL ACTIVITY, PHYSICAL EDUCATION

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## INTRODUCTION

Physical fitness is a multidimensional concept that includes cardiorespiratory fitness, muscular strength, speed, and balance. In children and adolescents, physical fitness has been associated with a plethora of physical and mental health benefits, such as (a) lower overall adiposity, (b) reduced risk of developing cardiovascular disease, (c) better bone mineral status, and (d) lower depression and higher self-esteem[1]. While PA encompasses any bodily movement that results in energy expenditure, exercise refers to a subset of PA that is planned, structured, and repetitive, with the specific objective of improving or maintaining physical fitness[2]. In Denmark, the percentage of young people meeting physical activity (PA) guidelines (≥ 60 minutes of moderate-to-vigorous PA per day) declines with age: 46% of 11-year-olds, 33% of 13-year-olds, and 23% of 15-year-olds meet such recommendations[3]. Given the strong positive association between PA participation and physical fitness[4–6], declining adherence to PA guidelines is closely linked to observed trends in adolescent fitness deterioration, underscoring the need for structured, accessible interventions delivered within existing school systems. In this regard, physical education (PE) has been shown to be efficacious in increasing adolescents' physical activity and fitness through exercise[7,8]. Alalawi et al. (2024) showed that the most promising interventions are embedded within the school curriculum[9], and Moeller et al. (2024) showed that training of school staff in delivering an intervention is a key factor in increasing students' PA levels[10].

Within the physical education contexts, a large body of evidence supports high-intensity interval training (HIIT) as an effective strategy for improving adolescents' cardiorespiratory fitness and other health outcomes[8,11,12]. A recent systematic review and meta-analysis showed that school-based HIIT programs improved adolescents' cardiorespiratory fitness and other health

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outcomes, such as resting heart rate and body fat percentage[11]. Researchers have further argued that school-based HIIT should integrate high-intensity exercise with sport-specific content to enhance both cardiorespiratory benefits and participant enjoyment[12]. However, most studies within this evidence base have delivered a single activity mode rather than a broad, rotating multisport curriculum. For instance, Duncombe et al.'s (2022) systematic review showed that running was used as the sole HIIT modality in 21 of 42 studies (50%), while circuit training and resistance training were each used in five studies, cycling and body-weight exercises in two studies each, dance in three studies. Only three studies incorporated a rotation of multiple activity types (e.g., dance, soccer, boxing, basketball). This can be explained by the fact that most studies have delivered short-term interventions (in Duncombe et al., only 14% of the studies delivered interventions longer than 12 weeks) or extra-curricular add-on interventions, rather than offering PE teacher-delivered interventions within the standard PE curriculum[13–15].

Furthermore, research lacks evidence of the extent to which school-based interventions influence adolescents' fitness over time. To address this limitation, researchers have implemented person-centered approaches to study adolescents' fitness. Unlike traditional variable-centered approaches, which estimate average intervention effects across a whole sample, person-centered approaches identify distinct subgroups (or profiles) of individuals who share similar patterns across multiple fitness or behavioral indicators. This approach recognizes that adolescents are heterogeneous in their fitness characteristics, and that these differences may be masked when examining only sample mean scores. Previous studies have attempted to profile adolescents based on some movement behaviors, but they used cross-sectional approaches (see Costa et al., 2021)[16]. When longitudinal approaches were employed, they focused on a specific population

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(i.e., adolescents with disabilities) and did not include an experimental approach[17]. Profiling adolescents based on their fitness characteristics within the context of an intervention is particularly crucial, as distinct profiles may shape how individuals respond to the same program, ultimately determining whether physical education interventions achieve their intended effects. To address these limitations, we developed FIT FIRST Teen (FFT), a multisport, high-intensity, curriculum-embedded PE program. By training PE teachers to deliver FFT using structured and flexible content lessons, FFT was designed to be implementable at scale within the existing PE curriculum and to support sustained improvements in physical fitness under real-world school conditions. Variable-centered analyses of mean intervention effects may, however, mask heterogeneity in individual responses; identifying subgroups of adolescents based on their combined fitness profiles provides insight into who benefits most from an intervention and how fitness trajectories evolve over time. Such an approach has not been previously applied in school-based PE research. Here, we aimed to evaluate the effectiveness of FFT in improving adolescents' physical fitness. The primary aim was to assess whether the FFT intervention improves adolescents' cardiorespiratory fitness, body composition, muscular strength, and well-being, and explore potential sex differences. The secondary aim was to unravel profiles of adolescents' physical fitness and explore the stability of profile membership over time. We hypothesized that: (1) adolescents in FFT would show greater improvements in cardiorespiratory fitness, blood pressure, and resting heart rate compared to controls; (2) FFT would positively affect secondary outcomes including muscular strength, body composition, and subjective well-being; and (3) FFT participants would be more likely to maintain or transition to favorable fitness profiles over time compared to controls.

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## METHODS

### Study design and power calculation

This study employed a cluster randomized controlled trial (RCT) design. A priori power analysis was employed using the Cluster Randomized Trials calculator (https://researchmethodsresources.nih.gov/) to determine the number of classes required (see our protocol for details)[18]. The results indicated that 20 classes were needed per arm, based on a target between-group effect of approximately $d = 0.26$[19], 90% power, $\alpha = 0.05$, an intraclass correlation of 0.05 for class- and individual-level clustering, and 10% anticipated attrition. To account for possible attrition, we recruited 22 classes per arm.

### Eligibility criteria

Schools were eligible if they were public secondary schools (grades 7–9) located in the targeted Danish regions, had at least one PE class willing to participate, and were not concurrently implementing another structured PE intervention. All PE classes within participating schools were eligible. At the individual level, all students enrolled in participating classes were eligible to take part. Students were excluded from physical testing only if they had acute injuries or medical contraindications (as identified by the school in consultation with parents/guardians), or if parental opted out or student assent was not provided.

### Ethical approval

The study was retrospectively registered at clinicaltrials.gov (NCT06615791) on September 13, 2024. The trial registration documentation was finalized prior to the commencement of data collection; however, submission to the clinicaltrials.gov was delayed due to the logistical demands of coordinating recruitment, randomization, and intervention rollout across 22 schools and 67 classes at the start of the school year. Despite this delay, registration was completed

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before baseline data collection was concluded (October 2024) and before any data analysis was undertaken hence, the registered protocol accurately reflected the study as conducted. Ethics approval was obtained from the Regional Committees on Health Research Ethics for Southern Denmark. The study was deemed to have minimal risks for the participants, and the committee provided ethics clearance for the project (S-20210099). An email containing information regarding the project was sent to the parents before the data collection, with the option for their children to opt out of the project. Oral assent was obtained from the students on the test day. Research staff introduced the project to the students at the beginning of the test day and reassured them that they could withdraw from participation at any moment and/or from any of the tests. No independent Data Safety Monitoring Board was convened. Given the low-risk nature of this school-based, non-pharmacological intervention, a formal Data Safety Monitoring Board was not deemed necessary. Participant safety and adverse events were monitored through constant observation during the testing procedures by the research staff and during the intervention period by the school personnel, following the ethics and school safeguarding procedures.

**Recruitment and participants**

To ensure broad geographic national coverage, we recruited schools across Denmark (Capital Region = 9, Zealand = 4, Southern Denmark = 7, Central Denmark = 2). Social media posts (LinkedIn and Facebook) supported the recruitment. Eighty-five per cent of the Danish schools were contacted via email or phone calls. One hundred forty schools expressed their initial interest in participating in the project. School principals and teachers from these schools were contacted via email and/or telephone and asked to participate in the trial with classes from the $7^{th}$, $8^{th}$, and $9^{th}$ grades of the Danish school system. Twenty-seven schools agreed to participate

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(response rate 19.3%); however, 5 schools (3 in the FFT arm, and 2 in the control arm) withdrew from the project after randomization due to several reasons. Specifically, in two FFT schools, the PE teachers were no longer available to deliver the intervention; in one FFT school the sports facilities were undergoing renovation; one schools changed the planning for the school year and could no longer allocate time for testing; and in one school the staff was no longer interested in the project.

**Randomization and blinding**

To avoid contamination bias, schools were the unit of randomization, with a 1:1 allocation to FFT or control. Randomization was conducted by the lead investigator using the Blockrand package in R, and it was stratified by number of classes per school (to ensure equal sizes across the two arms) and school location (rural and urban). However, given the positive reception of the research project and the minimal effort required for the control arm (two test days across 9 months with no changes in the curriculum), after randomization, some schools in the control arm decided to participate with more classes than originally planned, resulting in imbalanced sample sizes between the intervention and the control arms. Considering the nature of the intervention, it was not possible to blind experimental allocation to researchers delivering the FFT training to teachers, nor to blind outcome assessors. However, in relation to the primary outcomes, we note that the blood pressure and resting heart rate were measured by validated blood pressure monitors. Therefore, these measures provide objective readings and thus partially mitigate observer bias concerns. Blinding procedures were employed during data analyses, preventing potential interpretation bias.

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**FIT FIRST Teen and procedures**

The intervention manual was developed in collaboration with Danish sports organizations and the Danish National Olympic Committee and comprised lessons covering 26 widely recognized leisure-time sports (such as team handball, football, gymnastics, tennis, etc.). The manual was developed to provide high-intensity cardiovascular and strength training. It contains a total of 135 40-minute lessons. Each lesson consists mostly of pair-based exercises and small-sided games with active rest (namely, performing low-intensity movements during the resting phases of the lesson), removing the most complex rules and sport-specific techniques. Such adaptations maximize active time, making it more likely that students without prior experience with the sport in question participate actively and feel confident. Each lesson was designed to elicit an average heart rate (HR) of 75% of the individual's max HR, with at least 10% of the time being above 90% max HR. This 3 × 40-minute/week format represents an increase of approximately 30 minutes per week, compared with the Danish Ministry of Education's guiding allocation of 60 hours of PE per year for grades 7–9 (equivalent to ~90 minutes/week over a standard school year)[20].

PE teachers from the intervention schools were invited to a one-day-long training course, before the beginning of the school year, which was led by members of the research team. During this course, teachers were introduced to the FFT intervention and manual. The course consisted of theoretical sessions (e.g., training, physiology), as well as practical sessions where the teachers practiced the activities and discussed the content. The course also focused on how to use the manual, which outlines all the lessons to be implemented in the curriculum, three times a week, over a full school year. Teachers had autonomy in selecting and delivering lessons from the manual. They were encouraged to schedule sessions on Mondays, Wednesdays, and Fridays,

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choosing freely from the 26 sports included. Each week, teachers recorded the lessons delivered in a logbook. The one-day training format was designed to maximize feasibility and scalability, as more intensive training requirements are frequently cited as a barrier to implementation of school-based interventions, both in primary [21,22], and secondary school contexts [23,24]. Teachers were supported by the detailed manual and had access to the research team throughout the intervention period. Implementation fidelity was assessed, by a member of the research team (SK), in a purposively selected subsample of six intervention schools through systematic observations of FFT sessions at three timepoints (at the beginning, midway through, and towards the end of the intervention period) and via semi-structured teacher interviews, using an established implementation fidelity framework. Adherence to the FFT manual, session duration, student participation, session quality, and student inclusion and enjoyment rated. Full methodological and analytic details are reported elsewhere[25].

Teachers in the control arm were asked to continue with their usual PE curriculum. At the end of the research project, they were offered the FFT training course and the manual (available online at https://www.dif.dk/raadgivning-og-stoette/mere-idraet-i-folkeskolen/fit-first) and were encouraged to implement FFT.

**Primary Outcomes**

The primary outcomes were changes (1) in cardiorespiratory fitness from baseline to post-intervention, measured by the performance (total distance in meters) in the Yo-Yo Intermittent Recovery Level 1 test for children and adolescents (YYIR1C)***[26]***; and (2) blood pressure (systolic and diastolic) and resting heart rate, which were measured with the OMRON M6 HEM-7223-E blood pressure monitor. After an initial 8-minute supine rest, three readings

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were taken at 1-minute intervals with the blood pressure monitor positioned on the skin of the left upper arm.

**Secondary outcomes**

The secondary outcomes were changes in body composition, handgrip strength, standing long jump, balance, agility, and physical well-being, psychological well-being, autonomy and parent relations, peer and social support, and school environment. Details for all outcomes are reported in Table 1. Further information regarding the testing procedure for the primary and secondary outcomes is reported elsewhere[27] and in Supplementary Digital Content (Supplemental Digital Content, https://links.lww.com/MSS/D492). Secondary outcomes also included body image, functionality appreciation, motivation for physical activity, leisure-time sports participation, and self-perception. However, these latter secondary outcomes were not analyzed in this paper and will be reported elsewhere.

Participants were instructed to avoid vigorous physical activity the evening before testing and to fast for one hour prior to the assessments of blood pressure, resting heart rate, and body composition; food intake was permitted thereafter and before the subsequent physical tests. No instructions were given regarding caffeine intake. Testing was conducted in a fixed order for all participants: blood pressure, resting heart rate, body composition and balance tests were assessed first, followed by handgrip strength, standing long jump, and agility, and finally the YYIR1C test, ensuring that blood pressure and resting heart rate readings were not influenced by preceding physical exertion.

**Statistical analysis**

***Primary analysis*.** Primary and secondary analyses were conducted according to the intention-to-treat (ITT) principle. Anonymized participant data were analyzed according to their originally

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assigned study group, irrespective of intervention adherence. ITT populations were N = 517 (FFT) and N = 860 (control). Smaller sample sizes reported for specific analyses (e.g., N = 344 and N = 541 for the YYIR1C at post-intervention) reflect participants with available data at both time points.

To evaluate the plausibility of the missing-at-random assumption, we fitted logistic regression models predicting missingness in each primary outcome from treatment allocation, age, sex, and the respective baseline value of the outcome. Missingness in YYIR1C was significantly predicted by younger age (p=.005) and lower baseline cardiorespiratory fitness (p=.005). Missingness in resting heart rate was significantly predicted by higher baseline resting heart rate (p<.001), and female sex (p=.022). Missingness in systolic and diastolic blood pressure was significantly predicted by female sex (both p<.05). Given these patterns, the full-information maximum likelihood approach was used in the mixed-effects models to handle missing data, as it produces unbiased estimates under the assumption that missingness is conditionally random, given the observed data included in the model[28,29]. Furthermore, post-hoc robustness analyses (see below) were employed to provide sensitivity check.

Means and standard deviations of all outcomes for each arm at baseline and at post-intervention were calculated. Linear mixed (multilevel) modelling (MLM) was used to explore the mean difference between the two arms for each outcome. MLM analyses were carried out with Jamovi (version 2.6.26)[30]. Three models were estimated. A raw model (Model 1) without any covariate, in which we included Timepoint (0=baseline, 1=9 months), Group (0=control, 1=FFT), and the interaction Group × Timepoint as fixed effects, and the random effects intercepts for student ID and Class. Given the small number of schools, a school intercept was not included to avoid variance components exhibiting an unacceptable amount of downward

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bias[31]. We built on Model 1 to test Model 2, which included the covariates age, sex (0=male, 1=female), baseline height, and baseline weight. We controlled for height and weight to account for between-participant differences in body size, which can influence shuttle-running performance. All covariates, except for sex, were centered around their group mean[32]. For the well-being outcomes, height and weight were not included in the models. In Model 3, we added the interaction terms Sex × Group, Sex × Timepoint, and Sex × Group × Timepoint to explore potential sex differences. To assess robustness to missing data, we conducted post-hoc robustness analyses (not pre-specified in the trial protocol) in Model 3 by imputing missing outcomes using 50 multiple imputations (MI) and, furthermore, as a conservative alternative, using baseline observation carried forward (BOCF) for missing post-intervention outcomes (Supplementary Digital Content). Because multiple outcomes and interaction terms were tested in Model 3, we controlled the false discovery rate using a hierarchical Benjamini–Hochberg procedure[33] in the main and the robustness analyses.

***Post-hoc exploratory analysis***. Latent Transition Analysis (LTA) was employed to explore the fitness profiles of adolescents and potential transitions between profiles between the two timepoints. We created profiles based on five standardized physical fitness indicators (YYIR1C, standing long jump, agility, balance, and handgrip strength) measured at two time points (pre- and post-intervention). Collinearity was investigated by calculating correlations between the indicator variables (Supplemental Digital Content, https://links.lww.com/MSS/D492). LTA was conducted using a longitudinal mixture modelling approach based on the *depmixS4* package (version 1.5-1) in R[34]. Models were estimated by maximum likelihood, which was used to handle missing data. All indicators were z-standardized across time to place them on a common metric. To ensure that higher scores reflected more favorable physical fitness characteristics,

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agility (for which higher raw values indicated poorer scores) was reverse-coded before standardization. We tested for configural similarity (i.e., number and configuration of profiles over time) while freely estimating the within-profile means and variances of the indicators at each time point.

A series of models with varying numbers of latent profiles (K = 2–8) was estimated using multiple random starts (25 random starts, 3000 max iterations) to ensure convergence to a global solution. The models were estimated simultaneously across both time points, with solutions based on 2-8 profiles, with transitions between latent profiles included in the model. This approach allows for the estimation of the probability of moving from one latent profile at baseline to another at post-intervention. The models included arm contrast (control vs. FFT) as a predictor of the transition probabilities. More information regarding the selection of the optimal number of latent profiles and the external validation assessment (namely, checking whether the identified profiles were meaningfully related to variables not used to create them) is provided in the Supplementary Digital Content (Supplemental Digital Content, https://links.lww.com/MSS/D492). After identifying the optimal number of profiles, they were labelled based on their scores on the five fitness indicators. This resulted in profiles ranging from lower fitness scores (worse profiles) to higher fitness scores (better profiles). Finally, multinomial logistic regression models were estimated with arm (control = 0 vs. FFT = 1), sex (0 = male, 1 = female), age, BMI, and leisure-time sport participation (no = 0, and yes = 1) as predictors of participants moving to better or worse latent profiles across time. To assess the external validity of the identified profiles, a Welch ANOVA was used to compare baseline scores on physical and psychological well-being (KIDSCREEN-27 subscales) across fitness profiles, with Games–Howell post-hoc tests for pairwise comparisons.

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***Deviation from protocol.*** Two main deviations from the protocol were implemented in this study. First, robustness analyses (MI and BOCF) were included in the study to account for missing data and assess the stability of primary findings under different assumptions about participant dropout. As the extent of missing data only becomes apparent once data collection is complete, we decided to add these post-hoc analyses to ensure the findings were not unduly influenced by dropout patterns and to strengthen confidence in the primary results. Second, LTA was employed to further explore the heterogeneity of fitness trajectories across intervention and control groups. Mean-level analyses do not capture heterogeneity in fitness responses within the sample. LTA was added as an exploratory complement to the primary analyses, offering a person-centered perspective on which adolescents benefit most from the intervention, and which insights may be of practical relevance for schools and policymakers.

## RESULTS

Ten schools took part in the FFT intervention (with 25 classes), and 12 schools were part of the control arm (with 42 classes); see Figure 1. Overall, 1,518 participants were eligible to participate in the study.

Table 2 shows the mean age (13.76 years, SD = 0.69) and the number of participants for each test. Depending on the test, this number varied because some students had minor injuries and could not perform the physical tests, and other students refused to perform some tests. Data were collected from August to October 2024 (baseline) and from May to June 2025 (post-intervention).

### Implementation fidelity results

Implementation fidelity data, reported in full elsewhere[35], indicated that the mean FFT manual adherence was 82% (standard deviation = 30%) across all observed sessions. Mean session

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duration was 42.8 minutes (standard deviation = 9.1), and mean student participation was 95% (standard deviation = 10%). Moreover, across the observed sessions, delivery quality was generally favorable: student inclusion (namely, the extent to which all students, regardless of ability level, fitness, or prior experience, could meaningfully participate in the activity) was rated, by a member of the research team (SK), as *high* in 81.3% of the sessions, *medium* in 12.5%, and *low* in 6.2%; student enjoyment was rated as *high* in 68.8% of sessions and *medium* in 31.2%, with no sessions rated as *low*; and session intensity was rated as *high* in only 37.5% of sessions, *medium* in 43.7%, and *low* in 18.8%. However, teacher interviews indicated that sustained delivery of all three weekly sessions was, at times, constrained by timetabling rigidity, competing curricular demands, and variable leadership support.

**Primary analysis**

***Primary outcomes***. The complete results (including all models and corresponding figures) for each outcome are available in the Supplemental Digital Content (Supplemental Digital Content, https://links.lww.com/MSS/D492). In relation to cardiorespiratory fitness, YYIR1C results showed a statistically significant interaction between Group and Timepoint (b = 106.27; SE = 32.18; 95%CI = 169.35 to 886.95; p = 0.003), indicating that the mean difference between the arms with respect to the pre-/post-difference in the YYIR1C test was 106 meters in favor of the FFT arm (Figure 2). Results indicated no statistically significant Group × Timepoint interactions for blood pressure measures (systolic: b = 0.92; p = 0.19; diastolic: b = 0.18; p = 0.85; Figure 3 and 4) and resting heart rate (b = -1.64; p = 0.12; Figure 5).

***Secondary outcome***. Results showed differences in favor of the FFT arm for two secondary outcomes. Specifically, there was a statistically significant Group × Timepoint interaction for the handgrip strength (b = 0.81; SE = 0.26; 95%CI = 0.30 to 1.32; p = 0.003), and muscle mass (b =

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0.44; SE = 0.10; 95%CI = 0.24 to 0.63; p < 0.001). In relation to the other secondary outcomes (standing long jump, agility, balance, body weight, body fat percentage, body mass index, physical well-being, psychological well-being, autonomy and parent relations, peer and social support, and school environment), results revealed no statistically significant Group × Timepoint interactions.

***Post-hoc robustness analyses*.** In relation to the primary outcome, results for the robustness analyses revealed similar trends in the YYIR1C results both for the MI (b = 86.29; p = 0.028) and the BOCF (b = 60.55; p = 0.017). Regarding the secondary outcomes, robustness analyses revealed a similar trend for the handgrip strength in relation to BOCF (b = 0.51; p = 0.011), but a diminished trend with respect to the MI (b = 0.39; p = 0.29). In relation to muscle mass, similar trends were found both for the BOCF and the MI models (BOCF: b = 0.21; p = 0.017; MI: b = 0.30; p = 0.05).

**Post-Hoc Exploratory Latent Transition Analysis**

The fit indices of the LTA for the pre- and post-intervention models are reported in the Supplemental Digital Content (Supplemental Digital Content, https://links.lww.com/MSS/D492). For both models, there were 587 participants in the control arm and 341 in the FFT arm, who had a score for at least one observed indicator at both timepoints. The Bayesian Information Criterion kept decreasing until the k=8 profile solution, and the Akaike Information Criterion and Corrected Akaike Information Criterion reached the lowest values at k = 8. Entropy had the highest value at k = 2 at pre-intervention and k = 3 at post-intervention. Given these unclear results, we decided to rely on the elbow plot (Supplemental Digital Content, https://links.lww.com/MSS/D492), which clearly showed a plateau around the 4-profile solution

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for both time points, with the profiles being (from best to worst in terms of fitness scores): *high-fit*, *moderately-high-fit*, *moderately-low-fit*, and *low-fit*.

Supplementary Figure 12 (Supplemental Digital Content, https://links.lww.com/MSS/D492) shows the radar plot of the standardized z-scores for the profiles. The first profile (*high-fit*) consisted of 14·5% (181 students) at pre-intervention and 20·8% (218 students) at post-intervention. Participants in this profile were characterized by above-average scores on the five indicators, with values ranging from 0.5 (handgrip strength) to 1.25 (standing long jump). The second profile (*moderately-high-fit*) was the largest both at pre- (39.9%, 499 students) and post-intervention (35.7%, 374 students). Participants in this profile had values on the YYIR1C, standing long jump, agility, and handgrip strength that were slightly above average (z was between 0 and 0.5), and below average (z = -0.25) for the balance test. The third profile (*moderately-low-fit*) consisted of 15.4% (193 students) at pre-intervention, and 14.3% (150 students) at post-intervention. Contrary to the second profile, the third profile was characterized by slightly above-average standardized scores on the balance test (0.5), and slightly below-average scores on the other indicators, ranging from -0.25 to -0.5. Finally, the fourth profile (*low-fit*) was the second largest profile, and consisted of 30.2% (377) of the participants at pre-intervention, and 29.2% (306) of the participants at post-intervention. The standardized scores for the five indicators in this profile were below average, ranging from -1.0 to -0.5.

The Welch ANOVA provided some evidence of external validity for the 4-profile solution by comparing the baseline scores on physical and psychological well-being of the 4 profiles (Supplemental Digital Content, https://links.lww.com/MSS/D492). Pairwise comparisons (Games–Howell) confirmed significant differences between adjacent profiles for both well-being domains (all $p < 0.05$). The *high-fit* profile showed better scores on physical and psychological

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well-being (49.24 and 51.79, respectively) compared to the other profiles. The *moderately-high-fit* profile scored better on both well-being domains (47.39 and 50.33, respectively) than the *moderately-low-fit* and *low-fit* profiles. Finally, the *moderately-low-fit* profile scored better on both domains (46.07 for physical well-being and 48.06 for psychological well-being) than the *low-fit* profiles, which scored 43.55 in the physical well-being and 45.50 in the psychological well-being. According to the KIDSCREEN Handbook[36], for our study population, the "normal" values range from 42.91 to 49.61 for physical well-being, and from 43.67 to 53.74 for psychological well-being (calculated as: mean ± half a standard deviation). Therefore, the *low-fit* profile scores are close to the lower threshold for classifying test-values as normal, indicating evidence of a relative disadvantage in well-being for students belonging to this profile membership.

**Profile transitions across timepoints and multinomial logistic regression**

Results regarding the stability and change in profile membership are reported in Figure 6. Specifically, 100% of the FFT participants who were in the *high-fit* profile at pre-intervention stayed in the same profile at post-intervention, whereas 70.6% of the participants in the control arm who were *high-fit* at pre-intervention stayed in the same profile at post, with a statistically significant difference in this proportion (Fisher's exact test = 29.4%; $p < 0.001$). Similarly, 91.7% of the FFT participants who were *moderately-high-fit* at pre-intervention stayed in the same profile at post, whereas 78.3% of the participants in the control arm who were *moderately-high-fit* at pre-intervention stayed in the same profile after the school year (Fisher's exact test: = 13.4%; $p = 0.021$). Moreover, 98.8% of the FFT participants who were *moderately-low-fit* at pre-intervention stayed in the same profile at post-intervention, compared to 96.4% of the participants in the control arm (Fisher's exact test= 2.3%; $p = 0.68$). Finally, 98.0% of the FFT

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participants who were in the *low-fit* profile at pre-intervention stayed in the same profile at post-intervention, compared to 96.0% of the participants in the control arm (Fisher's exact test= 2.0%; p = 0.68). Overall, results from the LTA showed that participants in the FFT arm demonstrated greater stability in their fitness profiles over time compared to participants in the control arm, particularly in the high and moderately-high profiles, where differences in retention were statistically significant. These results were further supported by the multinomial logistic regression, which compared the likelihood of moving into better or worse fitness profiles, as opposed to staying in the same profile (Supplementary Table 15, Supplemental Digital Content, https://links.lww.com/MSS/D492). Findings of this analysis showed that the odds of moving into worse fitness profiles in FFT students (vs staying in the same fitness profile) were about 77% lower than those in the control arm (OR = 0.23; 95%CI = 0.11 to 0.43; $p < 0.001$).

**DISCUSSION**

The aim of this cluster RCT was to evaluate the effectiveness of the FFT intervention in a broadly comparable sample of schools across Denmark. Compared to the control arm, the FFT intervention improved participants' cardiorespiratory fitness (measured via the YYIR1C test), handgrip strength, and muscle mass. No significant intervention effects were observed for blood pressure, resting heart rate, or well-being. Taken together, these findings suggest that FFT may represent a structured complement to usual PE curricula for improving specific components of adolescents' physical fitness, particularly cardiorespiratory fitness and upper-body muscular strength.

Regarding the primary outcome, researchers have argued that high-intensity, high-frequency sessions are associated with improved physical fitness in adolescents[37,38]. Our results align with these findings and show that FFT, an intervention based on high-intensity drills and active

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rest, significantly improved cardiorespiratory fitness among adolescents. The sport lessons included high-intensity cardiovascular drills with strength-oriented multi-sport exercises and small-sided games and were delivered three times per week across an entire school year. This training load was sufficient to elicit the central and peripheral cardiovascular adaptations (e.g., increased stroke volume, improved vascular function, and greater muscle oxidative capacity) that are reflected in improved cardiorespiratory fitness. Meta-analytic evidence in children and adolescents supports this pattern, with HIIT-based interventions consistently producing moderate-to-large improvements in cardiorespiratory fitness across school-based and other youth samples[11,37,38]. We note, however, that the observed Group × Timepoint interaction for YYIR1C is partly a function of the FFT group's lower baseline cardiorespiratory fitness values relative to the control group (FFT: mean 658 m; control: mean 750 m). Rather than surpassing the control group at post-intervention, participants in the FFT arm narrowed the baseline fitness gap. While regression toward the mean may have contributed to this pattern, several design features mitigate this concern: cluster-level randomization occurred prior to baseline testing, reducing the probability of systematic selection of extreme values; the mixed-effects models with baseline as a covariate partially adjust for regression toward the mean; and both post-hoc robustness analyses (MI and BOCF) yielded consistent effects. We therefore interpret the primary findings as evidence that FFT helped to prevent fitness deterioration and promoted cardiorespiratory fitness improvement in adolescents who began the school year at lower fitness levels, rather than elevating cardiorespiratory fitness beyond the normative developmental trajectory. However, this interpretation should also be considered alongside the limitation that we did not assess biological maturity status, which is a determinant of physical fitness and body composition during early adolescence[39]. Given that FFT participants ranged from $7^{th}$–$9^{th}$

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grade, a period of substantial inter-individual variability in pubertal timing, differences in maturational stage between higher- and lower-fitness subgroups may partly account for the observed pattern of results, independent of any true intervention effect. Whether FFT can further improve cardiorespiratory fitness in students already at high fitness levels warrants investigation in future trials with balanced baseline characteristics.

Regarding the secondary outcomes, our results are also aligned with previous research findings. We showed that the total muscle mass (kilograms) increased more compared to the control arm. Zhou et al. (2024)[40] also showed that high-intensity exercises improved body composition. Similar to previous school-based interventions[41], our study showed that only participants in the intervention arm increased handgrip strength. These improvements are likely attributable to the specific activities delivered by teachers and the implementation of FFT across the school year. In parallel to the high cardiovascular loading induced in the FFT sessions, the repeated inclusion of strength and power tasks, together with a high volume of upper-body involvement (e.g., the FFT manual included sports such as tennis, badminton, and handball), provides an overload stimulus that can explain the observed increases in total muscle mass and handgrip strength.

Post-hoc robustness analyses generally supported the main findings in relation to the primary and secondary outcomes. MI and BOCF attenuated the YYIR1C estimate compared with the primary model, but both retained an intervention effect in favor of FFT. For handgrip strength, BOCF diminished the estimate ($\Delta b = -0.30$) while maintaining statistical significance, whereas MI resulted in a larger attenuation ($\Delta b = -0.42$) and the effect was no longer statistically significant. For muscle mass, both robustness analyses showed smaller but still significant estimates (BOCF: $\Delta b = -0.23$; MI: $\Delta b = -0.14$). These patterns are consistent with the different assumptions and

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uncertainty handling of the two approaches. MI propagates uncertainty about missing post-intervention values and can increase standard errors, particularly when missingness is non-trivial and when the imputation model must rely on imperfect predictors of individual change. This can reduce statistical precision and attenuate evidence for smaller effects, such as those observed for handgrip strength and muscle mass. In contrast, BOCF carries baseline values forward for missing post-intervention observations, which tends to reduce variability in the imputed post-intervention data and can yield smaller standard errors, so statistical significance may be retained even when the point estimate is attenuated. Therefore, while BOCF suggests that the secondary outcome effects persist under a conservative no-change assumption, the MI findings imply that evidence for handgrip depends on how missing post-intervention data are modelled and should be interpreted more cautiously.

In relation to physical and psychosocial well-being, our study showed no changes in such domains, which align with previous evidence. A previous meta-analysis showed that PA interventions (delivered during or outside school hours) only had a trivial to small effect on children and adolescents' physical and psychosocial well-being (measured using the KIDSCREEN domains)[42]. Bermejo-Cantarero et al.[42] found **no significant differences in** physical and psychosocial well-being **between trials that increased PA and those that did not**. Considering the positive association between PA or cardiorespiratory fitness, this suggests that physical and psychosocial well-being gains may not be detectable in interventions with demonstrated increases on PA or cardiorespiratory fitness. Our null results may be explained by the fact that FFT was developed mainly to elicit physical fitness (cardiorespiratory fitness, muscular strength, speed, balance, and metabolic adaptations) rather than psychosocial and physical well-being. Finally, baseline values were within the normative European ranges

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("normal" values for the KIDSCREEN domains ranged from 45 to 55 points)[36], potentially constraining short-term improvements due to ceiling effects.

Our study is the first study to examine transitions between fitness profiles from before to after a PE intervention. Our exploratory findings suggested that FFT produced greater profile stability, especially among more highly fit students, and fewer transitions toward worse fitness profiles, compared to the control arm. This aligns with evidence that school-based activity programs can preserve or modestly improve cardiorespiratory fitness over a school year[43,44]. This pattern suggests that FFT may help to stabilize favorable fitness trajectories over the course of a school year, particularly for students who begin the school year in higher profiles, while also reducing the likelihood of students drifting into worse fitness profiles. However, as this study did not include a post-intervention follow-up, it remains unclear whether these favorable profile trajectories are sustained once the structured FFT sessions cease. The combination of frequent, high-intensity sessions and systematic exposure to both aerobic and strength-oriented activities likely provided a sufficiently strong and consistent stimulus to counteract the declines in fitness typically seen in adolescents. Fitter students in the FFT group may have found the varied sport activities more aligned with their existing competencies, potentially contributing to sustained engagement across the school year. However, this interpretation remains speculative and warrants empirical investigation using the motivational data collected as part of this trial, which will be reported in a companion paper.

Our findings also carry practical implications for PE delivery in schools. FFT represented an approximate 30-minute weekly increase in structured PE time relative to Danish guidance for grades 7–9[20], meaning observed fitness improvements reflect both additional dose and a more structured, high-intensity format. Implementation fidelity data indicated that while session

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duration and participation were largely preserved as intended, fidelity to the high-intensity component was more variable, with only 37.5% of observed sessions rated as achieving high intensity and 43.7%, as medium[35]. Given that sustained delivery of three weekly sessions was, at times, constrained by timetabling and competing curricular demands[35], embedding this content within existing PE curricula, rather than requiring additional dedicated time, may offer a more feasible pathway to scaling.

Our study has several strengths. First, it was developed in collaboration with public sports organizations (i.e., Danish Sports Organization and Danish National Olympic Committee) and implemented under real-world conditions, with delivery by PE teachers. In addition, the diversity of participating schools (in terms of size and geographical region) enhances the generalizability of FFT and its potential applicability across a range of school contexts and locations. Second, we employed a comprehensive battery of tests to assess cardiorespiratory fitness, upper- and lower-body muscular strength, balance, blood pressure, resting heart rate, body composition, and well-being. This allowed us to evaluate the impact of the intervention on physical fitness and well-being from a broad, multidimensional perspective. Third, we complemented standard MLM with LTA to identify distinct fitness profiles and track transitions in profile membership over time. This approach offers novel, albeit preliminary evidence in school-based PE research on whether an intervention helps students maintain favorable fitness profiles and prevent shifts into lower-fitness profiles across a school year. In doing so, we add a person-centered, longitudinal perspective that helps clarify who benefits most from FFT and how fitness trajectories change in real-world school settings.

This study also has some limitations. First, blinding of teachers and assessors was not feasible, which may have introduced bias (e.g., differential encouragement) that could have influenced the

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observed differences. Expect for the YYIR1C, the primary outcomes (blood pressure and resting heart rate) were measured by validated blood pressure monitors, which provide objective readings and thus minimize the risk of observer bias. Second, five schools withdrew (three from the intervention arm and two from the control arm) after randomization, and class sizes differed between the two arms, potentially introducing imbalance despite the cluster-randomized design. Additionally, the FFT arm showed a lower mean baseline cardiorespiratory fitness (658 m) than the control arm (750 m), likely attributable to chance variation between clusters, which may have partially contributed to the observed interaction effect through regression toward the mean (see Discussion above). Third, we acknowledge that retrospective registration is a deviation from ICMJE standards for prospective trial registration. The trial was registered retrospectively at ClinicalTrials.gov (NCT06615791) on 13th September 2024, after baseline data collection commenced in August 2024. However, the registered protocol accurately reflects how the study was conducted, as the registration was completed in September 2024, before data collection ended (October 2024), and before any data analysis. Finally, the post-hoc robustness analyses (MI and BOCF) were not pre-specified in the trial protocol and should be considered exploratory rather than confirmatory.

Future research should test FFT with longer follow-ups to examine sustainability and potential carry-over effects in leisure-time PA and other health behaviors. For example, a hybrid type III effectiveness–implementation design could be developed to test scalable delivery strategies (e.g., training models, support and feedback systems, and adoption across different Danish municipalities) and to identify barriers and facilitators to sustained uptake into routine PE. Further, FFT should be evaluated for its effects on students' motivation to be physically active and on related 24-hour movement behaviors, such as sedentary behavior, screen time, and sleep,

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to better understand potential behavioral pathways, broader health impacts and potentially compensatory behavioral patterns. Finally, future studies should also build on the LTA by testing which psychosocial factors predict transitions between fitness profiles. For example, researchers could examine whether changes in autonomous motivation, perceived competence, enjoyment, and need satisfaction (autonomy, competence, relatedness), as well as perceived teacher support, mediate transitions toward better profiles or protect against transitions into lower-fitness profiles over time.

## CONCLUSIONS

In conclusion, the FFT multisport program delivered by trained PE teachers over one school year significantly improved cardiorespiratory fitness, handgrip strength, and muscle mass in adolescents, with no adverse effects on cardiovascular resting markers or well-being. Exploratory person-centered analyses further suggested that FFT helped stabilize favorable fitness profiles and substantially reduced the likelihood of adolescents transitioning to lower-fitness profiles over the school year. These findings suggest that structured, high-intensity multisport programs can be feasibly integrated into existing school PE settings to counter adolescent fitness decline. Future implementation should ensure formal alignment with existing PE curricular frameworks and engage relevant educational stakeholders, including Dansk Skoleidræt and the Ministry of Children and Education, to support equitable and sustainable scale-up across Danish schools.

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We declare no competing interests. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation. The results of the present study do not constitute endorsement by the American College of Sports Medicine. The FIT FIRST Teen anonymized dataset and the codebook are held at the SharePoint platform at the University of Southern Denmark, which provides secure data access consistent with the relevant ethics committee approvals. We will consider all requests for data sharing, which can be initiated by contacting pkrustrup@health.sdu.dk. Our study protocol, with the relative statistical plan, is available at https://www.medrxiv.org/content/10.1101/2025.08.01.25332617v1.

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## FIGURE CAPTIONS

**Figure 1. Trial flow diagram.**

**Figure 2. Plot of the primary outcome results for Model 3.**

*Notes*. The horizontal axis represents the time point, and the vertical axis represents the predicted metres run in the YYIR1C test. The dots indicate the estimated means at pre- and post-intervention. The vertical lines indicated the 95%CI limits. Pre = pre-intervention; Post = post-intervention; YYIR1C = Yo-Yo Intermittent Recovery Level 1 Children's test; CI = confidence interval.

**Figure 3. Plot of the primary outcome results for Model 3.**

*Notes*. The horizontal axis represents the time point, and the vertical axis represents the predicted mmHG in the systolic blood pressure test. The dots indicate the estimated means at pre- and post-intervention. The vertical lines indicated the 95%CI limits. Pre = pre-intervention; Post = post-intervention; SBP = Systolic Blood Pressure; CI = confidence interval.

**Figure 4. Plot of the primary outcome results for Model 3.**

*Notes*. The horizontal axis represents the time point, and the vertical axis represents the predicted the predicted mmHG in the diastolic blood pressure test. The dots indicate the estimated means at pre- and post-intervention. The vertical lines indicated the 95%CI limits. Pre = pre-intervention; Post = post-intervention; DBP = Diastolic Blood Pressure; CI = confidence interval.

**Figure 5. Plot of the primary outcome results for Model 3.**

*Notes*. The horizontal axis represents the time point, and the vertical axis represents the predicted beats per minute in the resting heart rate test. The dots indicate the estimated means at pre- and post-intervention. The vertical lines indicated the 95%CI limits. Pre = pre-intervention; Post = post-intervention; RHR = Resting Heart Rate; CI = confidence interval.

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**Figure 6. Transition matrix.**

*Notes*. The horizontal axis represents the profile membership before the intervention, and the vertical axis represents the profile membership after the intervention. The percentages inside the cells represent the probabilities of transitioning between profiles over time.

**SUPPLEMENTAL DIGITAL CONTENT**

**SDC 1:** Supplementary Material.pdf

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**Table 1. Procedure and instruments used to measure the secondary outcomes**

| Primary Outcomes | Instrument | Procedure |
|---|---|---|
| *Cardiorespiratory fitness* | Yo-Yo Intermittent Recovery Level 1 Children's test (*YYIR1C*) | The test involved repeated 2 × 16 m shuttle runs at progressively increasing speeds, with 10-second recovery periods between runs. It was administered in groups, ensuring at least 1 metre of running space per participant. |
| *Systolic Blood Pressure* | Omron M6 hEM-7322 U-E | Participants were asked to rest in a supine position over a mat for 8 minutes in a dark and quiet room with a bloop pressure monitor on the skin of their upper left arm. After the 8-minute rest period, three measurements were conducted. |
| *Diastolic Blood Pressure* | Omron M6 hEM-7322 U-E | |
| *Resting Heart Rate* | Omron M6 hEM-7322 U-E | |
| **Secondary Outcomes** | **Instrument** | **Procedure** |
| *Height* | Tanita Leicester Height Measure Mk II | Participants stood barefoot until the measurement was completed. |
| *Body Composition* | InBody270 (Chungcheongnam-do 331–824, South Korea) | Weight, Body Fat Percentage, and Muscle Mass were measured with participants standing barefoot and in light clothing on the InBody for approximately 1 minute. |
| *Standing Long Jump* | Paused standing long jump | From a quarter-squat position, they paused for 2 seconds and, on command, jumped with feet together and hands on hips. |
| *Handgrip Strength* | Smedley dynamometer (Scandidact) | Participants were asked to position their back against a wall, bend their dominant arm at a 90-degree angle, and press the dynamometer for 5 seconds. |
| *Balance* | Stork Balance Test | Participants stood on the toes of their left foot, placed their right foot against the left knee, and kept their hands on their hips. |
| *Agility* | Arrowhead Agility Test | Starting from a sprint stance behind the line, participants ran to the middle cone, turned right around the side cone, looped the far cone, and finished by crossing the start/finish line. |
| *Well-being* | KIDSCREEN-27 | The questionnaire was administered using the SurveyXact platform, and participants answered the questions using iPads. |

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**Table 2. Demographic characteristics of the study participants at baseline, and descriptive statistics for the primary and secondary outcomes.**

| *Demographics at baseline* | Control | | | FIT FIRST Teen | | | Total N |
|---|---|---|---|---|---|---|---|
| | N | % | | N | % | | |
| *Sex* | | | | | | | |
| Male | 445 | 51·7 | | 267 | 51·6 | | 1,337 |
| Female | 415 | 48·3 | | 250 | 48·4 | | |
| *Leisure-time sport* | | | | | | | |
| Yes | 584 | 75·5 | | 342 | 75·8 | | 1,225 |
| No | 190 | 24·5 | | 109 | 24·2 | | |
| | N | Mean | SD | N | Mean | SD | |
| *Age* | 814 | 13·81 | 0·71 | 492 | 13·67 | 0·63 | 1,306 |
| ***Primary Outcomes*** | | | | | | | |
| *YYIR1C (m)* | | | | | | | |
| Baseline | 682 | 750·45 | 521·77 | 398 | 658·01 | 505·61 | 1,080 |
| 9-month | 541 | 772·73 | 594·13 | 344 | 776·47 | 543·01 | 885 |
| *Systolic Blood Pressure (mmHg)* | | | | | | | |
| Baseline | 760 | 101·54 | 8·45 | 461 | 100·56 | 10·12 | 1,221 |
| 9-month | 592 | 103·66 | 9·88 | 384 | 103·81 | 9·38 | 976 |
| *Diastolic Blood Pressure (mmHg)* | | | | | | | |
| Baseline | 760 | 60·92 | 6·99 | 461 | 61·53 | 7·90 | 1,221 |
| 9-month | 592 | 58·98 | 6·76 | 384 | 59·93 | 6·79 | 976 |
| *Resting Heart Rate (bpm)* | | | | | | | |
| Baseline | 760 | 71·1 | 11·94 | 461 | 71·96 | 12·65 | 1,221 |
| 9-month | 592 | 69·02 | 10·10 | 384 | 69·02 | 11·65 | 976 |
| ***Secondary Outcomes*** | | | | | | | |
| *Agility (sec)* | | | | | | | |
| Baseline | 707 | 10·46 | 1·27 | 430 | 10·40 | 1·10 | 1,137 |
| 9-month | 562 | 10·37 | 1·41 | 352 | 10·40 | 1·24 | 914 |
| *Balance (sec)* | | | | | | | |
| Baseline | 761 | 6·92 | 6·26 | 460 | 6·58 | 5·75 | 1,221 |
| 9-month | 626 | 7·67 | 8·84 | 381 | 7·54 | 7·1 | 1,007 |
| *Handgrip Strength (kg)* | | | | | | | |

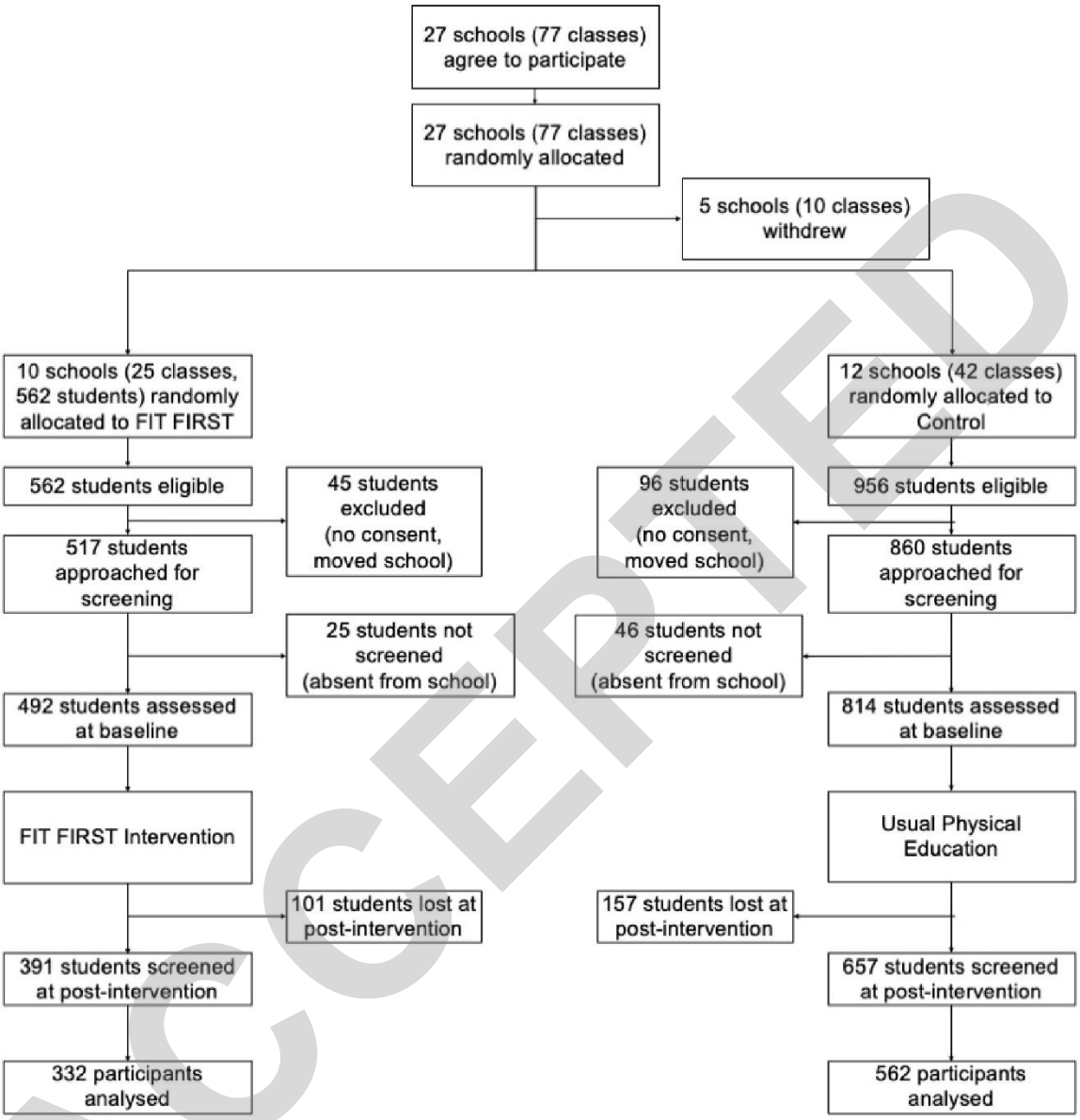
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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Baseline | 776 | 24·79 | 6·22 | 464 | 24·93 | 5·82 | 1,240 |
| 9-month | 617 | 25·19 | 6·54 | 385 | 25·86 | 7·23 | 1,002 |
| *Standing Long Jump (cm)* | | | | | | | |
| Baseline | 713 | 130·10 | 25·23 | 434 | 131·19 | 24·82 | 1,147 |
| 9-month | 570 | 136·01 | 29·56 | 352 | 133·93 | 26·09 | 922 |
| *BMI (kg/m^2)* | | | | | | | |
| Baseline | 764 | 20·31 | 3·74 | 460 | 20·47 | 3·95 | 1,224 |
| 9-month | 630 | 20·68 | 3·70 | 375 | 20·66 | 3·65 | 1,005 |
| *Weight (kg)* | | | | | | | |
| Baseline | 764 | 56·16 | 12·32 | 460 | 55·92 | 12·80 | 1,224 |
| 9-month | 630 | 59·41 | 12·40 | 375 | 58·81 | 12·49 | 1,005 |
| *Body Fat (%)* | | | | | | | |
| Baseline | 759 | 20·57 | 9·74 | 455 | 21·40 | 10·10 | 1,214 |
| 9-month | 627 | 20·36 | 9·41 | 371 | 21·07 | 9·37 | 998 |
| *Muscle Mass (kg)* | | | | | | | |
| Baseline | 764 | 24·18 | 5·03 | 455 | 23·68 | 4·98 | 1,219 |
| 9-month | 628 | 25·85 | 5·27 | 373 | 25·37 | 5·55 | 1,001 |
| *KS-27 Physical Well-being* | | | | | | | |
| Baseline | 774 | 46·21 | 6·61 | 451 | 46·35 | 6·84 | 1,225 |
| 9-month | 618 | 48·74 | 9·33 | 372 | 48·88 | 8·53 | 990 |
| *KS-27 Psychological Well-being* | | | | | | | |
| Baseline | 774 | 48·83 | 10·14 | 451 | 48·48 | 9·95 | 1,225 |
| 9-month | 618 | 49·10 | 10·15 | 372 | 48·89 | 10·12 | 990 |
| *KS-27 Autonomy & Parent Relation* | | | | | | | |
| Baseline | 774 | 50·94 | 10·02 | 451 | 51·08 | 9·11 | 1,225 |
| 9-month | 618 | 51·10 | 10·26 | 372 | 51·95 | 9·86 | 990 |
| *KS-27 Peers and Social Support* | | | | | | | |
| Baseline | 774 | 49·99 | 10·11 | 451 | 50·17 | 9·96 | 1,225 |
| 9-month | 618 | 50·21 | 9·90 | 372 | 50·10 | 9·59 | 990 |
| *KS-27 School Environment* | | | | | | | |
| Baseline | 774 | 48·43 | 8·69 | 451 | 49·85 | 8·80 | 1,225 |
| 9-month | 618 | 48·95 | 8·90 | 372 | 48·99 | 8·59 | 990 |

**Notes**. N = number; SD = standard deviation; YYIR1C = Yo-yo Intermittent Recovery test; sec = seconds; kg = kilograms; cm = centimetres; m = metres; mm/HG = millimetres of mercury; bpm = beats per minutes; KS-27 = KIDSCREEN-27

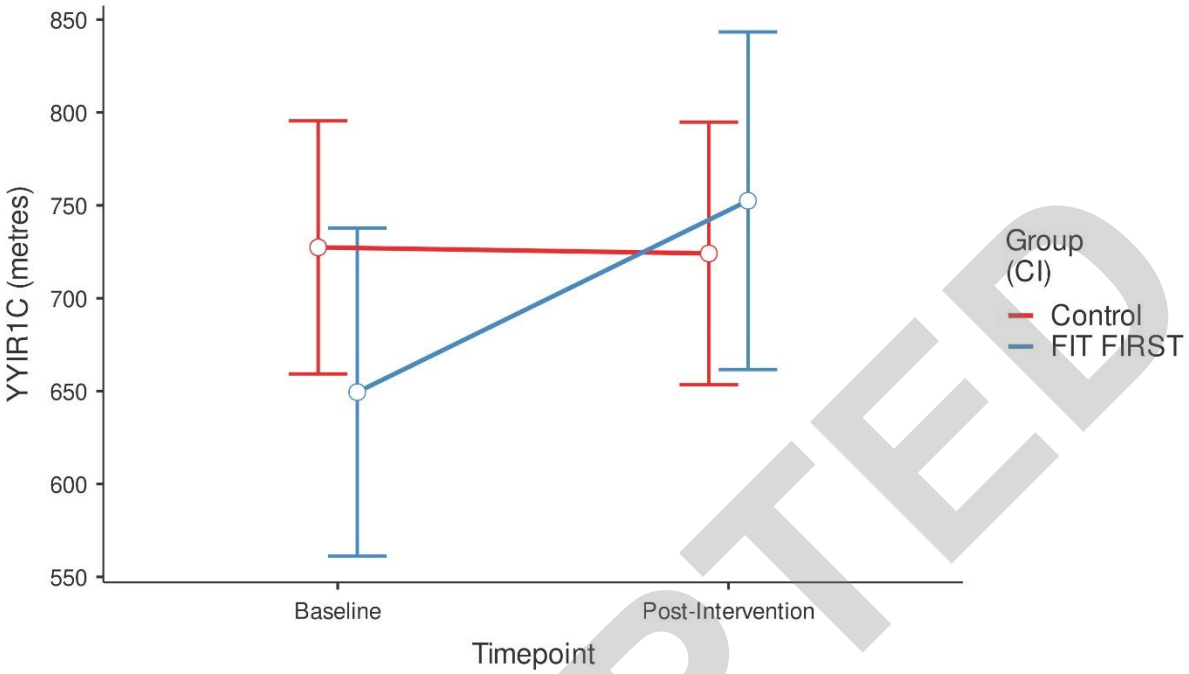
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Figure 1



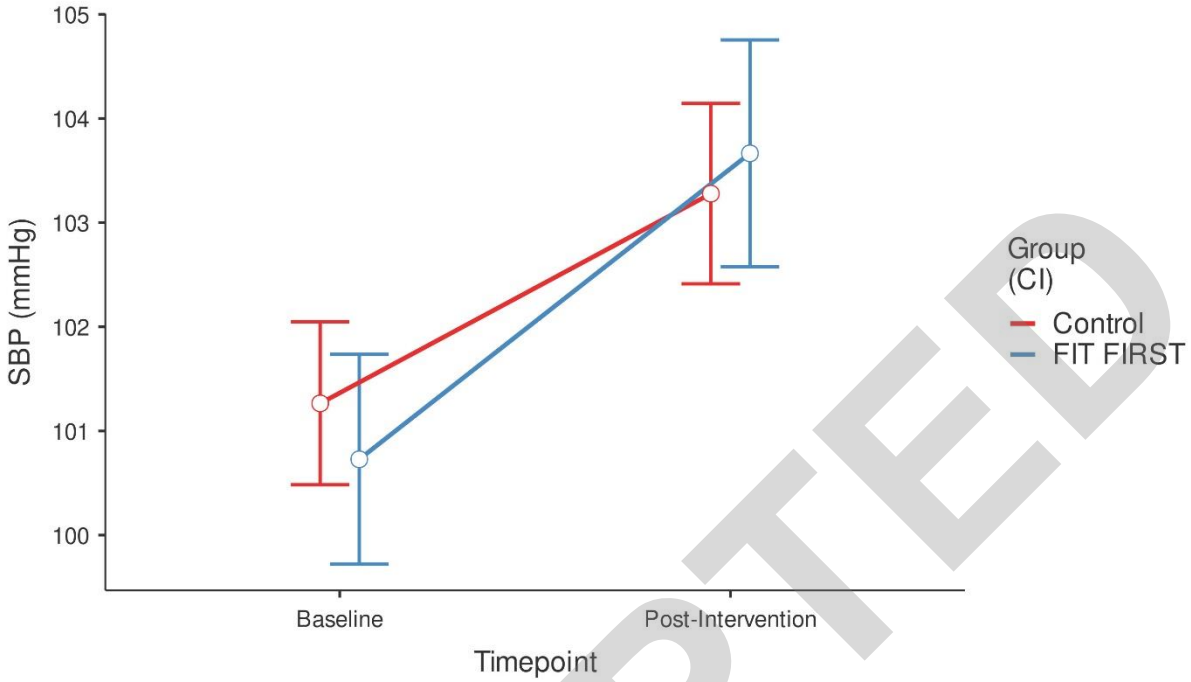

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Figure 2



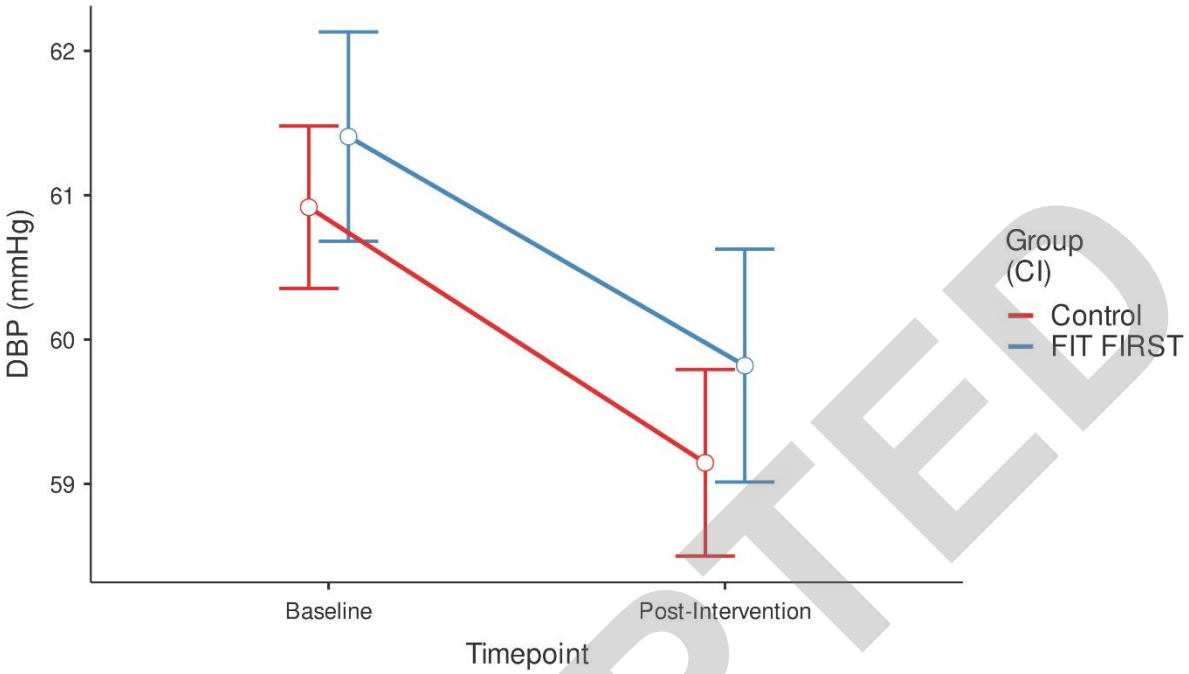

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Figure 3



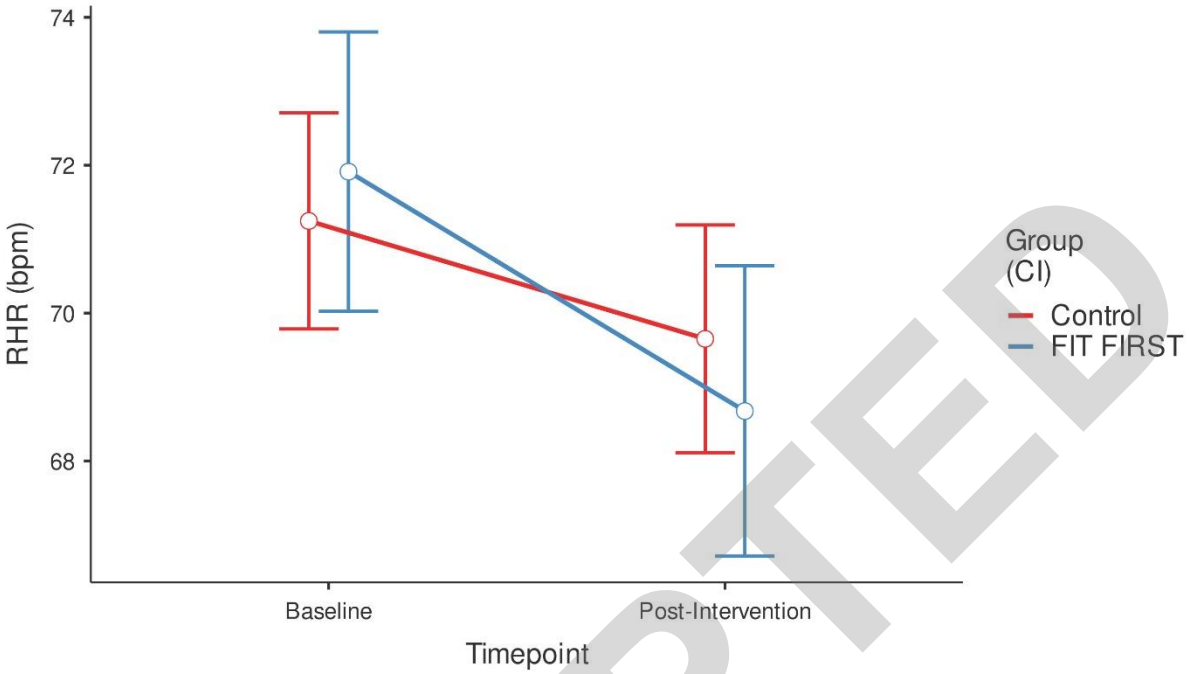

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Figure 4



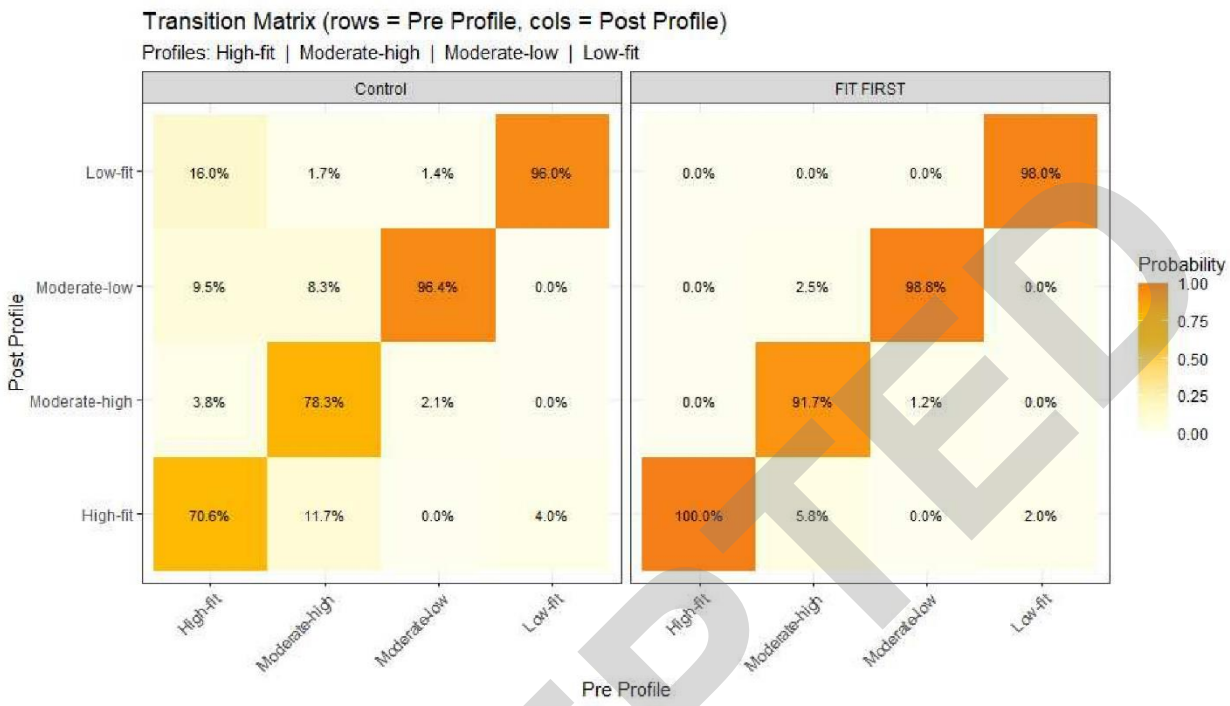

ACCEPTED

Figure 5




ACCEPTED

Figure 6




ACCEPTED