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Complete List of Authors:	Gammon, Catherine; University of Cambridge, MRC Epidemiology Unit Morton, Katie; University of Cambridge, MRC Epidemiology Unit Atkin, Andrew; University of East Anglia Faculty of Medicine and Health Sciences; University of Cambridge, MRC Epidemiology Unit Corder, Kirsten; University of Cambridge, MRC Epidemiology Unit Daly-Smith, Andy; Leeds Beckett University Quarmby, Thomas; Leeds Beckett University Suhrcke, Marc; University of York Centre for Health Economics, Turner, David; University of East Anglia, Public Health and Primary Care van Sluijs, Esther; University of Cambridge, MRC Epidemiology Unit
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Introducing physically active lessons in UK secondary schools: feasibility study and pilot cluster-randomised controlled trial

Catherine Gammon[1], Katie Morton[1], Andrew J Atkin[1,2], Kirsten Corder[1], Andy Daly-Smith[3], Thomas Quarmby[3], Marc Suhrcke, David Turner[2], Esther van Sluijs[1*]

[1] MRC Epidemiology Unit and UKCRC Centre for Diet and Activity Research (CEDAR), University of Cambridge, Cambridge, UK

[2] School of Health Sciences, University of East Anglia, Norwich, UK

[3] Carnegie School of Sport, Leeds Beckett University, Leeds, UK

[4] Centre for Health Economics, University of York, York, UK

* Corresponding author: Dr Esther van Sluijs (ev234@medschl.cam.ac.uk; 01223 769189)

Address: UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge, CB2 0QQ, UK

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Abstract

Objectives: To assess the feasibility and acceptability of delivering a physically active lessons (PAL) training programme to secondary school teachers and explore preliminary effectiveness for reducing pupil's sedentary time.

Design and setting: Mixed-sex, non fee-paying, secondary schools in East England; one school participated in a pre-post feasibility study, two in the pilot cluster-randomised controlled trial. In the pilot trial, blinding to group assignment was not possible.

Participants: Across both studies, 321 randomly selected students (51% male; mean age: 12.9 years), 78 teachers (35% male) and two assistant head teachers enrolled; 296 (92%) students, 69 (88%) teachers and two assistant head teachers completed the study.

Intervention: PAL training delivered to teachers over two, 2-hour after-school sessions, two weeks apart. Teachers are made aware of how to integrate movement into existing lesson plans.

Primary and secondary outcomes: Quantitative and qualitative data were collected to assess feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline and ~8 weeks post-training; measures included accelerometer-assessed activity, self-reported well-being, and classroom observations of time-on-task. Quantitative and qualitative process evaluation was conducted at follow-up.

Results: In the feasibility study, teachers reported acceptability of PAL training and mixed experiences of delivering PAL. In the pilot study, teacher's acceptability of PAL training was lower and teachers identified aspects of the training in need of review, including the outdoor PAL training component and learning challenge of the PAL strategies. In both studies, students and senior leadership representatives reported acceptability of the intervention. Preliminary effectiveness for reducing student's sedentary time during school was not demonstrated in either study.

Conclusions: No evidence of preliminary effectiveness on the primary outcome and mixed reports of teacher's acceptability of PAL training suggest the need to review the training programme. The results do not support continuation of research with the current intervention.

Trial registration: ISRCTN registry; ISRCTN38409550.

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Article Summary

Strength and limitations of this study

- We completed thorough feasibility and pilot testing work to inform the decision of whether to progress with the current intervention and its evaluation.
- We collected quantitative and qualitative data which provided valuable information on contextual influences and allowed us to address research questions more comprehensively.
- We were unable to collect all planned follow-up measures from teachers and students in feasibility study, including teacher follow-up questionnaires and class observations of time-on-task.
- We did not carry out longer-term follow-up measures of teacher acceptability and physically active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up would have provided an indication of the sustainability of the intervention.

INTRODUCTION

Globally, most adolescents (~80%) do not achieve government-recommended physical activity guidelines [1] and engage in high levels of sedentary behaviour[2]. As such, interventions are needed to support youth in achieving a healthy activity profile. Secondary/high schools present an opportunity for the implementation of activity interventions as during school hours, activity is lower and sedentary time is higher than during other segments of an adolescent's week[3, 4].

The Creating Active School Environments (CASE) project is a three-year research programme funded by the UK Department of Health Policy Research Programme. CASE aims to identify environmental strategies to help adolescents move more and sit less during school hours. Initial phases of CASE involved a systematic literature review[5] and secondary data analysis[6] to identify promising secondary school-based activity interventions. Morton and colleagues (2017) subsequently completed a Delphi study, involving stakeholders in the prioritisation of interventions. Physically active lessons (PAL) were identified as the most feasible, acceptable and cost-effective intervention in secondary school settings[7]; these results informed the final, feasibility and pilot-testing phase of CASE.

PAL are a pedagogical approach whereby activity supports the delivery of academic material[8]. During PAL, movement is integrated into teaching and as such, PAL are distinct from 'brain/movement breaks', when activity is separate from learning. Evidence from primary schools indicates that PAL can improve physical activity, academic achievement and lesson enjoyment [9-12]. To our knowledge, only two studies have trialled the use of PAL among adolescents [13, 14]. Helgeson (2013) reported no influence of the 'Energizers' PAL programme on reading comprehension scores among junior high school students and did not explore activity levels as a primary outcome[13]. Cothran and colleagues (2010) reported on primary and secondary/high school teacher's experiences of a one-year movement integration intervention. Compared to primary school teachers, secondary teachers faced different challenges when attempting to

integrate activity into lessons, in particular standardised testing pressures and students not staying with one teacher all day (as typically is the case in primary schools)[14]. Cothran and colleagues did not measure student activity behaviours as an intervention outcome[14]. The positive effects of PAL reported for primary students suggest there is value in exploring if secondary students can experience similar benefits. Given the organisational and environmental differences between primary and secondary schools, it is important to conduct high quality feasibility and pilot testing of secondary school PAL interventions.

A PAL training programme for secondary school teachers was tested in a feasibility study and a cluster-randomised controlled pilot study. The studies aimed to explore the feasibility, acceptability, preliminary effectiveness and costs of a PAL training programme for secondary teachers. Acceptability of study processes was also examined, in anticipation of conducting a subsequent full trial. This paper presents the feasibility study and pilot study followed by an overall discussion and conclusion (ISRCTN38409550).

1. FEASIBILITY STUDY

Ethical approval for both studies was granted by the University of Cambridge's School of the Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the feasibility, acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary school teachers, and (ii) the feasibility and acceptability of study procedures.

Feasibility Study - Methods

Recruitment

Potential schools were identified from previous local research and approached with study information (n=2). One mixed-sex, non fee-paying secondary school participated. The head teacher provided written consent for the intervention to be delivered to the teachers and elected for the

intervention to be trialled with maths and English teachers. The school were told they would be able to keep the PAL training resources.

Parents of all Year 7 and 9 students (11-14 years) received study information and students were invited to participate in evaluation measures. Parents were given two weeks to opt out (passive parental consent) via email, freephone, or freepost. From the students who had not been opted out, 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly selected for evaluation measures (using class lists and random number generating software). The study's feasibility focus meant that a formal power calculation was not necessary to inform sample size; a sample of 60 participants per year is consistent with samples of similar studies[15]. Students provided written assent for evaluation measures.

Maths and English teachers (n=15) received study information two weeks before the PAL training. The senior leadership team requested that all maths and English teachers attended the training. Teachers could choose to participate in the evaluation measures, those agreeing provided written consent. Over five school days students received approximately five maths lessons and four English lessons.

Intervention

The PAL training was developed by a team with teacher training qualifications and experience in indoor (two trainers) and outdoor active learning (one trainer). Table 1 outlines the training programme and example active lessons are published as supplementary material. The focus was on supporting teachers to adopt active pedagogical approaches, rather than providing new, PAL plans. Figure 1 outlines the preliminary logic model of how the teacher-focused intervention could lead to changes in student's activity. Prior to the training, the research team visited the participating school and ascertained the availability of indoor and outdoor spaces and equipment that could be used for PAL. Syllabi for maths and English were requested to allow trainers to prepare relevant examples for the training.

Measurements

Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed using questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7 and four Year-9 students) and an interview with the assistant head teacher were completed using a semi-structured interview.

Feasibility/acceptability of the intervention: Questionnaire items and focus group questions asked about teacher's perceptions of the utility, value and relevance of the training (adapted from[16, 17]). Questionnaires asked if teachers would recommend the training to other teachers and provided free-text boxes for teachers to suggest improvements. Training session attendance rates were recorded.

Feasibility/acceptability of PAL delivery: Questionnaire items and focus group questions asked teachers about classroom management during PAL, enjoyment of teaching PAL, time needed to prepare and deliver PAL, and barriers to PAL delivery (items from[18]).

Acceptability of PAL participation: Questionnaire items and focus group questions asked students about their experience of PAL participation, enjoyment of PAL, their preference for active vs. desk-based lessons, and the best and worst things about PAL.

Costs: Teachers and students reported resources purchased to deliver/participate in PAL. The research team recorded time and costs associated with the training team's development and delivery of the intervention.

Study processes: The research team made field notes on study processes that proved to be challenging or ineffective, for example, students struggling to understand a questionnaire item.

Student anthropometry: Anthropometric measures were completed by trained staff using standard procedures. Height was measured using a stadiometer (Leicester height measure, Chasmors, Leiceter, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg (Tanita, type

TBF-300A, Tokyo, Japan). Height, weight, sex, birthdate and measurement date were used to calculate participants' body mass index (BMI; kg/m^2) and BMI percentile.

Activity intensity: Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were used to measure activity behaviours. These devices have been used among a larger sample of Year-9 participants in the GoActive study[19] and the UK Biobank Cohort Study[20]. Wrist-worn monitors are validated for the assessment of energy expenditure in pediatric populations[21] with higher participant compliance when compared to waist-worn accelerometers[22]. Participants were given verbal and written instructions on monitor wear, including that the monitor was waterproof and could be worn continuously for the next seven days.

The first day of monitor wear was dropped[23]; included participants provided valid data for ≥80% of school hours for ≥two school days, at baseline and follow-up[24-26]. Acceleration was recorded at 100Hz with a dynamic range of ±8g. Data from the monitors was downloaded in continuous waveform. Euclidean Norm Minus One (ENMO) represents acceleration magnitude at each measurement, accounting for the influence of gravity. ENMO thresholds were used to classify activity intensities: time spent at 0-30 ENMO was classified as sedentary activity (equivalent to 1-1.5 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-500 ENMO as moderate-intensity activity (4-7 METs), and above 500 ENMO as vigorous-intensity activity[27, 28].

Mental Health and Wellbeing: Students completed questionnaire measures of positive and negative affect[29], academic efficacy, disruptive behaviour[30], enjoyment of school classes[31] and health related quality of life[32] at baseline and follow-up. All questionnaires are validated for use with adolescents.

Time-on-task: Student's time-on-task was assessed during lessons by one member of the research team. In each class, four students were observed using a momentary time-sampling procedure (which incurs less bias than other sampling procedures[33, 34]). Each student was observed once per

minute, for the duration of the lesson. Student's behaviour was coded as: (i) on-task, (ii) off-task-passive, (iii) off-task-motor, or (iv) off-task-noise[35].

Prior to classroom observations, a validation activity was completed where two researchers discussed definitions and concurrently coded student behaviour using four online videos. Observers' codes matched for 95% of observation intervals.

Descriptive Statistics

Descriptive statistics of the sample, primary and secondary outcomes, and quantitative measures of feasibility and acceptability are summarised. Focus group transcripts were reviewed; recurring comments and themes relevant to the research questions were identified.

Feasibility Study - Results

Recruitment and sample characteristics

Student and teacher recruitment and characteristics are summarised in supplementary tables 1 and 2. 99 Students were recruited, with 91 (92%) providing data at baseline and follow-up. Students had a mean age of 13.0 years, 52% were male and 27% were classified as overweight/obese. Teachers were predominantly female (67%) and below the age of 45 (83%).

Feasibility and Acceptability

Training session one was attended by 14 teachers (7 maths, 7 English), training session two was attended by 12 teachers (7 maths, 5 English), 11 teachers attended both sessions. Teacher feedback demonstrated acceptability of the training, with 100% recommending the training to other teachers (supplementary table 3). Individual and collective efficacy for delivering PAL improved from 2.7 to 3.2, and 2.4 to 3 (out of 4), respectively. At follow-up, ≥eight teachers had attempted to deliver PAL. Teacher's goals for PAL delivery averaged 2.1 (SD=1.0) lessons per week, with an average targeted

reduction in sitting time of 15.8 (SD=8.0) minutes. Some teachers reported positive experiences of delivering PAL, while others reported challenges (Text box 1).

Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting, challenges re-focusing students after an active portion of class, and limited classroom space. Teachers identified facilitators of PAL delivery as theirs and the students' enjoyment of PAL, good weather allowing them to go outside, more classroom space and a more diligent group of students. Teachers reported ≤15 extra minutes were required to plan PAL, and a few extra minutes were needed to prepare students for PAL participation.

Of the students who recalled participating in an active lesson (43 out of 91 [47%]), most preferred PAL to desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to continue delivering them. Students reported enjoying going outside and moving around (30%), that PAL were less boring/more fun than desk-based lessons (26%) and that they could concentrate better (14%). Negative comments about PAL included lethargy (12%), more disruptive behaviour (9%), and less work achieved (12%; text box 1).

The assistant head felt the training was well-received and high quality professional development. The assistant head teacher stated the reason for participating had been the potential for improving student's mental health and the school's motivation to be innovative in the classroom. The assistant head teacher commented that teaching staff had enjoyed taking their students outside for lessons and the project had involved a low level of commitment from the school.

Costs

Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment. Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student, ~£30).

Study Processes

The majority of study procedures were completed successfully. Challenges encountered included that students struggled to complete a blank timetable indicating when their Maths and English lessons were, and despite efforts, we were unable to schedule follow-up classroom observations. Teacher baseline questionnaire return was low and the follow-up focus group was conducted in a 15-minute timeslot due to late changes.

Preliminary effectiveness

Table 2 summarises baseline and follow-up data for all student measures.

Feasibility Study - Reflections

The findings suggest it is feasible and acceptable to deliver a PAL training program to secondary school maths and English teachers. Importantly, the senior leadership representative was supportive of the training[36]. Secondary school teachers had mixed reports of delivering PAL, the identified barriers and facilitators were consistent with those previously reported[36]. It was noted that teacher acceptability of PAL delivery should be explored further in the next phase of intervention evaluation. The positive student response to PAL indicates acceptability and is consistent with results from PAL interventions in primary schools[37].

We were successful in recruiting and consenting participants, and the majority of evaluation measures were completed without problems. The retention of >90% of participants from baseline to follow-up suggests evaluation measures were acceptable. Suggested changes included scheduling all research activities at the start of the project and acquiring student timetables from the school's administration team.

Limitations of this feasibility study include the small sample size and the lack of control group, making it not possible to draw conclusions about the contribution of the intervention to the observed changes. The change in sedentary activity levels is inconsistent with previous research reporting that younger children's sedentary time on weekdays decreases between spring and

summer[38]. Increased negative feelings and lower wellbeing among students between March and June is consistent with typical changes observed in student's wellbeing over a school term[39, 40].

2. PILOT STUDY

Following successful implementation of the intervention in the feasibility study, we sought to extend our previous work and explore the potential value of conducting a full-scale randomised controlled trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the feasibility, acceptability, preliminary effectiveness and costs of delivering a PAL intervention at a whole-school level (to all subject teachers) and (ii) to test the acceptability of school-level randomisation.

Pilot Study - Methods

Recruitment and Randomisation

Schools: We aimed to recruit three schools (two intervention, one control). In June-July 2017, 26 non fee-paying, mixed gender, secondary schools in the East of England were emailed study information and invited to participate. The first three schools to agree were recruited; one school withdrew prior to student recruitment (and randomisation). We were unable to replace the school within an appropriate timeframe. After baseline measures, individuals separate from the research team performed a coin-toss to assign intervention and control schools. The nature of the intervention and goals of the evaluation measures meant it was not possible to blind participants. Due to differences in follow-up measures between control and intervention schools, it was not possible to blind measurement staff at follow-up.

Students: Recruitment proceeded as outlined for the feasibility study. Schools were asked to choose one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation measures. This would allow assessment of differential responses to the intervention by age. The intervention

school selected Years 7 and 9 and the control school selected Years 8 and 9. Following feasibility study procedures, we randomly selected 130 students (50% male, 50% from each year) from each school for evaluation measures (based on feasibility study retention rates), with the aim of obtaining full data on 100 participants.

Teachers: A teacher information and recruitment meeting was scheduled at both schools, during which a researcher introduced the study and distributed consent forms. Teachers were advised by their senior leadership team that they would be required to attend the PAL training if allocated as the intervention school; all teachers were free to decide on participation in evaluation measures.

Intervention

Extending the feasibility study, the intervention was delivered to all subject teachers. Training all subject teachers is consistent with the whole-school approach recommended for activity promotion and obesity prevention among youth[41, 42]. Given the acceptability of the training demonstrated in the feasibility study, the structure and goals of the training for the pilot study were similar. Minimal changes were made to the indoor training component, which focused on generic active learning strategies, applicable to any subject (e.g., different workstations around the classroom). In the feasibility study, the outdoor training component provided multiple subject- and topic-specific lesson ideas; the inclusion of all subject teachers meant fewer subject-specific examples could be actively worked through during the pilot study training. One additional outdoor lessons trainer was involved to train the larger group of teachers.

Measurements

Table 1 outlines the timeline of study measures; all data were collected at schools, during school hours. To increase teacher baseline questionnaire return, questionnaires were distributed during the pre-training teacher information meeting, and completed following consent. Data collection

followed the same procedures as described for the feasibility study, except for the assessment of PAL dose and time on task.

PAL Dose: A teacher timetable was created using school-provided student timetables, detailing their Year 7 and 9 lessons. During the student accelerometer assessment at follow-up, teachers were given their personalised timetable and asked 'please circle which of the listed Year 7 and/or 9 classes were (or will be) delivered as an active lesson.' Teacher's responses were used to calculate PAL dose.

Time on task: Four lessons were observed at baseline and follow-up, at both schools.

Pilot Study - Results

Figure 2 shows the flow of participants, with further information on student and teacher recruitment and sample characteristics in supplementary tables 1 and 2. 222 students assented, of which 205 (92%) provided data at two time points. Half of the students were male and 24% were classified as overweight/obese. The majority of teachers were female and >50% of staff reported delivering at least one PAL a week at baseline. At the intervention school, 30 and 33 teachers attended training session one and two, respectively (29 teachers attended both).

Feasibility and Acceptability

Average scores regarding teacher's acceptability of the training fell below 4 (the 'neutral' value) indicating negative feelings towards the training (supplementary table 3). Teachers reported training activities to be more suited for primary schools and not sufficiently challenging for secondary students. One teacher commented: *"they were more bonus activities, like extra treat things… you couldn't get much learning done through them"* (Science teacher, female). Teachers felt it was assumed they weren't delivering PALs prior to the training and this created resistance towards the training effort. Teachers reported that the PAL ideas were not novel and repetitive, the focus on outdoor learning was distracting, and the value of outdoor activities wasn't clear.

More than half of teachers reported delivering at least one PAL a week at baseline. PAL delivery decreased for four teachers (11%), was maintained by six teachers (17%), and increased for 13 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers indicated they were likely to continue teaching PAL, although they reported concerns about students not learning as much during PAL. Some teachers felt older students could be more lethargic and resistant: "*the younger ones love getting up and interacting with each other. I think the older ones do, it just takes… more effort to get them going*" (History teacher, female).

The majority of teachers reported ≤15 minutes for planning, ≤5 minutes for classroom preparation, and ≤5 minutes for student preparation. The time needed to deliver an outdoor activity – in particular the transition between indoors and outdoors - was identified as a barrier to implementation. The assistant head teacher also commented about the pitch of the training and poor use of learning time due to transitioning. They felt the indoor component of the training had been more informative and appropriate, and commented staff had used active learning strategies indoors, but not outdoors. Finally, they commented that PAL implementation had declined with time.

Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue teaching PAL, with no evidence of differences in intervention acceptability by sex or weight status. Students commented that PAL were fun and helped learning, and they liked moving more: "*I really enjoyed it. It gave me more of an understanding… because when you're just copying off the board some writing I don't always understand it, then when you're moving about it's a lot more clearer*" (Year-7, female). Students however also commented that during PAL some students messed around more and didn't focus on work, and work was easier to do when sitting down.

Student PAL dose

In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each). Each teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an average of 6.9

PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range: 2-13; 28%). This represents the contribution across all subjects.

Costs

The cost of delivering the training was £901, comprised of £451 staff time and £450 equipment. Session one was delivered by three trainers, while session two was delivered by four trainers. Four teachers purchased resources to support PAL delivery, including science equipment, textiles equipment, post-it notes and whiteboard pens, and printed resources. Four students reported purchasing resources to support PAL participation – three purchased sports shoes (~£30 per pair) and one a mouth guard (~£7).

Preliminary Effectiveness

Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama lessons). There was no evidence of changes in time spent in different activity intensities. Table 4 summarises baseline and follow-up values for all outcome measures for intervention and control participants. There was no evidence of effectiveness.

Pilot Study - Reflections

Extending the work conducted in the feasibility study, this pilot study demonstrates the feasibility of whole-school intervention delivery. However, teachers expressed numerous concerns about the PAL training, including the insufficiently challenging content, lack of understanding of the value/purpose of the outdoor component, and potential loss of valuable learning time. These examples are consistent with previous research reporting that time and standardised testing pressures are barriers to PAL implementation, particularly for secondary school teachers[14]. The feedback suggests a need to review the content of the training, particularly the outdoor component.

Teacher's comments indicated acceptability of delivering PAL and there was a measurable increase in PAL delivery. Feedback suggests teacher's acceptability may reflect prior knowledge and

experience of PAL. In addition, students reported enjoying PAL. Support for the intervention by multiple stakeholders is an important facilitator of successful implementation[36]; as such, the feedback received here is encouraging.

We successfully tested study procedures and intervention delivery at a whole-school level, with adequate recruitment and retention rates and continued control school involvement indicating acceptability of randomisation. Efforts made to improve data collection processes from the feasibility study, e.g., of student timetables and teacher questionnaires, were successful.

The assessment of PAL dose showed that students received an average of 6-7 x 60-minute PAL a week, which has the potential to make a valuable contribution to reducing sedentary time among adolescents. Despite a measured increase in PAL delivery, there was no evidence of reduced sedentary time, suggesting a need to review the PAL strategies that were shared with teachers, with a focus on the amount of activity introduced.

OVERALL DISCUSSION

In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and costs of a teacher-training programme for integrating activity into secondary school lessons. We also sought to understand the feasibility and acceptability of study procedures, including repeated accelerometer wear and school-level randomisation. The intervention was successfully delivered in two schools and quantitative and qualitative data was successfully collected from multiple stakeholders, enabling us to address all research questions. The majority of PAL evaluations have been carried out in primary schools[9] and as such, this study makes a valuable contribution to the literature.

Feasibility/acceptability of PAL training

Consistent with previous research, it was feasible to deliver PAL training to secondary school teachers over two, 2-hour, after-school sessions[43]. While acceptability of the training was demonstrated in the feasibility study and is reported elsewhere[16, 37, 43], feedback from teachers in the pilot study was less positive. Delivery to teachers of two subjects in the feasibility study meant a smaller training group and a smaller trainer:staff ratio than in the pilot study. This allowed more subject-specific discussion and more time to address teacher's personal questions. Teacher feedback suggests that training acceptability is related to teacher's experience delivering PAL. In the pilot study, teachers delivering PAL more regularly rated the intervention more poorly than less experienced teachers. A PAL intervention targeting teachers not regularly delivering PAL may be more acceptable. The positive responses to the training in the feasibility study (involving teachers reporting low levels of PAL delivery) support this suggestion.

Feasibility/acceptability of delivering/participating in PAL

In the feasibility study, teachers had mixed reviews of delivering PAL, whereas in the pilot study, teachers reported acceptability of delivering PAL. Pilot study teachers were more likely to report regular PAL delivery at baseline than feasibility teachers and to have had previous exposure to PAL during their initial teacher training and/or career. A longer trial period and increased support may have allowed teachers in the feasibility study to become more confident and accrue more positive PAL experiences. Overall, the data suggest that PAL delivery can be acceptable to secondary school teachers.

While teachers were the direct intervention recipients and their acceptability is crucial for successful implementation, it is important to consider acceptability for other stakeholders, who also influence implementation. Across both studies students responded positively to PAL, and senior leadership representatives reported satisfaction with the intervention (in the pilot study, satisfaction with the indoor component). Both senior leadership representatives commented that reasons for study participation included the potential positive influence on student's mental health. This observation is

consistent with previous findings[7] and indicates potentially effective strategies for promotion of the intervention to schools.

Preliminary Effectiveness

Despite a measured increase in PAL delivery, no changes in activity were observed. Other PAL feasibility and pilot studies have reported more encouraging changes[35, 44, 45]. In the feasibility study, early implementation efforts of Maths and English teachers may not have been sufficient to translate to changes in activity. Across both studies, teachers were advised that any non-seated activity was considered an 'active lesson' - as such, the intervention may be too dilute for measurable impact using wrist-worn accelerometers. Overall, the results suggest the need to review the amount of activity the PAL strategies introduce.

Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose is consistent with previous studies, for example, 10-30 minutes of activity, daily[35, 45-48] and 3 x 60-minute PAL per week[49]. It is worth noting that teachers in the current pilot study chose how many PAL they delivered, rather than being prescribed a weekly target; as such the dose indicates what is naturally achievable by secondary school teachers. A weekly dose of 6-7 PAL has the potential to substantially reduce adolescent's sedentary time during school hours, providing sufficient activity is introduced as part of the PAL.

Costs

Training delivery costs (independent of travel and planning time) was estimated around £900 ($1,187) in both studies. Strategies to reduce costs could include reducing the number of staff delivering the sessions or hiring staff with a mixture of training levels, rather than the highly experienced staff in the current studies. Approximately 25% of the cost was spent on equipment, primarily for outdoor-based subject-specific examples; reviewing the equipment purchases may identify cost saving opportunities. Research reports that small grants (~$2,000) to schools can lead

to increased implementation of practices to promote activity[50]. Senior leadership teams commented on how thinly English schools budgets are stretched; it was suggested that school funds set aside for (for example) mental health services might represent an avenue of funding for the programme for some schools.

Strengths and Limitations

High quality formative work for interventions is necessary to ensure appropriate allocation of research efforts and funding, and the publication of feasibility and pilot research is important to support other researchers and interventionists[51]. Limitations of this work include that samples were predominantly white; consequently, we are unable to explore differential responses to PAL by ethnicity. Moreover, parental opt out consent procedures limited the ability to obtain information on participant's socioeconomic position. The issue of lack of diversity among samples in PAL studies has been previously raised[52]; future research should seek to explore feasibility, acceptability and effectiveness among different racial/ethnic and socio-economic groups. Estimated training delivery costs are based on wage rates, national insurance and superannuation costs but don't include overhead costs such as costs of employing individuals and providing building space. As such, training delivery costs may be underestimated. In addition, we did not carry out longer-term follow-up assessments so we do not know if teachers continued to deliver PAL beyond eight weeks after the training.

CONCLUSION

We successfully demonstrated the feasibility and acceptability of introducing and evaluating a PAL teacher-training programme in secondary schools. Across feasibility and pilot studies, teachers' acceptability of the intervention and of delivering PAL was demonstrated, although aspects of the training programme, particularly the outdoor component, require review. The intervention was acceptable to students and senior leadership representatives, and the dose of PAL received by students was sufficient to have the potential to make a substantial contribution to reducing

adolescent's sedentary time during school hours. However, we did not observe preliminary effectiveness on students' activity behaviours. Taken together, the findings do not support continuation with the current PAL training programme, though its acceptability does highlight the need for further research into how the identified barriers might be overcome.

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Data sharing

The datasets are not available for download. The study's participant information sheets and ethics applications stipulated that the data would not be shared outside of the research team. The data are held at the MRC Epidemiology Unit at the University of Cambridge.

Competing interests

The authors declare that they have no competing interests.

Author contributions

All authors contributed to the conceptualisation and design of the work, and reviewed and approved the final manuscript. CG, DT, and EvS contributed to the acquisition, analysis and interpretation of data. CG drafted the manuscript.

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Table 1. Outline of the PAL training programme and timeline of evaluation measures.

	Week 0 Baseline Measures	Week 1	Week 4	Week 12 Follow-Up Measures
Feasibility Study	**Students**: • Anthropometry • Questionnaire • Accelerometry • Time-on-Task **Teachers**: • Questionnaire	**Training session 1** (2 hours) **30 minutes:** Introduction to active learning **40 minutes:** Split group in half: • Half stay in classroom and review classroom-based PAL strategies • Half go outside and review outdoor PAL strategies **40 minutes:** Groups switch **10 minutes:** Final comments	**Training session 2** (2 hours) **30 minutes**: Sharing PAL experiences **30 minutes**: Outdoor PAL examples **15 minutes**: Indoor PAL examples **15 minutes**: Discussion of intervention expectations **10 minutes**: Post-training questionnaire	**Students**: • Questionnaire • Accelerometry • Time-on-Task • Focus groups **Teachers**: • Questionnaire • Focus group **Senior Leadership Team**: • Interview
Pilot Study: Intervention School	*Same as for feasibility study baseline measures*	*Same as for feasibility study training session 1*	**Training session 2** (2 hours) **45 minutes**: Split group in half: • Half review indoor PAL strategies • Half review outdoor PAL strategies **45 minutes**: Groups switch **10 minutes:** Whole-group outdoor activity. **10 minutes**: Post-training questionnaire	*Same as for feasibility study follow-up measures*
Pilot Study: Control School	*Same as for feasibility study baseline measures*	No training session	No training session	**Students**: • Questionnaire • Accelerometry • Time-on-Task

Table 2. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	76	237.4 (26.4)	246.1 (27.6)	8.7 (3.8,13.7)
Light activity (minutes)	76	139.8 (21.8)	131.7 (22.6)	-8.1 (-12.4,-3.8)
Moderate activity (minutes)	76	10.8 (6.0)	10.3 (5.8)	-0.6 (-1.4,0.3)
Vigorous activity (minutes)	76	2.0 (2.0)	1.9 (1.8)	-0.1 (-0.4,0.3)
Time-on-task (% intervals on-task)	11	66.1	-	-
Academic Efficacy (score 1-5)	85	3.51 (0.80)	3.63 (0.83)	-
Disruptive Behaviour (score 1-5)	82	1.90 (0.95)	1.94 (0.98)	-
CHU-9D (score 0.33-1.0)	89	0.86 (0.10)	0.84 (0.10)	-
Positive Affect (score 1-5)	81	17.35 (3.44)	16.16 (3.36)	-
Negative Affect (score 1-5)	84	10.55 (3.28)	10.71 (3.48)	-

Length of school day = 390 minutes

Table 3. Activity intensity during 60-minute PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama); mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	310	41.1 (8.4)	42.1 (8.6)	1.0 (-0.1,2.1)
Light activity (minutes)	310	17.9 (7.6)	16.9 (7.8)	-1.1 (-2.1,0)
Moderate activity (minutes)	310	0.8 (1.0)	0.9 (1.0)	0 (-0.1,0.2)
Vigorous activity (minutes)	310	0.2 (1.1)	0.2 (0.6)	0 (-0.1,0.1)

Table 4. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	Control School [a]				Intervention School [a]			
	N	Baseline	Follow-Up	Mean Difference (95% C.I.)	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	74	217.0 (32.4)	222.1 (36.2)	5.1 (-1.3,11.5)	96	236.4 (31.8)	237.7 (40.6)	1.3 (-6.2,8.7)
Light activity (minutes)	74	140.5 (26.0)	136.6 (31.9)	-4.0 (-10.1,2.2)	96	129.0 (26.8)	124.8 (31.2)	-4.2 (-10.5,2.1)
Moderate activity (minutes)	74	16.2 (7.5)	14.2 (7.8)	-2.0 (-3.2,-0.8)	96	11.1 (6.3)	10.1 (6.3)	-1.1 (-2.0,-0.1)
Vigorous activity (minutes)	74	5.5 (3.9)	4.7 (3.5)	-0.8 (-1.4,-0.2)	96	3.1 (3.0)	3.0 (2.9)	-0.1 (-0.6,0.4)
Time-on-task (% intervals on-task)	28[b]	73.7	56.6	-	27[c]	79.1	77.5	-
Academic Efficacy (score 1-5)	98	3.41 (0.71)	3.32 (0.71)	-	107	3.76 (0.64)	3.71 (0.76)	-
Disruptive Behaviour (score 1-5)	98	2.34 (1.23)	2.47 (1.19)	-	107	1.94 (0.94)	2.04 (1.01)	-
CHU-9D (score 0.33-1.0)	97	0.84 (0.10)	0.84 (0.09)	-	106	0.87 (0.09)	0.85 (0.10)	-
Positive Affect (score 1-5)	98	15.95 (3.33)	16.08 (3.53)	-	107	17.80 (3.10)	17.54 (3.74)	-
Negative Affect (score 1-5)	98	10.03 (3.30)	9.87 (3.14)	-	106	10.12 (3.47)	9.95 (3.06)	-

[a] Length of school day varies: control school = 380 minutes, intervention school = 400 minutes

[b] 14 students observed at baseline across 4 classes (all non-active lessons) and 14 students observed at follow-up across 4 classes (all non-active lessons). Students observed at baseline were different from students observed at follow-up.

[c] 14 students observed at baseline across 4 classes (all non-active lessons) and 13 students observed at follow-up across 4 classes (3 active lessons, 1 non-active lesson). Students observed at baseline were different from students observed at follow-up.

Text Box 1.

"*I really enjoyed them (active lessons), they (the students) enjoyed them as well, they seemed to get a lot out of them…it was good fun, it was nothing really any different to what I was normally doing, just with a few added extras*" (Maths teacher, female).

"*I thought they (the students) would enjoy going outside… I had high hopes for that but it was a Friday afternoon and I don't think they were ready for it… they were causing disruption, they tried to walk off*" (English teacher, female).

"we concentrated more because it was more fun than just sitting around" (Year-7, male), and "*when you're sitting down you can get quite bored and get easily distracted whereas if you're moving about you've actually got something to do*"(Year-7, female).

Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

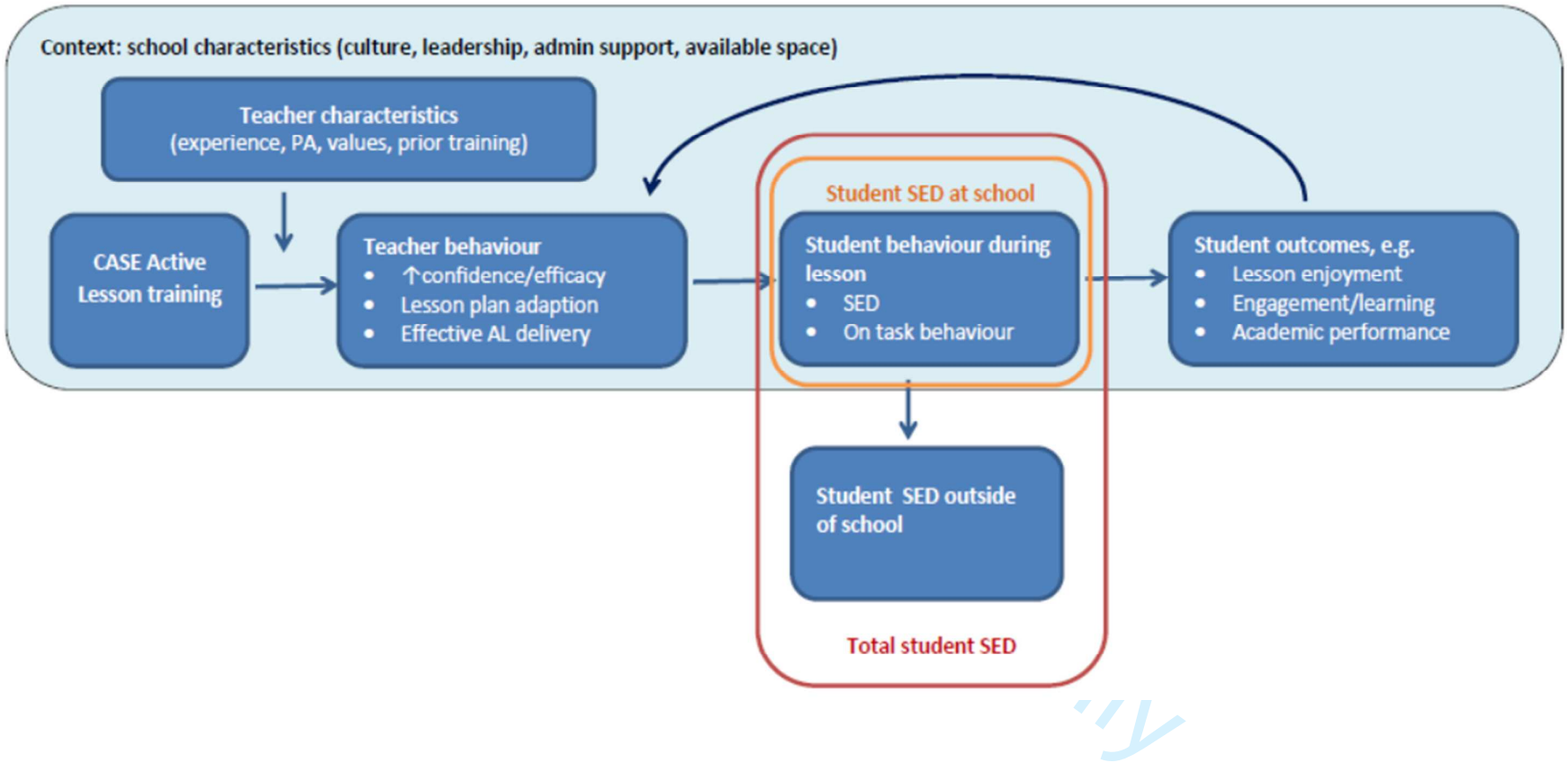
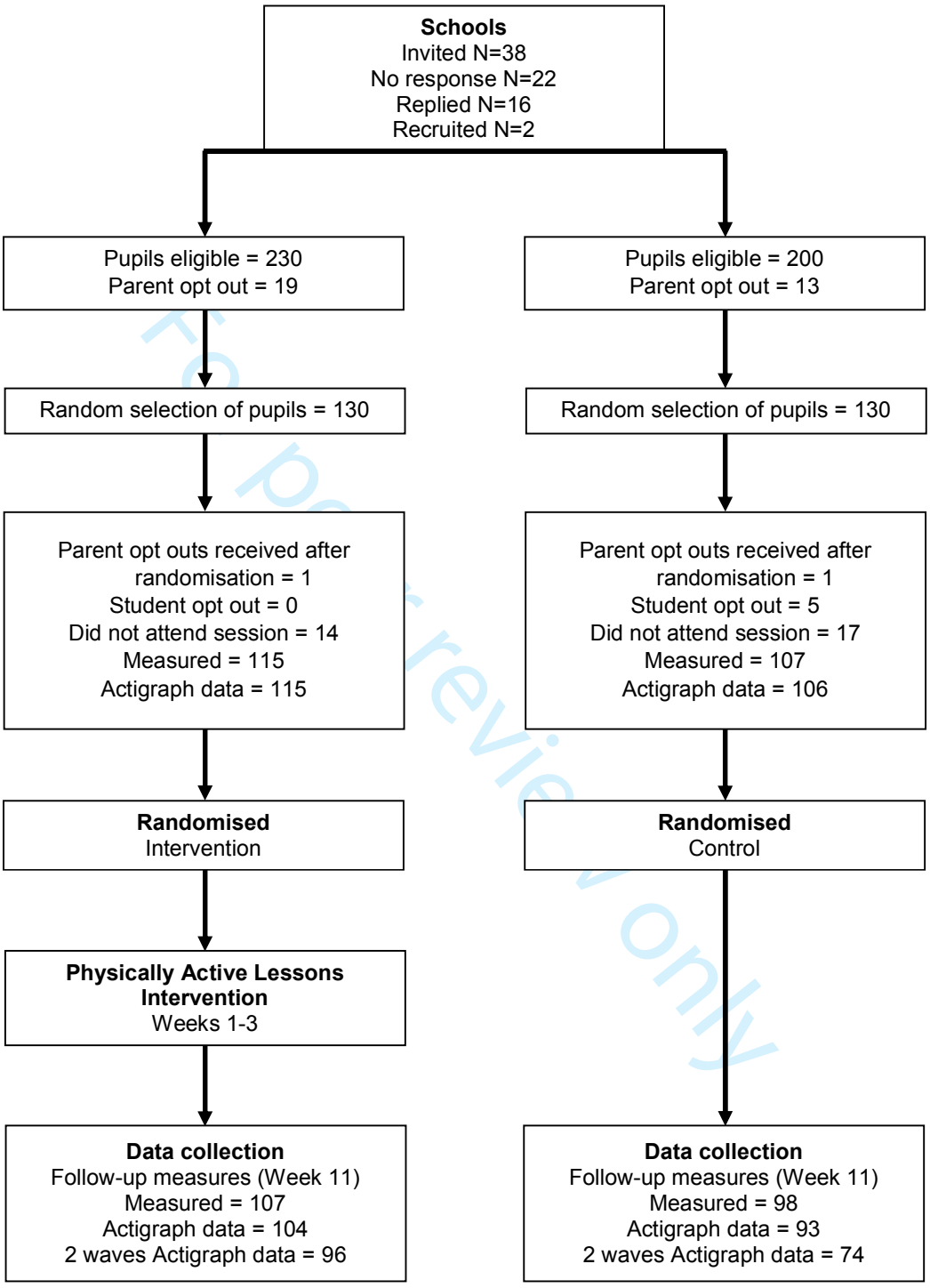


Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).



Supplementary Table 1. Descriptive, recruitment and retention statistics of student participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
N schools	1	1	1
N students invited	360	200	230
N parent opt out	25	13	19
N students randomly selected	120*	130*	130*
N student non assent	7	5	0
N student non attendance	11	17	14
N students assented	99	107	115
N two time points	91	98	107
N accepted monitor at two time points	91	93	104
N with sufficient PA at two time points	76	74	96
Age (years)	13.0 (1.1)	13.1 (0.6)	12.7 (1.0)
Sex: N (% male)	51 (52)	53 (50)	58 (50)
Height (cm)	158.6 (8.7)	159.6 (8.9)	156.2 (9.8)
Weight (kg)	51.9 (14.9)	54.1 (13.7)	48.1 (10.4)
BMI percentile	56.8 (30.8)	63.2 (29.4)	57.6 (28.2)
% overweight/obese	26.6	29.0	19.1

PA: physical activity

*After random selection, a small number of parent opt-out replies were received for students that had been randomly selected for evaluation measures (feasibility study = 3, pilot control school = 1, pilot intervention school = 1), as such, the number of students randomly selected who were eligible to assent were: feasibility study = 117, pilot control school = 129, pilot intervention school = 129.

Supplementary Table 2. Descriptive statistics of teacher participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
N teachers invited	15	32	36
N teachers assented	13	32	36[a]
Age Category: N (%)			
18-24 years	1 (17)	6 (19)	1 (3)
25-34 years	2 (33)	7 (22)	5 (14)
35-44 years	2 (33)	9 (28)	7 (19)
44-45 years	1 (17)	9 (28)	11 (31)
55-64 years	0	1 (3)	3 (8)
65 years +	0	0	0
N (%) male	2 (33)	10 (31)	10 (28)
Teaching Experience: N (%)			
< 1 year	1 (17)	8 (25)	0
2-5 years	2 (33)	7 (22)	6 (17)
6-10 years	2 (33)	5 (16)	7 (19)
>10 years	0	10 (31)	13 (36)
Current active lesson delivery N (%)			
Never/rarely	3 (50)	5 (16)	5 (14)
1-2 times / month	2 (33)	6 (19)	7 (19)
1-2 times / week	1 (17)	8 (25)	5 (14)
3-4 times / week	0	6 (19)	3 (8)
> once per day	0	6 (19)	6 (17)

[a]27 teachers attended the research team's study introduction and completed baseline questionnaires. A further 9 teachers consented at training session 1 or 2 and did not provide baseline data.

Supplementary Table 3. Teacher feedback on the PAL training programme; mean (SD).

		Pilot Study – Intervention School		
	Feasibility Study (n=9)	**Whole Group (n=33)**	**Baseline PAL delivery < once per week (n=11)**	**Baseline PAL delivery ≥ once per week (n=14)**
Usefulness of training in preparing you to deliver PAL *(1=not useful, 7=very useful)*	5.3 (0.5)	3.1 (1.4)	3.9 (1.6)	2.5 (1.1)
Appropriateness of depth and scope of training *(1=not appropriate, 7=very appropriate)*	5.2 (0.7)	3.1 (1.4)	3.6 (1.6)	2.7 (1.2)
Appropriateness of programme materials and resources *(1=not appropriate, 7=very appropriate)*	5.6 (1.3)	2.8 (1.4)	3.5 (1.6)	2.4 (1.2)
Clarity of program materials and resources *(1=not clear, 7=very clear)*	6.0 (0.7)	3.7 (1.2)	4.4 (1.3)	3.4 (1.1)
Relevance of training for your lessons *(1=not relevant, 7=very relevant)*	5.3 (1.1)	2.9 (1.4)	3.6 (1.4)	2.4 (1.4)
Would you recommend the training to other teachers? *N (%) yes*	9 (100)	15 (45)	7 (64%)	4 (29%)

Outdoor Active Lesson Examples

1. https://www.ltl.org.uk/pdf/Natural-Equations-2018-COMPLETE1518623029.pdf
2. https://www.ltl.org.uk/pdf/Fires-and-Cooking-Actvity1421850222.pdf

Indoor Active Lesson Examples

A. Jigsaw

What is it? The jigsaw is a cooperative learning strategy (one of several) whereby, as with a jigsaw puzzle, each piece (each student's part) is essential for the complete picture (full understanding of the final product). Here, if each student's part is essential then arguably, each student is essential!

Implications for classroom layout: There is minimal impact on classroom layout. Desk should be arranged together so students can sit together in small groups and be able to move between groups.

How does it work?

1. Divide students into 5 or 6-person jigsaw groups. Ideally these groups should be diverse in terms of gender, race/ethnicity and ability.
2. These groups are the 'Home teams'. In each home team, each team member should be given a letter (e.g. A, B, C etc.)
3. Team members then join their **Jigsaw team** e.g. all the A's, B's etc. get together. This will require them moving to their jigsaw teams. These jigsaw teams are responsible for discussing and understanding a pre-determined aspect or answering a particular task. For instance, a reading may be divided into several parts with each jigsaw team taking one of those parts.
4. As a teacher, you can move between each jigsaw team to ensure they are addressing the task in its entirety and the whole jigsaw team develops an understanding of it.

5. Jigsaw teams then return to back to their home teams to discuss what was learnt in the jigsaw team. **Each student will present her or his segment to the group** so that all learn from each other.

Benefits

- Learn a lot of material quickly
- Students are held individually accountable for their learning
- It helps to maximise student collaboration
- Encourages higher order and critical thinking skills.

B. Active Voting

What is it? This notion of Active Voting is useful for exploring differing and diverse opinions on particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of ambiguity and grey areas, which helps them to see that opinions often have to be justified with informed knowledge of the matter under discussion.

Implications for classroom layout: Each of the four key statements will need to positioned in one of corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree. When an issues is raised, pupils will then move to stand/sit in the corner that best reflects their views and with those who share the same opinion/perspective.

How does it work?

1. A range of issues (related to the content being delivered) should be read out in turn by the teacher.

2. Pupils are then given time to consider their opinion.
3. Pupils then move to the corner that best describes how they feel about what was read out. Pupils should be reminded that there are no right or wrong answers.
4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
5. When pupils move to the corner that best represent their views on the statement, they should be encouraged to explain why they feel that way with others in that group. General perspectives can be obtained from all corners.
6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and to refine the initial statement/problem/issues being discussed.
7. Pupils are allowed to move during the discussion of each statement if issues arrive that challenge their original opinion.
8. If pupils do switch then they should be encouraged to explain why.

Benefits

Developing thinking and decision making skills

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility randomized trial in a journal or conference abstract

Item	Description	Reported on line number
Title	Identification of study as randomised pilot or feasibility trial	1-2
Authors *	Contact details for the corresponding author	11
Trial design	Description of pilot trial design (eg, parallel, cluster)	22
Methods		
Participants	Eligibility criteria for participants and the settings where the pilot trial was conducted	21
Interventions	Interventions intended for each group	27-28
Objective	Specific objectives of the pilot trial	18-20
Outcome	Prespecified assessment or measurement to address the pilot trial objectives**	29-33
Randomization	How participants were allocated to interventions	22
Blinding (masking)	Whether or not participants, care givers, and those assessing the outcomes were blinded to group assignment	22-23
Results		
Numbers randomized	Number of participants screened and randomised to each group for the pilot trial objectives**	N/A
Recruitment	Trial status†	N/A
Numbers analysed	Number of participants analysed in each group for the pilot objectives**	N/A
Outcome	Results for the pilot objectives, including any expressions of uncertainty**	34-39
Harms	Important adverse events or side effects	N/A
Conclusions	General interpretation of the results of pilot trial and their implications for the future definitive trial	40-42
Trial registration	Registration number for pilot trial and name of trial register	43
Funding	Source of funding for pilot trial	44

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

**this item is specific to conference abstracts*

***Space permitting, list all pilot trial objectives and give the results for each. Otherwise, report those that are a priori agreed as the most important to the decision to proceed with the future definitive RCT.*

†For conference abstracts.

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	1
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	2-3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	4-5, 11-12
	2b	Specific objectives or research questions for pilot trial	11-12
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	12
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	12
Participants	4a	Eligibility criteria for participants	6, 12
	4b	Settings and locations where the data were collected	13
	4c	How participants were identified and consented	6, 12
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	26
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	6-8, 26
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	N/A
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	N/A
Sample size	7a	Rationale for numbers in the pilot trial	6, 12
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	12
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	N/A

Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	12
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	12
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	6-8, 13
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	12, Figure 2
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure 2
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Figure 2
	14b	Why the pilot trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Supp file 1, page 1
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	28-29, figure 2
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	28-29
Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
	19a	If relevant, other important unintended consequences	N/A
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	19-20
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	19-20
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	17-20
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	20
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	5
Protocol	24	Where the pilot trial protocol can be accessed, if available	5
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	21
	26	Ethical approval or approval by research review committee, confirmed with reference number	5

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.
*We strongly recommend reading this statement in conjunction with the CONSORT 2010, extension to randomised pilot and feasibility trials, Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

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Introducing physically active lessons in UK secondary schools: feasibility study and pilot cluster-randomised controlled trial

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Introducing physically active lessons in UK secondary schools: feasibility study and pilot cluster-randomised controlled trial

Catherine Gammon[1], Katie Morton[1], Andrew J Atkin[1,2], Kirsten Corder[1], Andy Daly-Smith[3], Thomas Quarmby[3], Marc Suhrcke, David Turner[2], Esther van Sluijs[1*]

[1] MRC Epidemiology Unit and UKCRC Centre for Diet and Activity Research (CEDAR), University of Cambridge, Cambridge, UK

[2] School of Health Sciences, University of East Anglia, Norwich, UK

[3] Carnegie School of Sport, Leeds Beckett University, Leeds, UK

[4] Centre for Health Economics, University of York, York, UK

* Corresponding author: Dr Esther van Sluijs (ev234@medschl.cam.ac.uk; 01223 769189)

Address: UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge, CB2 0QQ, UK

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Abstract

Objectives: Assess feasibility, acceptability and costs of delivering a physically active lessons (PAL) training programme to secondary school teachers and explore preliminary effectiveness for reducing pupils' sedentary time.

Design and setting: Secondary schools in East England; one school participated in a pre-post feasibility study, two in a pilot cluster-randomised controlled trial. In the pilot trial, blinding to group assignment was not possible.

Participants: Across studies, 321 randomly selected students (51% male; mean age: 12.9 years), 78 teachers (35% male) and two assistant head-teachers enrolled; 296(92%) students, 69(88%) teachers and two assistant head teachers completed the studies.

Intervention: PAL training was delivered to teachers over two after-school sessions. Teachers were made aware of how to integrate movement into lessons; strategies included students collecting data from the environment for class activities, and completing activities posted on classroom walls, instead of sitting at desks.

Primary and secondary outcomes: Quantitative and qualitative data were collected to assess feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline and ~8 weeks post-training; measures included accelerometer-assessed activity, self-

reported well-being, and observations of time-on-task. Process evaluation was conducted at follow-up.

Results: In the feasibility study, teachers reported good acceptability of PAL training and mixed experiences of delivering PAL. In the pilot study, teachers' acceptability of training was lower and teachers identified aspects of the training in need of review, including the outdoor PAL training and learning challenge of PAL strategies. In both studies, students and assistant head-teachers reported good acceptability of the intervention. Preliminary effectiveness for reducing students' sedentary time was not demonstrated in either study.

Conclusions: No evidence of preliminary effectiveness on the primary outcome and mixed reports of teachers' acceptability of PAL training suggest the need to review the training. The results do not support continuation of research with the current intervention.

Trial registration: ISRCTN registry; ISRCTN38409550.

Funding: Department of Health Policy Research Programme (PR-R5-0213-25001).

Article Summary

Strength and limitations of this study

- We completed thorough feasibility and pilot testing work to inform the decision of whether to progress with the current intervention and its evaluation.
- We collected quantitative and qualitative data which provided valuable information on contextual influences and allowed us to address research questions more comprehensively.
- We were unable to collect all planned follow-up measures from teachers and students in feasibility study, including teacher follow-up questionnaires and class observations of time-on-task.
- We did not carry out longer-term follow-up measures of teacher acceptability and physically active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up would have provided an indication of the sustainability of the intervention.

INTRODUCTION

Globally, most adolescents (~80%) do not achieve government-recommended physical activity guidelines[1] and engage in high levels of sedentary behaviour[2]. As such, interventions are needed to support youth in achieving a healthy activity profile. Secondary/high schools present an opportunity for the implementation of activity interventions, as during school hours activity is lower and sedentary time is higher than during other segments of an adolescent's week[3, 4].

The Creating Active School Environments (CASE) project is a three-year research programme funded by the UK Department of Health Policy Research Programme. CASE aims to identify environmental strategies to help adolescents move more and sit less during school hours. Initial phases of CASE involved a systematic literature review[5] and secondary data analysis[6] to identify promising secondary school-based activity interventions. Morton and colleagues (2017) subsequently completed a Delphi study, involving stakeholders in the prioritisation of interventions. Physically active lessons (PAL) were perceived to be the most feasible, acceptable and cost-effective intervention for secondary school settings[7]; these results informed the final, feasibility and pilot-testing phase of CASE.

PAL are a pedagogical approach whereby activity supports the delivery of academic material[8]. During PAL, movement is integrated into teaching and as such, PAL are distinct

from 'brain/movement breaks', when activity is separate from learning. Evidence from primary schools indicates that PAL can improve physical activity, academic achievement and lesson enjoyment[9-12]. To our knowledge, only two studies have trialled the use of PAL among adolescents[13, 14]. Helgeson (2013) reported no influence of the 'Energizers' PAL programme on reading comprehension scores among junior high school students and did not explore activity levels as a primary outcome[13]. Cothran and colleagues (2010) reported on primary and secondary/high school teachers' experiences of a one-year movement integration intervention. Compared to primary school teachers, secondary teachers faced different challenges when attempting to integrate activity into lessons, in particular standardised testing pressures and students not staying with one teacher all day (as typically is the case in primary schools)[14]. Cothran and colleagues did not measure student activity behaviours as an intervention outcome[14]. The positive effects of PAL reported for primary students suggest there is value in exploring if secondary students can experience similar benefits. Given the organisational and environmental differences between primary and secondary schools, it is important to conduct high quality feasibility and pilot testing of secondary school PAL interventions.

A PAL training programme for secondary school teachers was tested in a feasibility study and a cluster-randomised controlled pilot study. The studies aimed to explore the feasibility,

acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary teachers. Acceptability of study processes was also examined, in anticipation of conducting a subsequent full trial. The feasibility study tested the intervention among maths and English teachers at one school, the pilot study tested the intervention among all-subject teachers and as part of a controlled trial. This paper presents the feasibility study and pilot study followed by an overall discussion and conclusion (ISRCTN38409550).

1. FEASIBILITY STUDY

Ethical approval for both studies was granted by the University of Cambridge's School of the Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the feasibility, acceptability, costs, and preliminary effectiveness (for reducing sedentary time and improving wellbeing and time-on-task among students) of a PAL training programme for secondary school teachers, and (ii) the feasibility and acceptability of study procedures.

Feasibility Study - Methods

Recruitment

Potential schools were identified from previous local research and approached with study information (n=2). One mixed-sex, non fee-paying secondary school participated. The head

teacher provided written consent for the intervention to be delivered to the teachers, elected for the intervention to be trialled with maths and English teachers, and chose years 7 and 9 to participate in study evaluation measures. The school were told they would be able to keep the PAL training resources.

Parents of all Year 7 and 9 students (11-14 years) received study information and students were invited to participate in evaluation measures. Parents were given two weeks to opt out (passive parental consent) via email, freephone, or freepost. From the students who had not been opted out, 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly selected for evaluation measures (using class lists and random number generating software). The study's feasibility focus meant that a formal power calculation was not necessary to inform sample size; a sample of 60 participants per year is consistent with samples of similar studies[15]. Students provided written assent for evaluation measures.

Maths and English teachers (n=15) received study information two weeks before the PAL training. The senior leadership team requested that all maths and English teachers attend the training. Teachers could choose to participate in the evaluation measures, those agreeing provided written consent. Over five school days students received approximately five maths lessons and four English lessons.

Intervention

The PAL training was developed by a team with teacher training qualifications and experience in indoor (two trainers) and outdoor active learning (one trainer). The training was delivered at the intervention school between March and April, during pre-scheduled after-school teacher-training time. Table 1 outlines the training programme and example active lessons are published as supplementary material. The focus was on supporting teachers to adopt active pedagogical approaches (teaching strategies that incorporate activity), rather than providing new, PAL plans. The training was underpinned by aspects of social cognitive theory and aimed to enhance teachers' self-efficacy in relation to PAL[16]. As such it drew from two prominent behaviour change techniques: barrier identification and modelling/demonstrating behaviour[17]. With the former, teachers were encouraged to identify barriers that might impact their ability to implement PAL and plan ways to overcome these. With the latter, the trainers demonstrated a plethora of PAL teaching strategies that teachers could employ in their lessons. Figure 1 outlines the preliminary logic model of how the teacher-focused intervention could lead to changes in students' activity. Prior to the training, the research team visited the participating school and ascertained the availability of indoor and outdoor spaces and equipment that could be used for PAL. Syllabi for maths and English were requested to allow trainers to prepare relevant examples for the training.

Measurements

Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed using questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7 and four Year-9 students) and an interview with the assistant head teacher were completed using a semi-structured interview.

i. Evaluation of Intervention and Study

Feasibility/acceptability of the intervention: Questionnaire items and focus group questions asked about teachers' perceptions of the utility, value and relevance of the training (adapted from[18, 19]). Questionnaires asked if teachers would recommend the training to other teachers and provided free-text boxes for teachers to suggest improvements. Training session attendance rates were recorded.

Feasibility/acceptability of PAL delivery: Questionnaire items and focus group questions asked teachers about classroom management during PAL, enjoyment of teaching PAL, time needed to prepare and deliver PAL, and barriers to PAL delivery (items from[20]).

Acceptability of PAL participation: Questionnaire items and focus group questions asked students about their experience of PAL participation, enjoyment of PAL, their preference for active vs. desk-based lessons, and the best and worst things about PAL.

Costs: Teachers and students reported resources purchased to deliver/participate in PAL. The research team recorded time and costs associated with the training team's development and delivery of the intervention.

Study processes: The research team made field notes on study processes that proved to be challenging or ineffective, for example, students struggling to understand a questionnaire item.

ii. Intervention Outcomes

Student anthropometry: Anthropometric measures were completed by trained staff using standard procedures. Height was measured using a stadiometer (Leicester height measure, Chasmors, Leiceter, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg (Tanita, type TBF-300A, Tokyo, Japan). The measurement stations were set up so that results were not visible to anyone except the measurement staff. Height, weight, sex, birthdate and measurement date were used to calculate participants' body mass index (BMI; kg/m^2) and BMI percentile.

Activity intensity: Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were used to measure activity behaviours. These devices have been used among a larger sample of Year-9 participants in the GoActive study[21] and the UK Biobank Cohort Study[22]. Wrist-worn monitors are validated for the assessment of energy expenditure in pediatric

populations[23] with higher participant compliance when compared to waist-worn accelerometers[24]. Participants were given verbal and written instructions on monitor wear, including that the monitor was waterproof and could be worn continuously for the next seven days (Monday to Monday).

The first day of monitor wear was dropped[25]; included participants provided valid data for ≥80% of school hours for ≥two school days, at baseline and follow-up[26-28]. Acceleration was recorded at 100Hz with a dynamic range of ±8g. Data from the monitors was downloaded in continuous waveform. Euclidean Norm Minus One (ENMO) represents acceleration magnitude at each measurement, accounting for the influence of gravity. ENMO thresholds were used to classify activity intensities: time spent at 0-30 ENMO was classified as sedentary activity (equivalent to 1-1.5 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-500 ENMO as moderate-intensity activity (4-7 METs), and above 500 ENMO as vigorous-intensity activity[29, 30].

Mental Health and Wellbeing: Students completed questionnaire measures of positive and negative affect[31], academic efficacy, disruptive behaviour[32], enjoyment of school classes[33] and health related quality of life[34-39] at baseline and follow-up. All questionnaires are validated for use with adolescents and were analysed according to published instructions[31, 32, 39].

Time-on-task: Students' time-on-task was assessed during three lessons by one member of the research team using a momentary time-sampling procedure (which incurs less bias than other sampling procedures[40, 41]). At the start of each observed class, the teacher asked all students participating in the study to raise their hands. From the students that raised their hands, the researcher identified two boys and two girls (when possible) to observe. The researcher chose students sitting in different areas of the classroom. Each student was observed once per minute, in a consistent order, for the duration of the lesson. Students' behaviour was coded as: (i) on-task, (ii) off-task-passive, (iii) off-task-motor, or (iv) off-task-noise[42]. The mean percentage of intervals recorded as 'on task' for observed students and classes was calculated and used as the outcome measure.

Prior to classroom observations, a validation activity was completed where two researchers discussed definitions and concurrently coded student behaviour using four online videos. Observers' codes matched for 95% of observation intervals.

Descriptive Statistics

Descriptive statistics of the sample, primary and secondary outcomes, and quantitative measures of feasibility and acceptability are summarised. Focus group transcripts were reviewed; recurring comments and themes relevant to the research questions were identified.

Feasibility Study - Results

Recruitment and sample characteristics

Student and teacher recruitment and characteristics are summarised in supplementary tables 1 and 2. Of 120 students invited to participate in the evaluation measures, 99 were recruited, with 91 (92%) providing data at baseline and follow-up. Students had a mean age of 13.0 (±1.1) years, 52% were male and 27% were classified as overweight/obese. Teachers were predominantly female (67%) and below the age of 45 (83%).

Feasibility and Acceptability

Training session one was attended by 14 (out of 15) teachers (7 maths, 7 English), training session two was attended by 12 teachers (7 maths, 5 English), 11 teachers attended both sessions. Teacher feedback demonstrated acceptability of the training, with 100% recommending the training to other teachers (supplementary table 3). Individual and collective efficacy for delivering PAL improved from 2.7 to 3.2, and 2.4 to 3 (out of 4), respectively. At follow-up, ≥eight teachers had attempted to deliver PAL. Teacher's goals for PAL delivery averaged 2.1 (SD=1.0) lessons per week, with an average targeted reduction in sitting time of

15.8 (SD=8.0) minutes. Some teachers reported positive experiences of delivering PAL, while others reported challenges (Text box 1).

Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting, challenges re-focusing students after an active portion of class, and limited classroom space. Teachers identified facilitators of PAL delivery as theirs and the students' enjoyment of PAL, good weather allowing them to go outside, more classroom space and a more diligent group of students. Teachers reported ≤15 extra minutes were required to plan PAL, and a few extra minutes were needed to prepare students for PAL participation.

Of the students who recalled participating in an active lesson (47%), most preferred PAL to desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to continue delivering them. Students reported enjoying going outside and moving around (30%), that PAL were less boring/more fun than desk-based lessons (26%) and that they could concentrate better (14%). Negative comments about PAL included lethargy (12%), more disruptive behaviour (9%), and less work achieved (12%; text box 1).

The assistant head teacher felt the training was well-received and high-quality professional development. The school's reasons for participating in the project included the potential for improving students' mental health and the motivation to be innovative in the classroom. The

assistant head teacher commented that teaching staff had enjoyed taking students outside for lessons and the project had involved a low level of commitment from the school.

Costs

Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment. Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student, ~£30).

Study Processes

The majority of study procedures were completed successfully. Challenges encountered included that students struggled to complete a blank timetable indicating when their Maths and English lessons were, and despite efforts, we were unable to schedule follow-up classroom observations. Teacher baseline questionnaire return was low and the follow-up focus group was conducted in a 15-minute timeslot due to late changes.

Preliminary effectiveness

Table 2 summarises baseline and follow-up data for all student measures. Sedentary time increased by 8.7 minutes and time spent in light-intensity activity decreased by 8.1 minutes. Minimal changes were observed in the mental health and wellbeing scores between baseline and follow-up.

Feasibility Study - Reflections

The findings suggest it is feasible and acceptable to deliver a PAL training program to secondary school maths and English teachers. Importantly, the senior leadership representative was supportive of the training[43]. Secondary school teachers had mixed reports of delivering PAL, the identified barriers and facilitators were consistent with those previously reported[43]. It was noted that teacher acceptability of PAL delivery should be explored further in the next phase of intervention evaluation. The positive student response to PAL indicates acceptability and is consistent with results from PAL interventions in primary schools[44].

We were successful in recruiting and consenting participants, and the majority of evaluation measures were completed without problems. The retention of >90% of participants from baseline to follow-up suggests evaluation measures were acceptable. Suggested changes included scheduling all research activities at the start of the project and acquiring student timetables from the school's administration team.

Limitations of this feasibility study include the small sample size and the lack of control group, making it not possible to draw conclusions about the contribution of the intervention to the observed changes. The change in sedentary activity levels is inconsistent with previous research reporting that younger children's sedentary time on weekdays decreases between

spring and summer[45]. Increased negative feelings and lower wellbeing among students between March and June is consistent with typical changes observed in students' wellbeing over a school term[46, 47].

2. PILOT STUDY

Following successful implementation of the intervention in the feasibility study, we sought to extend our previous work and explore the potential value of conducting a full-scale randomised controlled trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the feasibility, acceptability, preliminary effectiveness and costs of delivering a PAL intervention at a whole-school level (to all subject teachers) and (ii) to test the acceptability of school-level randomisation.

Pilot Study - Methods

Recruitment and Randomisation

Schools: We aimed to recruit three schools - two intervention (to test whole-school delivery of the intervention in different settings) and one control (to test the acceptability of school-level randomisation). In June-July 2017, 26 non fee-paying, mixed gender, secondary schools in

the East of England were emailed study information and invited to participate (the school that took part in the feasibility study was not invited to participate in the pilot study). The first three schools to agree were recruited; one school withdrew prior to student recruitment (and randomisation). We were unable to replace the school within an appropriate timeframe. After baseline measures, individuals separate from the research team performed a coin-toss to assign intervention and control schools. The nature of the intervention and goals of the evaluation measures meant it was not possible to blind participants. Due to differences in follow-up measures between control and intervention schools, it was not possible to blind measurement staff at follow-up.

Students: Recruitment proceeded as outlined for the feasibility study. Schools were asked to choose one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation measures. This would allow assessment of differential responses to the intervention by age. The intervention school selected Years 7 and 9 and the control school selected Years 8 and 9. Following feasibility study procedures, we randomly selected 130 students (50% male, 50% from each year) from each school for evaluation measures (based on feasibility study retention rates), with the aim of obtaining full data on 100 participants.

Teachers: A teacher information and recruitment meeting was scheduled at both schools, during which a researcher introduced the study and distributed consent forms. Teachers were

advised by their senior leadership team that they would be required to attend the PAL training if allocated as the intervention school; all teachers were free to decide on participation in evaluation measures.

Intervention

Extending the feasibility study, the intervention was delivered to all subject teachers. Training all subject teachers is consistent with the whole-school approach recommended for activity promotion and obesity prevention among youth[48, 49]. Given the acceptability of the training demonstrated in the feasibility study, the structure and goals of the training for the pilot study were similar. Minimal changes were made to the indoor training component, which focused on generic active learning strategies, applicable to any subject (e.g., different workstations around the classroom). In the feasibility study, the outdoor training component provided multiple subject- and topic-specific lesson ideas; the inclusion of all subject teachers meant fewer subject-specific examples could be actively worked through during the pilot study training. One additional outdoor lessons trainer was involved to train the larger group of teachers.

Measurements

Table 1 outlines the timeline of study measures; all data were collected at schools, during school hours. To increase teacher baseline questionnaire return, questionnaires were distributed during the pre-training teacher information meeting, and completed following consent. Data collection followed the same procedures as described for the feasibility study, except for the assessment of PAL dose and time on task.

PAL Dose: A teacher timetable was created using school-provided student timetables, detailing their Year 7 and 9 lessons. During the student accelerometer assessment at follow-up, teachers were given their personalised timetable and asked 'please circle which of the listed Year 7 and/or 9 classes were (or will be) delivered as an active lesson.' Teachers responses were used to calculate PAL dose. *Time on task:* Four lessons were observed at baseline and follow-up, at both schools. At baseline (prior to delivery of PAL training) the research team observed typical desk-based lessons. At follow-up, the research team asked to observe physically active lessons.

Patient and Public Involvement

In an earlier phase of CASE, opinions of key stakeholders regarding (i) suitable PA interventions for secondary schools and (ii) salient outcomes, were explored in a Delphi study ([7]). The decision to trial a PAL intervention and inclusion of mental health and time-on-task measures were informed by the Delphi study. While stakeholders were not involved in study

design, conduct or recruitment, they reviewed questionnaires and provided feedback on qualitative findings. Student participants received a personal PA report and participating schools will be provided with a summary of the findings. Assistant head teachers commented on the time commitment of the intervention and teacher participants reported on time spent implementing intervention components.

Descriptive statistics

Descriptive statistics and focus group analysis proceeded as outlined for the feasibility study.

Pilot Study - Results

Figure 2 shows the flow of participants, with further information on student and teacher recruitment and sample characteristics in supplementary tables 1 and 2. Of the assenting students (n=222) 92% provided data at two time points. Half of the students were male and 24% were classified as overweight/obese. The majority of teachers were female and >50% of staff reported delivering at least one PAL a week at baseline. At the intervention school, 30 and 33 teachers attended training session one and two, respectively (29 teachers attended both).

Feasibility and Acceptability

Average scores regarding teachers' acceptability of the training fell below 4 (the 'neutral' value) indicating negative feelings towards the training (supplementary table 3). Teachers reported training activities to be more suited for primary schools and not sufficiently challenging for secondary students. One teacher commented: *"they were more bonus activities, like extra treat things… you couldn't get much learning done through them"* (Science teacher, female). Teachers felt it was assumed they weren't delivering PALs prior to the training and this created resistance towards the training effort. Teachers reported that the PAL ideas were not novel and repetitive, the focus on outdoor learning was distracting, and the value of outdoor activities wasn't clear.

More than half of teachers reported delivering at least one PAL a week at baseline. PAL delivery decreased for four teachers (11%), was maintained by six teachers (17%), and increased for 13 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers indicated they were likely to continue teaching PAL, although they reported concerns about students not learning as much during PAL. Some teachers felt older students could be more lethargic and resistant: "*the younger ones love getting up and interacting with each other. I think the older ones do, it just takes… more effort to get them going*" (History teacher, female).

The majority of teachers reported ≤15 minutes for planning, ≤5 minutes for classroom preparation, and ≤5 minutes for student preparation. The time needed to deliver an outdoor

activity – in particular the transition between indoors and outdoors - was identified as a barrier to implementation. The assistant head teacher also commented about the pitch of the training and poor use of learning time due to transitioning. They felt the indoor component of the training had been more informative and appropriate, and commented staff had used active learning strategies indoors, but not outdoors. Finally, they commented that PAL implementation had declined with time.

Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue teaching PAL, with no evidence of differences in intervention acceptability by sex or weight status. Students commented that PAL were fun and helped learning, and they liked moving more: "*I really enjoyed it. It gave me more of an understanding… because when you're just copying off the board some writing I don't always understand it, then when you're moving about it's a lot more clearer*" (Year-7, female). Students however also commented that during PAL some students messed around more and didn't focus on work, and work was easier to do when sitting down.

Student PAL dose

In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each). Each teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an

average of 6.9 PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range: 2-13; 28%). This represents the contribution across all subjects.

Costs

The cost of delivering the training was £901, comprised of £451 staff time and £450 equipment. Session one was delivered by three trainers, while session two was delivered by four trainers. Four teachers purchased resources to support PAL delivery, including science equipment, textiles equipment, post-it notes and whiteboard pens, and printed resources. Four students reported purchasing resources to support PAL participation – three purchased sports shoes (~£30 per pair) and one a mouth guard (~£7).

Preliminary Effectiveness

Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama lessons). There was no evidence of changes in sedentary activity or time spent in light, moderate and vigorous activity intensities. Table 4 summarises baseline and follow-up values for all outcome measures for intervention and control participants. There was no evidence of preliminary effectiveness on sedentary time or light activity, or on indicators of mental health and wellbeing (including academic efficacy, positive & negative affect, and disruptive behaviour).

Pilot Study - Reflections

Extending the work conducted in the feasibility study, this pilot study demonstrates the feasibility of whole-school intervention delivery. However, teachers expressed numerous concerns about the PAL training, including the insufficiently challenging content, lack of understanding of the value/purpose of the outdoor component, and potential loss of valuable learning time. These examples are consistent with previous research reporting that time and standardised testing pressures are barriers to PAL implementation, particularly for secondary school teachers[14]. The feedback suggests a need to review the content of the training, particularly the outdoor component.

Teachers comments indicated acceptability of delivering PAL and there was a measurable increase in PAL delivery. Feedback suggests teachers' acceptability may reflect prior knowledge and experience of PAL. In addition, students reported enjoying PAL. Support for the intervention by multiple stakeholders is an important facilitator of successful implementation[43]; as such, the feedback received here is encouraging.

Some students reported purchasing sports shoes and mouthguards for PAL; none of the strategies introduced in the PAL training involved students changing clothing/shoes or using mouthguards. It is conceivable that when completing the follow-up questionnaire some

students considered P.E. lessons in their appraisal of PAL and reported shoes and mouthguards purchased for this.

We successfully tested study procedures and intervention delivery at a whole-school level, with adequate recruitment and retention rates and continued control school involvement indicating acceptability of randomisation. Efforts made to improve data collection processes from the feasibility study, e.g., of student timetables and teacher questionnaires, were successful.

The assessment of PAL dose showed that students received an average of 6-7 x 60-minute PAL a week, which has the potential to make a valuable contribution to reducing sedentary time among adolescents. Despite a measured increase in PAL delivery, there was no evidence of reduced sedentary time, suggesting a need to review the PAL strategies that were shared with teachers, with a focus on the amount of activity introduced. It is also possible that teachers over-reported PAL delivery out of concern for being judged by the researchers and/or their senior leadership team.

OVERALL DISCUSSION

In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and costs of a teacher-training programme for integrating activity into secondary school lessons. We also sought to understand the feasibility and acceptability of study procedures, including repeated accelerometer wear and school-level randomisation. The intervention was successfully delivered in two schools and quantitative and qualitative data was successfully collected from multiple stakeholders, enabling us to address all research questions. The majority of PAL evaluations have been carried out in primary schools[9] and as such, this study makes a valuable contribution to the literature.

Feasibility/acceptability of PAL training

Consistent with previous research, it was feasible to deliver PAL training to secondary school teachers over two, 2-hour, after-school sessions[50]. Schools scheduled the PAL training during pre-scheduled after-school teacher-training slots, as such, the intervention did not require teachers to attend any more after-school training than they typically would within a school term. In both studies, a small number of teachers were unable to attend both training sessions which may have influenced intervention outcomes. It is realistic that at any school receiving the intervention, a proportion of staff would be unable to attend both training sessions. As such the external validity of the findings is supported.

While acceptability of the training was demonstrated in the feasibility study and is reported elsewhere[18, 44, 50], feedback from teachers in the pilot study was less positive. Delivery to teachers of two subjects in the feasibility study meant a smaller training group and a smaller trainer:staff ratio than in the pilot study. This allowed more subject-specific discussion and more time to address teachers' personal questions. Teacher feedback suggests that training acceptability is related to teachers' experience delivering PAL. In the pilot study, teachers delivering PAL more regularly rated the intervention more poorly than less experienced teachers. A PAL intervention targeting teachers not regularly delivering PAL may be more acceptable. The positive responses to the training in the feasibility study (involving teachers reporting low levels of PAL delivery) support this suggestion.

Feasibility/acceptability of delivering/participating in PAL

In the feasibility study, teachers had mixed reviews of delivering PAL, whereas in the pilot study, teachers reported acceptability of delivering PAL. Pilot study teachers were more likely to report regular PAL delivery at baseline than feasibility teachers and to have had previous exposure to PAL during their initial teacher training and/or career. A longer trial period and increased support may have allowed teachers in the feasibility study to become more confident and accrue more positive PAL experiences. Overall, the data suggest that PAL delivery can be acceptable to secondary school teachers.

While teachers were the direct intervention recipients and their acceptability is crucial for successful implementation, it is important to consider acceptability for other stakeholders, who also influence implementation. Across both studies students responded positively to PAL, and senior leadership representatives reported satisfaction with the intervention (in the pilot study, satisfaction with the indoor component). Both senior leadership representatives commented that reasons for study participation included the potential positive influence on students' mental health. This observation is consistent with previous findings[7] and indicates potentially effective strategies for promotion of the intervention to schools.

Preliminary Effectiveness

Despite a measured increase in PAL delivery, no changes in activity were observed. The findings are consistent with a systematic review and meta-analysis of secondary school classroom-based physical activity interventions, which reported no significant influence on activity behviours[51]. Although, other PAL feasibility and pilot studies have reported more encouraging changes[42, 51-53]. In the feasibility study, early implementation efforts of Maths and English teachers may not have been sufficient to translate to changes in activity. It's possible that more or longer training sessions could increase teacher's confidence and competency for delivering PAL, however, initial discussions with the feasibility study school suggested that a 2-hour after-school training session would be acceptable while a 3-hour

session would be too long. Across both studies, teachers were advised that any non-seated activity was considered an 'active lesson' - as such, the intervention may be too dilute for measurable impact using wrist-worn accelerometers; classroom observations of PAL (beyond assessing time on task) may have aided our interpretation of the findings. Overall, the results suggest the need to review the amount of activity the PAL strategies introduce.

Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose is consistent with previous studies, for example, 10-30 minutes of activity, daily[42, 53-56] and 3 x 60-minute PAL per week[57]. It is worth noting that teachers in the current pilot study chose how many PAL they delivered, rather than being prescribed a weekly target; as such the dose indicates what is naturally achievable by secondary school teachers. A weekly dose of 6-7 PAL has the potential to substantially reduce adolescents' sedentary time during school hours, providing sufficient activity is introduced as part of the PAL.

Costs

Training delivery costs (independent of travel and planning time) was estimated around £900 ($1,187) in both studies. Strategies to reduce costs could include reducing the number of staff delivering the sessions or hiring staff with a mixture of training levels, rather than the highly experienced staff in the current studies. Approximately 25% of the cost was spent on equipment, primarily for outdoor-based subject-specific examples; reviewing the equipment

purchases may identify cost saving opportunities. Research reports that small grants (~$2,000) to schools can lead to increased implementation of practices to promote activity[58]. Senior leadership teams commented on how thinly English schools budgets are stretched; it was suggested that school funds set aside for (for example) mental health services might represent an avenue of funding for the programme for some schools.

Strengths and Limitations

High quality formative work for interventions is necessary to ensure appropriate allocation of research efforts and funding, and the publication of feasibility and pilot research is important to support other researchers and interventionists[59]. Limitations of this work include that samples were predominantly white; consequently, we are unable to explore differential responses to PAL by ethnicity. Moreover, parental opt out consent procedures limited the ability to obtain information on participants' socioeconomic position. The issue of lack of diversity among samples in PAL studies has been previously raised[60]; future research should seek to explore feasibility, acceptability and effectiveness among different racial/ethnic and socio-economic groups. Estimated training delivery costs are based on wage rates, national insurance and superannuation costs but don't include overhead costs such as costs of employing individuals and providing building space. As such, training delivery costs may be underestimated. In addition, we did not carry out longer-term follow-up assessments so we do

not know if teachers continued to deliver PAL beyond eight weeks after the training. Finally, we do not believe that lack of blinding of measurement staff has impacted the conclusions drawn from these studies, but acknowledge that a potential fully-powered trial would benefit from efforts to blind measurement staff.

CONCLUSION

We successfully demonstrated the feasibility and acceptability of introducing and evaluating a PAL teacher-training programme in secondary schools. Across feasibility and pilot studies, teachers' acceptability of the intervention and of delivering PAL was demonstrated, although aspects of the training programme, particularly the outdoor component, require review. The intervention was acceptable to students and senior leadership representatives, and the dose of PAL received by students was sufficient to have the potential to make a substantial contribution to reducing adolescents' sedentary time during school hours. However, we did not observe preliminary effectiveness on students' activity behaviours or wellbeing indicators. Taken together, the findings do not support continuation with the current PAL training programme, though its acceptability does highlight the need for further research into how the identified barriers might be overcome.

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Data sharing

The datasets are not available for download. The study's participant information sheets and ethics applications stipulated that the data would not be shared outside of the research team. The data are held at the MRC Epidemiology Unit at the University of Cambridge.

Competing interests

The authors declare that they have no competing interests.

Author contributions

All authors (Catherine Gammon, Katie Morton, Andrew Atkin, Kirsten Corder, Andy Daly-Smith, Thomas Quarmby, Marc Suhrcke, David Turner and Esther van Sluijs) contributed to the conceptualisation and design of the work, and reviewed and approved the final manuscript. Catherine Gammon, David Turner, and Esther van Sluijs contributed to the acquisition, analysis and interpretation of data. Catherine Gammon drafted the manuscript.

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Figure legends:

Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

Table 1. Outline of the PAL training programme and timeline of evaluation measures.

	Week 0 Baseline Measures	Week 1	Week 4	Week 12 Follow-Up Measures
Feasibility Study	**Students**: • Anthropometry • Questionnaire (15 minutes) • Accelerometry • Time-on-Task **Teachers**: • Questionnaire	**Training session 1** (2 hours) **30 minutes:** Introduction to active learning **40 minutes:** Split group in half: • Half stay in classroom and review classroom-based PAL strategies • Half go outside and review outdoor PAL strategies **40 minutes:** Groups switch **10 minutes:** Final comments	**Training session 2** (2 hours) **30 minutes**: Sharing PAL experiences **30 minutes**: Outdoor PAL examples **15 minutes**: Indoor PAL examples **15 minutes**: Discussion of intervention expectations **10 minutes**: Post-training questionnaire	**Students**: • Questionnaire (15 minutes) • Accelerometry • Time-on-Task • Focus groups **Teachers**: • Questionnaire • Focus group **Senior Leadership Team**: • Interview
Pilot Study: Intervention School	*Same as for feasibility study baseline measures*	*Same as for feasibility study training session 1*	**Training session 2** (2 hours) **45 minutes**: Split group in half: • Half review indoor PAL strategies • Half review outdoor PAL strategies **45 minutes**: Groups switch	*Same as for feasibility study follow-up measures*

			10 minutes: Whole-group outdoor activity. **10 minutes**: Post-training questionnaire	
Pilot Study: Control School	*Same as for feasibility study baseline measures*	No training session	No training session	**Students**: • Questionnaire • Accelerometry • Time-on-Task

Table 2. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	76	237.4 (26.4)	246.1 (27.6)	8.7 (3.8,13.7)
Light activity (minutes)	76	139.8 (21.8)	131.7 (22.6)	-8.1 (-12.4,-3.8)
Moderate activity (minutes)	76	10.8 (6.0)	10.3 (5.8)	-0.6 (-1.4,0.3)
Vigorous activity (minutes)	76	2.0 (2.0)	1.9 (1.8)	-0.1 (-0.4,0.3)
Time-on-task (% intervals on-task)	11	66.1	-	-
Academic Efficacy (score 1-5)	85	3.51 (0.80)	3.63 (0.83)	-
Disruptive Behaviour (score 1-5)	82	1.90 (0.95)	1.94 (0.98)	-
CHU-9D (score 0.33-1.0)	89	0.86 (0.10)	0.84 (0.10)	-
Positive Affect (score 1-5)	81	17.35 (3.44)	16.16 (3.36)	-
Negative Affect (score 1-5)	84	10.55 (3.28)	10.71 (3.48)	-

Length of school day = 390 minutes

Table 3. Activity intensity during 60-minute PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama); mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	310	41.1 (8.4)	42.1 (8.6)	1.0 (-0.1,2.1)
Light activity (minutes)	310	17.9 (7.6)	16.9 (7.8)	-1.1 (-2.1,0)
Moderate activity (minutes)	310	0.8 (1.0)	0.9 (1.0)	0 (-0.1,0.2)
Vigorous activity (minutes)	310	0.2 (1.1)	0.2 (0.6)	0 (-0.1,0.1)

Table 4. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	Control School [a]				Intervention School [a]			
	N	Baseline	Follow-Up	Mean Difference (95% C.I.)	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	74	217.0 (32.4)	222.1 (36.2)	5.1 (-1.3,11.5)	96	236.4 (31.8)	237.7 (40.6)	1.3 (-6.2,8.7)
Light activity (minutes)	74	140.5 (26.0)	136.6 (31.9)	-4.0 (-10.1,2.2)	96	129.0 (26.8)	124.8 (31.2)	-4.2 (-10.5,2.1)
Moderate activity (minutes)	74	16.2 (7.5)	14.2 (7.8)	-2.0 (-3.2,-0.8)	96	11.1 (6.3)	10.1 (6.3)	-1.1 (-2.0,-0.1)
Vigorous activity (minutes)	74	5.5 (3.9)	4.7 (3.5)	-0.8 (-1.4,-0.2)	96	3.1 (3.0)	3.0 (2.9)	-0.1 (-0.6,0.4)
Time-on-task (% intervals on-task)	28[b]	73.7	56.6	-	27[c]	79.1	77.5	-
Academic Efficacy (score 1-5)	98	3.41 (0.71)	3.32 (0.71)	-	107	3.76 (0.64)	3.71 (0.76)	-
Disruptive Behaviour (score 1-5)	98	2.34 (1.23)	2.47 (1.19)	-	107	1.94 (0.94)	2.04 (1.01)	-
CHU-9D (score 0.33-1.0)	97	0.84 (0.10)	0.84 (0.09)	-	106	0.87 (0.09)	0.85 (0.10)	-
Positive Affect (score 1-5)	98	15.95 (3.33)	16.08 (3.53)	-	107	17.80 (3.10)	17.54 (3.74)	-
Negative Affect (score 1-5)	98	10.03 (3.30)	9.87 (3.14)	-	106	10.12 (3.47)	9.95 (3.06)	-

[a] Length of school day varies: control school = 380 minutes, intervention school = 400 minutes

[b] 14 students observed at baseline across 4 classes (all non-active lessons) and 14 students observed at follow-up across 4 classes (all non-active lessons). Students observed at baseline were different from students observed at follow-up.

[c] 14 students observed at baseline across 4 classes (all non-active lessons) and 13 students observed at follow-up across 4 classes (3 active lessons, 1 non-active lesson). Students observed at baseline were different from students observed at follow-up.

Text Box 1.

"*I really enjoyed them (active lessons), they (the students) enjoyed them as well, they seemed to get a lot out of them…it was good fun, it was nothing really any different to what I was normally doing, just with a few added extras*" (Maths teacher, female).

"*I thought they (the students) would enjoy going outside… I had high hopes for that but it was a Friday afternoon and I don't think they were ready for it… they were causing disruption, they tried to walk off*" (English teacher, female).

"we concentrated more because it was more fun than just sitting around" (Year-7, male), and "*when you're sitting down you can get quite bored and get easily distracted whereas if you're moving about you've actually got something to do*"(Year-7, female).

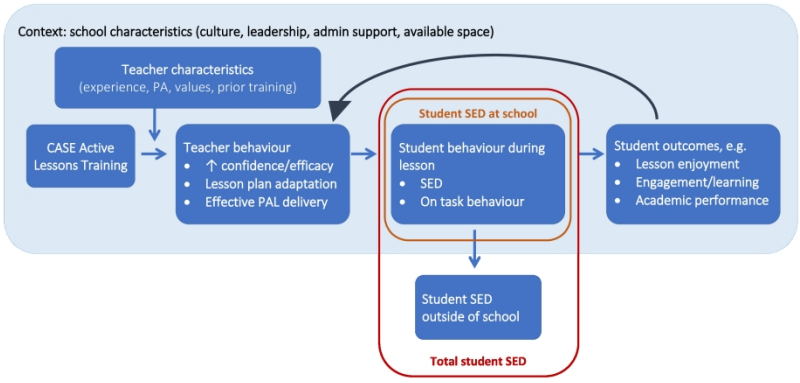

Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

297x209mm (300 x 300 DPI)

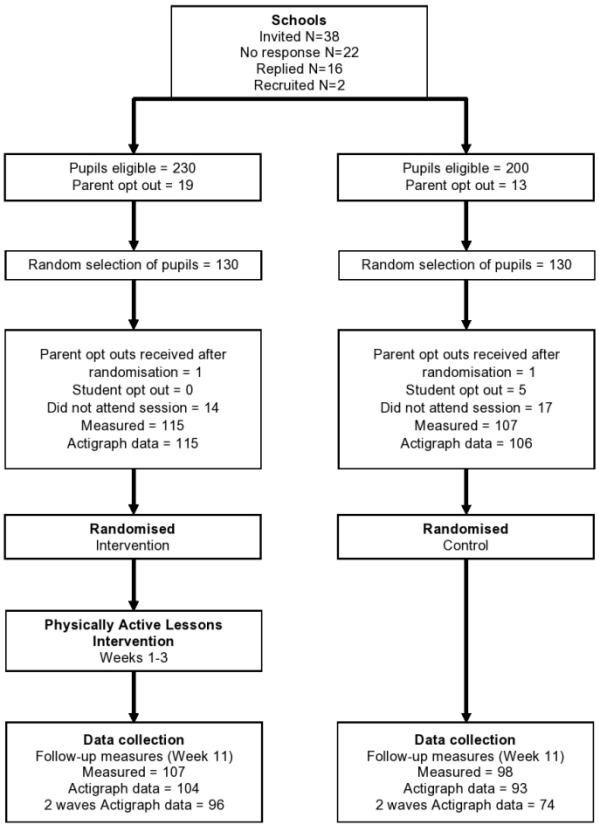

Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

104x148mm (300 x 300 DPI)

Supplementary Table 1. Descriptive, recruitment and retention statistics of student participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
N schools	1	1	1
N students invited	360	200	230
N parent opt out	25	13	19
N students randomly selected	120*	130*	130*
N student non assent	7	5	0
N student non attendance	11	17	14
N students assented	99	107	115
N two time points	91	98	107
N accepted monitor at two time points	91	93	104
N with sufficient PA at two time points	76	74	96
Age (years)	13.0 (1.1)	13.1 (0.6)	12.7 (1.0)
Sex: N (% male)	51 (52)	53 (50)	58 (50)
Height (cm)	158.6 (8.7)	159.6 (8.9)	156.2 (9.8)
Weight (kg)	51.9 (14.9)	54.1 (13.7)	48.1 (10.4)
BMI percentile	56.8 (30.8)	63.2 (29.4)	57.6 (28.2)
% overweight/obese	26.6	29.0	19.1

PA: physical activity

*After random selection, a small number of parent opt-out replies were received for students that had been randomly selected for evaluation measures (feasibility study = 3, pilot control school = 1, pilot intervention school = 1), as such, the number of students randomly selected who were eligible to assent were: feasibility study = 117, pilot control school = 129, pilot intervention school = 129.

Supplementary Table 2. Descriptive statistics of schools and teacher participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
School information			
Students per year group (for years 7, 8, 9)	180	100	115
Ofsted rating	2 (Good)	2 (Good)	2 (Good)
% pupils eligible for free school meals	20.5%	36.2%	21.4%
% pupils with special education needs	3.6%	0.9%	1.9%
Teacher information			
N teachers invited	15	32	36
N teachers assented	13	32	36[a]
Age Category: N (%)			
18-24 years	1 (17)	6 (19)	1 (3)
25-34 years	2 (33)	7 (22)	5 (14)
35-44 years	2 (33)	9 (28)	7 (19)
44-45 years	1 (17)	9 (28)	11 (31)
55-64 years	0	1 (3)	3 (8)
65 years +	0	0	0
N (%) male	2 (33)	10 (31)	10 (28)
Teaching Experience: N (%)			
< 1 year	1 (17)	8 (25)	0
2-5 years	2 (33)	7 (22)	6 (17)
6-10 years	2 (33)	5 (16)	7 (19)
>10 years	0	10 (31)	13 (36)
Current active lesson delivery N (%)			
Never/rarely	3 (50)	5 (16)	5 (14)
1-2 times / month	2 (33)	6 (19)	7 (19)
1-2 times / week	1 (17)	8 (25)	5 (14)
3-4 times / week	0	6 (19)	3 (8)
> once per day	0	6 (19)	6 (17)

[a]27 teachers attended the research team's study introduction and completed baseline questionnaires. A further 9 teachers consented at training session 1 or 2 and did not provide baseline data.

Supplementary Table 3. Teacher feedback on the PAL training programme; mean (SD).

		Pilot Study – Intervention School		
	Feasibility Study (n=9)	Whole Group (n=33)	Baseline PAL delivery < once per week (n=11)	Baseline PAL delivery ≥ once per week (n=14)
Usefulness of training in preparing you to deliver PAL *(1=not useful, 7=very useful)*	5.3 (0.5)	3.1 (1.4)	3.9 (1.6)	2.5 (1.1)
Appropriateness of depth and scope of training *(1=not appropriate, 7=very appropriate)*	5.2 (0.7)	3.1 (1.4)	3.6 (1.6)	2.7 (1.2)
Appropriateness of programme materials and resources *(1=not appropriate, 7=very appropriate)*	5.6 (1.3)	2.8 (1.4)	3.5 (1.6)	2.4 (1.2)
Clarity of program materials and resources *(1=not clear, 7=very clear)*	6.0 (0.7)	3.7 (1.2)	4.4 (1.3)	3.4 (1.1)
Relevance of training for your lessons *(1=not relevant, 7=very relevant)*	5.3 (1.1)	2.9 (1.4)	3.6 (1.4)	2.4 (1.4)
Would you recommend the training to other teachers? *N (%) yes*	9 (100)	15 (45)	7 (64%)	4 (29%)

Outdoor Active Lesson Examples

1. https://www.ltl.org.uk/pdf/Natural-Equations-2018-COMPLETE1518623029.pdf
2. https://www.ltl.org.uk/pdf/Fires-and-Cooking-Actvity1421850222.pdf

Indoor Active Lesson Examples

A. Jigsaw

What is it? The jigsaw is a cooperative learning strategy (one of several) whereby, as with a jigsaw puzzle, each piece (each student's part) is essential for the complete picture (full understanding of the final product). Here, if each student's part is essential then arguably, each student is essential!

Implications for classroom layout: There is minimal impact on classroom layout. Desk should be arranged together so students can sit together in small groups and be able to move between groups.

How does it work?

1. Divide students into 5 or 6-person jigsaw groups. Ideally these groups should be diverse in terms of gender, race/ethnicity and ability.
2. These groups are the 'Home teams'. In each home team, each team member should be given a letter (e.g. A, B, C etc.)
3. Team members then join their **Jigsaw team** e.g. all the A's, B's etc. get together. This will require them moving to their jigsaw teams. These jigsaw teams are responsible for discussing and understanding a pre-determined aspect or answering a particular task. For instance, a reading may be divided into several parts with each jigsaw team taking one of those parts.
4. As a teacher, you can move between each jigsaw team to ensure they are addressing the task in its entirety and the whole jigsaw team develops an understanding of it.

5. Jigsaw teams then return to back to their home teams to discuss what was learnt in the jigsaw team. **Each student will present her or his segment to the group** so that all learn from each other.

Benefits

- Learn a lot of material quickly
- Students are held individually accountable for their learning
- It helps to maximise student collaboration
- Encourages higher order and critical thinking skills.

B. Active Voting

What is it? This notion of Active Voting is useful for exploring differing and diverse opinions on particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of ambiguity and grey areas, which helps them to see that opinions often have to be justified with informed knowledge of the matter under discussion.

Implications for classroom layout: Each of the four key statements will need to positioned in one of corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree. When an issues is raised, pupils will then move to stand/sit in the corner that best reflects their views and with those who share the same opinion/perspective.

How does it work?

1. A range of issues (related to the content being delivered) should be read out in turn by the teacher.

2. Pupils are then given time to consider their opinion.
3. Pupils then move to the corner that best describes how they feel about what was read out. Pupils should be reminded that there are no right or wrong answers.
4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
5. When pupils move to the corner that best represent their views on the statement, they should be encouraged to explain why they feel that way with others in that group. General perspectives can be obtained from all corners.
6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and to refine the initial statement/problem/issues being discussed.
7. Pupils are allowed to move during the discussion of each statement if issues arrive that challenge their original opinion.
8. If pupils do switch then they should be encouraged to explain why.

Benefits

Developing thinking and decision making skills

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	1
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	2-3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	4-5, 11-12
	2b	Specific objectives or research questions for pilot trial	12
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	13
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	13
Participants	4a	Eligibility criteria for participants	5-6, 13
	4b	Settings and locations where the data were collected	5, 13
	4c	How participants were identified and consented	6, 13
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	30
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	7-9, 14-15, 30
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	N/A
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	N/A
Sample size	7a	Rationale for numbers in the pilot trial	6, 13
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	13
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	N/A

Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	13
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	13
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	7-9, 14-15, 30
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	13, Figure 2
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure 2
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Figure 2
	14b	Why the pilot trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Supp file 1 (pages 1-2)
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	31-33, figure 2
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	31-33
Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
	19a	If relevant, other important unintended consequences	N/A
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	22
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	22-23
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	19-23
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	22-23
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	5
Protocol	24	Where the pilot trial protocol can be accessed, if available	5
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	3, 24
	26	Ethical approval or approval by research review committee, confirmed with reference number	5

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.
*We strongly recommend reading this statement in conjunction with the CONSORT 2010, extension to randomised pilot and feasibility trials, Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility randomized trial in a journal or conference abstract

Item	Description	Reported on line number
Title	Identification of study as randomised pilot or feasibility trial	1-2
Authors *	Contact details for the corresponding author	11
Trial design	Description of pilot trial design (eg, parallel, cluster)	22
Methods		
Participants	Eligibility criteria for participants and the settings where the pilot trial was conducted	21
Interventions	Interventions intended for each group	27-30
Objective	Specific objectives of the pilot trial	18-20
Outcome	Prespecified assessment or measurement to address the pilot trial objectives**	31-34
Randomization	How participants were allocated to interventions	22
Blinding (masking)	Whether or not participants, care givers, and those assessing the outcomes were blinded to group assignment	22-23
Results		
Numbers randomized	Number of participants screened and randomised to each group for the pilot trial objectives**	N/A
Recruitment	Trial status†	N/A
Numbers analysed	Number of participants analysed in each group for the pilot objectives**	N/A
Outcome	Results for the pilot objectives, including any expressions of uncertainty**	35-40
Harms	Important adverse events or side effects	N/A
Conclusions	General interpretation of the results of pilot trial and their implications for the future definitive trial	41-43
Trial registration	Registration number for pilot trial and name of trial register	44
Funding	Source of funding for pilot trial	45

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

**this item is specific to conference abstracts*

***Space permitting, list all pilot trial objectives and give the results for each. Otherwise, report those that are a priori agreed as the most important to the decision to proceed with the future definitive RCT.*

†For conference abstracts.

BMJ Open

Introducing physically active lessons in UK secondary schools: feasibility study and pilot cluster-randomised controlled trial

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Introducing physically active lessons in UK secondary schools: feasibility study and pilot cluster-randomised controlled trial

Catherine Gammon[1], Katie Morton[1], Andrew J Atkin[1,2], Kirsten Corder[1], Andy Daly-Smith[3], Thomas Quarmby[3], Marc Suhrcke, David Turner[2], Esther van Sluijs[1*]

[1] MRC Epidemiology Unit and UKCRC Centre for Diet and Activity Research (CEDAR), University of Cambridge, Cambridge, UK

[2] School of Health Sciences, University of East Anglia, Norwich, UK

[3] Carnegie School of Sport, Leeds Beckett University, Leeds, UK

[4] Centre for Health Economics, University of York, York, UK

* Corresponding author: Dr Esther van Sluijs (ev234@medschl.cam.ac.uk; 01223 769189)

Address: UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge, CB2 0QQ, UK

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Word count: 5,717

Abstract

Objectives: Assess feasibility, acceptability and costs of delivering a physically active lessons (PAL) training programme to secondary school teachers and explore preliminary effectiveness for reducing pupils' sedentary time.

Design and setting: Secondary schools in East England; one school participated in a pre-post feasibility study, two in a pilot cluster-randomised controlled trial. In the pilot trial, blinding to group assignment was not possible.

Participants: Across studies, 321 randomly selected students (51% male; mean age: 12.9 years), 78 teachers (35% male) and two assistant head-teachers enrolled; 296(92%) students, 69(88%) teachers and two assistant head teachers completed the studies.

Intervention: PAL training was delivered to teachers over two after-school sessions. Teachers were made aware of how to integrate movement into lessons; strategies included students collecting data from the environment for class activities, and completing activities posted on classroom walls, instead of sitting at desks.

Primary and secondary outcomes: Quantitative and qualitative data were collected to assess feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline and ~8 weeks post-training; measures included accelerometer-assessed activity, self-

reported well-being, and observations of time-on-task. Process evaluation was conducted at follow-up.

Results: In the feasibility study, teachers reported good acceptability of PAL training and mixed experiences of delivering PAL. In the pilot study, teachers' acceptability of training was lower and teachers identified aspects of the training in need of review, including the outdoor PAL training and learning challenge of PAL strategies. In both studies, students and assistant head-teachers reported good acceptability of the intervention. Preliminary effectiveness for reducing students' sedentary time was not demonstrated in either study.

Conclusions: No evidence of preliminary effectiveness on the primary outcome and mixed reports of teachers' acceptability of PAL training suggest the need to review the training. The results do not support continuation of research with the current intervention.

Trial registration: ISRCTN registry; ISRCTN38409550.

Funding: Department of Health Policy Research Programme (PR-R5-0213-25001).

Article Summary

Strength and limitations of this study

- We completed thorough feasibility and pilot testing work to inform the decision of whether to progress with the current intervention and its evaluation.
- We collected quantitative and qualitative data which provided valuable information on contextual influences and allowed us to address research questions more comprehensively.
- We were unable to collect all planned follow-up measures from teachers and students in feasibility study, including teacher follow-up questionnaires and class observations of time-on-task.
- We did not carry out longer-term follow-up measures of teacher acceptability and physically active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up would have provided an indication of the sustainability of the intervention.

INTRODUCTION

Globally, most adolescents (~80%) do not achieve government-recommended physical activity guidelines[1] and engage in high levels of sedentary behaviour[2]. As such, interventions are needed to support youth in achieving a healthy activity profile. Secondary/high schools present an opportunity for the implementation of activity interventions, as during school hours activity is lower and sedentary time is higher than during other segments of an adolescent's week[3, 4].

The Creating Active School Environments (CASE) project is a three-year research programme funded by the UK Department of Health Policy Research Programme. CASE aims to identify environmental strategies to help adolescents move more and sit less during school hours. Initial phases of CASE involved a systematic literature review[5] and secondary data analysis[6] to identify promising secondary school-based activity interventions. Morton and colleagues (2017) subsequently completed a Delphi study, involving stakeholders in the prioritisation of interventions. Physically active lessons (PAL) were perceived to be the most feasible, acceptable and cost-effective intervention for secondary school settings[7]; these results informed the final, feasibility and pilot-testing phase of CASE.

PAL are a pedagogical approach whereby activity supports the delivery of academic material[8]. During PAL, movement is integrated into teaching and as such, PAL are distinct

from 'brain/movement breaks', when activity is separate from learning. Evidence from primary schools indicates that PAL can improve physical activity, academic achievement and lesson enjoyment[9-12]. To our knowledge, only two studies have trialled the use of PAL among adolescents[13, 14]. Helgeson (2013) reported no influence of the 'Energizers' PAL programme on reading comprehension scores among junior high school students and did not explore activity levels as a primary outcome[13]. Cothran and colleagues (2010) reported on primary and secondary/high school teachers' experiences of a one-year movement integration intervention. Compared to primary school teachers, secondary teachers faced different challenges when attempting to integrate activity into lessons, in particular standardised testing pressures and students not staying with one teacher all day (as typically is the case in primary schools)[14]. Cothran and colleagues did not measure student activity behaviours as an intervention outcome[14]. The positive effects of PAL reported for primary students suggest there is value in exploring if secondary students can experience similar benefits. Given the organisational and environmental differences between primary and secondary schools, it is important to conduct high quality feasibility and pilot testing of secondary school PAL interventions.

A PAL training programme for secondary school teachers was tested in a feasibility study and a cluster-randomised controlled pilot study. The studies aimed to explore the feasibility,

acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary teachers. Acceptability of study processes was also examined, in anticipation of conducting a subsequent full trial. The feasibility study tested the intervention among maths and English teachers at one school, the pilot study tested the intervention among all-subject teachers and as part of a controlled trial. This paper presents the feasibility study and pilot study followed by an overall discussion and conclusion (ISRCTN38409550).

1. FEASIBILITY STUDY

Ethical approval for both studies was granted by the University of Cambridge's School of the Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the feasibility, acceptability, costs, and preliminary effectiveness (for reducing sedentary time and improving wellbeing and time-on-task among students) of a PAL training programme for secondary school teachers, and (ii) the feasibility and acceptability of study procedures.

Feasibility Study - Methods

Recruitment

Potential schools were identified from previous local research and approached with study information (n=2). One mixed-sex, non fee-paying secondary school participated. The head

teacher provided written consent for the intervention to be delivered to the teachers, elected for the intervention to be trialled with maths and English teachers, and chose years 7 and 9 to participate in study evaluation measures. The school were told they would be able to keep the PAL training resources.

Parents of all Year 7 and 9 students (11-14 years) received study information and students were invited to participate in evaluation measures. Parents were given two weeks to opt out (passive parental consent) via email, freephone, or freepost. From the students who had not been opted out, 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly selected for evaluation measures (using class lists and random number generating software). The study's feasibility focus meant that a formal power calculation was not necessary to inform sample size; a sample of 60 participants per year is consistent with samples of similar studies[15]. Students provided written assent for evaluation measures.

Maths and English teachers (n=15) received study information two weeks before the PAL training. The senior leadership team requested that all maths and English teachers attend the training. Teachers could choose to participate in the evaluation measures, those agreeing provided written consent. Over five school days students received approximately five maths lessons and four English lessons.

Intervention

The PAL training was developed by a team with teacher training qualifications and experience in indoor (two trainers) and outdoor active learning (one trainer). The training was delivered at the intervention school between March and April, during pre-scheduled after-school teacher-training time. Table 1 outlines the training programme and example active lessons are published as supplementary material. The focus was on supporting teachers to adopt active pedagogical approaches (teaching strategies that incorporate activity), rather than providing new, PAL plans. The training was underpinned by aspects of social cognitive theory and aimed to enhance teachers' self-efficacy in relation to PAL[16]. As such it drew from two prominent behaviour change techniques: barrier identification and modelling/demonstrating behaviour[17]. With the former, teachers were encouraged to identify barriers that might impact their ability to implement PAL and plan ways to overcome these. With the latter, the trainers demonstrated a plethora of PAL teaching strategies that teachers could employ in their lessons. Figure 1 outlines the preliminary logic model of how the teacher-focused intervention could lead to changes in students' activity. Prior to the training, the research team visited the participating school and ascertained the availability of indoor and outdoor spaces and equipment that could be used for PAL. Syllabi for maths and English were requested to allow trainers to prepare relevant examples for the training.

Measurements

Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed using questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7 and four Year-9 students) and an interview with the assistant head teacher were completed using a semi-structured interview.

i. Evaluation of Intervention and Study

Feasibility/acceptability of the intervention: Questionnaire items and focus group questions asked about teachers' perceptions of the utility, value and relevance of the training (adapted from[18, 19]). Questionnaires asked if teachers would recommend the training to other teachers and provided free-text boxes for teachers to suggest improvements. Training session attendance rates were recorded.

Feasibility/acceptability of PAL delivery: Questionnaire items and focus group questions asked teachers about classroom management during PAL, enjoyment of teaching PAL, time needed to prepare and deliver PAL, and barriers to PAL delivery (items from[20]).

Acceptability of PAL participation: Questionnaire items and focus group questions asked students about their experience of PAL participation, enjoyment of PAL, their preference for active vs. desk-based lessons, and the best and worst things about PAL.

Costs: Teachers and students reported resources purchased to deliver/participate in PAL. The research team recorded time and costs associated with the training team's development and delivery of the intervention.

Study processes: The research team made field notes on study processes that proved to be challenging or ineffective, for example, students struggling to understand a questionnaire item.

ii. Intervention Outcomes

Student anthropometry: Anthropometric measures were completed by trained staff using standard procedures. Height was measured using a stadiometer (Leicester height measure, Chasmors, Leiceter, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg (Tanita, type TBF-300A, Tokyo, Japan). The measurement stations were set up so that results were not visible to anyone except the measurement staff. Height, weight, sex, birthdate and measurement date were used to calculate participants' body mass index (BMI; kg/m^2) and BMI percentile.

Activity intensity: Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were used to measure activity behaviours. These devices have been used among a larger sample of Year-9 participants in the GoActive study[21] and the UK Biobank Cohort Study[22]. Wrist-worn monitors are validated for the assessment of energy expenditure in pediatric

populations[23] with higher participant compliance when compared to waist-worn accelerometers[24]. Participants were given verbal and written instructions on monitor wear, including that the monitor was waterproof and could be worn continuously for the next seven days (Monday to Monday).

The first day of monitor wear was dropped[25]; included participants provided valid data for ≥80% of school hours for ≥two school days, at baseline and follow-up[26-28]. Acceleration was recorded at 100Hz with a dynamic range of ±8g. Data from the monitors was downloaded in continuous waveform. Euclidean Norm Minus One (ENMO) represents acceleration magnitude at each measurement, accounting for the influence of gravity. ENMO thresholds were used to classify activity intensities: time spent at 0-30 ENMO was classified as sedentary activity (equivalent to 1-1.5 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-500 ENMO as moderate-intensity activity (4-7 METs), and above 500 ENMO as vigorous-intensity activity[29, 30].

Mental Health and Wellbeing: Students completed questionnaire measures of positive and negative affect[31], academic efficacy, disruptive behaviour[32], enjoyment of school classes[33] and health related quality of life[34-39] at baseline and follow-up. All questionnaires are validated for use with adolescents and were analysed according to published instructions[31, 32, 39].

Time-on-task: Students' time-on-task was assessed during three lessons by one member of the research team using a momentary time-sampling procedure (which incurs less bias than other sampling procedures[40, 41]). At the start of each observed class, the teacher asked all students participating in the study to raise their hands. From the students that raised their hands, the researcher identified two boys and two girls (when possible) to observe. The researcher chose students sitting in different areas of the classroom. Each student was observed once per minute, in a consistent order, for the duration of the lesson. Students' behaviour was coded as: (i) on-task, (ii) off-task-passive, (iii) off-task-motor, or (iv) off-task-noise[42]. The mean percentage of intervals recorded as 'on task' for observed students and classes was calculated and used as the outcome measure.

Prior to classroom observations, a validation activity was completed where two researchers discussed definitions and concurrently coded student behaviour using four online videos. Observers' codes matched for 95% of observation intervals.

Descriptive Statistics

Descriptive statistics of the sample, primary and secondary outcomes, and quantitative measures of feasibility and acceptability are summarised. Focus group transcripts were reviewed; recurring comments and themes relevant to the research questions were identified.

Feasibility Study - Results

Recruitment and sample characteristics

Student and teacher recruitment and characteristics are summarised in supplementary tables 1 and 2. Of 120 students invited to participate in the evaluation measures, 99 were recruited, with 91 (92%) providing data at baseline and follow-up. Students had a mean age of 13.0 (±1.1) years, 52% were male and 27% were classified as overweight/obese. Teachers were predominantly female (67%) and below the age of 45 (83%).

Feasibility and Acceptability

Training session one was attended by 14 (out of 15) teachers (7 maths, 7 English), training session two was attended by 12 teachers (7 maths, 5 English), 11 teachers attended both sessions. Teacher feedback demonstrated acceptability of the training, with 100% recommending the training to other teachers (supplementary table 3). Individual and collective efficacy for delivering PAL improved from 2.7 to 3.2, and 2.4 to 3 (out of 4), respectively. At follow-up, ≥eight teachers had attempted to deliver PAL. Teacher's goals for PAL delivery averaged 2.1 (SD=1.0) lessons per week, with an average targeted reduction in sitting time of

15.8 (SD=8.0) minutes. Some teachers reported positive experiences of delivering PAL, while others reported challenges (Text box 1).

Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting, challenges re-focusing students after an active portion of class, and limited classroom space. Teachers identified facilitators of PAL delivery as theirs and the students' enjoyment of PAL, good weather allowing them to go outside, more classroom space and a more diligent group of students. Teachers reported ≤15 extra minutes were required to plan PAL, and a few extra minutes were needed to prepare students for PAL participation.

Of the students who recalled participating in an active lesson (47%), most preferred PAL to desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to continue delivering them. Students reported enjoying going outside and moving around (30%), that PAL were less boring/more fun than desk-based lessons (26%) and that they could concentrate better (14%). Negative comments about PAL included lethargy (12%), more disruptive behaviour (9%), and less work achieved (12%; text box 1).

The assistant head teacher felt the training was well-received and high-quality professional development. The school's reasons for participating in the project included the potential for improving students' mental health and the motivation to be innovative in the classroom. The

assistant head teacher commented that teaching staff had enjoyed taking students outside for lessons and the project had involved a low level of commitment from the school.

Costs

Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment. Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student, ~£30).

Study Processes

The majority of study procedures were completed successfully. Challenges encountered included that students struggled to complete a blank timetable indicating when their Maths and English lessons were, and despite efforts, we were unable to schedule follow-up classroom observations. Teacher baseline questionnaire return was low and the follow-up focus group was conducted in a 15-minute timeslot due to late changes.

Preliminary effectiveness

Table 2 summarises baseline and follow-up data for all student measures. Sedentary time increased by 8.7 minutes and time spent in light-intensity activity decreased by 8.1 minutes. Minimal changes were observed in the mental health and wellbeing scores between baseline and follow-up.

Feasibility Study - Reflections

The findings suggest it is feasible and acceptable to deliver a PAL training program to secondary school maths and English teachers. Importantly, the senior leadership representative was supportive of the training[43]. Secondary school teachers had mixed reports of delivering PAL, the identified barriers and facilitators were consistent with those previously reported[43]. It was noted that teacher acceptability of PAL delivery should be explored further in the next phase of intervention evaluation. The positive student response to PAL indicates acceptability and is consistent with results from PAL interventions in primary schools[44].

We were successful in recruiting and consenting participants, and the majority of evaluation measures were completed without problems. The retention of >90% of participants from baseline to follow-up suggests evaluation measures were acceptable. Suggested changes included scheduling all research activities at the start of the project and acquiring student timetables from the school's administration team.

Limitations of this feasibility study include the small sample size and the lack of control group, making it not possible to draw conclusions about the contribution of the intervention to the observed changes. The change in sedentary activity levels is inconsistent with previous research reporting that younger children's sedentary time on weekdays decreases between

spring and summer[45]. Increased negative feelings and lower wellbeing among students between March and June is consistent with typical changes observed in students' wellbeing over a school term[46, 47].

2. PILOT STUDY

Following successful implementation of the intervention in the feasibility study, we sought to extend our previous work and explore the potential value of conducting a full-scale randomised controlled trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the feasibility, acceptability, preliminary effectiveness and costs of delivering a PAL intervention at a whole-school level (to all subject teachers) and (ii) to test the acceptability of school-level randomisation.

Pilot Study - Methods

Recruitment and Randomisation

Schools: We aimed to recruit three schools - two intervention (to test whole-school delivery of the intervention in different settings) and one control (to test the acceptability of school-level randomisation). In June-July 2017, 26 non fee-paying, mixed gender, secondary schools in

the East of England were emailed study information and invited to participate (the school that took part in the feasibility study was not invited to participate in the pilot study). The first three schools to agree were recruited; one school withdrew prior to student recruitment (and randomisation). We were unable to replace the school within an appropriate timeframe. After baseline measures, individuals separate from the research team performed a coin-toss to assign intervention and control schools. The nature of the intervention and goals of the evaluation measures meant it was not possible to blind participants. Due to differences in follow-up measures between control and intervention schools, it was not possible to blind measurement staff at follow-up.

Students: Recruitment proceeded as outlined for the feasibility study. Schools were asked to choose one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation measures. This would allow assessment of differential responses to the intervention by age. The intervention school selected Years 7 and 9 and the control school selected Years 8 and 9. Following feasibility study procedures, we randomly selected 130 students (50% male, 50% from each year) from each school for evaluation measures (based on feasibility study retention rates), with the aim of obtaining full data on 100 participants.

Teachers: A teacher information and recruitment meeting was scheduled at both schools, during which a researcher introduced the study and distributed consent forms. Teachers were

advised by their senior leadership team that they would be required to attend the PAL training if allocated as the intervention school; all teachers were free to decide on participation in evaluation measures.

Intervention

Extending the feasibility study, the intervention was delivered to all subject teachers. Training all subject teachers is consistent with the whole-school approach recommended for activity promotion and obesity prevention among youth[48, 49]. Given the acceptability of the training demonstrated in the feasibility study, the structure and goals of the training for the pilot study were similar. Minimal changes were made to the indoor training component, which focused on generic active learning strategies, applicable to any subject (e.g., different workstations around the classroom). In the feasibility study, the outdoor training component provided multiple subject- and topic-specific lesson ideas; the inclusion of all subject teachers meant fewer subject-specific examples could be actively worked through during the pilot study training. One additional outdoor lessons trainer was involved to train the larger group of teachers.

Measurements

Table 1 outlines the timeline of study measures; all data were collected at schools, during school hours. To increase teacher baseline questionnaire return, questionnaires were distributed during the pre-training teacher information meeting, and completed following consent. Data collection followed the same procedures as described for the feasibility study, except for the assessment of PAL dose and time on task.

PAL Dose: A teacher timetable was created using school-provided student timetables, detailing their Year 7 and 9 lessons. During the student accelerometer assessment at follow-up, teachers were given their personalised timetable and asked 'please circle which of the listed Year 7 and/or 9 classes were (or will be) delivered as an active lesson.' Teachers responses were used to calculate PAL dose. *Time on task:* Four lessons were observed at baseline and follow-up, at both schools. At baseline (prior to delivery of PAL training) the research team observed typical desk-based lessons. At follow-up, the research team asked to observe physically active lessons.

Patient and Public Involvement

In an earlier phase of CASE, opinions of key stakeholders regarding (i) suitable PA interventions for secondary schools and (ii) salient outcomes, were explored in a Delphi study ([7]). The decision to trial a PAL intervention and inclusion of mental health and time-on-task measures were informed by the Delphi study. While stakeholders were not involved in study

design, conduct or recruitment, they reviewed questionnaires and provided feedback on qualitative findings. Student participants received a personal PA report and participating schools will be provided with a summary of the findings. Assistant head teachers commented on the time commitment of the intervention and teacher participants reported on time spent implementing intervention components.

Descriptive statistics

Descriptive statistics and focus group analysis proceeded as outlined for the feasibility study.

Pilot Study - Results

Figure 2 shows the flow of participants, with further information on student and teacher recruitment and sample characteristics in supplementary tables 1 and 2. Of the assenting students (n=222) 92% provided data at two time points. Half of the students were male and 24% were classified as overweight/obese. The majority of teachers were female and >50% of staff reported delivering at least one PAL a week at baseline. At the intervention school, 30 and 33 teachers attended training session one and two, respectively (29 teachers attended both).

Feasibility and Acceptability

Average scores regarding teachers' acceptability of the training fell below 4 (the 'neutral' value) indicating negative feelings towards the training (supplementary table 3). Teachers reported training activities to be more suited for primary schools and not sufficiently challenging for secondary students. One teacher commented: *"they were more bonus activities, like extra treat things… you couldn't get much learning done through them"* (Science teacher, female). Teachers felt it was assumed they weren't delivering PALs prior to the training and this created resistance towards the training effort. Teachers reported that the PAL ideas were not novel and repetitive, the focus on outdoor learning was distracting, and the value of outdoor activities wasn't clear.

More than half of teachers reported delivering at least one PAL a week at baseline. PAL delivery decreased for four teachers (11%), was maintained by six teachers (17%), and increased for 13 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers indicated they were likely to continue teaching PAL, although they reported concerns about students not learning as much during PAL. Some teachers felt older students could be more lethargic and resistant: "*the younger ones love getting up and interacting with each other. I think the older ones do, it just takes… more effort to get them going*" (History teacher, female).

The majority of teachers reported ≤15 minutes for planning, ≤5 minutes for classroom preparation, and ≤5 minutes for student preparation. The time needed to deliver an outdoor

activity – in particular the transition between indoors and outdoors - was identified as a barrier to implementation. The assistant head teacher also commented about the pitch of the training and poor use of learning time due to transitioning. They felt the indoor component of the training had been more informative and appropriate, and commented staff had used active learning strategies indoors, but not outdoors. Finally, they commented that PAL implementation had declined with time.

Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue teaching PAL, with no evidence of differences in intervention acceptability by sex or weight status. Students commented that PAL were fun and helped learning, and they liked moving more: "*I really enjoyed it. It gave me more of an understanding… because when you're just copying off the board some writing I don't always understand it, then when you're moving about it's a lot more clearer*" (Year-7, female). Students however also commented that during PAL some students messed around more and didn't focus on work, and work was easier to do when sitting down.

Student PAL dose

In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each). Each teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an

average of 6.9 PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range: 2-13; 28%). This represents the contribution across all subjects.

Costs

The cost of delivering the training was £901, comprised of £451 staff time and £450 equipment. Session one was delivered by three trainers, while session two was delivered by four trainers. Four teachers purchased resources to support PAL delivery, including science equipment, textiles equipment, post-it notes and whiteboard pens, and printed resources. Four students reported purchasing resources to support PAL participation – three purchased sports shoes (~£30 per pair) and one a mouth guard (~£7).

Preliminary Effectiveness

Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama lessons). There was no evidence of changes in sedentary activity or time spent in light, moderate and vigorous activity intensities. Table 4 summarises baseline and follow-up values for all outcome measures for intervention and control participants. There was no evidence of preliminary effectiveness on sedentary time or light activity, or on indicators of mental health and wellbeing (including academic efficacy, positive & negative affect, and disruptive behaviour).

Pilot Study - Reflections

Extending the work conducted in the feasibility study, this pilot study demonstrates the feasibility of whole-school intervention delivery. However, teachers expressed numerous concerns about the PAL training, including the insufficiently challenging content, lack of understanding of the value/purpose of the outdoor component, and potential loss of valuable learning time. These examples are consistent with previous research reporting that time and standardised testing pressures are barriers to PAL implementation, particularly for secondary school teachers[14]. The feedback suggests a need to review the content of the training, particularly the outdoor component.

Teachers comments indicated acceptability of delivering PAL and there was a measurable increase in PAL delivery. Feedback suggests teachers' acceptability may reflect prior knowledge and experience of PAL. In addition, students reported enjoying PAL. Support for the intervention by multiple stakeholders is an important facilitator of successful implementation[43]; as such, the feedback received here is encouraging.

Some students reported purchasing sports shoes and mouthguards for PAL; none of the strategies introduced in the PAL training involved students changing clothing/shoes or using mouthguards. It is conceivable that when completing the follow-up questionnaire some

students considered P.E. lessons in their appraisal of PAL and reported shoes and mouthguards purchased for this.

We successfully tested study procedures and intervention delivery at a whole-school level, with adequate recruitment and retention rates and continued control school involvement indicating acceptability of randomisation. Efforts made to improve data collection processes from the feasibility study, e.g., of student timetables and teacher questionnaires, were successful.

The assessment of PAL dose showed that students received an average of 6-7 x 60-minute PAL a week, which has the potential to make a valuable contribution to reducing sedentary time among adolescents. Despite a measured increase in PAL delivery, there was no evidence of reduced sedentary time, suggesting a need to review the PAL strategies that were shared with teachers, with a focus on the amount of activity introduced. It is also possible that teachers over-reported PAL delivery out of concern for being judged by the researchers and/or their senior leadership team.

OVERALL DISCUSSION

In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and costs of a teacher-training programme for integrating activity into secondary school lessons. We also sought to understand the feasibility and acceptability of study procedures, including repeated accelerometer wear and school-level randomisation. The intervention was delivered in two schools and quantitative and qualitative data were successfully collected from multiple stakeholders, enabling us to address all research questions. The majority of PAL evaluations have been carried out in primary schools[9] and as such, this study makes a valuable contribution to the literature.

Feasibility/acceptability of PAL training

Consistent with previous research, it was feasible to deliver PAL training to secondary school teachers over two, 2-hour, after-school sessions[50]. Schools scheduled the PAL training during pre-scheduled after-school teacher-training slots, as such, the intervention did not require teachers to attend any more after-school training than they typically would within a school term. In both studies, a small number of teachers were unable to attend both training sessions which may have influenced intervention outcomes. It is realistic that at any school receiving the intervention, a proportion of staff would be unable to attend both training sessions. As such the external validity of the findings is supported.

While acceptability of the training was demonstrated in the feasibility study and is reported elsewhere[18, 44, 50], feedback from teachers in the pilot study was less positive. Delivery to teachers of two subjects in the feasibility study meant a smaller training group and a smaller trainer:staff ratio than in the pilot study. This allowed more subject-specific discussion and more time to address teachers' personal questions. Teacher feedback suggests that training acceptability is related to teachers' experience delivering PAL. In the pilot study, teachers delivering PAL more regularly rated the intervention more poorly than less experienced teachers. A PAL intervention targeting teachers not regularly delivering PAL may be more acceptable. The positive responses to the training in the feasibility study (involving teachers reporting low levels of PAL delivery) support this suggestion. Teacher's concerns regarding the lack of learning associated with PAL strategies must be an important consideration in the design of future PAL interventions. Student learning is the core focus of schools and implementation of PAL is likely to be contingent on teachers perceiving that PAL supports this goal.

Feasibility/acceptability of delivering/participating in PAL

In the feasibility study, teachers had mixed reviews of delivering PAL, whereas in the pilot study, teachers reported acceptability of delivering PAL. Pilot study teachers were more likely to report regular PAL delivery at baseline than feasibility teachers and to have had previous

exposure to PAL during their initial teacher training and/or career. A longer trial period and increased support may have allowed teachers in the feasibility study to become more confident and accrue more positive PAL experiences. Overall, the data suggest that PAL delivery can be acceptable to secondary school teachers.

While teachers were the direct intervention recipients and their acceptability is crucial for successful implementation, it is important to consider acceptability for other stakeholders, who also influence implementation. Across both studies students responded positively to PAL, and senior leadership representatives reported satisfaction with the intervention (in the pilot study, satisfaction with the indoor component). Both senior leadership representatives commented that reasons for study participation included the potential positive influence on students' mental health. This observation is consistent with previous findings[7] and indicates potentially effective strategies for promotion of the intervention to schools.

Preliminary Effectiveness

Despite a measured increase in PAL delivery, no changes in activity were observed. The findings are consistent with a systematic review and meta-analysis of secondary school classroom-based physical activity interventions, which reported no significant influence on activity behviours[51]. Although, other PAL feasibility and pilot studies have reported more encouraging changes[42, 51-53]. In the feasibility study, early implementation efforts of Maths

and English teachers may not have been sufficient to translate to changes in activity. It's possible that more or longer training sessions could increase teacher's confidence and competency for delivering PAL, however, initial discussions with the feasibility study school suggested that a 2-hour after-school training session would be acceptable while a 3-hour session would be too long. Across both studies, teachers were advised that any non-seated activity was considered an 'active lesson' - as such, the intervention may be too dilute for measurable impact using wrist-worn accelerometers; classroom observations of PAL (beyond assessing time on task) may have aided our interpretation of the findings. Overall, the results suggest the need to review the amount of activity the PAL strategies introduce.

Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose is consistent with previous studies, for example, 10-30 minutes of activity, daily[42, 53-56] and 3 x 60-minute PAL per week[57]. It is worth noting that teachers in the current pilot study chose how many PAL they delivered, rather than being prescribed a weekly target; as such the dose indicates what is naturally achievable by secondary school teachers. A weekly dose of 6-7 PAL has the potential to substantially reduce adolescents' sedentary time during school hours, providing sufficient activity is introduced as part of the PAL.

Costs

Training delivery costs (independent of travel and planning time) was estimated around £900 ($1,187) in both studies. Strategies to reduce costs could include reducing the number of staff delivering the sessions or hiring staff with a mixture of training levels, rather than the highly experienced staff in the current studies. Approximately 25% of the cost was spent on equipment, primarily for outdoor-based subject-specific examples; reviewing the equipment purchases may identify cost saving opportunities. Research reports that small grants (~$2,000) to schools can lead to increased implementation of practices to promote activity[58]. Senior leadership teams commented on how thinly English schools budgets are stretched; it was suggested that school funds set aside for (for example) mental health services might represent an avenue of funding for the programme for some schools.

Strengths and Limitations

High quality formative work for interventions is necessary to ensure appropriate allocation of research efforts and funding, and the publication of feasibility and pilot research is important to support other researchers and interventionists[59]. Limitations of this work include that samples were predominantly white; consequently, we are unable to explore differential responses to PAL by ethnicity. Moreover, parental opt out consent procedures limited the ability to obtain information on participants' socioeconomic position. The issue of lack of diversity among samples in PAL studies has been previously raised[60]; future research

should seek to explore feasibility, acceptability and effectiveness among different racial/ethnic and socio-economic groups. Estimated training delivery costs are based on wage rates, national insurance and superannuation costs but don't include overhead costs such as costs of employing individuals and providing building space. As such, training delivery costs may be underestimated. In addition, we did not carry out longer-term follow-up assessments so we do not know if teachers continued to deliver PAL beyond eight weeks after the training. Finally, we do not believe that lack of blinding of measurement staff has impacted the conclusions drawn from these studies, but acknowledge that a potential fully-powered trial would benefit from efforts to blind measurement staff.

CONCLUSION

We successfully demonstrated the feasibility and acceptability of introducing and evaluating a PAL teacher-training programme in secondary schools. Across feasibility and pilot studies, teachers' acceptability of the intervention and of delivering PAL was demonstrated, although aspects of the training programme, particularly the outdoor component, require review. The intervention was acceptable to students and senior leadership representatives, and the dose of PAL received by students was sufficient to have the potential to make a substantial contribution to reducing adolescents' sedentary time during school hours. However, we did not observe preliminary effectiveness on students' activity behaviours or wellbeing indicators.

Taken together, the findings do not support continuation with the current PAL training programme, though its acceptability does highlight the need for further research into how the identified barriers might be overcome.

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Data sharing

The datasets are not available for download. The study's participant information sheets and ethics applications stipulated that the data would not be shared outside of the research team. The data are held at the MRC Epidemiology Unit at the University of Cambridge.

Competing interests

The authors declare that they have no competing interests.

Author contributions

All authors (Catherine Gammon, Katie Morton, Andrew Atkin, Kirsten Corder, Andy Daly-Smith, Thomas Quarmby, Marc Suhrcke, David Turner and Esther van Sluijs) contributed to the conceptualisation and design of the work, and reviewed and approved the final manuscript. Catherine Gammon, David Turner, and Esther van Sluijs contributed to the acquisition, analysis and interpretation of data. Catherine Gammon drafted the manuscript.

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59. Jago, R. and S.J. Sebire, *Publishing pilot and feasibility evaluations of behavioural interventions: implications for preventive medicine.* Prev Med, 2012. **55**(6): p. 548-9.
60. Benjamin Neelon, S.E., K.R. Hesketh, and E.M. van Sluijs, *Will Physically Active Lessons Improve Academic Achievement for All or Widen the Achievement Gap?* Pediatrics, 2016. **137**(3): p. e20154137.

Figure legends:

Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

Table 1. Outline of the PAL training programme and timeline of evaluation measures.

	Week 0 **Baseline Measures**	**Week 1**	**Week 4**	**Week 12** **Follow-Up Measures**
Feasibility Study	**Students**: • Anthropometry • Questionnaire (15 minutes) • Accelerometry • Time-on-Task **Teachers**: • Questionnaire	**Training session 1** (2 hours) **30 minutes:** Introduction to active learning **40 minutes:** Split group in half: • Half stay in classroom and review classroom-based PAL strategies • Half go outside and review outdoor PAL strategies **40 minutes:** Groups switch **10 minutes:** Final comments	**Training session 2** (2 hours) **30 minutes**: Sharing PAL experiences **30 minutes**: Outdoor PAL examples **15 minutes**: Indoor PAL examples **15 minutes**: Discussion of intervention expectations **10 minutes**: Post-training questionnaire	**Students**: • Questionnaire (15 minutes) • Accelerometry • Time-on-Task • Focus groups **Teachers**: • Questionnaire • Focus group **Senior Leadership Team**: • Interview
Pilot Study: Intervention School	*Same as for feasibility study baseline measures*	*Same as for feasibility study training session 1*	**Training session 2** (2 hours) **45 minutes**: Split group in half: • Half review indoor PAL strategies • Half review outdoor PAL strategies **45 minutes**: Groups switch	*Same as for feasibility study follow-up measures*

			10 minutes: Whole-group outdoor activity. **10 minutes**: Post-training questionnaire	
Pilot Study: Control School	*Same as for feasibility study baseline measures*	No training session	No training session	**Students**: • Questionnaire • Accelerometry • Time-on-Task

Table 2. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	76	237.4 (26.4)	246.1 (27.6)	8.7 (3.8,13.7)
Light activity (minutes)	76	139.8 (21.8)	131.7 (22.6)	-8.1 (-12.4,-3.8)
Moderate activity (minutes)	76	10.8 (6.0)	10.3 (5.8)	-0.6 (-1.4,0.3)
Vigorous activity (minutes)	76	2.0 (2.0)	1.9 (1.8)	-0.1 (-0.4,0.3)
Time-on-task (% intervals on-task)	11	66.1	-	-
Academic Efficacy (score 1-5)	85	3.51 (0.80)	3.63 (0.83)	-
Disruptive Behaviour (score 1-5)	82	1.90 (0.95)	1.94 (0.98)	-
CHU-9D (score 0.33-1.0)	89	0.86 (0.10)	0.84 (0.10)	-
Positive Affect (score 1-5)	81	17.35 (3.44)	16.16 (3.36)	-
Negative Affect (score 1-5)	84	10.55 (3.28)	10.71 (3.48)	-

Length of school day = 390 minutes

Table 3. Activity intensity during 60-minute PAL at follow-up and the equivalent lesson at baseline (excluding P.E. and drama); mean (SD).

	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	310	41.1 (8.4)	42.1 (8.6)	1.0 (-0.1,2.1)
Light activity (minutes)	310	17.9 (7.6)	16.9 (7.8)	-1.1 (-2.1,0)
Moderate activity (minutes)	310	0.8 (1.0)	0.9 (1.0)	0 (-0.1,0.2)
Vigorous activity (minutes)	310	0.2 (1.1)	0.2 (0.6)	0 (-0.1,0.1)

Table 4. Baseline and follow-up values for primary and secondary outcomes; mean (SD).

	Control School [a]				Intervention School [a]			
	N	Baseline	Follow-Up	Mean Difference (95% C.I.)	N	Baseline	Follow-Up	Mean Difference (95% C.I.)
Sedentary activity (minutes)	74	217.0 (32.4)	222.1 (36.2)	5.1 (-1.3,11.5)	96	236.4 (31.8)	237.7 (40.6)	1.3 (-6.2,8.7)
Light activity (minutes)	74	140.5 (26.0)	136.6 (31.9)	-4.0 (-10.1,2.2)	96	129.0 (26.8)	124.8 (31.2)	-4.2 (-10.5,2.1)
Moderate activity (minutes)	74	16.2 (7.5)	14.2 (7.8)	-2.0 (-3.2,-0.8)	96	11.1 (6.3)	10.1 (6.3)	-1.1 (-2.0,-0.1)
Vigorous activity (minutes)	74	5.5 (3.9)	4.7 (3.5)	-0.8 (-1.4,-0.2)	96	3.1 (3.0)	3.0 (2.9)	-0.1 (-0.6,0.4)
Time-on-task (% intervals on-task)	28[b]	73.7	56.6	-	27[c]	79.1	77.5	-
Academic Efficacy (score 1-5)	98	3.41 (0.71)	3.32 (0.71)	-	107	3.76 (0.64)	3.71 (0.76)	-
Disruptive Behaviour (score 1-5)	98	2.34 (1.23)	2.47 (1.19)	-	107	1.94 (0.94)	2.04 (1.01)	-
CHU-9D (score 0.33-1.0)	97	0.84 (0.10)	0.84 (0.09)	-	106	0.87 (0.09)	0.85 (0.10)	-
Positive Affect (score 1-5)	98	15.95 (3.33)	16.08 (3.53)	-	107	17.80 (3.10)	17.54 (3.74)	-
Negative Affect (score 1-5)	98	10.03 (3.30)	9.87 (3.14)	-	106	10.12 (3.47)	9.95 (3.06)	-

[a] Length of school day varies: control school = 380 minutes, intervention school = 400 minutes

[b] 14 students observed at baseline across 4 classes (all non-active lessons) and 14 students observed at follow-up across 4 classes (all non-active lessons). Students observed at baseline were different from students observed at follow-up.

[c] 14 students observed at baseline across 4 classes (all non-active lessons) and 13 students observed at follow-up across 4 classes (3 active lessons, 1 non-active lesson). Students observed at baseline were different from students observed at follow-up.

Text Box 1.

"*I really enjoyed them (active lessons), they (the students) enjoyed them as well, they seemed to get a lot out of them…it was good fun, it was nothing really any different to what I was normally doing, just with a few added extras*" (Maths teacher, female).

"*I thought they (the students) would enjoy going outside… I had high hopes for that but it was a Friday afternoon and I don't think they were ready for it… they were causing disruption, they tried to walk off*" (English teacher, female).

"we concentrated more because it was more fun than just sitting around" (Year-7, male), and "*when you're sitting down you can get quite bored and get easily distracted whereas if you're moving about you've actually got something to do*"(Year-7, female).

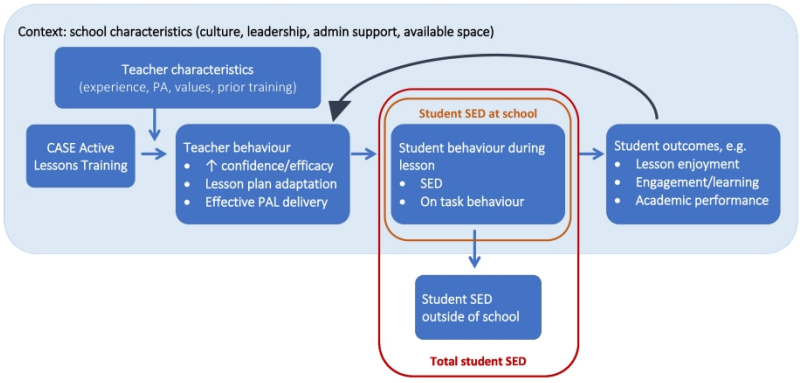

Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

297x209mm (300 x 300 DPI)

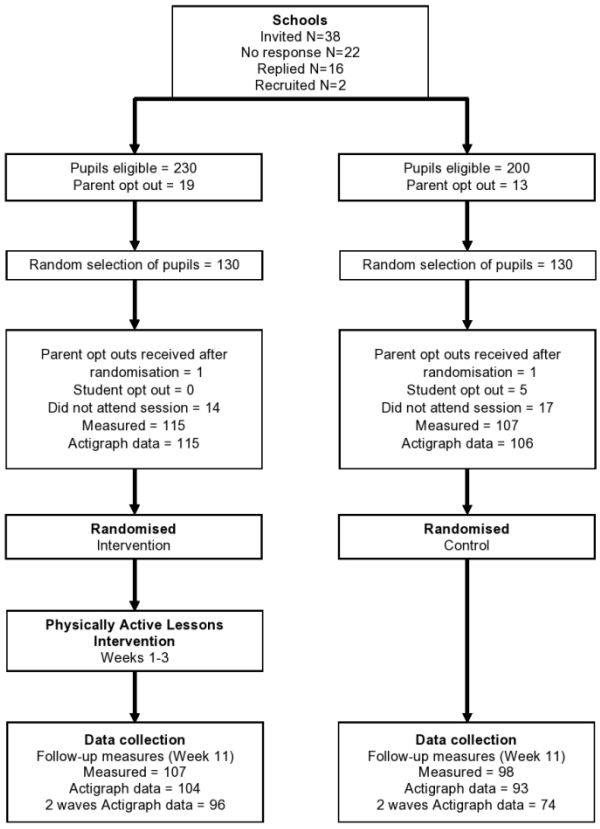

Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

104x148mm (300 x 300 DPI)

Supplementary Table 1. Descriptive, recruitment and retention statistics of student participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
N schools	1	1	1
N students invited	360	200	230
N parent opt out	25	13	19
N students randomly selected	120*	130*	130*
N student non assent	7	5	0
N student non attendance	11	17	14
N students assented	99	107	115
N two time points	91	98	107
N accepted monitor at two time points	91	93	104
N with sufficient PA at two time points	76	74	96
Age (years)	13.0 (1.1)	13.1 (0.6)	12.7 (1.0)
Sex: N (% male)	51 (52)	53 (50)	58 (50)
Height (cm)	158.6 (8.7)	159.6 (8.9)	156.2 (9.8)
Weight (kg)	51.9 (14.9)	54.1 (13.7)	48.1 (10.4)
BMI percentile	56.8 (30.8)	63.2 (29.4)	57.6 (28.2)
% overweight/obese	26.6	29.0	19.1

PA: physical activity

*After random selection, a small number of parent opt-out replies were received for students that had been randomly selected for evaluation measures (feasibility study = 3, pilot control school = 1, pilot intervention school = 1), as such, the number of students randomly selected who were eligible to assent were: feasibility study = 117, pilot control school = 129, pilot intervention school = 129.

Supplementary Table 2. Descriptive statistics of schools and teacher participants in feasibility and pilot studies.

	Feasibility Study	Pilot Study – Control	Pilot Study – Intervention
School information			
Students per year group (for years 7, 8, 9)	180	100	115
Ofsted rating	2 (Good)	2 (Good)	2 (Good)
% pupils eligible for free school meals	20.5%	36.2%	21.4%
% pupils with special education needs	3.6%	0.9%	1.9%
Teacher information			
N teachers invited	15	32	36
N teachers assented	13	32	36[a]
Age Category: N (%)			
18-24 years	1 (17)	6 (19)	1 (3)
25-34 years	2 (33)	7 (22)	5 (14)
35-44 years	2 (33)	9 (28)	7 (19)
44-45 years	1 (17)	9 (28)	11 (31)
55-64 years	0	1 (3)	3 (8)
65 years +	0	0	0
N (%) male	2 (33)	10 (31)	10 (28)
Teaching Experience: N (%)			
< 1 year	1 (17)	8 (25)	0
2-5 years	2 (33)	7 (22)	6 (17)
6-10 years	2 (33)	5 (16)	7 (19)
>10 years	0	10 (31)	13 (36)
Current active lesson delivery N (%)			
Never/rarely	3 (50)	5 (16)	5 (14)
1-2 times / month	2 (33)	6 (19)	7 (19)
1-2 times / week	1 (17)	8 (25)	5 (14)
3-4 times / week	0	6 (19)	3 (8)
> once per day	0	6 (19)	6 (17)

[a]27 teachers attended the research team's study introduction and completed baseline questionnaires. A further 9 teachers consented at training session 1 or 2 and did not provide baseline data.

Supplementary Table 3. Teacher feedback on the PAL training programme; mean (SD).

		Pilot Study – Intervention School		
	Feasibility Study (n=9)	Whole Group (n=33)	Baseline PAL delivery < once per week (n=11)	Baseline PAL delivery ≥ once per week (n=14)
Usefulness of training in preparing you to deliver PAL *(1=not useful, 7=very useful)*	5.3 (0.5)	3.1 (1.4)	3.9 (1.6)	2.5 (1.1)
Appropriateness of depth and scope of training *(1=not appropriate, 7=very appropriate)*	5.2 (0.7)	3.1 (1.4)	3.6 (1.6)	2.7 (1.2)
Appropriateness of programme materials and resources *(1=not appropriate, 7=very appropriate)*	5.6 (1.3)	2.8 (1.4)	3.5 (1.6)	2.4 (1.2)
Clarity of program materials and resources *(1=not clear, 7=very clear)*	6.0 (0.7)	3.7 (1.2)	4.4 (1.3)	3.4 (1.1)
Relevance of training for your lessons *(1=not relevant, 7=very relevant)*	5.3 (1.1)	2.9 (1.4)	3.6 (1.4)	2.4 (1.4)
Would you recommend the training to other teachers? *N (%) yes*	9 (100)	15 (45)	7 (64%)	4 (29%)

Outdoor Active Lesson Examples

1. https://www.ltl.org.uk/pdf/Natural-Equations-2018-COMPLETE1518623029.pdf
2. https://www.ltl.org.uk/pdf/Fires-and-Cooking-Actvity1421850222.pdf

Indoor Active Lesson Examples

A. Jigsaw

What is it? The jigsaw is a cooperative learning strategy (one of several) whereby, as with a jigsaw puzzle, each piece (each student's part) is essential for the complete picture (full understanding of the final product). Here, if each student's part is essential then arguably, each student is essential!

Implications for classroom layout: There is minimal impact on classroom layout. Desk should be arranged together so students can sit together in small groups and be able to move between groups.

How does it work?

1. Divide students into 5 or 6-person jigsaw groups. Ideally these groups should be diverse in terms of gender, race/ethnicity and ability.
2. These groups are the 'Home teams'. In each home team, each team member should be given a letter (e.g. A, B, C etc.)
3. Team members then join their **Jigsaw team** e.g. all the A's, B's etc. get together. This will require them moving to their jigsaw teams. These jigsaw teams are responsible for discussing and understanding a pre-determined aspect or answering a particular task. For instance, a reading may be divided into several parts with each jigsaw team taking one of those parts.
4. As a teacher, you can move between each jigsaw team to ensure they are addressing the task in its entirety and the whole jigsaw team develops an understanding of it.

5. Jigsaw teams then return to back to their home teams to discuss what was learnt in the jigsaw team. **Each student will present her or his segment to the group** so that all learn from each other.

Benefits

- Learn a lot of material quickly
- Students are held individually accountable for their learning
- It helps to maximise student collaboration
- Encourages higher order and critical thinking skills.

B. Active Voting

What is it? This notion of Active Voting is useful for exploring differing and diverse opinions on particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of ambiguity and grey areas, which helps them to see that opinions often have to be justified with informed knowledge of the matter under discussion.

Implications for classroom layout: Each of the four key statements will need to positioned in one of corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree. When an issues is raised, pupils will then move to stand/sit in the corner that best reflects their views and with those who share the same opinion/perspective.

How does it work?

1. A range of issues (related to the content being delivered) should be read out in turn by the teacher.

2. Pupils are then given time to consider their opinion.
3. Pupils then move to the corner that best describes how they feel about what was read out. Pupils should be reminded that there are no right or wrong answers.
4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
5. When pupils move to the corner that best represent their views on the statement, they should be encouraged to explain why they feel that way with others in that group. General perspectives can be obtained from all corners.
6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and to refine the initial statement/problem/issues being discussed.
7. Pupils are allowed to move during the discussion of each statement if issues arrive that challenge their original opinion.
8. If pupils do switch then they should be encouraged to explain why.

Benefits

Developing thinking and decision making skills

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility randomized trial in a journal or conference abstract

Item	Description	Reported on line number
Title	Identification of study as randomised pilot or feasibility trial	1-2
Authors *	Contact details for the corresponding author	11
Trial design	Description of pilot trial design (eg, parallel, cluster)	22
Methods		
Participants	Eligibility criteria for participants and the settings where the pilot trial was conducted	21
Interventions	Interventions intended for each group	27-30
Objective	Specific objectives of the pilot trial	18-20
Outcome	Prespecified assessment or measurement to address the pilot trial objectives**	31-34
Randomization	How participants were allocated to interventions	22
Blinding (masking)	Whether or not participants, care givers, and those assessing the outcomes were blinded to group assignment	22-23
Results		
Numbers randomized	Number of participants screened and randomised to each group for the pilot trial objectives**	N/A
Recruitment	Trial status†	N/A
Numbers analysed	Number of participants analysed in each group for the pilot objectives**	N/A
Outcome	Results for the pilot objectives, including any expressions of uncertainty**	35-40
Harms	Important adverse events or side effects	N/A
Conclusions	General interpretation of the results of pilot trial and their implications for the future definitive trial	41-43
Trial registration	Registration number for pilot trial and name of trial register	44
Funding	Source of funding for pilot trial	45

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

**this item is specific to conference abstracts*

***Space permitting, list all pilot trial objectives and give the results for each. Otherwise, report those that are a priori agreed as the most important to the decision to proceed with the future definitive RCT.*

†For conference abstracts.

CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a pilot or feasibility randomised trial in the title	1
	1b	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	2-3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	4-5, 11-12
	2b	Specific objectives or research questions for pilot trial	12
Methods			
Trial design	3a	Description of pilot trial design (such as parallel, factorial) including allocation ratio	13
	3b	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	13
Participants	4a	Eligibility criteria for participants	5-6, 13
	4b	Settings and locations where the data were collected	5, 13
	4c	How participants were identified and consented	6, 13
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	30
Outcomes	6a	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	7-9, 14-15, 30
	6b	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	N/A
	6c	If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	N/A
Sample size	7a	Rationale for numbers in the pilot trial	6, 13
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	13
	8b	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	N/A

Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	13
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	13
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12	Methods used to address each pilot trial objective whether qualitative or quantitative	7-9, 14-15, 30
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	13, Figure 2
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure 2
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Figure 2
	14b	Why the pilot trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Supp file 1 (pages 1-2)
Numbers analysed	16	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	31-33, figure 2
Outcomes and estimation	17	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	31-33
Ancillary analyses	18	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
	19a	If relevant, other important unintended consequences	N/A
Discussion			
Limitations	20	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	22
Generalisability	21	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	22-23
Interpretation	22	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	19-23
	22a	Implications for progression from pilot to future definitive trial, including any proposed amendments	22-23
Other information			
Registration	23	Registration number for pilot trial and name of trial registry	5
Protocol	24	Where the pilot trial protocol can be accessed, if available	5
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	3, 24
	26	Ethical approval or approval by research review committee, confirmed with reference number	5

Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

*We strongly recommend reading this statement in conjunction with the CONSORT 2010, extension to randomised pilot and feasibility trials, Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.