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

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Manuscripts

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3 **1 Introducing physically active lessons in UK secondary schools: feasibility**
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6 **2 study and pilot cluster-randomised controlled trial**
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8
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60 **Word count:** 4,917

1
2
3 17 **Abstract**
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5 18 **Objectives:** To assess the feasibility and acceptability of delivering a physically active lessons (PAL)
6
7 19 training programme to secondary school teachers and explore preliminary effectiveness for reducing
8
9 20 pupil's sedentary time.
10

11
12 21 **Design and setting:** Mixed-sex, non fee-paying, secondary schools in East England; one school
13
14 22 participated in a pre-post feasibility study, two in the pilot cluster-randomised controlled trial. In the
15
16 23 pilot trial, blinding to group assignment was not possible.
17

18
19 24 **Participants:** Across both studies, 321 randomly selected students (51% male; mean age: 12.9 years),
20
21 25 78 teachers (35% male) and two assistant head teachers enrolled; 296 (92%) students, 69 (88%)
22
23 26 teachers and two assistant head teachers completed the study.
24

25
26 27 **Intervention:** PAL training delivered to teachers over two, 2-hour after-school sessions, two weeks
27
28 28 apart. Teachers are made aware of how to integrate movement into existing lesson plans.
29

30
31 29 **Primary and secondary outcomes:** Quantitative and qualitative data were collected to assess
32
33 30 feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline and ~8
34
35 31 weeks post-training; measures included accelerometer-assessed activity, self-reported well-being,
36
37 32 and classroom observations of time-on-task. Quantitative and qualitative process evaluation was
38
39 33 conducted at follow-up.
40

41
42 34 **Results:** In the feasibility study, teachers reported acceptability of PAL training and mixed
43
44 35 experiences of delivering PAL. In the pilot study, teacher's acceptability of PAL training was lower
45
46 36 and teachers identified aspects of the training in need of review, including the outdoor PAL training
47
48 37 component and learning challenge of the PAL strategies. In both studies, students and senior
49
50 38 leadership representatives reported acceptability of the intervention. Preliminary effectiveness for
51
52 39 reducing student's sedentary time during school was not demonstrated in either study.
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3 40 **Conclusions:** No evidence of preliminary effectiveness on the primary outcome and mixed reports of
4
5 41 teacher's acceptability of PAL training suggest the need to review the training programme. The
6
7 42 results do not support continuation of research with the current intervention.
8
9

10 43 **Trial registration:** ISRCTN registry; ISRCTN38409550.
11

12 44 **Funding:** Department of Health Policy Research Programme (PR-R5-0213-25001).
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18 46 **Article Summary**

19 20 47 **Strength and limitations of this study**

- 23 48 • We completed thorough feasibility and pilot testing work to inform the decision of whether to
24
25 49 progress with the current intervention and its evaluation.
- 27 50 • We collected quantitative and qualitative data which provided valuable information on
28
29 51 contextual influences and allowed us to address research questions more comprehensively.
- 31 52 • We were unable to collect all planned follow-up measures from teachers and students in
32
33 53 feasibility study, including teacher follow-up questionnaires and class observations of time-on-
34
35 54 task.
- 37 55 • We did not carry out longer-term follow-up measures of teacher acceptability and physically
38
39 56 active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up would have
40
41 57 provided an indication of the sustainability of the intervention.
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58 INTRODUCTION

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

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

73 PAL are a pedagogical approach whereby activity supports the delivery of academic material[8].
74 During PAL, movement is integrated into teaching and as such, PAL are distinct from
75 'brain/movement breaks', when activity is separate from learning. Evidence from primary schools
76 indicates that PAL can improve physical activity, academic achievement and lesson enjoyment [9-
77 12]. To our knowledge, only two studies have trialled the use of PAL among adolescents [13, 14].
78 Helgeson (2013) reported no influence of the 'Energizers' PAL programme on reading
79 comprehension scores among junior high school students and did not explore activity levels as a
80 primary outcome[13]. Cothran and colleagues (2010) reported on primary and secondary/high
81 school teacher's experiences of a one-year movement integration intervention. Compared to
82 primary school teachers, secondary teachers faced different challenges when attempting to

1
2
3 83 integrate activity into lessons, in particular standardised testing pressures and students not staying
4
5 84 with one teacher all day (as typically is the case in primary schools)[14]. Cothran and colleagues did
6
7 85 not measure student activity behaviours as an intervention outcome[14]. The positive effects of PAL
8
9 86 reported for primary students suggest there is value in exploring if secondary students can
10
11 87 experience similar benefits. Given the organisational and environmental differences between
12
13 88 primary and secondary schools, it is important to conduct high quality feasibility and pilot testing of
14
15 89 secondary school PAL interventions.

16
17
18 90 A PAL training programme for secondary school teachers was tested in a feasibility study and a
19
20 91 cluster-randomised controlled pilot study. The studies aimed to explore the feasibility, acceptability,
21
22 92 preliminary effectiveness and costs of a PAL training programme for secondary teachers.
23
24 93 Acceptability of study processes was also examined, in anticipation of conducting a subsequent full
25
26 94 trial. This paper presents the feasibility study and pilot study followed by an overall discussion and
27
28 95 conclusion (ISRCTN38409550).

30 31 96 **1. FEASIBILITY STUDY**

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34 97 Ethical approval for both studies was granted by the University of Cambridge's School of the
35
36 98 Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the feasibility,
37
38 99 acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary school
39
40 100 teachers, and (ii) the feasibility and acceptability of study procedures.

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43 101

44 45 46 102 **Feasibility Study - Methods**

47 48 49 103 **Recruitment**

50
51 104 Potential schools were identified from previous local research and approached with study
52
53 105 information (n=2). One mixed-sex, non fee-paying secondary school participated. The head teacher
54
55 106 provided written consent for the intervention to be delivered to the teachers and elected for the

1
2
3 107 intervention to be trialled with maths and English teachers. The school were told they would be able
4
5 108 to keep the PAL training resources.

6
7
8 109 Parents of all Year 7 and 9 students (11-14 years) received study information and students were
9
10 110 invited to participate in evaluation measures. Parents were given two weeks to opt out (passive
11
12 111 parental consent) via email, freephone, or freepost. From the students who had not been opted out,
13
14 112 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly selected for evaluation
15
16 113 measures (using class lists and random number generating software). The study's feasibility focus
17
18 114 meant that a formal power calculation was not necessary to inform sample size; a sample of 60
19
20 115 participants per year is consistent with samples of similar studies[15]. Students provided written
21
22 116 assent for evaluation measures.

23
24
25 117 Maths and English teachers (n=15) received study information two weeks before the PAL training.
26
27 118 The senior leadership team requested that all maths and English teachers attended the training.
28
29 119 Teachers could choose to participate in the evaluation measures, those agreeing provided written
30
31 120 consent. Over five school days students received approximately five maths lessons and four English
32
33 121 lessons.

34 35 36 122 Intervention

37
38
39 123 The PAL training was developed by a team with teacher training qualifications and experience in
40
41 124 indoor (two trainers) and outdoor active learning (one trainer). Table 1 outlines the training
42
43 125 programme and example active lessons are published as supplementary material. The focus was on
44
45 126 supporting teachers to adopt active pedagogical approaches, rather than providing new, PAL plans.
46
47 127 Figure 1 outlines the preliminary logic model of how the teacher-focused intervention could lead to
48
49 128 changes in student's activity. Prior to the training, the research team visited the participating school
50
51 129 and ascertained the availability of indoor and outdoor spaces and equipment that could be used for
52
53 130 PAL. Syllabi for maths and English were requested to allow trainers to prepare relevant examples for
54
55 131 the training.

1
2
3 132 Measurements
4

5 133 Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed using
6
7 134 questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7 and four Year-
8
9 135 9 students) and an interview with the assistant head teacher were completed using a semi-
10
11 136 structured interview.
12
13

14 137 *Feasibility/acceptability of the intervention:* Questionnaire items and focus group questions asked
15
16 138 about teacher's perceptions of the utility, value and relevance of the training (adapted from[16, 17]).
17
18 139 Questionnaires asked if teachers would recommend the training to other teachers and provided
19
20 140 free-text boxes for teachers to suggest improvements. Training session attendance rates were
21
22 141 recorded.
23
24

25 142 *Feasibility/acceptability of PAL delivery:* Questionnaire items and focus group questions asked
26
27 143 teachers about classroom management during PAL, enjoyment of teaching PAL, time needed to
28
29 144 prepare and deliver PAL, and barriers to PAL delivery (items from[18]).
30
31

32 145 *Acceptability of PAL participation:* Questionnaire items and focus group questions asked students
33
34 146 about their experience of PAL participation, enjoyment of PAL, their preference for active vs. desk-
35
36 147 based lessons, and the best and worst things about PAL.
37
38

39 148 *Costs:* Teachers and students reported resources purchased to deliver/participate in PAL. The
40
41 149 research team recorded time and costs associated with the training team's development and
42
43 150 delivery of the intervention.
44
45

46 151 *Study processes:* The research team made field notes on study processes that proved to be
47
48 152 challenging or ineffective, for example, students struggling to understand a questionnaire item.
49
50

51 153 *Student anthropometry:* Anthropometric measures were completed by trained staff using standard
52
53 154 procedures. Height was measured using a stadiometer (Leicester height measure, Chasmors,
54
55 155 Leicester, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg (Tanita, type
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2
3 156 TBF-300A, Tokyo, Japan). Height, weight, sex, birthdate and measurement date were used to
4
5 157 calculate participants' body mass index (BMI; kg/m²) and BMI percentile.

6
7 158 *Activity intensity:* Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were used to
8
9 159 measure activity behaviours. These devices have been used among a larger sample of Year-9
10
11 160 participants in the GoActive study[19] and the UK Biobank Cohort Study[20]. Wrist-worn monitors
12
13 161 are validated for the assessment of energy expenditure in pediatric populations[21] with higher
14
15 162 participant compliance when compared to waist-worn accelerometers[22]. Participants were given
16
17 163 verbal and written instructions on monitor wear, including that the monitor was waterproof and
18
19 164 could be worn continuously for the next seven days.

20
21
22
23 165 The first day of monitor wear was dropped[23]; included participants provided valid data for ≥80% of
24
25 166 school hours for ≥two school days, at baseline and follow-up[24-26]. Acceleration was recorded at
26
27 167 100Hz with a dynamic range of ±8g. Data from the monitors was downloaded in continuous
28
29 168 waveform. Euclidean Norm Minus One (ENMO) represents acceleration magnitude at each
30
31 169 measurement, accounting for the influence of gravity. ENMO thresholds were used to classify
32
33 170 activity intensities: time spent at 0-30 ENMO was classified as sedentary activity (equivalent to 1-1.5
34
35 171 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-500 ENMO as moderate-intensity
36
37 172 activity (4-7 METs), and above 500 ENMO as vigorous-intensity activity[27, 28].

38
39
40 173 *Mental Health and Wellbeing:* Students completed questionnaire measures of positive and negative
41
42 174 affect[29], academic efficacy, disruptive behaviour[30], enjoyment of school classes[31] and health
43
44 175 related quality of life[32] at baseline and follow-up. All questionnaires are validated for use with
45
46 176 adolescents.

47
48
49 177 *Time-on-task:* Student's time-on-task was assessed during lessons by one member of the research
50
51 178 team. In each class, four students were observed using a momentary time-sampling procedure
52
53 179 (which incurs less bias than other sampling procedures[33, 34]). Each student was observed once per

1
2
3 180 minute, for the duration of the lesson. Student's behaviour was coded as: (i) on-task, (ii) off-task-
4
5 181 passive, (iii) off-task-motor, or (iv) off-task-noise[35].
6

7
8 182 Prior to classroom observations, a validation activity was completed where two researchers
9
10 183 discussed definitions and concurrently coded student behaviour using four online videos. Observers'
11
12 184 codes matched for 95% of observation intervals.
13

14 185 Descriptive Statistics

15
16
17 186 Descriptive statistics of the sample, primary and secondary outcomes, and quantitative measures of
18
19 187 feasibility and acceptability are summarised. Focus group transcripts were reviewed; recurring
20
21 188 comments and themes relevant to the research questions were identified.
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23

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25 26 27 190 **Feasibility Study - Results**

28 29 191 Recruitment and sample characteristics

30
31
32 192 Student and teacher recruitment and characteristics are summarised in supplementary tables 1 and
33
34 193 2. 99 Students were recruited, with 91 (92%) providing data at baseline and follow-up. Students had
35
36 194 a mean age of 13.0 years, 52% were male and 27% were classified as overweight/obese. Teachers
37
38 195 were predominantly female (67%) and below the age of 45 (83%).
39
40

41 196 Feasibility and Acceptability

42
43
44 197 Training session one was attended by 14 teachers (7 maths, 7 English), training session two was
45
46 198 attended by 12 teachers (7 maths, 5 English), 11 teachers attended both sessions. Teacher feedback
47
48 199 demonstrated acceptability of the training, with 100% recommending the training to other teachers
49
50 200 (supplementary table 3). Individual and collective efficacy for delivering PAL improved from 2.7 to
51
52 201 3.2, and 2.4 to 3 (out of 4), respectively. At follow-up, ≥eight teachers had attempted to deliver PAL.
53
54 202 Teacher's goals for PAL delivery averaged 2.1 (SD=1.0) lessons per week, with an average targeted
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3 203 reduction in sitting time of 15.8 (SD=8.0) minutes. Some teachers reported positive experiences of
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5 204 delivering PAL, while others reported challenges (Text box 1).

6
7 205 Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting, challenges
8
9 206 re-focusing students after an active portion of class, and limited classroom space. Teachers identified
10
11 207 facilitators of PAL delivery as theirs and the students' enjoyment of PAL, good weather allowing
12
13 208 them to go outside, more classroom space and a more diligent group of students. Teachers reported
14
15 209 ≤15 extra minutes were required to plan PAL, and a few extra minutes were needed to prepare
16
17 210 students for PAL participation.

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20
21 211 Of the students who recalled participating in an active lesson (43 out of 91 [47%]), most preferred
22
23 212 PAL to desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to
24
25 213 continue delivering them. Students reported enjoying going outside and moving around (30%), that
26
27 214 PAL were less boring/more fun than desk-based lessons (26%) and that they could concentrate
28
29 215 better (14%). Negative comments about PAL included lethargy (12%), more disruptive behaviour
30
31 216 (9%), and less work achieved (12%; text box 1).

32
33
34 217 The assistant head felt the training was well-received and high quality professional development.

35
36 218 The assistant head teacher stated the reason for participating had been the potential for improving
37
38 219 student's mental health and the school's motivation to be innovative in the classroom. The assistant
39
40 220 head teacher commented that teaching staff had enjoyed taking their students outside for lessons
41
42 221 and the project had involved a low level of commitment from the school.

43
44
45 222 Costs

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47
48 223 Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment.

49
50 224 Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student, ~£30).

51
52
53 225 Study Processes

1
2
3 226 The majority of study procedures were completed successfully. Challenges encountered included
4
5 227 that students struggled to complete a blank timetable indicating when their Maths and English
6
7 228 lessons were, and despite efforts, we were unable to schedule follow-up classroom observations.
8
9 229 Teacher baseline questionnaire return was low and the follow-up focus group was conducted in a
10
11 230 15-minute timeslot due to late changes.

12
13
14 231 Preliminary effectiveness

15
16
17 232 Table 2 summarises baseline and follow-up data for all student measures.

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19
20 233 **Feasibility Study - Reflections**

21
22 234 The findings suggest it is feasible and acceptable to deliver a PAL training program to secondary
23
24 235 school maths and English teachers. Importantly, the senior leadership representative was supportive
25
26 236 of the training[36]. Secondary school teachers had mixed reports of delivering PAL, the identified
27
28 237 barriers and facilitators were consistent with those previously reported[36]. It was noted that
29
30 238 teacher acceptability of PAL delivery should be explored further in the next phase of intervention
31
32 239 evaluation. The positive student response to PAL indicates acceptability and is consistent with
33
34 240 results from PAL interventions in primary schools[37].

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37
38 241 We were successful in recruiting and consenting participants, and the majority of evaluation
39
40 242 measures were completed without problems. The retention of >90% of participants from baseline to
41
42 243 follow-up suggests evaluation measures were acceptable. Suggested changes included scheduling all
43
44 244 research activities at the start of the project and acquiring student timetables from the school's
45
46 245 administration team.

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49 246 Limitations of this feasibility study include the small sample size and the lack of control group,
50
51 247 making it not possible to draw conclusions about the contribution of the intervention to the
52
53 248 observed changes. The change in sedentary activity levels is inconsistent with previous research
54
55 249 reporting that younger children's sedentary time on weekdays decreases between spring and

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2
3 250 summer[38]. Increased negative feelings and lower wellbeing among students between March and
4
5 251 June is consistent with typical changes observed in student's wellbeing over a school term[39, 40].
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9 253 **2. PILOT STUDY**

11
12 254 Following successful implementation of the intervention in the feasibility study, we sought to extend
13
14 255 our previous work and explore the potential value of conducting a full-scale randomised controlled
15
16 256 trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the feasibility,
17
18 257 acceptability, preliminary effectiveness and costs of delivering a PAL intervention at a whole-school
19
20 258 level (to all subject teachers) and (ii) to test the acceptability of school-level randomisation.
21
22
23 259

24 25 26 260 **Pilot Study - Methods**

27 28 29 261 Recruitment and Randomisation

30
31
32 262 *Schools:* We aimed to recruit three schools (two intervention, one control). In June-July 2017, 26 non
33
34 263 fee-paying, mixed gender, secondary schools in the East of England were emailed study information
35
36 264 and invited to participate. The first three schools to agree were recruited; one school withdrew prior
37
38 265 to student recruitment (and randomisation). We were unable to replace the school within an
39
40 266 appropriate timeframe. After baseline measures, individuals separate from the research team
41
42 267 performed a coin-toss to assign intervention and control schools. The nature of the intervention and
43
44 268 goals of the evaluation measures meant it was not possible to blind participants. Due to differences
45
46 269 in follow-up measures between control and intervention schools, it was not possible to blind
47
48 270 measurement staff at follow-up.

49
50
51 271 *Students:* Recruitment proceeded as outlined for the feasibility study. Schools were asked to choose
52
53 272 one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation measures.
54
55 273 This would allow assessment of differential responses to the intervention by age. The intervention
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57
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1
2
3 274 school selected Years 7 and 9 and the control school selected Years 8 and 9. Following feasibility
4
5 275 study procedures, we randomly selected 130 students (50% male, 50% from each year) from each
6
7 276 school for evaluation measures (based on feasibility study retention rates), with the aim of obtaining
8
9 277 full data on 100 participants.

10
11
12 278 *Teachers:* A teacher information and recruitment meeting was scheduled at both schools, during
13
14 279 which a researcher introduced the study and distributed consent forms. Teachers were advised by
15
16 280 their senior leadership team that they would be required to attend the PAL training if allocated as
17
18 281 the intervention school; all teachers were free to decide on participation in evaluation measures.

20 21 282 Intervention

22
23 283 Extending the feasibility study, the intervention was delivered to all subject teachers. Training all
24
25 284 subject teachers is consistent with the whole-school approach recommended for activity promotion
26
27 285 and obesity prevention among youth[41, 42]. Given the acceptability of the training demonstrated in
28
29 286 the feasibility study, the structure and goals of the training for the pilot study were similar. Minimal
30
31 287 changes were made to the indoor training component, which focused on generic active learning
32
33 288 strategies, applicable to any subject (e.g., different workstations around the classroom). In the
34
35 289 feasibility study, the outdoor training component provided multiple subject- and topic-specific
36
37 290 lesson ideas; the inclusion of all subject teachers meant fewer subject-specific examples could be
38
39 291 actively worked through during the pilot study training. One additional outdoor lessons trainer was
40
41 292 involved to train the larger group of teachers.

42 43 44 45 293 Measurements

46
47
48 294 Table 1 outlines the timeline of study measures; all data were collected at schools, during school
49
50 295 hours. To increase teacher baseline questionnaire return, questionnaires were distributed during the
51
52 296 pre-training teacher information meeting, and completed following consent. Data collection
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1
2
3 297 followed the same procedures as described for the feasibility study, except for the assessment of
4
5 298 PAL dose and time on task.

6
7 299 *PAL Dose:* A teacher timetable was created using school-provided student timetables, detailing their
8
9 300 Year 7 and 9 lessons. During the student accelerometer assessment at follow-up, teachers were
10
11 301 given their personalised timetable and asked 'please circle which of the listed Year 7 and/or 9 classes
12
13 302 were (or will be) delivered as an active lesson.' Teacher's responses were used to calculate PAL dose.

14
15
16
17 303 *Time on task:* Four lessons were observed at baseline and follow-up, at both schools.

18 19 304 **Pilot Study - Results**

20
21
22 305 Figure 2 shows the flow of participants, with further information on student and teacher recruitment
23
24 306 and sample characteristics in supplementary tables 1 and 2. 222 students assented, of which 205
25
26 307 (92%) provided data at two time points. Half of the students were male and 24% were classified as
27
28 308 overweight/obese. The majority of teachers were female and >50% of staff reported delivering at
29
30 309 least one PAL a week at baseline. At the intervention school, 30 and 33 teachers attended training
31
32 310 session one and two, respectively (29 teachers attended both).

33 34 35 311 **Feasibility and Acceptability**

36
37
38 312 Average scores regarding teacher's acceptability of the training fell below 4 (the 'neutral' value)
39
40 313 indicating negative feelings towards the training (supplementary table 3). Teachers reported training
41
42 314 activities to be more suited for primary schools and not sufficiently challenging for secondary
43
44 315 students. One teacher commented: "*they were more bonus activities, like extra treat things... you*
45
46 316 *couldn't get much learning done through them*" (Science teacher, female). Teachers felt it was
47
48 317 assumed they weren't delivering PALs prior to the training and this created resistance towards the
49
50 318 training effort. Teachers reported that the PAL ideas were not novel and repetitive, the focus on
51
52 319 outdoor learning was distracting, and the value of outdoor activities wasn't clear.

1
2
3 320 More than half of teachers reported delivering at least one PAL a week at baseline. PAL delivery
4
5 321 decreased for four teachers (11%), was maintained by six teachers (17%), and increased for 13
6
7 322 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers indicated they were likely
8
9 323 to continue teaching PAL, although they reported concerns about students not learning as much
10
11 324 during PAL. Some teachers felt older students could be more lethargic and resistant: *"the younger*
12
13 325 *ones love getting up and interacting with each other. I think the older ones do, it just takes... more*
14
15 326 *effort to get them going"* (History teacher, female).

16
17
18 327 The majority of teachers reported ≤15 minutes for planning, ≤5 minutes for classroom preparation,
19
20 328 and ≤5 minutes for student preparation. The time needed to deliver an outdoor activity – in
21
22 329 particular the transition between indoors and outdoors - was identified as a barrier to
23
24 330 implementation. The assistant head teacher also commented about the pitch of the training and
25
26 331 poor use of learning time due to transitioning. They felt the indoor component of the training had
27
28 332 been more informative and appropriate, and commented staff had used active learning strategies
29
30 333 indoors, but not outdoors. Finally, they commented that PAL implementation had declined with
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32 334 time.

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35 335 Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue
36
37 336 teaching PAL, with no evidence of differences in intervention acceptability by sex or weight status.
38
39 337 Students commented that PAL were fun and helped learning, and they liked moving more: *"I really*
40
41 338 *enjoyed it. It gave me more of an understanding... because when you're just copying off the board*
42
43 339 *some writing I don't always understand it, then when you're moving about it's a lot more clearer"*
44
45 340 (Year-7, female). Students however also commented that during PAL some students messed around
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47 341 more and didn't focus on work, and work was easier to do when sitting down.

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51 342 Student PAL dose

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54 343 In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each). Each
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56 344 teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an average of 6.9

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3 345 PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range: 2-13; 28%). This
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5 346 represents the contribution across all subjects.

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7 347 Costs

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10 348 The cost of delivering the training was £901, comprised of £451 staff time and £450 equipment.
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12 349 Session one was delivered by three trainers, while session two was delivered by four trainers. Four
13
14 350 teachers purchased resources to support PAL delivery, including science equipment, textiles
15
16 351 equipment, post-it notes and whiteboard pens, and printed resources. Four students reported
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18 352 purchasing resources to support PAL participation – three purchased sports shoes (~£30 per pair)
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20 353 and one a mouth guard (~£7).

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23 354 Preliminary Effectiveness

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26 355 Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at baseline
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28 356 (excluding P.E. and drama lessons). There was no evidence of changes in time spent in different
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30 357 activity intensities. Table 4 summarises baseline and follow-up values for all outcome measures for
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32 358 intervention and control participants. There was no evidence of effectiveness.

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35 359 **Pilot Study - Reflections**

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38 360 Extending the work conducted in the feasibility study, this pilot study demonstrates the feasibility of
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40 361 whole-school intervention delivery. However, teachers expressed numerous concerns about the PAL
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42 362 training, including the insufficiently challenging content, lack of understanding of the value/purpose
43
44 363 of the outdoor component, and potential loss of valuable learning time. These examples are
45
46 364 consistent with previous research reporting that time and standardised testing pressures are barriers
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48 365 to PAL implementation, particularly for secondary school teachers[14]. The feedback suggests a
49
50 366 need to review the content of the training, particularly the outdoor component.

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53 367 Teacher's comments indicated acceptability of delivering PAL and there was a measurable increase
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55 368 in PAL delivery. Feedback suggests teacher's acceptability may reflect prior knowledge and

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3 369 experience of PAL. In addition, students reported enjoying PAL. Support for the intervention by
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5 370 multiple stakeholders is an important facilitator of successful implementation[36]; as such, the
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7 371 feedback received here is encouraging.
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10 372 We successfully tested study procedures and intervention delivery at a whole-school level, with
11
12 373 adequate recruitment and retention rates and continued control school involvement indicating
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14 374 acceptability of randomisation. Efforts made to improve data collection processes from the
15
16 375 feasibility study, e.g., of student timetables and teacher questionnaires, were successful.
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18
19 376 The assessment of PAL dose showed that students received an average of 6-7 x 60-minute PAL a
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21 377 week, which has the potential to make a valuable contribution to reducing sedentary time among
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23 378 adolescents. Despite a measured increase in PAL delivery, there was no evidence of reduced
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25 379 sedentary time, suggesting a need to review the PAL strategies that were shared with teachers, with
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27 380 a focus on the amount of activity introduced.
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32 382 **OVERALL DISCUSSION**

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35 383 In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and costs
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37 384 of a teacher-training programme for integrating activity into secondary school lessons. We also
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39 385 sought to understand the feasibility and acceptability of study procedures, including repeated
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41 386 accelerometer wear and school-level randomisation. The intervention was successfully delivered in
42
43 387 two schools and quantitative and qualitative data was successfully collected from multiple
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45 388 stakeholders, enabling us to address all research questions. The majority of PAL evaluations have
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47 389 been carried out in primary schools[9] and as such, this study makes a valuable contribution to the
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49 390 literature.
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51 52 53 391 **Feasibility/acceptability of PAL training**

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3 392 Consistent with previous research, it was feasible to deliver PAL training to secondary school
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5 393 teachers over two, 2-hour, after-school sessions[43]. While acceptability of the training was
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7 394 demonstrated in the feasibility study and is reported elsewhere[16, 37, 43], feedback from teachers
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9 395 in the pilot study was less positive. Delivery to teachers of two subjects in the feasibility study meant
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11 396 a smaller training group and a smaller trainer:staff ratio than in the pilot study. This allowed more
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13 397 subject-specific discussion and more time to address teacher's personal questions. Teacher feedback
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15 398 suggests that training acceptability is related to teacher's experience delivering PAL. In the pilot
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17 399 study, teachers delivering PAL more regularly rated the intervention more poorly than less
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19 400 experienced teachers. A PAL intervention targeting teachers not regularly delivering PAL may be
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21 401 more acceptable. The positive responses to the training in the feasibility study (involving teachers
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23 402 reporting low levels of PAL delivery) support this suggestion.

26 403 **Feasibility/acceptability of delivering/participating in PAL**

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29 404 In the feasibility study, teachers had mixed reviews of delivering PAL, whereas in the pilot study,
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31 405 teachers reported acceptability of delivering PAL. Pilot study teachers were more likely to report
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33 406 regular PAL delivery at baseline than feasibility teachers and to have had previous exposure to PAL
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35 407 during their initial teacher training and/or career. A longer trial period and increased support may
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37 408 have allowed teachers in the feasibility study to become more confident and accrue more positive
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39 409 PAL experiences. Overall, the data suggest that PAL delivery can be acceptable to secondary school
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41 410 teachers.

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44 411 While teachers were the direct intervention recipients and their acceptability is crucial for successful
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46 412 implementation, it is important to consider acceptability for other stakeholders, who also influence
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48 413 implementation. Across both studies students responded positively to PAL, and senior leadership
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50 414 representatives reported satisfaction with the intervention (in the pilot study, satisfaction with the
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52 415 indoor component). Both senior leadership representatives commented that reasons for study
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54 416 participation included the potential positive influence on student's mental health. This observation is

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3 417 consistent with previous findings[7] and indicates potentially effective strategies for promotion of
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5 418 the intervention to schools.

6 7 8 419 **Preliminary Effectiveness**

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10 420 Despite a measured increase in PAL delivery, no changes in activity were observed. Other PAL
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12 421 feasibility and pilot studies have reported more encouraging changes[35, 44, 45]. In the feasibility
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14 422 study, early implementation efforts of Maths and English teachers may not have been sufficient to
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16 423 translate to changes in activity. Across both studies, teachers were advised that any non-seated
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18 424 activity was considered an 'active lesson' - as such, the intervention may be too dilute for
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20 425 measurable impact using wrist-worn accelerometers. Overall, the results suggest the need to review
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22 426 the amount of activity the PAL strategies introduce.

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25 427 Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose is
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27 428 consistent with previous studies, for example, 10-30 minutes of activity, daily[35, 45-48] and 3 x 60-
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29 429 minute PAL per week[49]. It is worth noting that teachers in the current pilot study chose how many
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31 430 PAL they delivered, rather than being prescribed a weekly target; as such the dose indicates what is
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33 431 naturally achievable by secondary school teachers. A weekly dose of 6-7 PAL has the potential to
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35 432 substantially reduce adolescent's sedentary time during school hours, providing sufficient activity is
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37 433 introduced as part of the PAL.

38 39 40 41 434 **Costs**

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44 435 Training delivery costs (independent of travel and planning time) was estimated around £900
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46 436 (\$1,187) in both studies. Strategies to reduce costs could include reducing the number of staff
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48 437 delivering the sessions or hiring staff with a mixture of training levels, rather than the highly
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50 438 experienced staff in the current studies. Approximately 25% of the cost was spent on equipment,
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52 439 primarily for outdoor-based subject-specific examples; reviewing the equipment purchases may
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54 440 identify cost saving opportunities. Research reports that small grants (~\$2,000) to schools can lead

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3 441 to increased implementation of practices to promote activity[50]. Senior leadership teams
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5 442 commented on how thinly English schools budgets are stretched; it was suggested that school funds
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7 443 set aside for (for example) mental health services might represent an avenue of funding for the
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9 444 programme for some schools.

10 11 12 445 **Strengths and Limitations**

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14 446 High quality formative work for interventions is necessary to ensure appropriate allocation of
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16 447 research efforts and funding, and the publication of feasibility and pilot research is important to
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18 448 support other researchers and interventionists[51]. Limitations of this work include that samples
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20 449 were predominantly white; consequently, we are unable to explore differential responses to PAL by
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22 450 ethnicity. Moreover, parental opt out consent procedures limited the ability to obtain information
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24 451 on participant's socioeconomic position. The issue of lack of diversity among samples in PAL studies
25
26 452 has been previously raised[52]; future research should seek to explore feasibility, acceptability and
27
28 453 effectiveness among different racial/ethnic and socio-economic groups. Estimated training delivery
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30 454 costs are based on wage rates, national insurance and superannuation costs but don't include
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32 455 overhead costs such as costs of employing individuals and providing building space. As such, training
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34 456 delivery costs may be underestimated. In addition, we did not carry out longer-term follow-up
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36 457 assessments so we do not know if teachers continued to deliver PAL beyond eight weeks after the
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38 458 training.

39 40 41 42 459 **CONCLUSION**

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45 460 We successfully demonstrated the feasibility and acceptability of introducing and evaluating a PAL
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47 461 teacher-training programme in secondary schools. Across feasibility and pilot studies, teachers'
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49 462 acceptability of the intervention and of delivering PAL was demonstrated, although aspects of the
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51 463 training programme, particularly the outdoor component, require review. The intervention was
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53 464 acceptable to students and senior leadership representatives, and the dose of PAL received by
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55 465 students was sufficient to have the potential to make a substantial contribution to reducing

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3 466 adolescent's sedentary time during school hours. However, we did not observe preliminary
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5 467 effectiveness on students' activity behaviours. Taken together, the findings do not support
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7 468 continuation with the current PAL training programme, though its acceptability does highlight the
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9 469 need for further research into how the identified barriers might be overcome.

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10
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12
13 475 adolescents; PR-R5-0213-25001). The views expressed in the publication are those of the author(s)
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28
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34 484 **Data sharing**
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36 485 The datasets are not available for download. The study's participant information sheets and ethics
37
38 486 applications stipulated that the data would not be shared outside of the research team. The data are
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40 487 held at the MRC Epidemiology Unit at the University of Cambridge.
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45 489 **Competing interests**
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47 490 The authors declare that they have no competing interests.
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495 **Author contributions**

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

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REFERENCES

1. Hallal, P.C., et al., *Global physical activity levels: surveillance progress, pitfalls, and prospects*. The Lancet, 2012. **380**(9838): p. 247-257.
2. Matthews, C.E., et al., *Amount of time spent in sedentary behaviors in the United States, 2003-2004*. Am J Epidemiol, 2008. **167**(7): p. 875-81.
3. Brooke, H.L., et al., *Changes in time-segment specific physical activity between ages 10 and 14 years: A longitudinal observational study*. J Sci Med Sport, 2016. **19**(1): p. 29-34.
4. Steele, R.M., et al., *An investigation of patterns of children's sedentary and vigorous physical activity throughout the week*. Int J Behav Nutr Phys Act, 2010. **7**: p. 88.
5. Morton, K.L., et al., *The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review*. Obes Rev, 2016. **17**(2): p. 142-58.
6. Morton, K.L., et al., *School policies, programmes and facilities, and objectively measured sedentary time, LPA and MVPA: associations in secondary school and over the transition from primary to secondary school*. Int J Behav Nutr Phys Act, 2016. **13**: p. 54.
7. Morton, K.L., et al., *Engaging stakeholders and target groups in prioritising a public health intervention: the Creating Active School Environments (CASE) online Delphi study*. BMJ Open, 2017. **7**(1): p. e013340.
8. Bartholomew, J.B. and E.M. Jowers, *Physically active academic lessons in elementary children*. Prev Med, 2011. **52 Suppl 1**: p. S51-4.
9. Martin, R. and E.M. Murtagh, *Effect of Active Lessons on Physical Activity, Academic, and Health Outcomes: A Systematic Review*. Res Q Exerc Sport, 2017. **88**(2): p. 149-168.
10. Norris, E., et al., *Physically active lessons as physical activity and educational interventions: a systematic review of methods and results*. Prev Med, 2015. **72**: p. 116-25.
11. Howie, E.K., R.D. Newman-Norlund, and R.R. Pate, *Smiles count but minutes matter: responses to classroom exercise breaks*. Am J Health Behav, 2014. **38**(5): p. 681-9.
12. Daly-Smith, A.J., et al., *Systematic review of acute physically active learning and classroom movement breaks on children's physical activity, cognition, academic performance and classroom behaviour: understanding critical design features*. BMJ Open Sport Exerc Med, 2018. **4**(1): p. e000341.
13. Helgeson, J., *The impact of physical activity on academics in English classes at the junior high school level*. 2013, Northcentral University: ProQuest LLC. p. 188.
14. Cothran, D.J., P.H. Kulinna, and A.C. Garn, *Classroom teachers and physical activity integration*. Teaching and Teacher Education, 2010. **26**(7): p. 1381-1388.
15. Mullender-Wijnsma, M.J., et al., *Improving academic performance of school-age children by physical activity in the classroom: 1-year program evaluation*. J Sch Health, 2015. **85**(6): p. 365-71.
16. Gibson, C.A., et al., *Physical activity across the curriculum: year one process evaluation results*. Int J Behav Nutr Phys Act, 2008. **5**: p. 36.
17. Edmundson, E.W., et al., *CATCH: classroom process evaluation in a multicenter trial*. Health Educ Q, 1994. **Suppl 2**: p. S27-s50.
18. Webster, C.A., H. Erwin, and M. Parks, *Relationships Between and Changes in Preservice Classroom Teachers' Efficacy Beliefs, Willingness to Integrate Movement, and Perceived Barriers to Movement Integration*. Physical Educator, 2013. **70**(3): p. 314-335.
19. Brown, H.E., et al., *A cluster randomised controlled trial to evaluate the effectiveness and cost-effectiveness of the GoActive intervention to increase physical activity among adolescents aged 13-14 years*. BMJ Open, 2017. **7**(9): p. e014419.
20. Sudlow, C., et al., *UK biobank: an open access resource for identifying the causes of a wide range of complex diseases of middle and old age*. PLoS Med, 2015. **12**(3): p. e1001779.
21. Phillips, L.R., G. Parfitt, and A.V. Rowlands, *Calibration of the GENEA accelerometer for assessment of physical activity intensity in children*. J Sci Med Sport, 2013. **16**(2): p. 124-8.

- 1
2
3 22. Rosenberger, M.E., et al., *Estimating activity and sedentary behavior from an accelerometer on the hip or wrist*. *Med Sci Sports Exerc*, 2013. **45**(5): p. 964-75.
- 4 23. Dossegger, A., et al., *Reactivity to accelerometer measurement of children and adolescents*. *Med Sci Sports Exerc*, 2014. **46**(6): p. 1140-6.
- 5 24. Haapala, H.L., et al., *Changes in physical activity and sedentary time in the Finnish Schools on the Move program: a quasi-experimental study*. *Scand J Med Sci Sports*, 2017. **27**(11): p. 1442-1453.
- 6 25. Yli-Piipari, S., et al., *Objectively Measured School Day Physical Activity Among Elementary Students in the United States and Finland*. *J Phys Act Health*, 2016. **13**(4): p. 440-6.
- 7 26. Lau, E.Y., et al., *Changes in Physical Activity in the School, Afterschool, and Evening Periods During the Transition From Elementary to Middle School*. *J Sch Health*, 2017. **87**(7): p. 531-537.
- 8 27. White, T., et al., *Estimation of Physical Activity Energy Expenditure during Free-Living from Wrist Accelerometry in UK Adults*. *PLoS One*, 2016. **11**(12): p. e0167472.
- 9 28. Janssen, I. and A.G. Leblanc, *Systematic review of the health benefits of physical activity and fitness in school-aged children and youth*. *Int J Behav Nutr Phys Act*, 2010. **7**: p. 40.
- 10 29. Thompson, E.R., *Development and Validation of an Internationally Reliable Short-Form of the Positive and Negative Affect Schedule (PANAS)*. *Journal of Cross-Cultural Psychology*, 2016. **38**(2): p. 227-242.
- 11 30. Midgley, C., et al., *Manual for the patterns of adaptive learning scales*. 2000, University of Michigan: Michigan, US.
- 12 31. Jones, R.D., *Student engagement. Teacher handbook*. 2009, Center for Leadership in Education: New York.
- 13 32. Furber, G. and L. Segal, *The validity of the Child Health Utility instrument (CHU9D) as a routine outcome measure for use in child and adolescent mental health services*. *Health Qual Life Outcomes*, 2015. **13**: p. 22.
- 14 33. Hintze, J.M., V.R. J., and E.S. Shapiro, *Best practices in the systematic direct observation of student behaviour*. 2002. **IV**(4): p. 993-1006.
- 15 34. Johnson, A.H., S.M. Chafouleas, and A.M. Briesch, *Dependability of data derived from time sampling methods with multiple observation targets*. *Sch Psychol Q*, 2017. **32**(1): p. 22-34.
- 16 35. Mahar, M.T., et al., *Effects of a classroom-based program on physical activity and on-task behavior*. *Med Sci Sports Exerc*, 2006. **38**(12): p. 2086-94.
- 17 36. Nathan, N., et al., *Barriers and facilitators to the implementation of physical activity policies in schools: A systematic review*. *Prev Med*, 2018. **107**: p. 45-53.
- 18 37. Dyrstad, S.M., et al., *Physically active academic lessons: acceptance, barriers and facilitators for implementation*. *BMC Public Health*, 2018. **18**(1): p. 322.
- 19 38. Atkin, A.J., et al., *Seasonal Variation in Children's Physical Activity and Sedentary Time*. *Med Sci Sports Exerc*, 2016. **48**(3): p. 449-56.
- 20 39. Verma, S., et al., *Highs and lows: Naturalistic changes in mood and everyday hassles over school and vacation periods in adolescents*. *J Adolesc*, 2017. **61**: p. 17-21.
- 21 40. Eminson, K., et al., *How does age affect the relationship between weight and health utility during the middle years of childhood?* *Qual Life Res*, 2018.
- 22 41. Lee, A., *Health-promoting schools: evidence for a holistic approach to promoting health and improving health literacy*. *Appl Health Econ Health Policy*, 2009. **7**(1): p. 11-7.
- 23 42. Committee on Physical Activity Physical Education in the School. *Educating the Student Body: Taking Physical Activity and Physical Education to School*, ed. H.W. Kohl, III and H.D. Cook. 2013, Washington (DC): National Academies Press (US).
- 24 43. Hankonen, N., et al., *Randomised controlled feasibility study of a school-based multi-level intervention to increase physical activity and decrease sedentary behaviour among vocational school students*. *Int J Behav Nutr Phys Act*, 2017. **14**(1): p. 37.

- 1
2
3 44. Oliver, M., G. Schofield, and E. McEvoy, *An integrated curriculum approach to increasing habitual physical activity in children: a feasibility study*. J Sch Health, 2006. **76**(2): p. 74-9.
- 4 45. Erwin, H.E., et al., *Promoting children's health through physically active math classes: a pilot study*. Health Promot Pract, 2011. **12**(2): p. 244-51.
- 6 46. Reznik, M., et al., *A classroom-based physical activity intervention for urban kindergarten and first-grade students: a feasibility study*. Child Obes, 2015. **11**(3): p. 314-24.
- 8 47. Li, Y.P., et al., *Report on childhood obesity in China (8): effects and sustainability of physical activity intervention on body composition of Chinese youth*. Biomed Environ Sci, 2010. **23**(3): p. 180-7.
- 10 48. Donnelly, J.E., et al., *Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children*. Prev Med, 2009. **49**(4): p. 336-41.
- 12 49. Riley, N., et al., *Outcomes and process evaluation of a programme integrating physical activity into the primary school mathematics curriculum: The EASY Minds pilot randomised controlled trial*. J Sci Med Sport, 2015. **18**(6): p. 656-61.
- 14 50. Miller, G.F., et al., *Evaluation of Let's Move! active schools activation grants*. Prev Med, 2018. **108**: p. 36-40.
- 16 51. 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.
- 18 52. 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.
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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: <ul style="list-style-type: none"> • Anthropometry • Questionnaire • Accelerometry • Time-on-Task Teachers: <ul style="list-style-type: none"> • Questionnaire 	Training session 1 (2 hours) 30 minutes: Introduction to active learning 40 minutes: Split group in half: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Questionnaire • Accelerometry • Time-on-Task • Focus groups Teachers: <ul style="list-style-type: none"> • Questionnaire • Focus group Senior Leadership Team: <ul style="list-style-type: none"> • Interview
Pilot Study: Intervention School	<i>Same as for feasibility study baseline measures</i>	<i>Same as for feasibility study training session 1</i>	Training session 2 (2 hours) 45 minutes: Split group in half: <ul style="list-style-type: none"> • 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	<i>Same as for feasibility study follow-up measures</i>
Pilot Study: Control School	<i>Same as for feasibility study baseline measures</i>	No training session	No training session	Students: <ul style="list-style-type: none"> • 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)

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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).

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

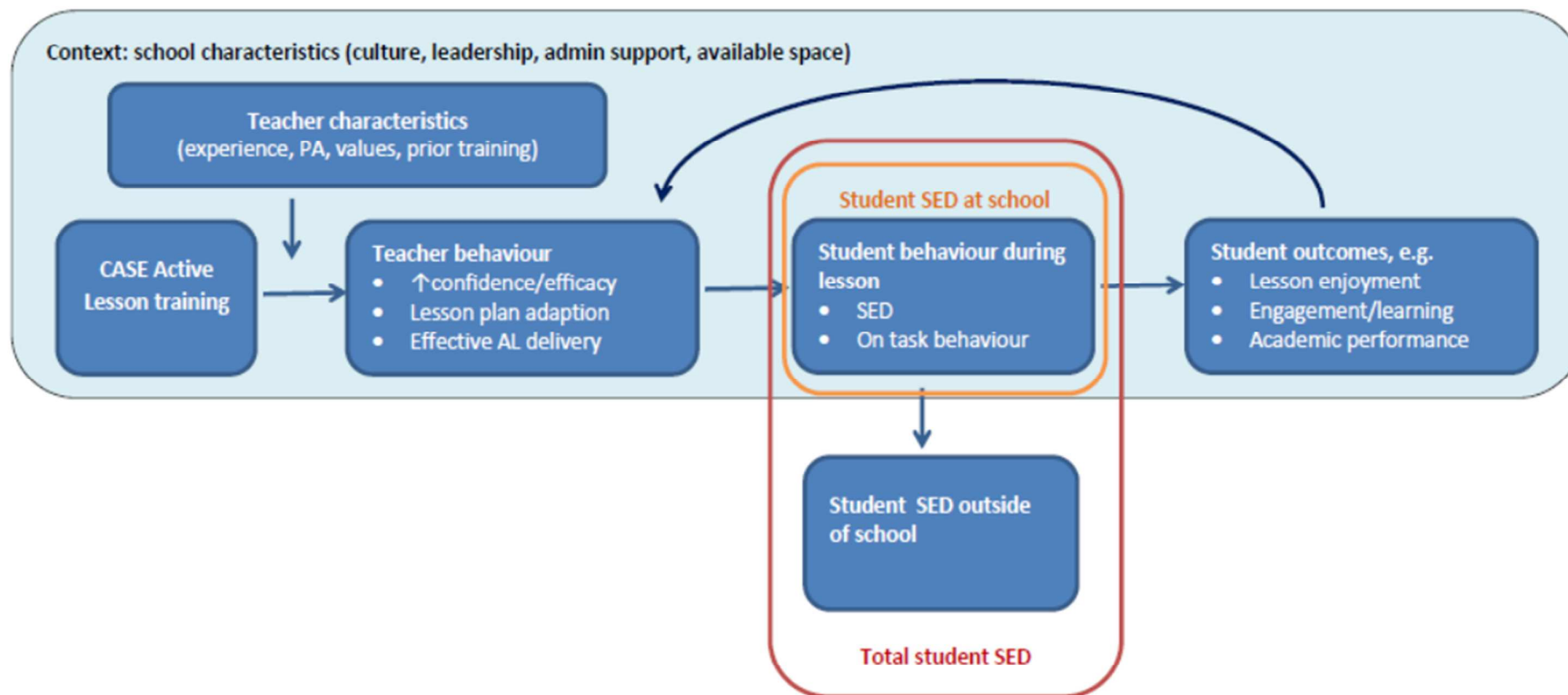
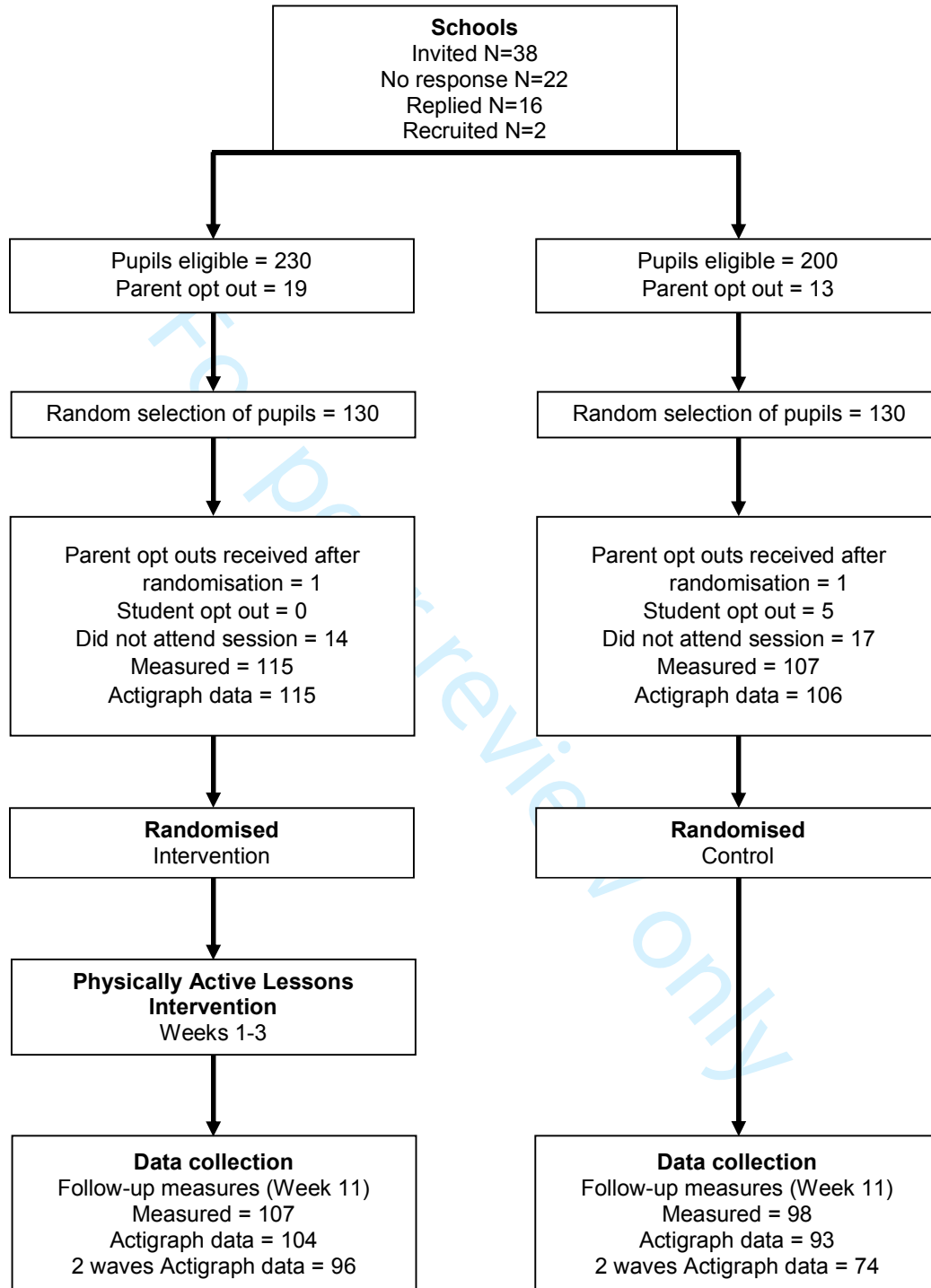


Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).



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)

^a27 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).

	Feasibility Study (n=9)	Pilot Study – Intervention School		
		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-Activity1421850222.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.

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

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

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24 B. Active Voting

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27 *What is it?* This notion of Active Voting is useful for exploring differing and diverse opinions on
28 particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought
29 of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the
30 stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if
31 they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of
32 ambiguity and grey areas, which helps them to see that opinions often have to be justified with
33 informed knowledge of the matter under discussion.
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42 *Implications for classroom layout:* Each of the four key statements will need to be positioned in one of
43 corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree.
44 When an issue is raised, pupils will then move to stand/sit in the corner that best reflects their
45 views and with those who share the same opinion/perspective.
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51 *How does it work?*

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54 1. A range of issues (related to the content being delivered) should be read out in turn by the
55 teacher.
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- 3 2. Pupils are then given time to consider their opinion.
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- 5 3. Pupils then move to the corner that best describes how they feel about what was read out.
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- 7 Pupils should be reminded that there are no right or wrong answers.
- 8
- 9 4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
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- 11 5. When pupils move to the corner that best represent their views on the statement, they
- 12
- 13 should be encouraged to explain why they feel that way with others in that group. General
- 14
- 15 perspectives can be obtained from all corners.
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- 17 6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and
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- 19 to refine the initial statement/problem/issues being discussed.
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- 21 7. Pupils are allowed to move during the discussion of each statement if issues arise that
- 22
- 23 challenge their original opinion.
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- 26 8. If pupils do switch then they should be encouraged to explain why.
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28 *Benefits*

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31 Developing thinking and decision making skills

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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

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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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BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-025080.R1
Article Type:	Research
Date Submitted by the Author:	14-Nov-2018
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 Suhrccke, 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
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health
Keywords:	Active lessons, Movement integration, Physical activity, Sedentary time, School health

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Manuscripts

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4 1 **Introducing physically active lessons in UK secondary schools: feasibility**
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8 2 **study and pilot cluster-randomised controlled trial**
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12 3 Catherine Gammon¹, Katie Morton¹, Andrew J Atkin^{1,2}, Kirsten Corder¹, Andy Daly-
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56 15 **Keywords:** Active lessons, movement integration, physical activity, sedentary time, school

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17 **Word count: 5,717**

For peer review only

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4 18 **Abstract**
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7 19 **Objectives:** Assess feasibility, acceptability and costs of delivering a physically active lessons
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10 20 (PAL) training programme to secondary school teachers and explore preliminary effectiveness
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14 21 for reducing pupils' sedentary time.
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17 22 **Design and setting:** Secondary schools in East England; one school participated in a pre-post
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20 23 feasibility study, two in a pilot cluster-randomised controlled trial. In the pilot trial, blinding to
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24 24 group assignment was not possible.
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27 25 **Participants:** Across studies, 321 randomly selected students (51% male; mean age: 12.9
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30 26 years), 78 teachers (35% male) and two assistant head-teachers enrolled; 296(92%) students,
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34 27 69(88%) teachers and two assistant head teachers completed the studies.
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38 28 **Intervention:** PAL training was delivered to teachers over two after-school sessions. Teachers
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41 29 were made aware of how to integrate movement into lessons; strategies included students
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44 30 collecting data from the environment for class activities, and completing activities posted on
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48 31 classroom walls, instead of sitting at desks.
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51 32 **Primary and secondary outcomes:** Quantitative and qualitative data were collected to assess
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54 33 feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline
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58 34 and ~8 weeks post-training; measures included accelerometer-assessed activity, self-
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4 35 reported well-being, and observations of time-on-task. Process evaluation was conducted at
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7 36 follow-up.
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10 37 **Results:** In the feasibility study, teachers reported good acceptability of PAL training and mixed
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13 38 experiences of delivering PAL. In the pilot study, teachers' acceptability of training was lower
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17 39 and teachers identified aspects of the training in need of review, including the outdoor PAL
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20 40 training and learning challenge of PAL strategies. In both studies, students and assistant head-
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23 41 teachers reported good acceptability of the intervention. Preliminary effectiveness for reducing
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26 42 students' sedentary time was not demonstrated in either study.
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30 43 **Conclusions:** No evidence of preliminary effectiveness on the primary outcome and mixed
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33 44 reports of teachers' acceptability of PAL training suggest the need to review the training. The
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36 45 results do not support continuation of research with the current intervention.
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40 46 **Trial registration:** ISRCTN registry; ISRCTN38409550.
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44 47 **Funding:** Department of Health Policy Research Programme (PR-R5-0213-25001).
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52 49 **Article Summary**
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56 50 **Strength and limitations of this study**
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4 51 • We completed thorough feasibility and pilot testing work to inform the decision of whether
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7 52 to progress with the current intervention and its evaluation.
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10 53 • We collected quantitative and qualitative data which provided valuable information on
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13 54 contextual influences and allowed us to address research questions more
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16 55 comprehensively.
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19 56 • We were unable to collect all planned follow-up measures from teachers and students in
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22 57 feasibility study, including teacher follow-up questionnaires and class observations of time-
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26 58 on-task.
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29 59 • We did not carry out longer-term follow-up measures of teacher acceptability and
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32 60 physically active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up
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35 61 would have provided an indication of the sustainability of the intervention.
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62 INTRODUCTION

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

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

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

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4 80 from 'brain/movement breaks', when activity is separate from learning. Evidence from primary
5
6
7 81 schools indicates that PAL can improve physical activity, academic achievement and lesson
8
9
10 82 enjoyment[9-12]. To our knowledge, only two studies have trialled the use of PAL among
11
12
13 83 adolescents[13, 14]. Helgeson (2013) reported no influence of the 'Energizers' PAL
14
15
16 84 programme on reading comprehension scores among junior high school students and did not
17
18
19 85 explore activity levels as a primary outcome[13]. Cothran and colleagues (2010) reported on
20
21
22 86 primary and secondary/high school teachers' experiences of a one-year movement integration
23
24
25
26 87 intervention. Compared to primary school teachers, secondary teachers faced different
27
28
29 88 challenges when attempting to integrate activity into lessons, in particular standardised testing
30
31
32 89 pressures and students not staying with one teacher all day (as typically is the case in primary
33
34
35 90 schools)[14]. Cothran and colleagues did not measure student activity behaviours as an
36
37
38 91 intervention outcome[14]. The positive effects of PAL reported for primary students suggest
39
40
41
42 92 there is value in exploring if secondary students can experience similar benefits. Given the
43
44
45 93 organisational and environmental differences between primary and secondary schools, it is
46
47
48 94 important to conduct high quality feasibility and pilot testing of secondary school PAL
49
50
51 95 interventions.

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54
55 96 A PAL training programme for secondary school teachers was tested in a feasibility study and
56
57
58 97 a cluster-randomised controlled pilot study. The studies aimed to explore the feasibility,
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3 98 acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary
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6 99 teachers. Acceptability of study processes was also examined, in anticipation of conducting a
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9
10 100 subsequent full trial. The feasibility study tested the intervention among maths and English
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12
13 101 teachers at one school, the pilot study tested the intervention among all-subject teachers and
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15
16 102 as part of a controlled trial. This paper presents the feasibility study and pilot study followed
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18
19 103 by an overall discussion and conclusion (ISRCTN38409550).
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23 104 1. FEASIBILITY STUDY

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27 105 Ethical approval for both studies was granted by the University of Cambridge's School of the
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30 106 Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the
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33 107 feasibility, acceptability, costs, and preliminary effectiveness (for reducing sedentary time and
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35
36 108 improving wellbeing and time-on-task among students) of a PAL training programme for
37
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39 109 secondary school teachers, and (ii) the feasibility and acceptability of study procedures.
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45 46 47 111 Feasibility Study - Methods

48 49 50 51 112 Recruitment

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55 113 Potential schools were identified from previous local research and approached with study
56
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58 114 information (n=2). One mixed-sex, non fee-paying secondary school participated. The head
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4 115 teacher provided written consent for the intervention to be delivered to the teachers, elected
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6
7 116 for the intervention to be trialled with maths and English teachers, and chose years 7 and 9 to
8
9
10 117 participate in study evaluation measures. The school were told they would be able to keep the
11
12
13 118 PAL training resources.

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15
16
17 119 Parents of all Year 7 and 9 students (11-14 years) received study information and students
18
19
20 120 were invited to participate in evaluation measures. Parents were given two weeks to opt out
21
22
23 121 (passive parental consent) via email, freephone, or freepost. From the students who had not
24
25
26 122 been opted out, 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly
27
28
29 123 selected for evaluation measures (using class lists and random number generating software).
30
31
32
33 124 The study's feasibility focus meant that a formal power calculation was not necessary to inform
34
35
36 125 sample size; a sample of 60 participants per year is consistent with samples of similar
37
38
39 126 studies[15]. Students provided written assent for evaluation measures.

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43 127 Maths and English teachers (n=15) received study information two weeks before the PAL
44
45
46 128 training. The senior leadership team requested that all maths and English teachers attend the
47
48
49 129 training. Teachers could choose to participate in the evaluation measures, those agreeing
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51
52
53 130 provided written consent. Over five school days students received approximately five maths
54
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56 131 lessons and four English lessons.

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60 132 Intervention

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4 133 The PAL training was developed by a team with teacher training qualifications and experience
5
6
7 134 in indoor (two trainers) and outdoor active learning (one trainer). The training was delivered at
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9
10 135 the intervention school between March and April, during pre-scheduled after-school teacher-
11
12
13 136 training time. Table 1 outlines the training programme and example active lessons are
14
15
16 137 published as supplementary material. The focus was on supporting teachers to adopt active
17
18
19 138 pedagogical approaches (teaching strategies that incorporate activity), rather than providing
20
21
22 139 new, PAL plans. The training was underpinned by aspects of social cognitive theory and aimed
23
24
25
26 140 to enhance teachers' self-efficacy in relation to PAL[16]. As such it drew from two prominent
27
28
29 141 behaviour change techniques: barrier identification and modelling/demonstrating
30
31
32 142 behaviour[17]. With the former, teachers were encouraged to identify barriers that might
33
34
35 143 impact their ability to implement PAL and plan ways to overcome these. With the latter, the
36
37
38 144 trainers demonstrated a plethora of PAL teaching strategies that teachers could employ in
39
40
41 145 their lessons. Figure 1 outlines the preliminary logic model of how the teacher-focused
42
43
44 146 intervention could lead to changes in students' activity. Prior to the training, the research team
45
46
47
48 147 visited the participating school and ascertained the availability of indoor and outdoor spaces
49
50
51 148 and equipment that could be used for PAL. Syllabi for maths and English were requested to
52
53
54 149 allow trainers to prepare relevant examples for the training.

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58 150 Measurements
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4 151 Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed
5
6
7 152 using questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7
8
9
10 153 and four Year-9 students) and an interview with the assistant head teacher were completed
11
12
13 154 using a semi-structured interview.

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16
17 155 *i. Evaluation of Intervention and Study*

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21 156 *Feasibility/acceptability of the intervention:* Questionnaire items and focus group questions
22
23
24 157 asked about teachers' perceptions of the utility, value and relevance of the training (adapted
25
26
27 158 from[18, 19]). Questionnaires asked if teachers would recommend the training to other
28
29
30 159 teachers and provided free-text boxes for teachers to suggest improvements. Training session
31
32
33 160 attendance rates were recorded.

34
35
36
37 161 *Feasibility/acceptability of PAL delivery:* Questionnaire items and focus group questions asked
38
39
40 162 teachers about classroom management during PAL, enjoyment of teaching PAL, time needed
41
42
43 163 to prepare and deliver PAL, and barriers to PAL delivery (items from[20]).

44
45
46
47 164 *Acceptability of PAL participation:* Questionnaire items and focus group questions asked
48
49
50 165 students about their experience of PAL participation, enjoyment of PAL, their preference for
51
52
53 166 active vs. desk-based lessons, and the best and worst things about PAL.
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4 167 *Costs:* Teachers and students reported resources purchased to deliver/participate in PAL. The
5
6
7 168 research team recorded time and costs associated with the training team's development and
8
9
10 169 delivery of the intervention.

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14 170 *Study processes:* The research team made field notes on study processes that proved to be
15
16
17 171 challenging or ineffective, for example, students struggling to understand a questionnaire item.

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21 172 *ii. Intervention Outcomes*

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24 173 *Student anthropometry:* Anthropometric measures were completed by trained staff using
25
26
27
28 174 standard procedures. Height was measured using a stadiometer (Leicester height measure,
29
30
31 175 Chasmors, Leicester, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1
32
33
34 176 kg (Tanita, type TBF-300A, Tokyo, Japan). The measurement stations were set up so that
35
36
37 177 results were not visible to anyone except the measurement staff. Height, weight, sex, birthdate
38
39
40 178 and measurement date were used to calculate participants' body mass index (BMI; kg/m²) and
41
42
43
44 179 BMI percentile.

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47
48 180 *Activity intensity:* Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were
49
50
51 181 used to measure activity behaviours. These devices have been used among a larger sample
52
53
54 182 of Year-9 participants in the GoActive study[21] and the UK Biobank Cohort Study[22]. Wrist-
55
56
57 183 worn monitors are validated for the assessment of energy expenditure in pediatric
58
59
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4 184 populations[23] with higher participant compliance when compared to waist-worn
5
6
7 185 accelerometers[24]. Participants were given verbal and written instructions on monitor wear,
8
9
10 186 including that the monitor was waterproof and could be worn continuously for the next seven
11
12
13 187 days (Monday to Monday).

14
15
16
17 188 The first day of monitor wear was dropped[25]; included participants provided valid data for
18
19
20 189 $\geq 80\%$ of school hours for \geq two school days, at baseline and follow-up[26-28]. Acceleration
21
22
23 190 was recorded at 100Hz with a dynamic range of $\pm 8g$. Data from the monitors was downloaded
24
25
26 191 in continuous waveform. Euclidean Norm Minus One (ENMO) represents acceleration
27
28
29 192 magnitude at each measurement, accounting for the influence of gravity. ENMO thresholds
30
31
32
33 193 were used to classify activity intensities: time spent at 0-30 ENMO was classified as sedentary
34
35
36 194 activity (equivalent to 1-1.5 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-
37
38
39 195 500 ENMO as moderate-intensity activity (4-7 METs), and above 500 ENMO as vigorous-
40
41
42 196 intensity activity[29, 30].

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46 197 *Mental Health and Wellbeing:* Students completed questionnaire measures of positive and
47
48
49 198 negative affect[31], academic efficacy, disruptive behaviour[32], enjoyment of school
50
51
52
53 199 classes[33] and health related quality of life[34-39] at baseline and follow-up. All
54
55
56 200 questionnaires are validated for use with adolescents and were analysed according to
57
58
59 201 published instructions[31, 32, 39].
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4 202 *Time-on-task*: Students' time-on-task was assessed during three lessons by one member of
5
6
7 203 the research team using a momentary time-sampling procedure (which incurs less bias than
8
9
10 204 other sampling procedures[40, 41]). At the start of each observed class, the teacher asked all
11
12
13 205 students participating in the study to raise their hands. From the students that raised their
14
15
16 206 hands, the researcher identified two boys and two girls (when possible) to observe. The
17
18
19 207 researcher chose students sitting in different areas of the classroom. Each student was
20
21
22 208 observed once per minute, in a consistent order, for the duration of the lesson. Students'
23
24
25 209 behaviour was coded as: (i) on-task, (ii) off-task-passive, (iii) off-task-motor, or (iv) off-task-
26
27
28 210 noise[42]. The mean percentage of intervals recorded as 'on task' for observed students and
29
30
31 211 classes was calculated and used as the outcome measure.
32
33
34
35
36 212 Prior to classroom observations, a validation activity was completed where two researchers
37
38
39 213 discussed definitions and concurrently coded student behaviour using four online videos.
40
41
42 214 Observers' codes matched for 95% of observation intervals.
43
44
45

46 215 Descriptive Statistics

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50 216 Descriptive statistics of the sample, primary and secondary outcomes, and quantitative
51
52
53 217 measures of feasibility and acceptability are summarised. Focus group transcripts were
54
55
56 218 reviewed; recurring comments and themes relevant to the research questions were identified.
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220 Feasibility Study - Results

221 Recruitment and sample characteristics

222 Student and teacher recruitment and characteristics are summarised in supplementary tables

223 1 and 2. Of 120 students invited to participate in the evaluation measures, 99 were recruited,

224 with 91 (92%) providing data at baseline and follow-up. Students had a mean age of 13.0

225 (± 1.1) years, 52% were male and 27% were classified as overweight/obese. Teachers were

226 predominantly female (67%) and below the age of 45 (83%).

227 Feasibility and Acceptability

228 Training session one was attended by 14 (out of 15) teachers (7 maths, 7 English), training

229 session two was attended by 12 teachers (7 maths, 5 English), 11 teachers attended both

230 sessions. Teacher feedback demonstrated acceptability of the training, with 100%

231 recommending the training to other teachers (supplementary table 3). Individual and collective

232 efficacy for delivering PAL improved from 2.7 to 3.2, and 2.4 to 3 (out of 4), respectively. At

233 follow-up, \geq eight teachers had attempted to deliver PAL. Teacher's goals for PAL delivery

234 averaged 2.1 (SD=1.0) lessons per week, with an average targeted reduction in sitting time of

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4 235 15.8 (SD=8.0) minutes. Some teachers reported positive experiences of delivering PAL, while
5
6
7 236 others reported challenges (Text box 1).
8
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10 237 Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting,
11
12
13 238 challenges re-focusing students after an active portion of class, and limited classroom space.
14
15

16 239 Teachers identified facilitators of PAL delivery as theirs and the students' enjoyment of PAL,
17
18
19
20 240 good weather allowing them to go outside, more classroom space and a more diligent group
21
22
23 241 of students. Teachers reported ≤ 15 extra minutes were required to plan PAL, and a few extra
24
25
26 242 minutes were needed to prepare students for PAL participation.
27
28

29
30 243 Of the students who recalled participating in an active lesson (47%), most preferred PAL to
31
32
33 244 desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to
34
35
36 245 continue delivering them. Students reported enjoying going outside and moving around (30%),
37
38
39 246 that PAL were less boring/more fun than desk-based lessons (26%) and that they could
40
41
42
43 247 concentrate better (14%). Negative comments about PAL included lethargy (12%), more
44
45
46 248 disruptive behaviour (9%), and less work achieved (12%; text box 1).
47
48

49
50 249 The assistant head teacher felt the training was well-received and high-quality professional
51
52
53 250 development. The school's reasons for participating in the project included the potential for
54
55
56 251 improving students' mental health and the motivation to be innovative in the classroom. The
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3 252 assistant head teacher commented that teaching staff had enjoyed taking students outside for

4
5
6
7 253 lessons and the project had involved a low level of commitment from the school.

8
9
10 254 Costs

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14 255 Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment.

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16
17 256 Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student,

18
19
20 257 ~£30).

21
22
23
24 258 Study Processes

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27
28 259 The majority of study procedures were completed successfully. Challenges encountered

29
30
31 260 included that students struggled to complete a blank timetable indicating when their Maths

32
33
34 261 and English lessons were, and despite efforts, we were unable to schedule follow-up

35
36
37 262 classroom observations. Teacher baseline questionnaire return was low and the follow-up

38
39
40 263 focus group was conducted in a 15-minute timeslot due to late changes.

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44 264 Preliminary effectiveness

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48 265 Table 2 summarises baseline and follow-up data for all student measures. Sedentary time

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51 266 increased by 8.7 minutes and time spent in light-intensity activity decreased by 8.1 minutes.

52
53
54 267 Minimal changes were observed in the mental health and wellbeing scores between baseline

55
56
57 268 and follow-up.

269 Feasibility Study - Reflections

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

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

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

1
2
3 287 spring and summer[45]. Increased negative feelings and lower wellbeing among students
4
5
6 288 between March and June is consistent with typical changes observed in students' wellbeing
7
8
9
10 289 over a school term[46, 47].
11
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17 291 **2. PILOT STUDY**

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21 292 Following successful implementation of the intervention in the feasibility study, we sought to
22
23
24 293 extend our previous work and explore the potential value of conducting a full-scale randomised
25
26
27 294 controlled trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the
28
29
30 295 feasibility, acceptability, preliminary effectiveness and costs of delivering a PAL intervention
31
32
33 296 at a whole-school level (to all subject teachers) and (ii) to test the acceptability of school-level
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35
36 297 randomisation.
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45 299 **Pilot Study - Methods**

46 47 48 300 **Recruitment and Randomisation**

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51
52 301 *Schools:* We aimed to recruit three schools - two intervention (to test whole-school delivery of
53
54
55 302 the intervention in different settings) and one control (to test the acceptability of school-level
56
57
58 303 randomisation). In June-July 2017, 26 non fee-paying, mixed gender, secondary schools in
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60

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2
3
4 304 the East of England were emailed study information and invited to participate (the school that
5
6
7 305 took part in the feasibility study was not invited to participate in the pilot study). The first three
8
9
10 306 schools to agree were recruited; one school withdrew prior to student recruitment (and
11
12
13 307 randomisation). We were unable to replace the school within an appropriate timeframe. After
14
15
16 308 baseline measures, individuals separate from the research team performed a coin-toss to
17
18
19 309 assign intervention and control schools. The nature of the intervention and goals of the
20
21
22 310 evaluation measures meant it was not possible to blind participants. Due to differences in
23
24
25
26 311 follow-up measures between control and intervention schools, it was not possible to blind
27
28
29 312 measurement staff at follow-up.

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31
32
33 313 *Students:* Recruitment proceeded as outlined for the feasibility study. Schools were asked to
34
35
36 314 choose one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation
37
38
39 315 measures. This would allow assessment of differential responses to the intervention by age.
40
41
42 316 The intervention school selected Years 7 and 9 and the control school selected Years 8 and
43
44
45
46 317 9. Following feasibility study procedures, we randomly selected 130 students (50% male, 50%
47
48
49 318 from each year) from each school for evaluation measures (based on feasibility study retention
50
51
52 319 rates), with the aim of obtaining full data on 100 participants.

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56 320 *Teachers:* A teacher information and recruitment meeting was scheduled at both schools,
57
58
59 321 during which a researcher introduced the study and distributed consent forms. Teachers were
60

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4 322 advised by their senior leadership team that they would be required to attend the PAL training
5
6
7 323 if allocated as the intervention school; all teachers were free to decide on participation in
8
9
10 324 evaluation measures.

11 12 13 14 325 Intervention

15
16
17 326 Extending the feasibility study, the intervention was delivered to all subject teachers. Training
18
19
20 327 all subject teachers is consistent with the whole-school approach recommended for activity
21
22
23
24 328 promotion and obesity prevention among youth[48, 49]. Given the acceptability of the training
25
26
27 329 demonstrated in the feasibility study, the structure and goals of the training for the pilot study
28
29
30 330 were similar. Minimal changes were made to the indoor training component, which focused
31
32
33 331 on generic active learning strategies, applicable to any subject (e.g., different workstations
34
35
36 332 around the classroom). In the feasibility study, the outdoor training component provided
37
38
39
40 333 multiple subject- and topic-specific lesson ideas; the inclusion of all subject teachers meant
41
42
43 334 fewer subject-specific examples could be actively worked through during the pilot study
44
45
46 335 training. One additional outdoor lessons trainer was involved to train the larger group of
47
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49 336 teachers.

50 51 52 53 337 Measurements

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4 338 Table 1 outlines the timeline of study measures; all data were collected at schools, during
5
6
7 339 school hours. To increase teacher baseline questionnaire return, questionnaires were
8
9
10 340 distributed during the pre-training teacher information meeting, and completed following
11
12
13 341 consent. Data collection followed the same procedures as described for the feasibility study,
14
15
16 342 except for the assessment of PAL dose and time on task.

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18
19
20 343 *PAL Dose:* A teacher timetable was created using school-provided student timetables,
21
22
23 344 detailing their Year 7 and 9 lessons. During the student accelerometer assessment at follow-
24
25
26 345 up, teachers were given their personalised timetable and asked 'please circle which of the
27
28
29 346 listed Year 7 and/or 9 classes were (or will be) delivered as an active lesson.' Teachers
30
31
32
33 347 responses were used to calculate PAL dose. *Time on task:* Four lessons were observed at
34
35
36 348 baseline and follow-up, at both schools. At baseline (prior to delivery of PAL training) the
37
38
39 349 research team observed typical desk-based lessons. At follow-up, the research team asked
40
41
42 350 to observe physically active lessons.

43 44 45 46 351 Patient and Public Involvement

47
48
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50 352 In an earlier phase of CASE, opinions of key stakeholders regarding (i) suitable PA
51
52
53 353 interventions for secondary schools and (ii) salient outcomes, were explored in a Delphi study
54
55
56 354 ([7]). The decision to trial a PAL intervention and inclusion of mental health and time-on-task
57
58
59 355 measures were informed by the Delphi study. While stakeholders were not involved in study

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2
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4 356 design, conduct or recruitment, they reviewed questionnaires and provided feedback on
5
6
7 357 qualitative findings. Student participants received a personal PA report and participating
8
9
10 358 schools will be provided with a summary of the findings. Assistant head teachers commented
11
12
13 359 on the time commitment of the intervention and teacher participants reported on time spent
14
15
16 360 implementing intervention components.

20 361 Descriptive statistics

22
23
24 362 Descriptive statistics and focus group analysis proceeded as outlined for the feasibility study.
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28 363 **Pilot Study - Results**

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31 364 Figure 2 shows the flow of participants, with further information on student and teacher
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35 365 recruitment and sample characteristics in supplementary tables 1 and 2. Of the assenting
36
37
38 366 students (n=222) 92% provided data at two time points. Half of the students were male and
39
40
41 367 24% were classified as overweight/obese. The majority of teachers were female and >50% of
42
43
44 368 staff reported delivering at least one PAL a week at baseline. At the intervention school, 30
45
46
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48 369 and 33 teachers attended training session one and two, respectively (29 teachers attended
49
50
51 370 both).

54 371 Feasibility and Acceptability

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4 372 Average scores regarding teachers' acceptability of the training fell below 4 (the 'neutral'
5
6
7 373 value) indicating negative feelings towards the training (supplementary table 3). Teachers
8
9
10 374 reported training activities to be more suited for primary schools and not sufficiently
11
12
13 375 challenging for secondary students. One teacher commented: "*they were more bonus*
14
15
16 376 *activities, like extra treat things... you couldn't get much learning done through them*" (Science
17
18
19 377 teacher, female). Teachers felt it was assumed they weren't delivering PALs prior to the
20
21
22 378 training and this created resistance towards the training effort. Teachers reported that the PAL
23
24
25 379 ideas were not novel and repetitive, the focus on outdoor learning was distracting, and the
26
27
28
29 380 value of outdoor activities wasn't clear.

31
32
33 381 More than half of teachers reported delivering at least one PAL a week at baseline. PAL
34
35
36 382 delivery decreased for four teachers (11%), was maintained by six teachers (17%), and
37
38
39 383 increased for 13 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers
40
41
42 384 indicated they were likely to continue teaching PAL, although they reported concerns about
43
44
45 385 students not learning as much during PAL. Some teachers felt older students could be more
46
47
48
49 386 lethargic and resistant: "*the younger ones love getting up and interacting with each other. I*
50
51
52 387 *think the older ones do, it just takes... more effort to get them going*" (History teacher, female).

53
54
55
56 388 The majority of teachers reported ≤ 15 minutes for planning, ≤ 5 minutes for classroom
57
58
59 389 preparation, and ≤ 5 minutes for student preparation. The time needed to deliver an outdoor
60

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4 390 activity – in particular the transition between indoors and outdoors - was identified as a barrier
5
6
7 391 to implementation. The assistant head teacher also commented about the pitch of the training
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10 392 and poor use of learning time due to transitioning. They felt the indoor component of the
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13 393 training had been more informative and appropriate, and commented staff had used active
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16 394 learning strategies indoors, but not outdoors. Finally, they commented that PAL
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19 395 implementation had declined with time.

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23 396 Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue
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26 397 teaching PAL, with no evidence of differences in intervention acceptability by sex or weight
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29 398 status. Students commented that PAL were fun and helped learning, and they liked moving
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33 399 more: *"I really enjoyed it. It gave me more of an understanding... because when you're just*
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36 400 *copying off the board some writing I don't always understand it, then when you're moving*
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39 401 *about it's a lot more clearer"* (Year-7, female). Students however also commented that during
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42 402 PAL some students messed around more and didn't focus on work, and work was easier to
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45 403 do when sitting down.

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49 404 Student PAL dose

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53 405 In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each).
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56 406 Each teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an
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4 407 average of 6.9 PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range:
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7 408 2-13; 28%). This represents the contribution across all subjects.
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10 409 Costs

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14 410 The cost of delivering the training was £901, comprised of £451 staff time and £450
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17 411 equipment. Session one was delivered by three trainers, while session two was delivered by
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20 412 four trainers. Four teachers purchased resources to support PAL delivery, including science
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23 413 equipment, textiles equipment, post-it notes and whiteboard pens, and printed resources. Four
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27 414 students reported purchasing resources to support PAL participation – three purchased sports
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30 415 shoes (~£30 per pair) and one a mouth guard (~£7).
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34 416 Preliminary Effectiveness

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38 417 Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at
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41 418 baseline (excluding P.E. and drama lessons). There was no evidence of changes in sedentary
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44 419 activity or time spent in light, moderate and vigorous activity intensities. Table 4 summarises
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48 420 baseline and follow-up values for all outcome measures for intervention and control
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51 421 participants. There was no evidence of preliminary effectiveness on sedentary time or light
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54 422 activity, or on indicators of mental health and wellbeing (including academic efficacy, positive
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57 423 & negative affect, and disruptive behaviour).
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424 Pilot Study - Reflections

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

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

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

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3 441 students considered P.E. lessons in their appraisal of PAL and reported shoes and
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6 442 mouthguards purchased for this.
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10 443 We successfully tested study procedures and intervention delivery at a whole-school level,
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13 444 with adequate recruitment and retention rates and continued control school involvement
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16 445 indicating acceptability of randomisation. Efforts made to improve data collection processes
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19 446 from the feasibility study, e.g., of student timetables and teacher questionnaires, were
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23 447 successful.
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27 448 The assessment of PAL dose showed that students received an average of 6-7 x 60-minute
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30 449 PAL a week, which has the potential to make a valuable contribution to reducing sedentary
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33 450 time among adolescents. Despite a measured increase in PAL delivery, there was no evidence
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36 451 of reduced sedentary time, suggesting a need to review the PAL strategies that were shared
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39 452 with teachers, with a focus on the amount of activity introduced. It is also possible that teachers
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42 453 over-reported PAL delivery out of concern for being judged by the researchers and/or their
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45 454 senior leadership team.
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54 456 **OVERALL DISCUSSION**

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4 457 In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and
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7 458 costs of a teacher-training programme for integrating activity into secondary school lessons.
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10 459 We also sought to understand the feasibility and acceptability of study procedures, including
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13 460 repeated accelerometer wear and school-level randomisation. The intervention was
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16 461 successfully delivered in two schools and quantitative and qualitative data was successfully
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19 462 collected from multiple stakeholders, enabling us to address all research questions. The
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22 463 majority of PAL evaluations have been carried out in primary schools[9] and as such, this
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26 464 study makes a valuable contribution to the literature.

29 465 **Feasibility/acceptability of PAL training**

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33 466 Consistent with previous research, it was feasible to deliver PAL training to secondary school
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37 467 teachers over two, 2-hour, after-school sessions[50]. Schools scheduled the PAL training
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40 468 during pre-scheduled after-school teacher-training slots, as such, the intervention did not
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43 469 require teachers to attend any more after-school training than they typically would within a
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46 470 school term. In both studies, a small number of teachers were unable to attend both training
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49 471 sessions which may have influenced intervention outcomes. It is realistic that at any school
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52 472 receiving the intervention, a proportion of staff would be unable to attend both training
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56 473 sessions. As such the external validity of the findings is supported.
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4 474 While acceptability of the training was demonstrated in the feasibility study and is reported
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7 475 elsewhere[18, 44, 50], feedback from teachers in the pilot study was less positive. Delivery to
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10 476 teachers of two subjects in the feasibility study meant a smaller training group and a smaller
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13 477 trainer:staff ratio than in the pilot study. This allowed more subject-specific discussion and
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16 478 more time to address teachers' personal questions. Teacher feedback suggests that training
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19 479 acceptability is related to teachers' experience delivering PAL. In the pilot study, teachers
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22 480 delivering PAL more regularly rated the intervention more poorly than less experienced
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25 481 teachers. A PAL intervention targeting teachers not regularly delivering PAL may be more
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28 482 acceptable. The positive responses to the training in the feasibility study (involving teachers
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31 483 reporting low levels of PAL delivery) support this suggestion.

32 33 34 35 36 484 **Feasibility/acceptability of delivering/participating in PAL**

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40 485 In the feasibility study, teachers had mixed reviews of delivering PAL, whereas in the pilot
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43 486 study, teachers reported acceptability of delivering PAL. Pilot study teachers were more likely
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46 487 to report regular PAL delivery at baseline than feasibility teachers and to have had previous
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49 488 exposure to PAL during their initial teacher training and/or career. A longer trial period and
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52 489 increased support may have allowed teachers in the feasibility study to become more
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55 490 confident and accrue more positive PAL experiences. Overall, the data suggest that PAL
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58 491 delivery can be acceptable to secondary school teachers.

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3 492 While teachers were the direct intervention recipients and their acceptability is crucial for
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6 493 successful implementation, it is important to consider acceptability for other stakeholders, who
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10 494 also influence implementation. Across both studies students responded positively to PAL, and
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13 495 senior leadership representatives reported satisfaction with the intervention (in the pilot study,
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16 496 satisfaction with the indoor component). Both senior leadership representatives commented
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19 497 that reasons for study participation included the potential positive influence on students'
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22 498 mental health. This observation is consistent with previous findings[7] and indicates potentially
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25 499 effective strategies for promotion of the intervention to schools.
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30 **Preliminary Effectiveness**

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33 501 Despite a measured increase in PAL delivery, no changes in activity were observed. The
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36 502 findings are consistent with a systematic review and meta-analysis of secondary school
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39 503 classroom-based physical activity interventions, which reported no significant influence on
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42 504 activity behaviours[51]. Although, other PAL feasibility and pilot studies have reported more
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45 505 encouraging changes[42, 51-53]. In the feasibility study, early implementation efforts of Maths
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48 506 and English teachers may not have been sufficient to translate to changes in activity. It's
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51 507 possible that more or longer training sessions could increase teacher's confidence and
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54 508 competency for delivering PAL, however, initial discussions with the feasibility study school
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57 509 suggested that a 2-hour after-school training session would be acceptable while a 3-hour
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3 510 session would be too long. Across both studies, teachers were advised that any non-seated
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6 511 activity was considered an 'active lesson' - as such, the intervention may be too dilute for
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10 512 measurable impact using wrist-worn accelerometers; classroom observations of PAL (beyond
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13 513 assessing time on task) may have aided our interpretation of the findings. Overall, the results
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16 514 suggest the need to review the amount of activity the PAL strategies introduce.

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20 515 Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose
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23 516 is consistent with previous studies, for example, 10-30 minutes of activity, daily[42, 53-56] and
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26 517 3 x 60-minute PAL per week[57]. It is worth noting that teachers in the current pilot study chose
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29 518 how many PAL they delivered, rather than being prescribed a weekly target; as such the dose
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32 519 indicates what is naturally achievable by secondary school teachers. A weekly dose of 6-7
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35 520 PAL has the potential to substantially reduce adolescents' sedentary time during school hours,
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38 521 providing sufficient activity is introduced as part of the PAL.
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43 522 **Costs**

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47 523 Training delivery costs (independent of travel and planning time) was estimated around £900
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50 524 (\$1,187) in both studies. Strategies to reduce costs could include reducing the number of staff
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53 525 delivering the sessions or hiring staff with a mixture of training levels, rather than the highly
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56 526 experienced staff in the current studies. Approximately 25% of the cost was spent on
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59 527 equipment, primarily for outdoor-based subject-specific examples; reviewing the equipment

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4 528 purchases may identify cost saving opportunities. Research reports that small grants
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7 529 (~\$2,000) to schools can lead to increased implementation of practices to promote activity[58].
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10 530 Senior leadership teams commented on how thinly English schools budgets are stretched; it
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13 531 was suggested that school funds set aside for (for example) mental health services might
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16 532 represent an avenue of funding for the programme for some schools.
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20 533 **Strengths and Limitations**

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24 534 High quality formative work for interventions is necessary to ensure appropriate allocation of
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27 535 research efforts and funding, and the publication of feasibility and pilot research is important
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30 536 to support other researchers and interventionists[59]. Limitations of this work include that
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33 537 samples were predominantly white; consequently, we are unable to explore differential
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36 538 responses to PAL by ethnicity. Moreover, parental opt out consent procedures limited the
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40 539 ability to obtain information on participants' socioeconomic position. The issue of lack of
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43 540 diversity among samples in PAL studies has been previously raised[60]; future research
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46 541 should seek to explore feasibility, acceptability and effectiveness among different racial/ethnic
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49 542 and socio-economic groups. Estimated training delivery costs are based on wage rates,
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52 543 national insurance and superannuation costs but don't include overhead costs such as costs
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55 544 of employing individuals and providing building space. As such, training delivery costs may be
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58 545 underestimated. In addition, we did not carry out longer-term follow-up assessments so we do
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4 546 not know if teachers continued to deliver PAL beyond eight weeks after the training. Finally,
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7 547 we do not believe that lack of blinding of measurement staff has impacted the conclusions
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10 548 drawn from these studies, but acknowledge that a potential fully-powered trial would benefit
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13 549 from efforts to blind measurement staff.
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16 17 550 **CONCLUSION**

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21 551 We successfully demonstrated the feasibility and acceptability of introducing and evaluating a
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24 552 PAL teacher-training programme in secondary schools. Across feasibility and pilot studies,
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27 553 teachers' acceptability of the intervention and of delivering PAL was demonstrated, although
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30 554 aspects of the training programme, particularly the outdoor component, require review. The
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33 555 intervention was acceptable to students and senior leadership representatives, and the dose
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36 556 of PAL received by students was sufficient to have the potential to make a substantial
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40 557 contribution to reducing adolescents' sedentary time during school hours. However, we did
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43 558 not observe preliminary effectiveness on students' activity behaviours or wellbeing indicators.
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46 559 Taken together, the findings do not support continuation with the current PAL training
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49 560 programme, though its acceptability does highlight the need for further research into how the
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52 561 identified barriers might be overcome.
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575 and processing the accelerometer data.

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577 Data sharing

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4 578 The datasets are not available for download. The study's participant information sheets and
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7 579 ethics applications stipulated that the data would not be shared outside of the research team.
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10 580 The data are held at the MRC Epidemiology Unit at the University of Cambridge.
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16 582 **Competing interests**

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19 583 The authors declare that they have no competing interests.
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35 588 **Author contributions**

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38 589 All authors (Catherine Gammon, Katie Morton, Andrew Atkin, Kirsten Corder, Andy Daly-
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42 590 Smith, Thomas Quarmby, Marc Suhrcke, David Turner and Esther van Sluijs) contributed to
43
44
45 591 the conceptualisation and design of the work, and reviewed and approved the final manuscript.
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48 592 Catherine Gammon, David Turner, and Esther van Sluijs contributed to the acquisition,
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51 593 analysis and interpretation of data. Catherine Gammon drafted the manuscript.
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REFERENCES

1. Hallal, P.C., et al., *Global physical activity levels: surveillance progress, pitfalls, and prospects*. The Lancet, 2012. **380**(9838): p. 247-257.
2. Matthews, C.E., et al., *Amount of time spent in sedentary behaviors in the United States, 2003-2004*. Am J Epidemiol, 2008. **167**(7): p. 875-81.
3. Brooke, H.L., et al., *Changes in time-segment specific physical activity between ages 10 and 14 years: A longitudinal observational study*. J Sci Med Sport, 2016. **19**(1): p. 29-34.
4. Steele, R.M., et al., *An investigation of patterns of children's sedentary and vigorous physical activity throughout the week*. Int J Behav Nutr Phys Act, 2010. **7**: p. 88.
5. Morton, K.L., et al., *The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review*. Obes Rev, 2016. **17**(2): p. 142-58.
6. Morton, K.L., et al., *School policies, programmes and facilities, and objectively measured sedentary time, LPA and MVPA: associations in secondary school and over the transition from primary to secondary school*. Int J Behav Nutr Phys Act, 2016. **13**: p. 54.
7. Morton, K.L., et al., *Engaging stakeholders and target groups in prioritising a public health intervention: the Creating Active School Environments (CASE) online Delphi study*. BMJ Open, 2017. **7**(1): p. e013340.
8. Bartholomew, J.B. and E.M. Jowers, *Physically active academic lessons in elementary children*. Prev Med, 2011. **52 Suppl 1**: p. S51-4.
9. Martin, R. and E.M. Murtagh, *Effect of Active Lessons on Physical Activity, Academic, and Health Outcomes: A Systematic Review*. Res Q Exerc Sport, 2017. **88**(2): p. 149-168.
10. Norris, E., et al., *Physically active lessons as physical activity and educational interventions: a systematic review of methods and results*. Prev Med, 2015. **72**: p. 116-25.
11. Howie, E.K., R.D. Newman-Norlund, and R.R. Pate, *Smiles count but minutes matter: responses to classroom exercise breaks*. Am J Health Behav, 2014. **38**(5): p. 681-9.
12. Daly-Smith, A.J., et al., *Systematic review of acute physically active learning and classroom movement breaks on children's physical activity, cognition, academic performance and classroom behaviour: understanding critical design features*. BMJ Open Sport Exerc Med, 2018. **4**(1): p. e000341.
13. Helgeson, J., *The impact of physical activity on academics in English classes at the junior high school level*. 2013, Northcentral University: ProQuest LLC. p. 188.
14. Cothran, D.J., P.H. Kulinna, and A.C. Garn, *Classroom teachers and physical activity integration*. Teaching and Teacher Education, 2010. **26**(7): p. 1381-1388.
15. Mullender-Wijnsma, M.J., et al., *Improving academic performance of school-age children by physical activity in the classroom: 1-year program evaluation*. J Sch Health, 2015. **85**(6): p. 365-71.
16. Bandura, A., *Social foundations of thought and action: a social-cognitive theory*. 1986, Englewood Cliffs, NJ: Prentice-Hall
17. Abraham, C. and S. Michie, *A taxonomy of behavior change techniques used in interventions*. Health Psychol, 2008. **27**(3): p. 379-87.
18. Gibson, C.A., et al., *Physical activity across the curriculum: year one process evaluation results*. Int J Behav Nutr Phys Act, 2008. **5**: p. 36.
19. Edmundson, E.W., et al., *CATCH: classroom process evaluation in a multicenter trial*. Health Educ Q, 1994. **Suppl 2**: p. S27-s50.
20. Webster, C.A., H. Erwin, and M. Parks, *Relationships Between and Changes in Preservice Classroom Teachers' Efficacy Beliefs, Willingness to Integrate Movement, and Perceived Barriers to Movement Integration*. Physical Educator, 2013. **70**(3): p. 314-335.
21. Brown, H.E., et al., *A cluster randomised controlled trial to evaluate the effectiveness and cost-effectiveness of the GoActive intervention to increase physical activity among adolescents aged 13-14 years*. BMJ Open, 2017. **7**(9): p. e014419.

22. Sudlow, C., et al., *UK biobank: an open access resource for identifying the causes of a wide range of complex diseases of middle and old age*. PLoS Med, 2015. **12**(3): p. e1001779.
23. Phillips, L.R., G. Parfitt, and A.V. Rowlands, *Calibration of the GENEA accelerometer for assessment of physical activity intensity in children*. J Sci Med Sport, 2013. **16**(2): p. 124-8.
24. Rosenberger, M.E., et al., *Estimating activity and sedentary behavior from an accelerometer on the hip or wrist*. Med Sci Sports Exerc, 2013. **45**(5): p. 964-75.
25. Dossegger, A., et al., *Reactivity to accelerometer measurement of children and adolescents*. Med Sci Sports Exerc, 2014. **46**(6): p. 1140-6.
26. Haapala, H.L., et al., *Changes in physical activity and sedentary time in the Finnish Schools on the Move program: a quasi-experimental study*. Scand J Med Sci Sports, 2017. **27**(11): p. 1442-1453.
27. Yli-Piipari, S., et al., *Objectively Measured School Day Physical Activity Among Elementary Students in the United States and Finland*. J Phys Act Health, 2016. **13**(4): p. 440-6.
28. Lau, E.Y., et al., *Changes in Physical Activity in the School, Afterschool, and Evening Periods During the Transition From Elementary to Middle School*. J Sch Health, 2017. **87**(7): p. 531-537.
29. White, T., et al., *Estimation of Physical Activity Energy Expenditure during Free-Living from Wrist Accelerometry in UK Adults*. PLoS One, 2016. **11**(12): p. e0167472.
30. Janssen, I. and A.G. Leblanc, *Systematic review of the health benefits of physical activity and fitness in school-aged children and youth*. Int J Behav Nutr Phys Act, 2010. **7**: p. 40.
31. Thompson, E.R., *Development and Validation of an Internationally Reliable Short-Form of the Positive and Negative Affect Schedule (PANAS)*. Journal of Cross-Cultural Psychology, 2016. **38**(2): p. 227-242.
32. Midgley, C., et al., *Manual for the patterns of adaptive learning scales*. 2000, University of Michigan: Michigan, US.
33. Jones, R.D., *Student engagement. Teacher handbook*. 2009, Center for Leadership in Education: New York.
34. Furber, G. and L. Segal, *The validity of the Child Health Utility instrument (CHU9D) as a routine outcome measure for use in child and adolescent mental health services*. Health Qual Life Outcomes, 2015. **13**: p. 22.
35. Stevens, K., *Developing a descriptive system for a new preference-based measure of health-related quality of life for children*. Qual Life Res, 2009. **18**(8): p. 1105-13.
36. Stevens, K., *Assessing the performance of a new generic measure of health-related quality of life for children and refining it for use in health state valuation*. Appl Health Econ Health Policy, 2011. **9**(3): p. 157-69.
37. Stevens, K., *The Child Health Utility 9D (CHU9D) – A New Paediatric Preference Based Measure of Health Related Quality of Life*, in PRO Newsletter. 2010.
38. Stevens, K.J., *Working with children to develop dimensions for a preference-based, generic, pediatric, health-related quality-of-life measure*. Qual Health Res, 2010. **20**(3): p. 340-51.
39. Stevens, K., *The development of a preference based paediatric health related quality of life measure for use in economic evaluation*. 2008, The University of Sheffield: Sheffield.
40. Hintze, J.M., V.R. J., and E.S. Shapiro, *Best practices in the systematic direct observation of student behaviour*. 2002. **IV**(4): p. 993-1006.
41. Johnson, A.H., S.M. Chafouleas, and A.M. Briesch, *Dependability of data derived from time sampling methods with multiple observation targets*. Sch Psychol Q, 2017. **32**(1): p. 22-34.
42. Mahar, M.T., et al., *Effects of a classroom-based program on physical activity and on-task behavior*. Med Sci Sports Exerc, 2006. **38**(12): p. 2086-94.
43. Nathan, N., et al., *Barriers and facilitators to the implementation of physical activity policies in schools: A systematic review*. Prev Med, 2018. **107**: p. 45-53.
44. Dyrstad, S.M., et al., *Physically active academic lessons: acceptance, barriers and facilitators for implementation*. BMC Public Health, 2018. **18**(1): p. 322.

- 1
- 2
- 3
- 4 45. Atkin, A.J., et al., *Seasonal Variation in Children's Physical Activity and Sedentary Time*. Med Sci Sports Exerc, 2016. **48**(3): p. 449-56.
- 5
- 6 46. Verma, S., et al., *Highs and lows: Naturalistic changes in mood and everyday hassles over school and vacation periods in adolescents*. J Adolesc, 2017. **61**: p. 17-21.
- 7
- 8 47. Eminson, K., et al., *How does age affect the relationship between weight and health utility during the middle years of childhood?* Qual Life Res, 2018.
- 9
- 10 48. Lee, A., *Health-promoting schools: evidence for a holistic approach to promoting health and improving health literacy*. Appl Health Econ Health Policy, 2009. **7**(1): p. 11-7.
- 11
- 12 49. Committee on Physical Activity Physical Education in the School. *Educating the Student Body: Taking Physical Activity and Physical Education to School*, ed. H.W. Kohl, III and H.D. Cook. 2013, Washington (DC): National Academies Press (US).
- 13
- 14
- 15 50. Hankonen, N., et al., *Randomised controlled feasibility study of a school-based multi-level intervention to increase physical activity and decrease sedentary behaviour among vocational school students*. Int J Behav Nutr Phys Act, 2017. **14**(1): p. 37.
- 16
- 17
- 18 51. McMichan, L., A.M. Gibson, and D.A. Rowe, *Classroom-Based Physical Activity and Sedentary Behavior Interventions in Adolescents: A Systematic Review and Meta-Analysis*. J Phys Act Health, 2018. **15**(5): p. 383-393.
- 19
- 20
- 21
- 22 52. Oliver, M., G. Schofield, and E. McEvoy, *An integrated curriculum approach to increasing habitual physical activity in children: a feasibility study*. J Sch Health, 2006. **76**(2): p. 74-9.
- 23
- 24 53. Erwin, H.E., et al., *Promoting children's health through physically active math classes: a pilot study*. Health Promot Pract, 2011. **12**(2): p. 244-51.
- 25
- 26 54. Reznik, M., et al., *A classroom-based physical activity intervention for urban kindergarten and first-grade students: a feasibility study*. Child Obes, 2015. **11**(3): p. 314-24.
- 27
- 28 55. Li, Y.P., et al., *Report on childhood obesity in China (8): effects and sustainability of physical activity intervention on body composition of Chinese youth*. Biomed Environ Sci, 2010. **23**(3): p. 180-7.
- 29
- 30 56. Donnelly, J.E., et al., *Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children*. Prev Med, 2009. **49**(4): p. 336-41.
- 31
- 32
- 33 57. Riley, N., et al., *Outcomes and process evaluation of a programme integrating physical activity into the primary school mathematics curriculum: The EASY Minds pilot randomised controlled trial*. J Sci Med Sport, 2015. **18**(6): p. 656-61.
- 34
- 35 58. Miller, G.F., et al., *Evaluation of Let's Move! active schools activation grants*. Prev Med, 2018. **108**: p. 36-40.
- 36
- 37 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.
- 38
- 39 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.
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3 **Figure legends:**
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6 Figure 1. Logic model of how a PAL intervention may result in changes in student's
7 sedentary activity (SED).
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10 Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).
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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: <ul style="list-style-type: none"> • Anthropometry • Questionnaire (15 minutes) • Accelerometry • Time-on-Task Teachers: <ul style="list-style-type: none"> • Questionnaire 	Training session 1 (2 hours) 30 minutes: Introduction to active learning 40 minutes: Split group in half: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Questionnaire (15 minutes) • Accelerometry • Time-on-Task • Focus groups Teachers: <ul style="list-style-type: none"> • Questionnaire • Focus group Senior Leadership Team: <ul style="list-style-type: none"> • Interview
Pilot Study:	<i>Same as for</i>	<i>Same as for feasibility study</i>	Training session 2 (2 hours)	<i>Same as for feasibility</i>
Intervention School	<i>feasibility study baseline measures</i>	<i>training session 1</i>	45 minutes: Split group in half: <ul style="list-style-type: none"> • Half review indoor PAL strategies • Half review outdoor PAL strategies 45 minutes: Groups switch	<i>study follow-up measures</i>

10 minutes: Whole-group outdoor activity.
10 minutes: Post-training questionnaire

Pilot Study:	<i>Same as for</i>	No training session	No training session	Students:
Control	<i>feasibility study</i>			<ul style="list-style-type: none"> • Questionnaire
School	<i>baseline measures</i>			<ul style="list-style-type: none"> • Accelerometry • Time-on-Task

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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)	-	10 7	3.76 (0.64)	3.71 (0.76)	-
Disruptive Behaviour (score 1-5)	98	2.34 (1.23)	2.47 (1.19)	-	10 7	1.94 (0.94)	2.04 (1.01)	-
CHU-9D (score 0.33-1.0)	97	0.84 (0.10)	0.84 (0.09)	-	10 6	0.87 (0.09)	0.85 (0.10)	-
Positive Affect (score 1-5)	98	15.95 (3.33)	16.08 (3.53)	-	10 7	17.80 (3.10)	17.54 (3.74)	-
Negative Affect (score 1-5)	98	10.03 (3.30)	9.87 (3.14)	-	10 6	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.

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6 Text Box 1.
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8 *"I really enjoyed them (active lessons), they (the students) enjoyed them as well, they*
9 *seemed to get a lot out of them...it was good fun, it was nothing really any different to*
10 *what I was normally doing, just with a few added extras"* (Maths teacher, female).
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14 *"I thought they (the students) would enjoy going outside... I had high hopes for that but it*
15 *was a Friday afternoon and I don't think they were ready for it... they were causing*
16 *disruption, they tried to walk off"* (English teacher, female).
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20 *"we concentrated more because it was more fun than just sitting around"* (Year-7, male),
21 and *"when you're sitting down you can get quite bored and get easily distracted whereas*
22 *if you're moving about you've actually got something to do"* (Year-7, female).
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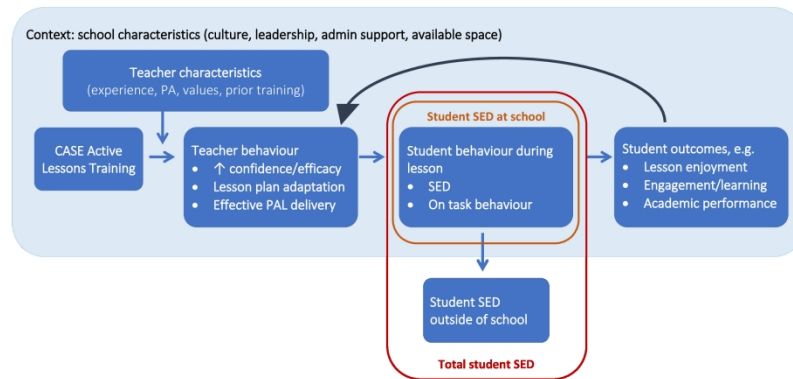


Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

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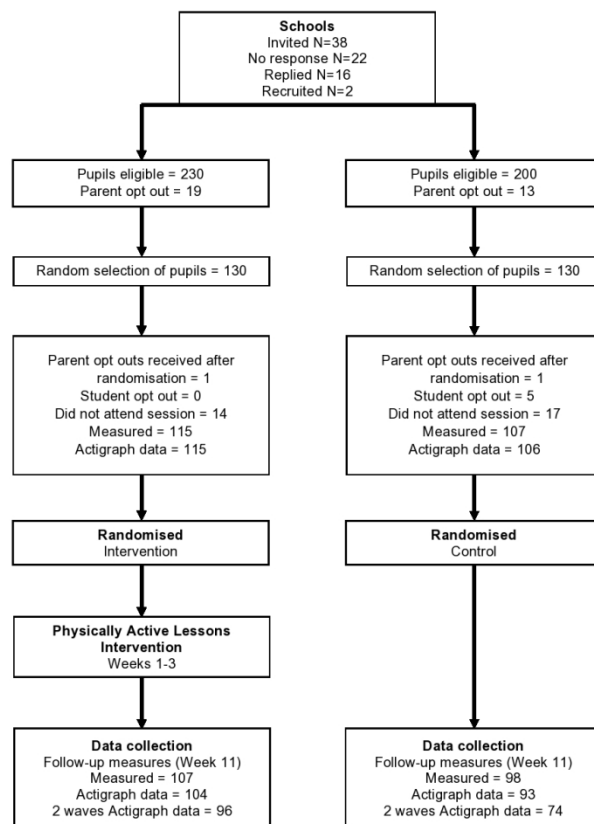


Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

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)

^a27 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-COMLETE1518623029.pdf>
2. <https://www.ltl.org.uk/pdf/Fires-and-Cooking-Activity1421850222.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.

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

- 13 • Learn a lot of material quickly
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- 15 • Students are held individually accountable for their learning
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- 17 • It helps to maximise student collaboration
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- 19 • Encourages higher order and critical thinking skills.
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26 B. Active Voting

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28 *What is it?* This notion of Active Voting is useful for exploring differing and diverse opinions on
29 particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought
30 of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the
31 stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if
32 they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of
33 ambiguity and grey areas, which helps them to see that opinions often have to be justified with
34 informed knowledge of the matter under discussion.
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45 *Implications for classroom layout:* Each of the four key statements will need to be positioned in one of
46 corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree.
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48 When an issue is raised, pupils will then move to stand/sit in the corner that best reflects their
49 views and with those who share the same opinion/perspective.
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53 *How does it work?*

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55 1. A range of issues (related to the content being delivered) should be read out in turn by the
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57 teacher.
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- 3 2. Pupils are then given time to consider their opinion.
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- 5 3. Pupils then move to the corner that best describes how they feel about what was read out.
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- 7 Pupils should be reminded that there are no right or wrong answers.
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- 10 4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
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- 12 5. When pupils move to the corner that best represent their views on the statement, they
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- 14 should be encouraged to explain why they feel that way with others in that group. General
- 15
- 16 perspectives can be obtained from all corners.
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- 18 6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and
- 19
- 20 to refine the initial statement/problem/issues being discussed.
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- 23 7. Pupils are allowed to move during the discussion of each statement if issues arrive that
- 24
- 25 challenge their original opinion.
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- 28 8. If pupils do switch then they should be encouraged to explain why.
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30 *Benefits*

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33 Developing thinking and decision making skills
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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

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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.

For peer review only



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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-025080.R2
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Keywords:	Active lessons, Movement integration, Physical activity, Sedentary time, School health

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Manuscripts

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4 1 **Introducing physically active lessons in UK secondary schools: feasibility**
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8 2 **study and pilot cluster-randomised controlled trial**
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56 15 **Keywords:** Active lessons, movement integration, physical activity, sedentary time, school

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17 **Word count: 5,717**

For peer review only

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4 18 **Abstract**
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7 19 **Objectives:** Assess feasibility, acceptability and costs of delivering a physically active lessons
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10 20 (PAL) training programme to secondary school teachers and explore preliminary effectiveness
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14 21 for reducing pupils' sedentary time.
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17 22 **Design and setting:** Secondary schools in East England; one school participated in a pre-post
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20 23 feasibility study, two in a pilot cluster-randomised controlled trial. In the pilot trial, blinding to
21
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24 24 group assignment was not possible.
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27 25 **Participants:** Across studies, 321 randomly selected students (51% male; mean age: 12.9
28
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30 26 years), 78 teachers (35% male) and two assistant head-teachers enrolled; 296(92%) students,
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34 27 69(88%) teachers and two assistant head teachers completed the studies.
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38 28 **Intervention:** PAL training was delivered to teachers over two after-school sessions. Teachers
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41 29 were made aware of how to integrate movement into lessons; strategies included students
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43
44 30 collecting data from the environment for class activities, and completing activities posted on
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48 31 classroom walls, instead of sitting at desks.
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51 32 **Primary and secondary outcomes:** Quantitative and qualitative data were collected to assess
52
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54 33 feasibility and acceptability of PAL training and delivery. Outcomes were assessed at baseline
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58 34 and ~8 weeks post-training; measures included accelerometer-assessed activity, self-
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4 35 reported well-being, and observations of time-on-task. Process evaluation was conducted at
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7 36 follow-up.
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10 37 **Results:** In the feasibility study, teachers reported good acceptability of PAL training and mixed
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13 38 experiences of delivering PAL. In the pilot study, teachers' acceptability of training was lower
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17 39 and teachers identified aspects of the training in need of review, including the outdoor PAL
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20 40 training and learning challenge of PAL strategies. In both studies, students and assistant head-
21
22
23 41 teachers reported good acceptability of the intervention. Preliminary effectiveness for reducing
24
25
26 42 students' sedentary time was not demonstrated in either study.
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30 43 **Conclusions:** No evidence of preliminary effectiveness on the primary outcome and mixed
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33 44 reports of teachers' acceptability of PAL training suggest the need to review the training. The
34
35
36 45 results do not support continuation of research with the current intervention.
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40 46 **Trial registration:** ISRCTN registry; ISRCTN38409550.
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44 47 **Funding:** Department of Health Policy Research Programme (PR-R5-0213-25001).
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52 49 **Article Summary**
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56 50 **Strength and limitations of this study**
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4 51 • We completed thorough feasibility and pilot testing work to inform the decision of whether
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7 52 to progress with the current intervention and its evaluation.
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10 53 • We collected quantitative and qualitative data which provided valuable information on
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13 54 contextual influences and allowed us to address research questions more
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16 55 comprehensively.
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19 56 • We were unable to collect all planned follow-up measures from teachers and students in
20
21
22 57 feasibility study, including teacher follow-up questionnaires and class observations of time-
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26 58 on-task.
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29 59 • We did not carry out longer-term follow-up measures of teacher acceptability and
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32 60 physically active lesson delivery (i.e., beyond ~8 weeks post-training); longer follow-up
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35 61 would have provided an indication of the sustainability of the intervention.
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62 INTRODUCTION

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

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

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

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4 80 from 'brain/movement breaks', when activity is separate from learning. Evidence from primary
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7 81 schools indicates that PAL can improve physical activity, academic achievement and lesson
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10 82 enjoyment[9-12]. To our knowledge, only two studies have trialled the use of PAL among
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13 83 adolescents[13, 14]. Helgeson (2013) reported no influence of the 'Energizers' PAL
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16 84 programme on reading comprehension scores among junior high school students and did not
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19 85 explore activity levels as a primary outcome[13]. Cothran and colleagues (2010) reported on
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21
22 86 primary and secondary/high school teachers' experiences of a one-year movement integration
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26 87 intervention. Compared to primary school teachers, secondary teachers faced different
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29 88 challenges when attempting to integrate activity into lessons, in particular standardised testing
30
31
32 89 pressures and students not staying with one teacher all day (as typically is the case in primary
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35 90 schools)[14]. Cothran and colleagues did not measure student activity behaviours as an
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38 91 intervention outcome[14]. The positive effects of PAL reported for primary students suggest
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42 92 there is value in exploring if secondary students can experience similar benefits. Given the
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45 93 organisational and environmental differences between primary and secondary schools, it is
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48 94 important to conduct high quality feasibility and pilot testing of secondary school PAL
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51 95 interventions.

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55 96 A PAL training programme for secondary school teachers was tested in a feasibility study and
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58 97 a cluster-randomised controlled pilot study. The studies aimed to explore the feasibility,
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3 98 acceptability, costs, and preliminary effectiveness of a PAL training programme for secondary
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6 99 teachers. Acceptability of study processes was also examined, in anticipation of conducting a
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10 100 subsequent full trial. The feasibility study tested the intervention among maths and English
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13 101 teachers at one school, the pilot study tested the intervention among all-subject teachers and
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16 102 as part of a controlled trial. This paper presents the feasibility study and pilot study followed
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19 103 by an overall discussion and conclusion (ISRCTN38409550).
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23 104 1. FEASIBILITY STUDY

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27 105 Ethical approval for both studies was granted by the University of Cambridge's School of the
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30 106 Humanities and Social Sciences. The aim of the feasibility study was to assess (i) the
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33 107 feasibility, acceptability, costs, and preliminary effectiveness (for reducing sedentary time and
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36 108 improving wellbeing and time-on-task among students) of a PAL training programme for
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39 109 secondary school teachers, and (ii) the feasibility and acceptability of study procedures.
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48 111 Feasibility Study - Methods

49 50 51 112 Recruitment

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55 113 Potential schools were identified from previous local research and approached with study
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58 114 information (n=2). One mixed-sex, non fee-paying secondary school participated. The head
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4 115 teacher provided written consent for the intervention to be delivered to the teachers, elected
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7 116 for the intervention to be trialled with maths and English teachers, and chose years 7 and 9 to
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10 117 participate in study evaluation measures. The school were told they would be able to keep the
11
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13 118 PAL training resources.

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17 119 Parents of all Year 7 and 9 students (11-14 years) received study information and students
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19
20 120 were invited to participate in evaluation measures. Parents were given two weeks to opt out
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23 121 (passive parental consent) via email, freephone, or freepost. From the students who had not
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26 122 been opted out, 120 (sixty Year-7 and sixty Year-9 students; 50% male) were randomly
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29 123 selected for evaluation measures (using class lists and random number generating software).
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33 124 The study's feasibility focus meant that a formal power calculation was not necessary to inform
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36 125 sample size; a sample of 60 participants per year is consistent with samples of similar
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39 126 studies[15]. Students provided written assent for evaluation measures.

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43 127 Maths and English teachers (n=15) received study information two weeks before the PAL
44
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46 128 training. The senior leadership team requested that all maths and English teachers attend the
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49 129 training. Teachers could choose to participate in the evaluation measures, those agreeing
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53 130 provided written consent. Over five school days students received approximately five maths
54
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56 131 lessons and four English lessons.

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60 132 Intervention

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4 133 The PAL training was developed by a team with teacher training qualifications and experience
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7 134 in indoor (two trainers) and outdoor active learning (one trainer). The training was delivered at
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10 135 the intervention school between March and April, during pre-scheduled after-school teacher-
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12
13 136 training time. Table 1 outlines the training programme and example active lessons are
14
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16 137 published as supplementary material. The focus was on supporting teachers to adopt active
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19 138 pedagogical approaches (teaching strategies that incorporate activity), rather than providing
20
21
22 139 new, PAL plans. The training was underpinned by aspects of social cognitive theory and aimed
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25
26 140 to enhance teachers' self-efficacy in relation to PAL[16]. As such it drew from two prominent
27
28
29 141 behaviour change techniques: barrier identification and modelling/demonstrating
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32 142 behaviour[17]. With the former, teachers were encouraged to identify barriers that might
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35 143 impact their ability to implement PAL and plan ways to overcome these. With the latter, the
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38 144 trainers demonstrated a plethora of PAL teaching strategies that teachers could employ in
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42 145 their lessons. Figure 1 outlines the preliminary logic model of how the teacher-focused
43
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45 146 intervention could lead to changes in students' activity. Prior to the training, the research team
46
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48 147 visited the participating school and ascertained the availability of indoor and outdoor spaces
49
50
51 148 and equipment that could be used for PAL. Syllabi for maths and English were requested to
52
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54 149 allow trainers to prepare relevant examples for the training.

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58 150 Measurements
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4 151 Table 1 outlines the timeline of study measures. Feasibility and acceptability were assessed
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6
7 152 using questionnaires and focus groups. Three focus groups (with five teachers, eight Year-7
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10 153 and four Year-9 students) and an interview with the assistant head teacher were completed
11
12
13 154 using a semi-structured interview.

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17 155 *i. Evaluation of Intervention and Study*

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21 156 *Feasibility/acceptability of the intervention:* Questionnaire items and focus group questions
22
23
24 157 asked about teachers' perceptions of the utility, value and relevance of the training (adapted
25
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27 158 from[18, 19]). Questionnaires asked if teachers would recommend the training to other
28
29
30 159 teachers and provided free-text boxes for teachers to suggest improvements. Training session
31
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33 160 attendance rates were recorded.

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37 161 *Feasibility/acceptability of PAL delivery:* Questionnaire items and focus group questions asked
38
39
40 162 teachers about classroom management during PAL, enjoyment of teaching PAL, time needed
41
42
43 163 to prepare and deliver PAL, and barriers to PAL delivery (items from[20]).

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47 164 *Acceptability of PAL participation:* Questionnaire items and focus group questions asked
48
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50 165 students about their experience of PAL participation, enjoyment of PAL, their preference for
51
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53 166 active vs. desk-based lessons, and the best and worst things about PAL.
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4 167 *Costs:* Teachers and students reported resources purchased to deliver/participate in PAL. The
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6
7 168 research team recorded time and costs associated with the training team's development and
8
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10 169 delivery of the intervention.

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14 170 *Study processes:* The research team made field notes on study processes that proved to be
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17 171 challenging or ineffective, for example, students struggling to understand a questionnaire item.

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21 172 *ii. Intervention Outcomes*

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24 173 *Student anthropometry:* Anthropometric measures were completed by trained staff using
25
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28 174 standard procedures. Height was measured using a stadiometer (Leicester height measure,
29
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31 175 Chasmors, Leicester, UK) to the nearest 0.1 cm, and weight was measured to the nearest 0.1
32
33
34 176 kg (Tanita, type TBF-300A, Tokyo, Japan). The measurement stations were set up so that
35
36
37 177 results were not visible to anyone except the measurement staff. Height, weight, sex, birthdate
38
39
40 178 and measurement date were used to calculate participants' body mass index (BMI; kg/m²) and
41
42
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44 179 BMI percentile.

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48 180 *Activity intensity:* Axivity AX3 triaxial wrist-worn accelerometers (non-dominant wrist) were
49
50
51 181 used to measure activity behaviours. These devices have been used among a larger sample
52
53
54 182 of Year-9 participants in the GoActive study[21] and the UK Biobank Cohort Study[22]. Wrist-
55
56
57 183 worn monitors are validated for the assessment of energy expenditure in pediatric
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4 184 populations[23] with higher participant compliance when compared to waist-worn
5
6
7 185 accelerometers[24]. Participants were given verbal and written instructions on monitor wear,
8
9
10 186 including that the monitor was waterproof and could be worn continuously for the next seven
11
12
13 187 days (Monday to Monday).

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17 188 The first day of monitor wear was dropped[25]; included participants provided valid data for
18
19
20 189 $\geq 80\%$ of school hours for \geq two school days, at baseline and follow-up[26-28]. Acceleration
21
22
23 190 was recorded at 100Hz with a dynamic range of $\pm 8g$. Data from the monitors was downloaded
24
25
26 191 in continuous waveform. Euclidean Norm Minus One (ENMO) represents acceleration
27
28
29 192 magnitude at each measurement, accounting for the influence of gravity. ENMO thresholds
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33 193 were used to classify activity intensities: time spent at 0-30 ENMO was classified as sedentary
34
35
36 194 activity (equivalent to 1-1.5 METs); 30-210 ENMO as light-intensity activity (1.5-4 METs); 210-
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38
39 195 500 ENMO as moderate-intensity activity (4-7 METs), and above 500 ENMO as vigorous-
40
41
42 196 intensity activity[29, 30].

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46 197 *Mental Health and Wellbeing:* Students completed questionnaire measures of positive and
47
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49 198 negative affect[31], academic efficacy, disruptive behaviour[32], enjoyment of school
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53 199 classes[33] and health related quality of life[34-39] at baseline and follow-up. All
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56 200 questionnaires are validated for use with adolescents and were analysed according to
57
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59 201 published instructions[31, 32, 39].
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4 202 *Time-on-task*: Students' time-on-task was assessed during three lessons by one member of
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7 203 the research team using a momentary time-sampling procedure (which incurs less bias than
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10 204 other sampling procedures[40, 41]). At the start of each observed class, the teacher asked all
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13 205 students participating in the study to raise their hands. From the students that raised their
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16 206 hands, the researcher identified two boys and two girls (when possible) to observe. The
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18
19 207 researcher chose students sitting in different areas of the classroom. Each student was
20
21
22 208 observed once per minute, in a consistent order, for the duration of the lesson. Students'
23
24
25 209 behaviour was coded as: (i) on-task, (ii) off-task-passive, (iii) off-task-motor, or (iv) off-task-
26
27
28 210 noise[42]. The mean percentage of intervals recorded as 'on task' for observed students and
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30
31 211 classes was calculated and used as the outcome measure.
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36 212 Prior to classroom observations, a validation activity was completed where two researchers
37
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39 213 discussed definitions and concurrently coded student behaviour using four online videos.
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41
42 214 Observers' codes matched for 95% of observation intervals.
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46 215 Descriptive Statistics

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50 216 Descriptive statistics of the sample, primary and secondary outcomes, and quantitative
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53 217 measures of feasibility and acceptability are summarised. Focus group transcripts were
54
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56 218 reviewed; recurring comments and themes relevant to the research questions were identified.
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220 Feasibility Study - Results

221 Recruitment and sample characteristics

222 Student and teacher recruitment and characteristics are summarised in supplementary tables

223 1 and 2. Of 120 students invited to participate in the evaluation measures, 99 were recruited,

224 with 91 (92%) providing data at baseline and follow-up. Students had a mean age of 13.0

225 (± 1.1) years, 52% were male and 27% were classified as overweight/obese. Teachers were

226 predominantly female (67%) and below the age of 45 (83%).

227 Feasibility and Acceptability

228 Training session one was attended by 14 (out of 15) teachers (7 maths, 7 English), training

229 session two was attended by 12 teachers (7 maths, 5 English), 11 teachers attended both

230 sessions. Teacher feedback demonstrated acceptability of the training, with 100%

231 recommending the training to other teachers (supplementary table 3). Individual and collective

232 efficacy for delivering PAL improved from 2.7 to 3.2, and 2.4 to 3 (out of 4), respectively. At

233 follow-up, \geq eight teachers had attempted to deliver PAL. Teacher's goals for PAL delivery

234 averaged 2.1 (SD=1.0) lessons per week, with an average targeted reduction in sitting time of

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4 235 15.8 (SD=8.0) minutes. Some teachers reported positive experiences of delivering PAL, while
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7 236 others reported challenges (Text box 1).
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10 237 Teacher-reported barriers included disruptive behaviour, lethargy and off-topic chatting,
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13 238 challenges re-focusing students after an active portion of class, and limited classroom space.
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16 239 Teachers identified facilitators of PAL delivery as theirs and the students' enjoyment of PAL,
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20 240 good weather allowing them to go outside, more classroom space and a more diligent group
21
22
23 241 of students. Teachers reported ≤ 15 extra minutes were required to plan PAL, and a few extra
24
25
26 242 minutes were needed to prepare students for PAL participation.
27
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30 243 Of the students who recalled participating in an active lesson (47%), most preferred PAL to
31
32
33 244 desk-based lessons (70%; 19% indicated 'no preference') and 93% wanted teachers to
34
35
36 245 continue delivering them. Students reported enjoying going outside and moving around (30%),
37
38
39 246 that PAL were less boring/more fun than desk-based lessons (26%) and that they could
40
41
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43 247 concentrate better (14%). Negative comments about PAL included lethargy (12%), more
44
45
46 248 disruptive behaviour (9%), and less work achieved (12%; text box 1).
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49
50 249 The assistant head teacher felt the training was well-received and high-quality professional
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53 250 development. The school's reasons for participating in the project included the potential for
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56 251 improving students' mental health and the motivation to be innovative in the classroom. The
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3 252 assistant head teacher commented that teaching staff had enjoyed taking students outside for

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7 253 lessons and the project had involved a low level of commitment from the school.

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10 254 Costs

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14 255 Training delivery costed £910, comprised of £410 staff costs and £500 for training equipment.

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17 256 Participants reported purchasing sticky tape (teacher, ~£2) and shoes and tights (student,

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20
21 257 ~£30).

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24 258 Study Processes

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28 259 The majority of study procedures were completed successfully. Challenges encountered

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31 260 included that students struggled to complete a blank timetable indicating when their Maths

32
33
34 261 and English lessons were, and despite efforts, we were unable to schedule follow-up

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36
37 262 classroom observations. Teacher baseline questionnaire return was low and the follow-up

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41 263 focus group was conducted in a 15-minute timeslot due to late changes.

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45 264 Preliminary effectiveness

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49 265 Table 2 summarises baseline and follow-up data for all student measures. Sedentary time

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52 266 increased by 8.7 minutes and time spent in light-intensity activity decreased by 8.1 minutes.

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55 267 Minimal changes were observed in the mental health and wellbeing scores between baseline

56
57
58 268 and follow-up.

269 Feasibility Study - Reflections

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

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

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

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3 287 spring and summer[45]. Increased negative feelings and lower wellbeing among students
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6 288 between March and June is consistent with typical changes observed in students' wellbeing
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10 289 over a school term[46, 47].
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17 291 **2. PILOT STUDY**

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21 292 Following successful implementation of the intervention in the feasibility study, we sought to
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24 293 extend our previous work and explore the potential value of conducting a full-scale randomised
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26
27 294 controlled trial. The aims of the pilot cluster-randomised controlled trial were (i) to assess the
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29
30 295 feasibility, acceptability, preliminary effectiveness and costs of delivering a PAL intervention
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33 296 at a whole-school level (to all subject teachers) and (ii) to test the acceptability of school-level
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36 297 randomisation.
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44 299 **Pilot Study - Methods**

45 46 47 48 300 **Recruitment and Randomisation**

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52 301 *Schools:* We aimed to recruit three schools - two intervention (to test whole-school delivery of
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54
55 302 the intervention in different settings) and one control (to test the acceptability of school-level
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58 303 randomisation). In June-July 2017, 26 non fee-paying, mixed gender, secondary schools in
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4 304 the East of England were emailed study information and invited to participate (the school that
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6
7 305 took part in the feasibility study was not invited to participate in the pilot study). The first three
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10 306 schools to agree were recruited; one school withdrew prior to student recruitment (and
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12
13 307 randomisation). We were unable to replace the school within an appropriate timeframe. After
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15
16 308 baseline measures, individuals separate from the research team performed a coin-toss to
17
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19 309 assign intervention and control schools. The nature of the intervention and goals of the
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22 310 evaluation measures meant it was not possible to blind participants. Due to differences in
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25
26 311 follow-up measures between control and intervention schools, it was not possible to blind
27
28
29 312 measurement staff at follow-up.

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32
33 313 *Students:* Recruitment proceeded as outlined for the feasibility study. Schools were asked to
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35
36 314 choose one younger year (7 or 8) and one older year (9 or 10) group to participate in evaluation
37
38
39 315 measures. This would allow assessment of differential responses to the intervention by age.
40
41
42 316 The intervention school selected Years 7 and 9 and the control school selected Years 8 and
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44
45
46 317 9. Following feasibility study procedures, we randomly selected 130 students (50% male, 50%
47
48
49 318 from each year) from each school for evaluation measures (based on feasibility study retention
50
51
52 319 rates), with the aim of obtaining full data on 100 participants.

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56 320 *Teachers:* A teacher information and recruitment meeting was scheduled at both schools,
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58
59 321 during which a researcher introduced the study and distributed consent forms. Teachers were
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4 322 advised by their senior leadership team that they would be required to attend the PAL training
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6
7 323 if allocated as the intervention school; all teachers were free to decide on participation in
8
9
10 324 evaluation measures.

11 12 13 14 325 Intervention

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16
17 326 Extending the feasibility study, the intervention was delivered to all subject teachers. Training
18
19
20 327 all subject teachers is consistent with the whole-school approach recommended for activity
21
22
23
24 328 promotion and obesity prevention among youth[48, 49]. Given the acceptability of the training
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26
27 329 demonstrated in the feasibility study, the structure and goals of the training for the pilot study
28
29
30 330 were similar. Minimal changes were made to the indoor training component, which focused
31
32
33 331 on generic active learning strategies, applicable to any subject (e.g., different workstations
34
35
36 332 around the classroom). In the feasibility study, the outdoor training component provided
37
38
39
40 333 multiple subject- and topic-specific lesson ideas; the inclusion of all subject teachers meant
41
42
43 334 fewer subject-specific examples could be actively worked through during the pilot study
44
45
46 335 training. One additional outdoor lessons trainer was involved to train the larger group of
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49 336 teachers.

50 51 52 53 337 Measurements

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4 338 Table 1 outlines the timeline of study measures; all data were collected at schools, during
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7 339 school hours. To increase teacher baseline questionnaire return, questionnaires were
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10 340 distributed during the pre-training teacher information meeting, and completed following
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12
13 341 consent. Data collection followed the same procedures as described for the feasibility study,
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15
16 342 except for the assessment of PAL dose and time on task.

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20 343 *PAL Dose:* A teacher timetable was created using school-provided student timetables,
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22
23 344 detailing their Year 7 and 9 lessons. During the student accelerometer assessment at follow-
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25
26 345 up, teachers were given their personalised timetable and asked 'please circle which of the
27
28
29 346 listed Year 7 and/or 9 classes were (or will be) delivered as an active lesson.' Teachers
30
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32
33 347 responses were used to calculate PAL dose. *Time on task:* Four lessons were observed at
34
35
36 348 baseline and follow-up, at both schools. At baseline (prior to delivery of PAL training) the
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38
39 349 research team observed typical desk-based lessons. At follow-up, the research team asked
40
41
42 350 to observe physically active lessons.

43 44 45 46 351 Patient and Public Involvement

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50 352 In an earlier phase of CASE, opinions of key stakeholders regarding (i) suitable PA
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53 353 interventions for secondary schools and (ii) salient outcomes, were explored in a Delphi study
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55
56 354 ([7]). The decision to trial a PAL intervention and inclusion of mental health and time-on-task
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58
59 355 measures were informed by the Delphi study. While stakeholders were not involved in study

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4 356 design, conduct or recruitment, they reviewed questionnaires and provided feedback on
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6
7 357 qualitative findings. Student participants received a personal PA report and participating
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9
10 358 schools will be provided with a summary of the findings. Assistant head teachers commented
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12
13 359 on the time commitment of the intervention and teacher participants reported on time spent
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15
16 360 implementing intervention components.

20 361 Descriptive statistics

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23
24 362 Descriptive statistics and focus group analysis proceeded as outlined for the feasibility study.
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28 363 **Pilot Study - Results**

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31 364 Figure 2 shows the flow of participants, with further information on student and teacher
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35 365 recruitment and sample characteristics in supplementary tables 1 and 2. Of the assenting
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38 366 students (n=222) 92% provided data at two time points. Half of the students were male and
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41 367 24% were classified as overweight/obese. The majority of teachers were female and >50% of
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44 368 staff reported delivering at least one PAL a week at baseline. At the intervention school, 30
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48 369 and 33 teachers attended training session one and two, respectively (29 teachers attended
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50
51 370 both).

54 371 Feasibility and Acceptability

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4 372 Average scores regarding teachers' acceptability of the training fell below 4 (the 'neutral'
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6
7 373 value) indicating negative feelings towards the training (supplementary table 3). Teachers
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10 374 reported training activities to be more suited for primary schools and not sufficiently
11
12
13 375 challenging for secondary students. One teacher commented: "*they were more bonus*
14
15
16 376 *activities, like extra treat things... you couldn't get much learning done through them*" (Science
17
18
19 377 teacher, female). Teachers felt it was assumed they weren't delivering PALs prior to the
20
21
22 378 training and this created resistance towards the training effort. Teachers reported that the PAL
23
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25 379 ideas were not novel and repetitive, the focus on outdoor learning was distracting, and the
26
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28 380 value of outdoor activities wasn't clear.

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33 381 More than half of teachers reported delivering at least one PAL a week at baseline. PAL
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36 382 delivery decreased for four teachers (11%), was maintained by six teachers (17%), and
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39 383 increased for 13 teachers (36%) (excluding P.E. and drama teachers). At follow-up, teachers
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42 384 indicated they were likely to continue teaching PAL, although they reported concerns about
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44
45 385 students not learning as much during PAL. Some teachers felt older students could be more
46
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48 386 lethargic and resistant: "*the younger ones love getting up and interacting with each other. I*
49
50
51 387 *think the older ones do, it just takes... more effort to get them going*" (History teacher, female).
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55 388 The majority of teachers reported ≤ 15 minutes for planning, ≤ 5 minutes for classroom
56
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58 389 preparation, and ≤ 5 minutes for student preparation. The time needed to deliver an outdoor
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4 390 activity – in particular the transition between indoors and outdoors - was identified as a barrier
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7 391 to implementation. The assistant head teacher also commented about the pitch of the training
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10 392 and poor use of learning time due to transitioning. They felt the indoor component of the
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13 393 training had been more informative and appropriate, and commented staff had used active
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16 394 learning strategies indoors, but not outdoors. Finally, they commented that PAL
17
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19 395 implementation had declined with time.

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23 396 Of the students who recalled participating in a PAL (58%), >90% wanted teachers to continue
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25
26 397 teaching PAL, with no evidence of differences in intervention acceptability by sex or weight
27
28
29 398 status. Students commented that PAL were fun and helped learning, and they liked moving
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33 399 more: *"I really enjoyed it. It gave me more of an understanding... because when you're just*
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36 400 *copying off the board some writing I don't always understand it, then when you're moving*
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38
39 401 *about it's a lot more clearer"* (Year-7, female). Students however also commented that during
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42 402 PAL some students messed around more and didn't focus on work, and work was easier to
43
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45 403 do when sitting down.

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49 404 Student PAL dose

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53 405 In one week, 62/175 lessons (35%) to Year 7 and 9 students were active (31 lessons each).
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56 406 Each teacher delivered an average of 2.2 PALs (range = 0-9). Year-7 students received an
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4 407 average of 6.9 PAL (range: 5-10; 28% of one week's lessons) and Year-9 students 6.9 (range:
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7 408 2-13; 28%). This represents the contribution across all subjects.
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10 409 Costs

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14 410 The cost of delivering the training was £901, comprised of £451 staff time and £450
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17 411 equipment. Session one was delivered by three trainers, while session two was delivered by
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19
20 412 four trainers. Four teachers purchased resources to support PAL delivery, including science
21
22
23 413 equipment, textiles equipment, post-it notes and whiteboard pens, and printed resources. Four
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27 414 students reported purchasing resources to support PAL participation – three purchased sports
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30 415 shoes (~£30 per pair) and one a mouth guard (~£7).
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34 416 Preliminary Effectiveness

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38 417 Table 3 presents activity intensity during PAL at follow-up and the equivalent lesson at
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41 418 baseline (excluding P.E. and drama lessons). There was no evidence of changes in sedentary
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44 419 activity or time spent in light, moderate and vigorous activity intensities. Table 4 summarises
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48 420 baseline and follow-up values for all outcome measures for intervention and control
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51 421 participants. There was no evidence of preliminary effectiveness on sedentary time or light
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54 422 activity, or on indicators of mental health and wellbeing (including academic efficacy, positive
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57 423 & negative affect, and disruptive behaviour).
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424 Pilot Study - Reflections

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

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

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

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3 441 students considered P.E. lessons in their appraisal of PAL and reported shoes and
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5
6 442 mouthguards purchased for this.
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10 443 We successfully tested study procedures and intervention delivery at a whole-school level,
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12
13 444 with adequate recruitment and retention rates and continued control school involvement
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15
16 445 indicating acceptability of randomisation. Efforts made to improve data collection processes
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19 446 from the feasibility study, e.g., of student timetables and teacher questionnaires, were
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23 447 successful.
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27 448 The assessment of PAL dose showed that students received an average of 6-7 x 60-minute
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30 449 PAL a week, which has the potential to make a valuable contribution to reducing sedentary
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33 450 time among adolescents. Despite a measured increase in PAL delivery, there was no evidence
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36 451 of reduced sedentary time, suggesting a need to review the PAL strategies that were shared
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39 452 with teachers, with a focus on the amount of activity introduced. It is also possible that teachers
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42 453 over-reported PAL delivery out of concern for being judged by the researchers and/or their
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45 454 senior leadership team.
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54 456 **OVERALL DISCUSSION**

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3 457 In this project, we aimed to assess the feasibility, acceptability, preliminary effectiveness and
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7 458 costs of a teacher-training programme for integrating activity into secondary school lessons.
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10 459 We also sought to understand the feasibility and acceptability of study procedures, including
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13 460 repeated accelerometer wear and school-level randomisation. The intervention was delivered
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16 461 in two schools and quantitative and qualitative data were successfully collected from multiple
17
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19 462 stakeholders, enabling us to address all research questions. The majority of PAL evaluations
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21
22 463 have been carried out in primary schools[9] and as such, this study makes a valuable
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26 464 contribution to the literature.

29 465 **Feasibility/acceptability of PAL training**

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33 466 Consistent with previous research, it was feasible to deliver PAL training to secondary school
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37 467 teachers over two, 2-hour, after-school sessions[50]. Schools scheduled the PAL training
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40 468 during pre-scheduled after-school teacher-training slots, as such, the intervention did not
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43 469 require teachers to attend any more after-school training than they typically would within a
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46 470 school term. In both studies, a small number of teachers were unable to attend both training
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49 471 sessions which may have influenced intervention outcomes. It is realistic that at any school
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52 472 receiving the intervention, a proportion of staff would be unable to attend both training
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56 473 sessions. As such the external validity of the findings is supported.
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4 474 While acceptability of the training was demonstrated in the feasibility study and is reported
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7 475 elsewhere[18, 44, 50], feedback from teachers in the pilot study was less positive. Delivery to
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10 476 teachers of two subjects in the feasibility study meant a smaller training group and a smaller
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12
13 477 trainer:staff ratio than in the pilot study. This allowed more subject-specific discussion and
14
15
16 478 more time to address teachers' personal questions. Teacher feedback suggests that training
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18
19 479 acceptability is related to teachers' experience delivering PAL. In the pilot study, teachers
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21
22 480 delivering PAL more regularly rated the intervention more poorly than less experienced
23
24
25 481 teachers. A PAL intervention targeting teachers not regularly delivering PAL may be more
26
27
28 482 acceptable. The positive responses to the training in the feasibility study (involving teachers
29
30
31 483 reporting low levels of PAL delivery) support this suggestion. Teacher's concerns regarding
32
33
34 484 the lack of learning associated with PAL strategies must be an important consideration in the
35
36
37 485 design of future PAL interventions. Student learning is the core focus of schools and
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39
40 486 implementation of PAL is likely to be contingent on teachers perceiving that PAL supports this
41
42
43 487 goal.

488 **Feasibility/acceptability of delivering/participating in PAL**

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

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3 492 exposure to PAL during their initial teacher training and/or career. A longer trial period and
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6 493 increased support may have allowed teachers in the feasibility study to become more
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9 494 confident and accrue more positive PAL experiences. Overall, the data suggest that PAL
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13 495 delivery can be acceptable to secondary school teachers.

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16 496 While teachers were the direct intervention recipients and their acceptability is crucial for
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19 497 successful implementation, it is important to consider acceptability for other stakeholders, who
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21
22 498 also influence implementation. Across both studies students responded positively to PAL, and
23
24
25 499 senior leadership representatives reported satisfaction with the intervention (in the pilot study,
26
27
28 500 satisfaction with the indoor component). Both senior leadership representatives commented
29
30
31 501 that reasons for study participation included the potential positive influence on students'
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33
34 502 mental health. This observation is consistent with previous findings[7] and indicates potentially
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36
37 503 effective strategies for promotion of the intervention to schools.
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41 42 43 504 **Preliminary Effectiveness**

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46 505 Despite a measured increase in PAL delivery, no changes in activity were observed. The
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49 506 findings are consistent with a systematic review and meta-analysis of secondary school
50
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52 507 classroom-based physical activity interventions, which reported no significant influence on
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55 508 activity behaviours[51]. Although, other PAL feasibility and pilot studies have reported more
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58 509 encouraging changes[42, 51-53]. In the feasibility study, early implementation efforts of Maths
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4 510 and English teachers may not have been sufficient to translate to changes in activity. It's
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6
7 511 possible that more or longer training sessions could increase teacher's confidence and
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10 512 competency for delivering PAL, however, initial discussions with the feasibility study school
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12
13 513 suggested that a 2-hour after-school training session would be acceptable while a 3-hour
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16 514 session would be too long. Across both studies, teachers were advised that any non-seated
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19 515 activity was considered an 'active lesson' - as such, the intervention may be too dilute for
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21
22 516 measurable impact using wrist-worn accelerometers; classroom observations of PAL (beyond
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25
26 517 assessing time on task) may have aided our interpretation of the findings. Overall, the results
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28
29 518 suggest the need to review the amount of activity the PAL strategies introduce.

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33 519 Students received an encouraging dose of PAL (6-7 x 60-minute lessons per week). This dose
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35
36 520 is consistent with previous studies, for example, 10-30 minutes of activity, daily[42, 53-56] and
37
38
39 521 3 x 60-minute PAL per week[57]. It is worth noting that teachers in the current pilot study chose
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41
42 522 how many PAL they delivered, rather than being prescribed a weekly target; as such the dose
43
44
45 523 indicates what is naturally achievable by secondary school teachers. A weekly dose of 6-7
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47
48 524 PAL has the potential to substantially reduce adolescents' sedentary time during school hours,
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52 525 providing sufficient activity is introduced as part of the PAL.

56 526 **Costs**

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4 527 Training delivery costs (independent of travel and planning time) was estimated around £900
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6
7 528 (\$1,187) in both studies. Strategies to reduce costs could include reducing the number of staff
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9
10 529 delivering the sessions or hiring staff with a mixture of training levels, rather than the highly
11
12
13 530 experienced staff in the current studies. Approximately 25% of the cost was spent on
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15
16 531 equipment, primarily for outdoor-based subject-specific examples; reviewing the equipment
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19 532 purchases may identify cost saving opportunities. Research reports that small grants
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21
22 533 (~\$2,000) to schools can lead to increased implementation of practices to promote activity[58].
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26 534 Senior leadership teams commented on how thinly English schools budgets are stretched; it
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29 535 was suggested that school funds set aside for (for example) mental health services might
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32 536 represent an avenue of funding for the programme for some schools.
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36 537 **Strengths and Limitations**

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40 538 High quality formative work for interventions is necessary to ensure appropriate allocation of
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43 539 research efforts and funding, and the publication of feasibility and pilot research is important
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46 540 to support other researchers and interventionists[59]. Limitations of this work include that
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48
49 541 samples were predominantly white; consequently, we are unable to explore differential
50
51
52 542 responses to PAL by ethnicity. Moreover, parental opt out consent procedures limited the
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54
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56 543 ability to obtain information on participants' socioeconomic position. The issue of lack of
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59 544 diversity among samples in PAL studies has been previously raised[60]; future research
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3 545 should seek to explore feasibility, acceptability and effectiveness among different racial/ethnic
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6 546 and socio-economic groups. Estimated training delivery costs are based on wage rates,
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10 547 national insurance and superannuation costs but don't include overhead costs such as costs
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13 548 of employing individuals and providing building space. As such, training delivery costs may be
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16 549 underestimated. In addition, we did not carry out longer-term follow-up assessments so we do
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18
19 550 not know if teachers continued to deliver PAL beyond eight weeks after the training. Finally,
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21
22 551 we do not believe that lack of blinding of measurement staff has impacted the conclusions
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26 552 drawn from these studies, but acknowledge that a potential fully-powered trial would benefit
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28
29 553 from efforts to blind measurement staff.
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31

32 554 **CONCLUSION**

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36 555 We successfully demonstrated the feasibility and acceptability of introducing and evaluating a
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40 556 PAL teacher-training programme in secondary schools. Across feasibility and pilot studies,
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43 557 teachers' acceptability of the intervention and of delivering PAL was demonstrated, although
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46 558 aspects of the training programme, particularly the outdoor component, require review. The
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49 559 intervention was acceptable to students and senior leadership representatives, and the dose
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51
52 560 of PAL received by students was sufficient to have the potential to make a substantial
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56 561 contribution to reducing adolescents' sedentary time during school hours. However, we did
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59 562 not observe preliminary effectiveness on students' activity behaviours or wellbeing indicators.
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563 Taken together, the findings do not support continuation with the current PAL training
564 programme, though its acceptability does highlight the need for further research into how the
565 identified barriers might be overcome.

For peer review only

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6

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22
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34
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44
45
46 579 and processing the accelerometer data.
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53 581 **Data sharing**
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4 582 The datasets are not available for download. The study's participant information sheets and
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7 583 ethics applications stipulated that the data would not be shared outside of the research team.
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10 584 The data are held at the MRC Epidemiology Unit at the University of Cambridge.
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16 586 **Competing interests**

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19 587 The authors declare that they have no competing interests.
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35 592 **Author contributions**

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37
38 593 All authors (Catherine Gammon, Katie Morton, Andrew Atkin, Kirsten Corder, Andy Daly-
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41

42 594 Smith, Thomas Quarmby, Marc Suhrcke, David Turner and Esther van Sluijs) contributed to
43
44
45 595 the conceptualisation and design of the work, and reviewed and approved the final manuscript.
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48 596 Catherine Gammon, David Turner, and Esther van Sluijs contributed to the acquisition,
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51 597 analysis and interpretation of data. Catherine Gammon drafted the manuscript.
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REFERENCES

1. Hallal, P.C., et al., *Global physical activity levels: surveillance progress, pitfalls, and prospects*. The Lancet, 2012. **380**(9838): p. 247-257.
2. Matthews, C.E., et al., *Amount of time spent in sedentary behaviors in the United States, 2003-2004*. Am J Epidemiol, 2008. **167**(7): p. 875-81.
3. Brooke, H.L., et al., *Changes in time-segment specific physical activity between ages 10 and 14 years: A longitudinal observational study*. J Sci Med Sport, 2016. **19**(1): p. 29-34.
4. Steele, R.M., et al., *An investigation of patterns of children's sedentary and vigorous physical activity throughout the week*. Int J Behav Nutr Phys Act, 2010. **7**: p. 88.
5. Morton, K.L., et al., *The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review*. Obes Rev, 2016. **17**(2): p. 142-58.
6. Morton, K.L., et al., *School policies, programmes and facilities, and objectively measured sedentary time, LPA and MVPA: associations in secondary school and over the transition from primary to secondary school*. Int J Behav Nutr Phys Act, 2016. **13**: p. 54.
7. Morton, K.L., et al., *Engaging stakeholders and target groups in prioritising a public health intervention: the Creating Active School Environments (CASE) online Delphi study*. BMJ Open, 2017. **7**(1): p. e013340.
8. Bartholomew, J.B. and E.M. Jowers, *Physically active academic lessons in elementary children*. Prev Med, 2011. **52 Suppl 1**: p. S51-4.
9. Martin, R. and E.M. Murtagh, *Effect of Active Lessons on Physical Activity, Academic, and Health Outcomes: A Systematic Review*. Res Q Exerc Sport, 2017. **88**(2): p. 149-168.
10. Norris, E., et al., *Physically active lessons as physical activity and educational interventions: a systematic review of methods and results*. Prev Med, 2015. **72**: p. 116-25.
11. Howie, E.K., R.D. Newman-Norlund, and R.R. Pate, *Smiles count but minutes matter: responses to classroom exercise breaks*. Am J Health Behav, 2014. **38**(5): p. 681-9.
12. Daly-Smith, A.J., et al., *Systematic review of acute physically active learning and classroom movement breaks on children's physical activity, cognition, academic performance and classroom behaviour: understanding critical design features*. BMJ Open Sport Exerc Med, 2018. **4**(1): p. e000341.
13. Helgeson, J., *The impact of physical activity on academics in English classes at the junior high school level*. 2013, Northcentral University: ProQuest LLC. p. 188.
14. Cothran, D.J., P.H. Kulinna, and A.C. Garn, *Classroom teachers and physical activity integration*. Teaching and Teacher Education, 2010. **26**(7): p. 1381-1388.
15. Mullender-Wijnsma, M.J., et al., *Improving academic performance of school-age children by physical activity in the classroom: 1-year program evaluation*. J Sch Health, 2015. **85**(6): p. 365-71.
16. Bandura, A., *Social foundations of thought and action: a social-cognitive theory*. 1986, Englewood Cliffs, NJ: Prentice-Hall
17. Abraham, C. and S. Michie, *A taxonomy of behavior change techniques used in interventions*. Health Psychol, 2008. **27**(3): p. 379-87.
18. Gibson, C.A., et al., *Physical activity across the curriculum: year one process evaluation results*. Int J Behav Nutr Phys Act, 2008. **5**: p. 36.
19. Edmundson, E.W., et al., *CATCH: classroom process evaluation in a multicenter trial*. Health Educ Q, 1994. **Suppl 2**: p. S27-s50.
20. Webster, C.A., H. Erwin, and M. Parks, *Relationships Between and Changes in Preservice Classroom Teachers' Efficacy Beliefs, Willingness to Integrate Movement, and Perceived Barriers to Movement Integration*. Physical Educator, 2013. **70**(3): p. 314-335.
21. Brown, H.E., et al., *A cluster randomised controlled trial to evaluate the effectiveness and cost-effectiveness of the GoActive intervention to increase physical activity among adolescents aged 13-14 years*. BMJ Open, 2017. **7**(9): p. e014419.

22. Sudlow, C., et al., *UK biobank: an open access resource for identifying the causes of a wide range of complex diseases of middle and old age*. PLoS Med, 2015. **12**(3): p. e1001779.
23. Phillips, L.R., G. Parfitt, and A.V. Rowlands, *Calibration of the GENEA accelerometer for assessment of physical activity intensity in children*. J Sci Med Sport, 2013. **16**(2): p. 124-8.
24. Rosenberger, M.E., et al., *Estimating activity and sedentary behavior from an accelerometer on the hip or wrist*. Med Sci Sports Exerc, 2013. **45**(5): p. 964-75.
25. Dossegger, A., et al., *Reactivity to accelerometer measurement of children and adolescents*. Med Sci Sports Exerc, 2014. **46**(6): p. 1140-6.
26. Haapala, H.L., et al., *Changes in physical activity and sedentary time in the Finnish Schools on the Move program: a quasi-experimental study*. Scand J Med Sci Sports, 2017. **27**(11): p. 1442-1453.
27. Yli-Piipari, S., et al., *Objectively Measured School Day Physical Activity Among Elementary Students in the United States and Finland*. J Phys Act Health, 2016. **13**(4): p. 440-6.
28. Lau, E.Y., et al., *Changes in Physical Activity in the School, Afterschool, and Evening Periods During the Transition From Elementary to Middle School*. J Sch Health, 2017. **87**(7): p. 531-537.
29. White, T., et al., *Estimation of Physical Activity Energy Expenditure during Free-Living from Wrist Accelerometry in UK Adults*. PLoS One, 2016. **11**(12): p. e0167472.
30. Janssen, I. and A.G. Leblanc, *Systematic review of the health benefits of physical activity and fitness in school-aged children and youth*. Int J Behav Nutr Phys Act, 2010. **7**: p. 40.
31. Thompson, E.R., *Development and Validation of an Internationally Reliable Short-Form of the Positive and Negative Affect Schedule (PANAS)*. Journal of Cross-Cultural Psychology, 2016. **38**(2): p. 227-242.
32. Midgley, C., et al., *Manual for the patterns of adaptive learning scales*. 2000, University of Michigan: Michigan, US.
33. Jones, R.D., *Student engagement. Teacher handbook*. 2009, Center for Leadership in Education: New York.
34. Furber, G. and L. Segal, *The validity of the Child Health Utility instrument (CHU9D) as a routine outcome measure for use in child and adolescent mental health services*. Health Qual Life Outcomes, 2015. **13**: p. 22.
35. Stevens, K., *Developing a descriptive system for a new preference-based measure of health-related quality of life for children*. Qual Life Res, 2009. **18**(8): p. 1105-13.
36. Stevens, K., *Assessing the performance of a new generic measure of health-related quality of life for children and refining it for use in health state valuation*. Appl Health Econ Health Policy, 2011. **9**(3): p. 157-69.
37. Stevens, K., *The Child Health Utility 9D (CHU9D) – A New Paediatric Preference Based Measure of Health Related Quality of Life*, in PRO Newsletter. 2010.
38. Stevens, K.J., *Working with children to develop dimensions for a preference-based, generic, pediatric, health-related quality-of-life measure*. Qual Health Res, 2010. **20**(3): p. 340-51.
39. Stevens, K., *The development of a preference based paediatric health related quality of life measure for use in economic evaluation*. 2008, The University of Sheffield: Sheffield.
40. Hintze, J.M., V.R. J., and E.S. Shapiro, *Best practices in the systematic direct observation of student behaviour*. 2002. **IV**(4): p. 993-1006.
41. Johnson, A.H., S.M. Chafouleas, and A.M. Briesch, *Dependability of data derived from time sampling methods with multiple observation targets*. Sch Psychol Q, 2017. **32**(1): p. 22-34.
42. Mahar, M.T., et al., *Effects of a classroom-based program on physical activity and on-task behavior*. Med Sci Sports Exerc, 2006. **38**(12): p. 2086-94.
43. Nathan, N., et al., *Barriers and facilitators to the implementation of physical activity policies in schools: A systematic review*. Prev Med, 2018. **107**: p. 45-53.
44. Dyrstad, S.M., et al., *Physically active academic lessons: acceptance, barriers and facilitators for implementation*. BMC Public Health, 2018. **18**(1): p. 322.

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- 2
- 3
- 4 45. Atkin, A.J., et al., *Seasonal Variation in Children's Physical Activity and Sedentary Time*. Med Sci Sports Exerc, 2016. **48**(3): p. 449-56.
- 5
- 6 46. Verma, S., et al., *Highs and lows: Naturalistic changes in mood and everyday hassles over school and vacation periods in adolescents*. J Adolesc, 2017. **61**: p. 17-21.
- 7
- 8 47. Eminson, K., et al., *How does age affect the relationship between weight and health utility during the middle years of childhood?* Qual Life Res, 2018.
- 9
- 10 48. Lee, A., *Health-promoting schools: evidence for a holistic approach to promoting health and improving health literacy*. Appl Health Econ Health Policy, 2009. **7**(1): p. 11-7.
- 11
- 12 49. Committee on Physical Activity Physical Education in the School. *Educating the Student Body: Taking Physical Activity and Physical Education to School*, ed. H.W. Kohl, III and H.D. Cook. 2013, Washington (DC): National Academies Press (US).
- 13
- 14
- 15 50. Hankonen, N., et al., *Randomised controlled feasibility study of a school-based multi-level intervention to increase physical activity and decrease sedentary behaviour among vocational school students*. Int J Behav Nutr Phys Act, 2017. **14**(1): p. 37.
- 16
- 17
- 18 51. McMichan, L., A.M. Gibson, and D.A. Rowe, *Classroom-Based Physical Activity and Sedentary Behavior Interventions in Adolescents: A Systematic Review and Meta-Analysis*. J Phys Act Health, 2018. **15**(5): p. 383-393.
- 19
- 20
- 21
- 22 52. Oliver, M., G. Schofield, and E. McEvoy, *An integrated curriculum approach to increasing habitual physical activity in children: a feasibility study*. J Sch Health, 2006. **76**(2): p. 74-9.
- 23
- 24 53. Erwin, H.E., et al., *Promoting children's health through physically active math classes: a pilot study*. Health Promot Pract, 2011. **12**(2): p. 244-51.
- 25
- 26 54. Reznik, M., et al., *A classroom-based physical activity intervention for urban kindergarten and first-grade students: a feasibility study*. Child Obes, 2015. **11**(3): p. 314-24.
- 27
- 28 55. Li, Y.P., et al., *Report on childhood obesity in China (8): effects and sustainability of physical activity intervention on body composition of Chinese youth*. Biomed Environ Sci, 2010. **23**(3): p. 180-7.
- 29
- 30 56. Donnelly, J.E., et al., *Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children*. Prev Med, 2009. **49**(4): p. 336-41.
- 31
- 32
- 33 57. Riley, N., et al., *Outcomes and process evaluation of a programme integrating physical activity into the primary school mathematics curriculum: The EASY Minds pilot randomised controlled trial*. J Sci Med Sport, 2015. **18**(6): p. 656-61.
- 34
- 35 58. Miller, G.F., et al., *Evaluation of Let's Move! active schools activation grants*. Prev Med, 2018. **108**: p. 36-40.
- 36
- 37 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.
- 38
- 39 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.
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3 **Figure legends:**
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6 Figure 1. Logic model of how a PAL intervention may result in changes in student's
7 sedentary activity (SED).
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10 Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).
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For peer review only

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

	Week 0	Week 1	Week 4	Week 12
	Baseline Measures			Follow-Up Measures
Feasibility Study	Students: <ul style="list-style-type: none"> Anthropometry Questionnaire (15 minutes) Accelerometry Time-on-Task Teachers: <ul style="list-style-type: none"> Questionnaire 	Training session 1 (2 hours) 30 minutes: Introduction to active learning 40 minutes: Split group in half: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Questionnaire (15 minutes) Accelerometry Time-on-Task Focus groups Teachers: <ul style="list-style-type: none"> Questionnaire Focus group Senior Leadership Team: <ul style="list-style-type: none"> Interview
Pilot Study:	<i>Same as for</i>	<i>Same as for feasibility study</i>	Training session 2 (2 hours)	<i>Same as for feasibility</i>
Intervention School	<i>feasibility study baseline measures</i>	<i>training session 1</i>	45 minutes: Split group in half: <ul style="list-style-type: none"> Half review indoor PAL strategies Half review outdoor PAL strategies 45 minutes: Groups switch	<i>study follow-up measures</i>

10 minutes: Whole-group outdoor activity.
10 minutes: Post-training questionnaire

Pilot Study:	<i>Same as for</i>	No training session	No training session	Students:
Control	<i>feasibility study</i>			<ul style="list-style-type: none"> • Questionnaire • Accelerometry • Time-on-Task
School	<i>baseline measures</i>			

For peer review only

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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)	-	10	3.76 (0.64)	3.71 (0.76)	-
Disruptive Behaviour (score 1-5)	98	2.34 (1.23)	2.47 (1.19)	-	10	1.94 (0.94)	2.04 (1.01)	-
CHU-9D (score 0.33-1.0)	97	0.84 (0.10)	0.84 (0.09)	-	10	0.87 (0.09)	0.85 (0.10)	-
Positive Affect (score 1-5)	98	15.95 (3.33)	16.08 (3.53)	-	10	17.80 (3.10)	17.54 (3.74)	-
Negative Affect (score 1-5)	98	10.03 (3.30)	9.87 (3.14)	-	10	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.

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6 Text Box 1.
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8 *"I really enjoyed them (active lessons), they (the students) enjoyed them as well, they*
9 *seemed to get a lot out of them...it was good fun, it was nothing really any different to*
10 *what I was normally doing, just with a few added extras"* (Maths teacher, female).
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14 *"I thought they (the students) would enjoy going outside... I had high hopes for that but it*
15 *was a Friday afternoon and I don't think they were ready for it... they were causing*
16 *disruption, they tried to walk off"* (English teacher, female).
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20 *"we concentrated more because it was more fun than just sitting around"* (Year-7, male),
21 and *"when you're sitting down you can get quite bored and get easily distracted whereas*
22 *if you're moving about you've actually got something to do"* (Year-7, female).
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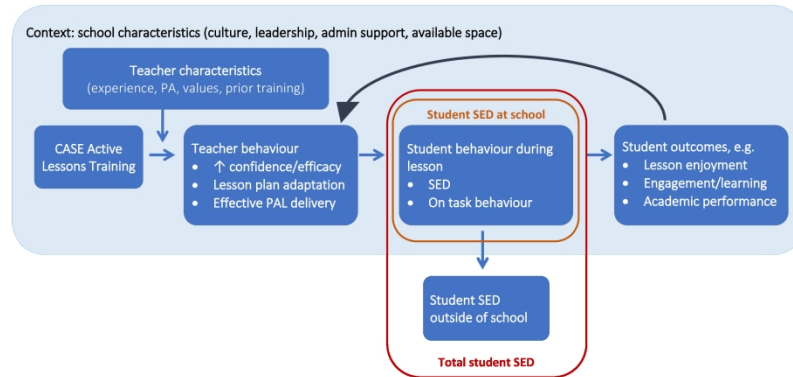


Figure 1. Logic model of how a PAL intervention may result in changes in student's sedentary activity (SED).

297x209mm (300 x 300 DPI)

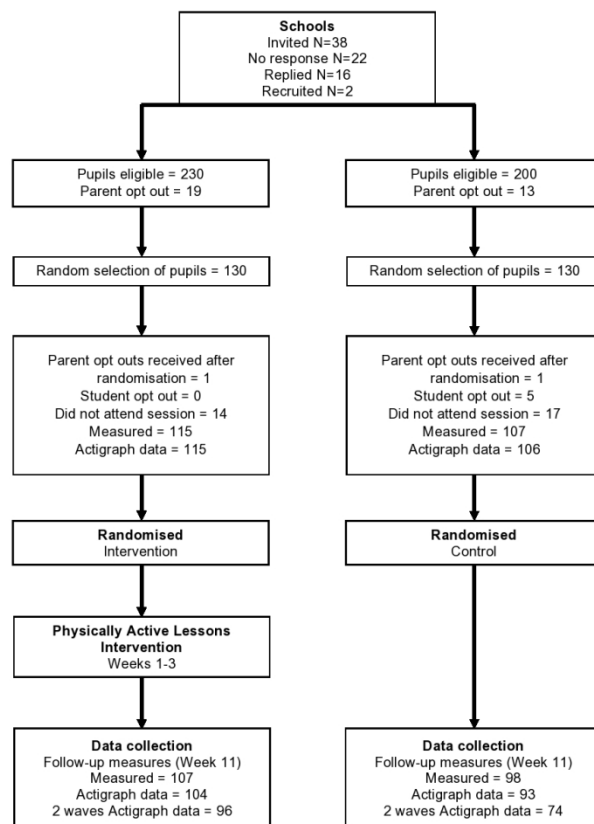


Figure 2. CONSORT flow chart of pilot study participant recruitment (schools and students).

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)

^a27 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-COMLETE1518623029.pdf>
2. <https://www.ltl.org.uk/pdf/Fires-and-Cooking-Activity1421850222.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.

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3 5. Jigsaw teams then return to back to their home teams to discuss what was learnt in the
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5 jigsaw team. **Each student will present her or his segment to the group** so that all learn
6
7 from each other.
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10 *Benefits*

- 13 • Learn a lot of material quickly
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- 15 • Students are held individually accountable for their learning
- 16
- 17 • It helps to maximise student collaboration
- 18
- 19 • Encourages higher order and critical thinking skills.
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26 B. Active Voting

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28 *What is it?* This notion of Active Voting is useful for exploring differing and diverse opinions on
29 particular issues. It can lead into a specific topic and gauge pupil understanding and critical thought
30 of the issue in question. It requires pupils to adopt a view on the issue and identify a reason for the
31 stance they take. Moreover, it will allow everyone to be heard, promoting student voice (even if
32 they choose not to speak). To facilitate Active Voting, pupils need to be confronted with levels of
33 ambiguity and grey areas, which helps them to see that opinions often have to be justified with
34 informed knowledge of the matter under discussion.
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45 *Implications for classroom layout:* Each of the four key statements will need to be positioned in one of
46 corners of a room. These statements include: Strongly agree, agree, disagree, and strongly disagree.
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48 When an issue is raised, pupils will then move to stand/sit in the corner that best reflects their
49 views and with those who share the same opinion/perspective.
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53 *How does it work?*

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- 58 1. A range of issues (related to the content being delivered) should be read out in turn by the
59 teacher.
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- 3 2. Pupils are then given time to consider their opinion.
- 4
- 5 3. Pupils then move to the corner that best describes how they feel about what was read out.
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- 7 Pupils should be reminded that there are no right or wrong answers.
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- 10 4. What is read out (e.g. a particular statement) should aim to evoke a range of responses.
- 11
- 12 5. When pupils move to the corner that best represent their views on the statement, they
- 13
- 14 should be encouraged to explain why they feel that way with others in that group. General
- 15
- 16 perspectives can be obtained from all corners.
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- 18 6. Teachers may wish to introduce subsidiary questions to draw out more complex issues and
- 19
- 20 to refine the initial statement/problem/issues being discussed.
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- 23 7. Pupils are allowed to move during the discussion of each statement if issues arrive that
- 24
- 25 challenge their original opinion.
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- 28 8. If pupils do switch then they should be encouraged to explain why.
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30 *Benefits*

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33 Developing thinking and decision making skills
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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

1 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.
2
3 *We strongly recommend reading this statement in conjunction with the CONSORT 2010, extension to randomised pilot and feasibility trials, Explanation and Elaboration for important
4 clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological
5 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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For peer review only