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Feasibility and Acceptability of a Classroom-Based Active Breaks Intervention for 8–12-Year-Old Children

Gillian McLellan[a], Rosie Arthur[a], Samantha Donnelly[a], Andisheh Bakshi[b], Stuart J. Fairclough[c], Sarah L. Taylor[d], and Duncan S. Buchan[a]

[a]The University of the West of Scotland, Lanarkshire Campus; [b]University of the West of Scotland; [c]Edge Hill University; [d]Leeds Trinity University

ABSTRACT

Purpose: This study explored the feasibility of conducting a classroom-based active breaks intervention on sedentary behavior (SB), physical activity (PA) and attention in 8–12-year-old children. **Methods:** Eight schools were randomized on a 1:1 basis to the control or intervention. Teachers selected 10 cards detailing an activity break at random. Children then undertook each of the ten activity breaks for 30 s, three times per day for 6 weeks. School and participant recruitment, attrition rates, percentage of outcome measures collected, and acceptability were used to explore the feasibility of the study. Mixed effects models were undertaken to examine intervention effects upon measures of PA, SB and attention. **Results:** Two hundred and thirty-nine consent forms were issued and 153 were returned (64%). Of the 153 consents, 146 children (95%) were measured at baseline, and 117 participated in the follow-up measures (80%) 6 weeks later suggesting the intervention was acceptable for the participants. From teacher interviews, it was noted that the intervention was feasible to implement, and teachers observed positive classroom behavior changes in children. Inclusion rates for outcome measures ranged from 49% to 66%. Significant, intervention effects were observed for sitting time (B = −27.19; 95%CI: −36.84, −17.17), standing time (B = 23.51; 95%CI 14.1, 32.45) and the number of sit to stand transitions (B = 16.1; 95%CI 4.7, 26.79). **Conclusion:** Findings suggest that it was feasible and acceptable to implement an active breaks intervention within the classroom setting. Future work should consider the effectiveness of implementing this intervention across a full academic year.

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School; executive function; ActiGraph; activPAL

Globally, children and young people are failing to meet current physical activity (PA) recommendations of accumulating on average 60 min of moderate-to-vigorous PA (MVPA) per day across the week (UK Chief Medical Officers; Guthold et al., 2019). One of the biggest contributors to childhood sedentary behavior (SB) is through the delivery of the education curriculum, which makes a substantial contribution to an estimated 7–8 h of sitting time per day (McLellan et al., 2019; Van Stralen et al., 2014). Yet, the school environment affords an ideal setting to encourage health-promoting behaviors given the large amount of time children spend there and the pivotal role schools play in the health and education of communities (Dobbins et al., 2013; Scottish Government). As childhood is a critical period for developing favorable lifestyle behaviors that can continue into adolescence and adulthood (Conti & Heckman, 2013), governments and leading organizations often recommend health-promoting interventions that target physical inactivity in the school environment (UK Chief Medical Officer; Department of Health; US Department of Health and Human Services, 2018; Ministerie van Volksgezondheid W en S; Tremblay et al., 2016). Due to the constraints placed on teachers through curriculum priorities and limited time, however, it is often difficult for schools and teachers to provide opportunities for children to be active within the classroom environment.

Recent findings from systematic reviews and meta-analysis evidence suggests that classroom-based PA interventions could increase activity levels of children within schools (Norris et al., 2020; A Watson et al., 2017). These classroom-based PA interventions can either be in the form of curriculum-focused PA breaks, active classroom breaks (without curriculum content) or physically active academic lessons (Aadland et al., 2019; Calella et al., 2020; Drummy et al., 2016; A Watson et al., 2017). PA breaks are performed inside the classroom and afford children the opportunity to stand-up from their desks and be active. Findings from previous studies suggest that active breaks within the classroom can improve classroom behavior (AJL Watson et al., 2019), on-task behavior and learning (Howie et al., 2015; Mavilidi et al., 2019), as well as selective attention (Ma et al., 2015). There is also evidence that suggests that incorporating active breaks within the classroom can improve the measures of PA (AJL Watson et al., 2019; Calella et al., 2020; Drummy et al., 2016; Murtagh et al., 2013; Stewart et al., 2004; Wilson et al., 2017). However, in these studies, PA was measured using pedometers which recorded step counts only (Murtagh et al., 2013) and through three different models of accelerometers worn at the wrist (Wilson et al., 2017)

CONTACT Duncan S. Buchan duncan.buchan@uws.ac.uk Senior Lecturer in Exercise Science Division of Sport and Exercise, The University of the West of Scotland, Lanarkshire Campus, Stephenson Place, Hamilton International Technology Park, South Lanarkshire G72 0LH, Scotland, UK.

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and hip (AJL Watson et al., 2019; Calella et al., 2020; Drummy et al., 2016; Stewart et al., 2004).

A notable strength of a recent intervention delivered within the classroom setting was the use of short active breaks (5 min) interventions delivered three times daily within the classroom (AJL Watson et al., 2019). It has been reported that teachers are more receptive to short active breaks (≤5 min) which may limit disruption and time away from the curriculum (Howie et al). Incorporating short active breaks may therefore enhance the acceptability of such interventions by the teachers and enhance intervention fidelity. A further strength of the study was the objective measurement of PA and in particular, MVPA (AJL Watson et al., 2019). Although the authors found no effect of the intervention on levels of MVPA, it is important to consider the effects of similar interventions on other health-related outcomes. For instance, excessive SB's have demonstrated independent and detrimental associations with cardiometabolic disease risk factors in children and youth (Saunders et al., 2014). Yet, none of the aforementioned studies that implemented an active breaks intervention in the classroom (AJL Watson et al., 2019; Howie et al; Murtagh et al., 2013; Stewart et al., 2004; Wilson et al., 2017) reported SB outcomes.

The active breaks intervention used in this study was taken from a previous study that evaluated a multi-component intervention that sought to increase children's PA and decrease sedentary time (Taylor, Noonan, Knowles, Owen et al., 2018). Subsequent work from the authors also evaluated the effects of an active breaks intervention in class as a single component and found significant increases in MVPA and decreases in sedentary time when compared to usual class time (Taylor, Noonan, Knowles, McGrane et al., 2018). Nonetheless, the sedentary time in this study was captured from a wrist worn accelerometer. The activPAL activity monitor (activPAL, PAL Technologies Ltd., UK) is considered as the current gold standard for the objective measurement of SB, which can classify time spent sitting and standing and allows investigators to study SB's in more detail (Chastin et al., 2018). With this in mind, further research is needed that incorporates measures of SB and PA to evaluate the effectiveness of active breaks within the classroom across a range of behavior-related outcomes. Therefore, the aim of this pilot randomized control trial (RCT) was to explore the feasibility, acceptability and potential efficacy of the Activity Breaks intervention upon measures of PA, SB and attention.

Materials and methods

Recruitment and design

Following meetings with representatives from the Scottish National Health Service, a school-wide circular e-mail was issued to all primary schools across North Lanarkshire, Scotland, detailing the proposed study. Following this e-mail, 34 schools registered their interest in participating. Our recruitment target was eight primary schools, each providing 15 pupils from one class only (approximately half of a typical class size) to give an overall sample of 120. This exceeds sample size recommendations for pilot studies (Julious, 2005) and is in line with recent RCTs that assumed this sample size would be sufficient to estimate recruitment and adherence rates (Clemes et al., 2020). The first eight schools to register their interest in the study were contacted and meetings were arranged with all Head Teachers. After meeting with the Head Teachers, all eight schools agreed to participate. The CONSORT extension statement for cluster trials was used as a guide to inform the reporting of this study (MK Campbell et al., 2012).

Children aged 8–12-years from primaries 5–7 were recruited to participate. No other exclusion criteria were applied. Once each class had been identified by the Head Teacher, all Head Teachers agreed to be randomized to either the control or intervention arm. Upon ethical approval by the University of the West of Scotland ethical committee, 239 information packs and consent forms were distributed across the eight schools. Upon baseline measurement, schools were randomly allocated to the control or intervention arm using an allocation ratio of 1:1 using Stata's version 13 (StataCorp. College Station, TX, USA) random-number generator command. This was undertaken by an independent individual not involved in the study. Once randomized, schools assigned to the control arm were asked to continue their normal teaching routine. Baseline measurements were undertaken in October 2018, which preceded randomization. Postintervention measures were taken 6 weeks after each school commenced their involvement in either the intervention or control arm of the study.

Activity breaks intervention

Details of the Activity Breaks intervention have been provided elsewhere (Taylor, Noonan, Knowles, McGrane et al., 2018). Briefly, the intervention utilizes 23 laminated cards that have a picture on one side and instructions on the other. Each card has a different picture of an adult demonstrating a PA movement, that is, jogging on the spot, and the relevant instructions associated with the movement are located on the back of each card. All PA movements are suitable to be performed in a limited space. Intervention teachers were provided with one set of cards to use three times per day, every day, with their class for 6 weeks. The teacher would instruct the students to stop their classroom task and participate in 5 min of PA using the Activity Breaks cards. The teacher would select ten cards at random and ask their class to perform the PA movement on each of the cards for 30 s to equate to five mins of total PA per session, and 15 mins of daily total PA for 6 weeks. Each intervention teacher received training lasting approximately 20 mins on how to deliver the intervention by the lead author. Each teacher reviewed the 23 Activity Break cards to familiarize themselves with the activity movements with the lead author demonstrating any unfamiliar movements or techniques if required. Finally, how to implement the Activity Breaks activities was explained to each teacher.

Measures

The aim of this feasibility clustered RCT was to explore the feasibility and acceptability of the Activity Breaks intervention, as well as the potential efficacy of the intervention upon measures of SB, PA and attention. As all schools started and ended at the same time (09:00–15:00), SB and PA outcomes are reported from this segment only.

Feasibility and acceptability of the intervention

Data pertaining to the recruitment and retention rates were recorded. As recommended by the Medical Research Council guidelines (Moore et al., 2015), semi-structured interviews were undertaken with teachers to gain an insight in to their use and perceptions of the Activity Breaks cards, as well as the implementation of the intervention. All teachers volunteered to participate in a face-to-face interview following the completion of the intervention. All interviews were conducted by the lead author who then transcribed the recorded interviews. Interviews lasted on average 12 mins. The interview guide was designed based on contemporary recommendations (Sparkes & Smith, 2014) and covered the following topics (icebreaker, regularity of Activity Breaks implementation, ease and modification during implementation and impact of the Activity Breaks). The interview guide was then reviewed by two experts in qualitative research before being piloted. The pilot interview ensured the suitability of the questions and provided an estimation of the length of the interview before interviewing teachers.

Fidelity

All intervention teachers were provided with a log sheet and asked to record the frequency (how many times they used the intervention each day) and duration (how long each intervention lasted) of the Activity Breaks. Teachers were asked to complete this log sheet daily for the 6-week intervention duration.

Participant characteristics

Each school's postcode was used as an indication of participant socioeconomic status (SES) with postcodes inputted into the Scottish Index of Multiple Deprivation (SIMD) calculator (SIMD 2016, 2019). SIMD is ranked between deciles 1 and 10, with 1 representing the most deprived areas and 10 representing the least deprived areas in Scotland. The SES of the intervention schools were as follows: two from decile 2, one from decile 3 and one from decile 4. The SES of the control schools were as follows: one from decile 2, one from decile 4 and two from decile 5.

Participant stature was measured barefoot to the nearest 0.1 cm using a portable stadiometer (Seca Stadiometre, Seca Ltd, Birmingham, UK). Mass was measured barefoot with light clothing to the nearest 0.1 kg on electronic scales (Seca Digital Scales, Seca Ltd, Birmingham, UK). From measured stature and body mass, body mass index (BMI) z-scores were calculated relative to the UK 1990 BMI population reference data (Cole et al., 1995).

ActivPAL micro 4 accelerometers

The activPAL micro 4 (PAL Technologies Ltd, Glasgow, UK) was used to measure SB's during each monitoring period. Previous versions of the activPAL have demonstrated good accuracy and precision for assessing free-living sitting and standing time in classroom settings (Ridley et al., 2016). Participants wore one activPAL on the anterior midline of the right thigh for 7 days and were instructed to wear the device at all times (24 h). The device was placed into a nitrile sleeve and self-adhered to the thigh using hypoallergenic Hypafix (BSN Medical) dressings to waterproof and facilitate 24 h wear. All participants were asked to wear the device at all times (24 h). Prior to dissemination, each device was synchronized with Greenwich Mean Time (GMT) and initialized using the manufacturers proprietary software (activPAL Professional v7.2.28) to commence data collection at 06:30 on the following day. Device placement was demonstrated, and all participants were fitted with their device prior to leaving the testing session. Additional Hypafix dressing was provided for participants to re-attach their device if necessary.

ActivPAL data reduction and processing

Time- and date-stamped activPAL data files were downloaded in 15-s epochs using the manufacturer proprietary software (activPAL Professional, v7.2.28) and processed using Processing PAL software (v1.21). Events.csv files were produced in activPAL and analyzed in Processing PAL. Summary sheets were compared against individual participant activity heat maps to identify necessary corrections. Once individual summary sheets were analyzed, output measures were selected and generated. Output measures were selected based on previous research (Clemes et al., 2020, 2018; Edwardson et al., 2017) and included sitting time, standing time and the number of sit-to-stand transitions. Due to the exploratory nature of the study, participants were included in a subsequent analysis if they provided ≥1 weekdays of complete school day data (i.e. 6 h) as done elsewhere (Clemes et al., 2020).

ActiGraph GT3X+accelerometers

Each participant wore one ActiGraph GT3X+ monitor on their non-dominant wrist for 7 days to estimate measures of PA. Verbal confirmation of participant's non-dominant wrist was noted prior to being instructed to wear the device at all times (24 h) except for water-based activities (i.e. swimming or bathing). The wrist placement was chosen to counterbalance the well-cited issue of poor device wear-time (WT) compliance (Troiano et al., 2014) and the 24 h protocol was implemented to encourage longer WT (Arvidsson et al., 2019). Prior to testing, each accelerometer was synchronized with GMT, initialized to capture data at 80 Hz and programmed to commence data collection at 06:30 on the following day. The low-frequency extension was not enabled. Device placement was demonstrated, and all participants were fitted with their device prior to leaving the testing session.

ActiGraph data reduction and processing

Following device return, data were downloaded using ActiLife (v.6.14.3; ActiGraph, Pensacola, FL, USA) and saved in raw format as .gt3x files. These files were subsequently converted to time-stamp free .csv files and exported into R v3.5.3 (R Foundation for Statistical Computing, Vienna, Austria, https://cran.r-project.org/) for processing using the GGIR package v1.9.1 (Hees et al., 2014, 2013). This processing method detects abnormally high values, non-WT (Hees et al., 2013) and auto-calibrates the raw triaxial accelerometer signals using local gravity as a reference (Hees et al., 2014). GGIR calculates Euclidean Norm Minus One (ENMO) (1 *g*) averaged over 5-s epochs and expressed in milli-gravitational (m*g*) units as previously described (Rowlands et al., 2018).

The metrics generated in GGIR included average acceleration (AA), time spent in MVPA, time spent inactive and the accumulated acceleration level above which the most active 2-, 30- and 60-min were accumulated ($M2_{ACC}$, $M30_{ACC}$ and $M60_{ACC}$; m*g*) as previously described (Rowlands et al., 2019). The distribution of time spent in intensity categories of 25 m*g* resolution (i.e. 0–25 m*g*, 25–50 m*g*, 50–75 m*g* . . . .4000 m*g*, >4000 m*g*) was determined in GGIR using the argument "iglevels = TRUE" to describe a participant's activity intensity distribution, which represented the intensity gradient (IG). Time spent in MVPA was defined as the time accumulated above an acceleration of 200 m*g* (Hildebrand et al., 2014). Due to the exploratory nature of the study, participants were included in the subsequent analysis if they provided ≥1 weekday of complete school day data (i.e. 6 h).

D2 test

Classroom attention levels were measured using the d2 test of attention (Bates & Lemay, 2004). This test is a pen and paper assessment of selective and sustained attention, as well as visual scanning speed and has been linked to academic performance (Brickenkamp & Zilmer, 1998). The d2 is commonly used to measure attention in child populations (Ibis & Aktug, 2018; Ma et al., 2015) and was selected due to the ease at which it can be administered in a classroom setting. The d2 also demonstrates high levels of test–retest internal reliability alongside criterion, construct and predictive validity (Bates & Lemay, 2004; Brickenkamp & Zilmer, 1998). Children were given a paper copy of the test and asked to highlight the letter d with two dashes. This may be presented in the following forms: d", "d, "d". Within the test, there were 16 different types of characters, some of which were similar distracting targets, for example, the letter p with one, two, three or four dashes or the target letter d with less or more than the desired two dashes. The test has 14 lines, each containing 16 letters. The lead author explained the aim of the test to all participants and answered any questions before the test commenced. All participants were given 20 s to complete each line of the test. The lead author timed each line and after 20 s had elapsed, participants were asked to move on to the next line regardless if they had finished the previous line or not. The test lasted a total of 5 min, after which all participants were asked to stop writing and the lead author collected all tests.

The test was scored as follows: total number of items processed (TN), total error (TE; missed letters (E1) and incorrectly marked letters (E2)), and percentage error (% E). As the percentage error rate decreases, the accuracy, quality and level of attentiveness increases. Concentration performance (CP) was obtained by subtracting E2 from the number of relevant letters marked correctly. Total Item-Error (TN-E) was obtained by subtracting the total number of items scanned from all error points. TN-E is the total performance score that gives a measure of the relationship between performance accuracy and speed. Postintervention tests were completed during the final week of the intervention, and with the intervention group immediately after a 5-min Activity Break had been completed.

Statistical analysis

All quantitative analyses were programmed in R statistical software v3.6.1 (R Foundation for Statistical Computing, Vienna, Austria, https://cran.r-project.org/) applying the lme4 package (Bates et al., 2014) for mixed models. Only participants that provided both baseline and postintervention data were included within the analysis. Complete case analysis has been recommended if outcome data are used to develop a larger-scale RCT rather than to assess the full effectiveness of an intervention (Jakobsen et al., 2017; Thabane et al., 2010). Mixed-effects models were applied to examine the effect of group (intervention or control) on outcome measures. The models were adjusted for the fixed effects of group, time and sex, as well as the baseline outcome. The participant and school SIMD were included in the models as random effects. This allowed the model to account for the variation amongst different participants and school SIMD. Schools were not used within the model as it was nested within groups and did not add any additional value to the models.

The interviews were analyzed using a framework approach to thematic analysis (Gale et al., 2013; Ritchie et al., 2013). Once the lead author was familiarized with the data, the analysis was undertaken using Microsoft Excel 2016 (Microsoft, Redmond, WA). Using the principle of abductive reasoning, the transcripts were read and initial codes which referred to deductive themes were identified. Quotes that were relevant to the research study but outside any a priori themes were subsequently coded inductively. Following the identification of codes, the data were charted into a framework table to summarize the data into primary themes and sub-headings to summarize common themes from the four interviews. The lead and second author (an expert in qualitative research) then met to discuss the data analysis. The second author acted as a "critical friend" by reading the interview transcripts and then challenging and promoting discussion around the "construction of knowledge" and varying data interpretations (Smith & McGannon, 2018) to ensure the interpretations appropriately represented participant's views. An overview of themes was provided to teachers through e-mail as an opportunity for member checking. Teachers were encouraged to respond if they had any concerns with the identified themes, but no responses were received.

Results

Feasibility and acceptability

A CONSORT flow diagram can be seen in Figure 1. Of the 239 consent forms distributed across the eight schools, 153 (64%) were returned and provided consent to participate. Seven children were absent on the first day of data collection leaving 146 child participants (70 control and 76 intervention) providing baseline measures (66 boys; mean age 10.39 ± 0.75 years). At follow-up, 8 participants withdrew consent (5 control and 3 intervention), 4 were removed by the teacher due to behavioral issues (3 control and 1 intervention) and 17 participants (9 from the control and 8 from the intervention) were absent. Descriptive characteristics of participants at baseline can be found in Table 1. Finally,

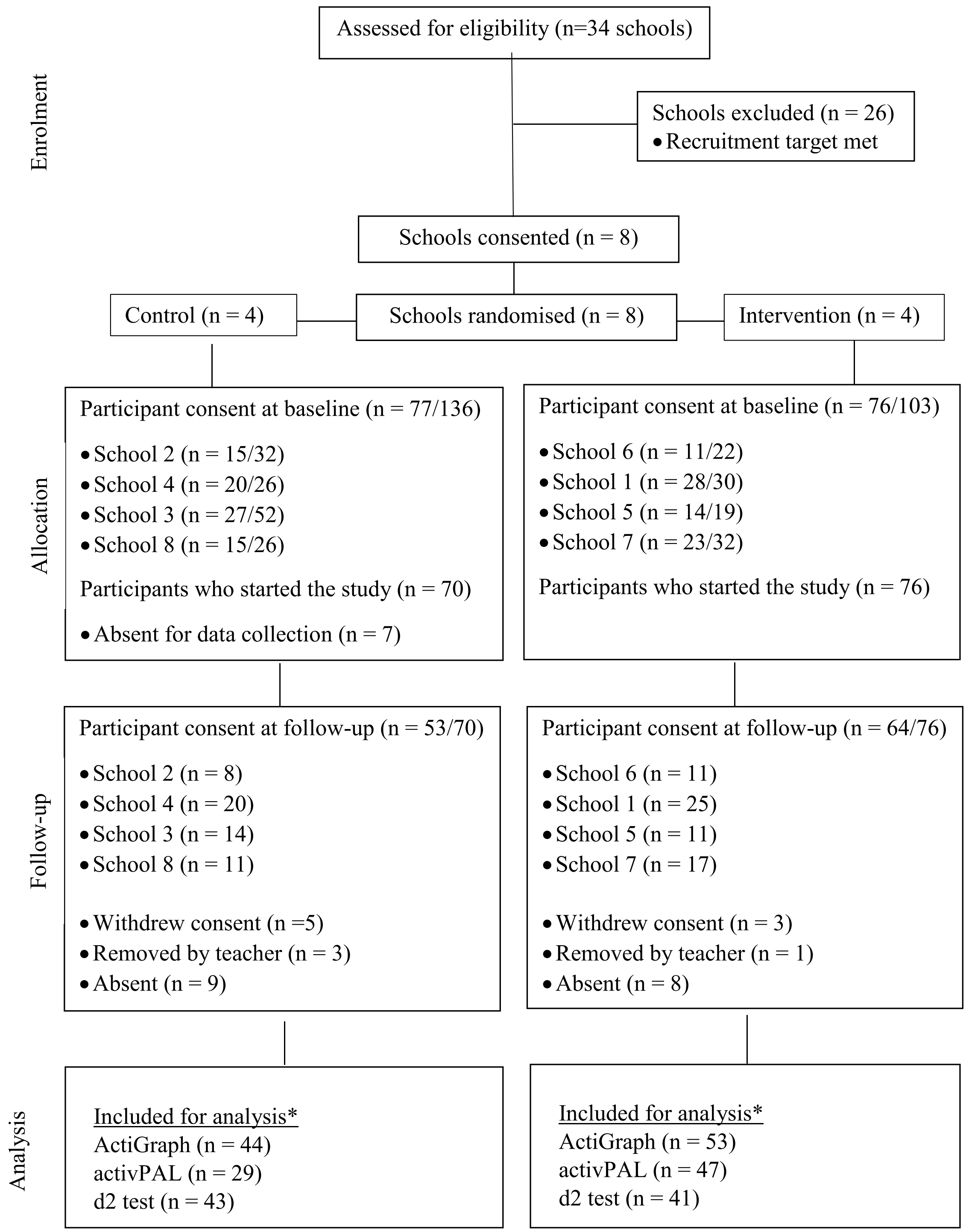

Figure 1. A CONSORT diagram for the Activity Breaks pilot cluster RCT. *Only participants that provided both baseline and postintervention data were included within subsequent analyses.

Table 1. Descriptive characteristics of the participants, by group and total sample.

		Control (*n* = 70)	Intervention (*n* = 76)	Overall (*n* = 146)
Age	Mean ± SD	10.4 ± 0.9	10.4 ± 0.6	10.4 ± 0.7
Sex, n (%)	Male	32 (45.7%)	34 (44.7%)	66 (45.2%)
	Female	38 (54.3%)	42 (55.3%)	80 (54.8%)
SES decile, n (%)	Decile 2	20 (28.6%)	25 (32.9%)	45 (30.8%)
	Decile 3	N/A	28 (36.8%)	28 (19.2%)
	Decile 4	13 (18.6%)	23 (30.3%)	36 (24.7%
	Decile 5	37 (52.9%)	N/A	37 (25.3%)

SES = socioeconomic status.

eight teachers were recruited to the study. The same four teachers taught the classes assigned to the intervention group and the same four teachers taught the classes assigned to the control group throughout the study period.

Teacher interviews

The first aim of the intervention teacher interviews was to confirm the delivery of the Activity Breaks intervention. Teachers who reported no use of the intervention during the

6-week period would be removed along with any participants from their class. From the interviews, all four teachers reported using the intervention most days throughout the intervention period. One teacher claimed to use the intervention every day (90 Activity Breaks), whereas another teacher reported missing two full days and another four sessions due to school trips/activities, meaning 80 Activity Breaks were delivered. For the other two intervention teachers, there were occasions when the intervention was not implemented due to a school trip/event, teacher absence or in-service days. Although they were unable to provide a reliable estimate of the number of Activity Breaks sessions delivered, each teacher confirmed that no more than 1 day per week was missed.

Using the interview transcriptions, the second aim of the teacher interviews was to gain an insight into the implementation and impact of the intervention. Table 2 contains primary quotes that support the summaries within each theme and subtheme. Teachers were asked to discuss their experience using the intervention with their class and to comment on the suitability of implementing the intervention within a classroom setting. By answering these questions, this acted as another fidelity check as all teachers were able to detail specific elements of the intervention, indicating that the intervention had been delivered.

Intervention implementation within the classroom

Intervention teachers were asked about their experience using the Activity Break cards and how easy or difficult the intervention was to incorporate into their classroom. All four teachers reported that the intervention was easy to implement into their teaching schedules, though time was a restricting factor. For example, three teachers noted occasionally forgetting about the intervention and that the children would remind them. Equally though, the intervention was described as being straightforward and child-friendly with one teacher stating that online interventions were more time-consuming and that using physical cards was more convenient. There was some variation in the implementation of the intervention. Two teachers played music whilst their class completed each 5-min activity break and the children responded well to this in their opinion. One teacher selected a weekly class champion who was responsible for setting daily alarms on the class iPad to remind the teacher to initiate each break. Another teacher selected a different child for each session to randomly pick the 10 activity cards for that break to encourage child involvement.

Intervention impact

From a teacher perspective, all four teachers noted that most of their class enjoyed participating in the intervention. One teacher stated that a few children claimed not to enjoy the intervention but did participate in the daily sessions. Three teachers found that their class were more settled following their participation in the intervention. These same teachers noted that they could sense when their class was becoming demotivated and they used this physical deterioration signal to deliver the Activity Breaks. However, the fourth teacher stated that although the class displayed the same demotivated behavior, the class displayed more excitable behavior after participating in the Activity Breaks. Despite finding no significant between-group differences for the d2 test scores, teachers reported an improved work ethic from their class. Teacher 3 stated that children who were previously slow at finishing tasks or usually did not finish tasks had improved both the speed and quality of their work after participating in the Activity Breaks. Furthermore, the fourth teacher that reported more excitable behavior in the class also stated that the class were more eager to ask and answer questions following their participation.

Changes in outcome measures

Following the return of the ActiGraph accelerometers, predata and postdata were available for 97 children (44 control and 53 intervention). Only participants that provided data at both preintervention and postintervention were included in the analysis. During the baseline testing session, participants were unable to provide data for the following reasons: absence (n = 7), failed to meet the WT criteria (n = 7) and loss of device (n = 5). At follow-up, participants were unable to provide data for the following reasons: absence (n = 17), failed to meet WT criteria (n = 4), withdrew consent (n = 8), removed by teacher due to behavior (n = 4) and loss of device (n = 6). No significant differences in age or BMI z-scores were evident between those included and excluded from subsequent analysis (data not shown).

Following the return of the activPAL accelerometers, predata and postdata were available for 76 participants (29 control and 47 intervention). Only participants that provided data at both preintervention and postintervention were included in the analysis. Participants were unable to provide baseline data for the following reasons: absence (n = 7), device malfunction (n = 1), failed to meet WT criteria (n = 6), and loss of device (n = 5). At follow-up, participants were unable to provide data for the following reasons: absence (n = 17), device malfunction (n = 2), withdrew consent (n = 8), removed by teacher due to behavior (n = 4), failed to meet WT criteria (n = 26) and loss of device (n = 4). No significant differences in age or BMI z-scores were evident between those included and excluded from subsequent analysis (data not shown).

Finally, predata and postdata from the d2 test were available for 84 participants (43 control and 41 intervention). Only participants that provided data at both preintervention and postintervention were included in the analysis. Seven participants were absent at baseline, whereas at follow-up, participants were unable to provide data for the following reasons: absence (n = 17), withdrew consent (n = 8) and removed by teacher due to behavior (n = 4). No significant differences in age or BMI z-scores were evident between those included and excluded from subsequent analysis (data not shown).

Table 3 details the intervention effects upon outcome measures. No intervention effect was observed at the group level for any of the ActiGraph or d2 test performance scores. For the activPAL outcomes, findings showed a positive intervention effect with improvements in sitting time, standing time and the number of sit-to-stand transitions at the group level.

Discussion

The purpose of this study was to evaluate the feasibility of implementing a cluster RCT to explore the effects of an active break intervention upon measures of PA, SB and attention in

Table 2. Primary quotes with supporting summaries reported from the teacher interviews.

Themes	Sub-themes	Description	Example Quotation
Classroom Application	Use	All teachers used the AB	"We did use it for 6-week" (T1)
	Frequency	All teachers used the AB most days with one teacher using it every day, 3 times per day	"Most days yes. There were a couple of days that we were out of school for transition events or trips that we weren't able to use it, but on the whole, it was mostly every single day, 3 times" (T2) "Yeah we did it 3 times per day, every day"(T3)
Implementation of AB Cards	Ease of implementation	Most teachers found the AB easy to implement into the classroom	"It was easy to implement because it was all there for us [the cards]" (T2) "Aw it was dead easy, really really easy. It [AB] kind of became part of the daily routine . . . it was really really easy to use" (T3)
	Teacher adaptions to implementation	Playing music during the AB. Selecting a weekly AB class champion to set alarms for each AB. Different children selecting the AB cards to be used.	"I just put it along with music and the first few weeks I had to explain the cards, but after that they knew them so I just held them up and let the kids see it which was fine" (T1) "We had a child in the class who was responsible for setting an alarm and at the alarm every day we would just drop everything and do it [AB]" (T2) "I tried to involve the kids by letting them select the cards to make it more fun and less prescriptive for them" (T3)
	Positive experience for children (teacher's opinion)	Most children enjoyed participating in the AB	"The kids really enjoyed it [AB], they responded well to it, it's become part of their daily routine" (T3)
	Lack of time limited implementation	Most teachers reporting limited time hindered their experience of the	"Sometimes we didn't always have time just because primary 7 is really busy and there's lots going on . . . trying to spare 5-min to do things, just because of transitions and things, primary 7 is really busy, but I think possibly in another class it might be a bit easier" (T1)
Impact of AB intervention	Classroom behavior and attention	Most teachers reported a positive influence on their class One teacher reported a negative behavior influence on their class	"I would say their cognitive skills increased a bit after they done them. I think the mind is working more. I would say answering more questions kind of thing, more eager to answer instead of just sitting at their tables" (T4) "It totally releases all that energy and they're [the class] back focussed . . . it's done wonders for them . . . children who didn't finish tasks were finishing tasks and actually working quite well and progressing at a better speed than what they would be expected to do" (T3) "I think it makes them more hyper, really hyper. As soon as they did it [AB] they're more hyper" (T4)
	Long-term use	Some teachers intended to continue using the Activity Breaks with their class	"Having used it [AB], I still use it and will use it again because I think actually we do get a better standard of work out of the kids and the kids respond well to it and they like doing it, it breaks it up for them, sometimes it gets monotonous and that wee five minutes can totally re-group and bring them back" (T3)

AB = Activity Breaks.

Table 3. Effects of the activity break intervention.

	Group[a] B (95%CI)
ActiGraph GT3X+ (n = 97)	
Inactive time (min.d-1)	−0.3 (−12.93, 10.32)
AA (mg)	2.62 (−4.96, 10.14)
IG	−0.05 (−0.22, 0.11)
LPA ($min.d^{-1}$)	0.19 (−8.06, 10.1)
MVPA ($min.d^{-1}$)	0.95 (−2.43, 4.41)
M60ACC (m*g*)	13.95 (−31.38, 59.21)
M30ACC (m*g*)	37.85 (−38.31, 113.82)
$M2_{ACC}$ (m*g*)	48.73 (−172.82, 288.26)
ActivPAL (n = 76)	
Sitting time ($min.d^{-1}$)	−27.19 (−36.84, −17.17)*
Standing time ($min.d^{-1}$)	23.51 (14.1, 32.45)*
No of sit to stand transitions	16.1 (4.7, 26.79)*
d2 test (n = 84)	
TN-E (score)	14.53 (−23.01, 52.06)
CP (score)	1.78 (−12.89, 16.45)

[a]Coefficients are estimated for the intervention group, adjusted for sex, time and baseline outcome.
Data are presented as coefficients and 95% CI.
*Coefficients are significant.

8–12-year-old Scottish children. Findings confirmed that our recruitment strategy and attrition rates were acceptable and that most of the outcome measures were acceptable for the participants. The following discussion will review specific findings related to study recruitment, adherence and intervention feasibility, intervention effectiveness, teacher perceptions and intervention acceptability, as well as the strengths and limitations of this study.

Recruitment, adherence and feasibility

Our recruitment strategy proved successful with 34 schools expressing an interest in the study. Due to limited resources and the exploratory nature of the study, eight schools were selected to participate with one class from each school identified by the Head Teacher. From the 146 children who provided baseline measures, 117 children (80%) participated in the follow-up measures. Direct comparison of retention rates is difficult between studies because of varying sample sizes but our retention rates are lower than those from a similar study which reported a 92% retention rate (AJL Watson et al., 2019).

From our interviews with the teachers, we found that only one teacher claimed to use the intervention three times per day, every day for 6 weeks with the other three teachers unable to implement the intervention as intended due to school trips/events, in-service days or teacher absence(s). Additional barriers often reported by teachers when implementing school-based PA interventions include challenging child behavior and a lack of administrative support (Naylor et al., 2015). Although these barriers were not highlighted by our teachers. The inclusion of school, class or teacher incentives have been shown to encourage teacher implementation of school-based interventions (Corepal et al., 2018; Fairclough et al., 2016; Malden et al., 2019; Schneller et al., 2017). Therefore, future work should consider offering either school, class or teacher incentives as a means of encouraging intervention implementation.

Findings revealed that 97 out of 118 (82%) participants that were provided with, and returned, the ActiGraph accelerometer met the WT criteria, whereas 76 out of 120 (63%) participants that were provided with, and returned, the activPAL accelerometer met the WT criteria. As has been reported elsewhere, some children indicated that they experienced some irritation from the medical adhesive used to attach the activPAL which may have discouraged them to wear the device (Clemes et al., 2020). In this study, we required participants to wear both accelerometers for 24 h per day over 7 days so that the device did not need to be removed and re-attached. Whilst this may have facilitated compliance for some children, it may have increased the likelihood of irritation for others making them less likely to wear the device or attend the post-measures data collection session. Comparing compliance rates between studies is difficult due to different WT criteria's used and placement location, but our compliance rates for the ActiGraph accelerometer were broadly similar to other studies involving participants of the same age (AJL Watson et al., 2019; Taylor, Noonan, Knowles, McGrane et al., 2018) but greater than those reported recently (Innerd et al., 2019).

Sticky note reminders, mobile phone reminders and social conformity are perceived by children as effective compliance strategies for accelerometer WT compliance (McCann et al., 2016). Previous studies have also provided participants with gift vouchers to encourage a timely return of accelerometers (Clemes et al., 2018). Future trials should therefore consider implementing these strategies as a means of encouraging accelerometer compliance. Furthermore, having time to offer additional data collection sessions for those that were absent may be another approach that could be considered in future studies to increase adherence rates. Finally, providing children with an adjustable belt that the activPAL can be secured in encouraged high compliance across an 8-day monitoring period (Ridgers et al., 2015). Such an approach may be worth considering in future trials.

Teacher perspectives

Individual teacher interviews concluded that the intervention was both easy to implement and straightforward to use, indicating that it was acceptable for the teachers. This is important since a lack of knowledge and time to plan physically active lessons has previously been reported as a barrier for teachers when implementing these forms of lessons within the curriculum (Dyrstad et al., 2018). The Activity Breaks cards were deemed child-friendly and contained a good variety of activities that were simple yet challenging for children. It was also evident that teachers implemented the intervention differently with two teachers playing music during the Activity Breaks and another teacher allowing children to choose the activity cards. These strategies were also reported in a similar study (Taylor, Noonan, Knowles, McGrane et al., 2018). As teachers have the flexibility to implement the Activity Breaks intervention in a manner that suits them and their class, this may aid the integration of the intervention within the classroom setting and subsequent long-term sustainability (Webster et al., 2017).

The only issue highlighted regarding the intervention implementation was the time-constraints associated with incorporating three bouts of five-min breaks into their daily routine. One teacher suggested reducing the duration of the active break to less than 5 min but to continue implementing the breaks throughout the school day. This may be a necessary compromise as shorter interventions may be considered more feasible and acceptable for teachers (Salmon et al., 2011). School-based interventions are always going to be faced with time-constraints from most teacher perspectives and as others suggest, reducing the active break duration may be an alternative to not implementing the intervention at all (Chalkley et al., 2018). Teachers were asked to record the times that each break was implemented during each school day for 6 weeks using a log sheet, which acted as another fidelity check. Only two teachers attempted to complete the log but due to extensive missing entries, we were unable to use the data. Teachers often highlight concerns over time-constraints and demanding workloads (Naylor et al., 2015) so the lack of compliance of the log sheets is not surprising, and is similar to the findings of others reporting poor compliance when asked to complete log books (R Campbell et al., 2015; Chalkley et al., 2018; Malden & Doi, 2019; Punukollu et al., 2020).

Another consideration highlighted by one teacher was that the intervention was implemented with an older cohort and with the transition into high school approaching, the older children were unusually busy. Both age and demographic status of children are influential variables upon PA and SB and an intervention implemented in one school may not be suitable in every class (Chesham et al., 2018). Future studies may wish to consider recruiting younger children as their curriculum may pose less time constraints and allow greater adherence to the study.

Effectiveness of activity breaks

Exploratory analysis revealed no improvement in PA outcomes or attention between the control and intervention groups, which is similar to other studies reporting on the effectiveness of school-based interventions (Dobbins et al., 2009, 2013; Love et al., 2019). Nonetheless, we did observe significant improvements in sitting time, standing time and the number of sit-to-stand transitions as a result of the Activity Breaks intervention. Although others have demonstrated similar findings with reductions in sedentary time from ActiGraph accelerometers (Calella et al., 2020; Taylor, Noonan, Knowles, McGrane et al., 2018), this is the first study to report reductions in sitting time, as well as increased standing time and the number of sit-to-stand transitions from an activPAL accelerometer after an Activity Breaks intervention. Others have reported improvements in MVPA, step count, reduced sitting time, on-task classroom behavior and selective attention after implementing classroom-based PA interventions (AJL Watson et al., 2019; Carlson et al., 2015; Clemes et al., 2016; Drummy et al., 2016; Ma et al., 2015; Taylor, Noonan, Knowles, McGrane et al., 2018). One reason that may explain the increased school MVPA in previous studies could be due to the greater exposure of the intervention (10-min per day over 8-months) (Carlson et al., 2015) and 15 mins per day over 12 weeks (Calella et al., 2020; Drummy et al., 2016) compared to our study. As our intervention was conducted over 6 weeks and was not implemented every day by all intervention schools, the intervention exposure may not have been large enough to induce positive improvements in PA.

Contrary to the lack of positive effects of our Activity Breaks intervention upon selective attention, others have demonstrated that running at both moderate (Tine & Butler) and vigorous (Niemann et al., 2013) intensities can result in greater d2 test performance. Although both interventions involved undertaking activity out with the classroom, more recently Ma et al. (2015) demonstrated that 4 min of high-intensity interval activity implemented within the classroom can also improve d2 test performance. Whilst these findings suggest that short active breaks that are vigorous in nature may be needed to elicit improvements in selective attention, teachers may find such interventions disruptive and unfeasible to implement within many classroom settings (A Watson et al., 2017).

Encouragingly, three teachers commented on how their class appeared calmer after participating in the Activity Breaks. Furthermore, one teacher stated that children were completing tasks quicker and were producing a better quality of work after participating in the intervention. In contrast, the fourth teacher found their class to be more excitable after the active breaks, but in-turn, more eager to ask and answer questions. Overall, two teachers stated that they planned to incorporate the Activity Breaks intervention into their future daily class routine. Although the other two teachers never explicitly stated this, they did comment on the benefits of active breaks and would consider incorporating an active break of some kind within their classroom in future.

Strengths and limitations

This study is comprised of both strengths and weaknesses. School interest in the study was excellent and supports the recruitment approach taken. Informed consent was received by 64% of the children, of which 95% provided baseline measures. Study retention was high (80%), but like studies of this nature, meeting accelerometer WT criteria was not achieved by all participants. A lack of incentives has been cited as one reason for poor participant adherence to study objectives (Breslin et al., 2012). Future studies therefore may wish to consider offering incentives at school, teacher and participant level to increase compliance to study objectives. The addition of objectively measured PA and SB is a strength of this study as is the reporting of novel activity metrics that could facilitate comparisons between other studies reporting on similar interventions. Furthermore, incorporating both ActiGraph and activPAL devices was another strength because although ActiGraph software can estimate time spent inactive, activPAL software has demonstrated almost 100% accuracy in measuring sitting, standing, walking and postural transitions in children (Ridley et al., 2016). Therefore, both devices provide independent benefits when measuring objective outcomes and together may provide a more detailed insight into behavior-related outcomes. A further strength of the study is that teachers were trained and used the Activity Breaks intervention autonomously which enhances sustainability. Limitations of the study include the small sample size and the short intervention duration. However, this was a feasibility study that was not conducted with the intention to make statistical inferences and hence was not adequately powered. A further limitation concerns the somewhat poor compliance to the activPAL WT criteria.

Conclusion

Findings from this present study indicate that recruitment and retention rates were good, and schools and participants had no concerns with most of the outcome measures, being randomized or participating in the intervention. Interest in the study was high, which is likely due to the recruitment strategy used. Further evaluation of the Activity Breaks intervention should consider the use of incentives to increase teacher and participant compliance to study aims and consider offering additional testing sessions to account for absences and for those failing to meet minimal accelerometer WT criteria. Exploring the acceptability of alternative methods of wearing the activPAL accelerometer should also be considered. Our preliminary findings also demonstrated that a teacher led 5-min active break in the classroom three times per day reduces the sitting time of primary school children. Future work should consider the feasibility of implementing the Activity Breaks intervention over a full academic year to provide novel and robust evidence of the longer-term benefits of this classroom-based intervention.

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Declaration of interest

The authors can confirm that they have no conflict of interests.

Data deposition

The data that support the findings of this study are available upon reasonable request from the corresponding author [DSB].

ORCID

Gillian McLellan http://orcid.org/0000-0002-1676-4916
Rosie Arthur http://orcid.org/0000-0003-0651-4056
Samantha Donnelly http://orcid.org/0000-0002-1735-0600
Duncan S. Buchan http://orcid.org/0000-0002-4320-4615

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