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PHYSICAL ACTIVITY, HEALTH AND EXERCISE

Exploring the feasibility of a cluster pilot randomised control trial to improve children's 24-hour movement behaviours and dietary intake: Happy homework

Samantha Donnelly [a], Duncan S. Buchan [a], Gillian McLellan [a], Ross Roberts [b] and Rosie Arthur [a]

[a]School of Health and Life Science, University of the West of Scotland, South Lanarkshire, UK; [b]Institute for the Psychology of Elite Performance, School of Human and Behavioural Sciences, Bangor University, Bangor, UK

ABSTRACT

We aimed to explore the feasibility, acceptability, and potential efficacy of Happy Homework (HH); an 8-week home-focussed intervention, with the purpose of encouraging children's positive dietary behaviours and engagement in positive physical activity (PA) and sleep behaviours. We randomised four Scottish schools ($n = 71$ participants; 5 classrooms) to either the HH intervention ($n = 2$) or usual curriculum control group ($n = 2$). HH consisted of movement and dietary-focused parent and child tasks. Primary outcome measures were intervention feasibility, acceptability, and potential efficacy. Secondary outcomes were objectively measured PA via ActiGraph GT3X+, sedentary behaviours (SBs) and sleep duration via activPAL4™ accelerometers and dietary behaviours, fruit and vegetable consumption and screen-time via questionnaires. After controlling for pre-test levels, post intervention stepping time and sleep duration were significantly greater for the HH group in comparison to the control group. The HH group reported eating more fruit and vegetables at post-test than the control group. Participants also reported the intervention to be enjoyable and motivating. These findings provide promising evidence that given a greater sample size, better retention and the prioritisation of health and wellbeing homework, HH could enhance children's health and wellbeing.

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Children; 24 h movement; physical activity; sedentary behaviour; diet; self-determination theory

Introduction

Within physical activity (PA) research and practice, there is growing recognition that all types of movement during a child's day are relevant to their health (Chaput et al., 2014). Indeed, the 24-hour (h) movement guidelines (Australian Government Department of Health, 2019; Tremblay et al., 2016) recommend that children should participate in at least 60 min of daily moderate-vigorous PA (MVPA) and no more than 2 h of recreational screen time (ST) per day. Such guidelines also recommend that children sustain adequate sleep of between 9 and 11 h per night and maintain consistent bed and wake times. Evidence suggests that children meeting all three recommendations are less likely to be obese and have a better health-related quality of life in comparison to those not meeting them (Carson et al., 2016). Whilst 24 h guidelines progress our understanding of health behaviours, there is a lack of interventions designed to encourage children to meet them.

The development of effective interventions that encourage children to meet the 24 h movement guidelines is a key priority for public health (Okely et al., 2022). Most interventions aiming to promote healthy behaviours in children are implemented whilst children are at school. Although some school-based interventions have shown positive effects such as children engaging in more PA (Yuksel et al., 2020), various recent systematic reviews have found no significant improvements in MVPA levels or sedentary behaviour (SB) (Love et al., 2018; Nally et al., 2021). Furthermore, low levels of PA, high levels of ST, and short sleep durations are all associated with increased food intake and poor diet in children (Thivel et al., 2019), a key driver of childhood obesity (Faught et al., 2016). Therefore, future school-based interventions should consider a multidimensional strategy across different settings to achieve sustained effects across the whole day (Love et al., 2018).

Whilst children spend a considerable amount of their day at school, their home environment is fundamental to their health, with parents being the most important influence on children's obesogenic behaviours (Story et al., 2009). Unfortunately, home-based interventions can be impractical and unsustainable (Duncan et al., 2011), however using schools to communicate with children and parents in order to encourage healthy behaviours in the home may be a feasible approach. In previous attempts to promote healthy lifestyles using homework activities in school-based interventions, homework components often assumed secondary importance to the school-based component with some studies reporting positive effects upon PA, fitness and eating habits (Eather et al., 2013; Eyre et al., 2016). Nonetheless, other interventions comprising child-parent interactive homework activities demonstrated no effect on increasing PA, reducing SB or increasing fruit and vegetable consumption (Kipping et al., 2014). Comparing the contributions of such homework interventions is difficult as studies tend to employ multiple approaches, some are limited by low

CONTACT Samantha Donnelly Samantha.donnelly@uws.ac.uk School of Health and Life Science, University of the West of Scotland, South Lanarkshire G72 0LH, UK

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statistical power (Tercedor et al., 2017) and others have used self- or proxy-measures to quantify PA (Manios et al., 2006). Furthermore, studies deploying objective measures of PA through accelerometers use varying devices and cut-points making it difficult to quantify and compare the magnitude of effect (Kriemler et al., 2010).

Recently, promising findings have been demonstrated through a compulsory, health-related homework programme alongside in-class teaching upon primary school-aged children's PA levels (Duncan et al., 2019; Kääpä et al., 2021). Also, an activity-based homework intervention on adolescent girls' activity patterns (Duncan et al., 2011), showed PA improvements, which have been shown to be the greatest in children from the most socioeconomically deprived schools (Duncan et al., 2011, 2019). Whilst these results are promising, PA was measured using pedometers which limits the ability to determine the time spent in each activity intensity. With this in mind, we developed a curriculum-focussed homework intervention (Supplementary file (SF) 1), designed in collaboration with primary school teachers, which aimed to improve 24 h movement behaviours, including sleep as well as diet quality in primary-school-aged children. The development of the Happy Homework (HH) intervention was theoretically grounded in order to increase children's motivation to exercise at home (Ryan & Deci, 2000), detailed in SF 2, and was based upon recommendations from parents of low socioeconomic status (SES; 22). To the best of our knowledge, this is the first school-based homework intervention which focusses on improving 24 h movement behaviours in primary-school-aged children. Therefore, the aim of this study was to explore the feasibility, acceptability and potential efficacy of HH, a pilot randomised control which aims to encourage children's positive dietary behaviours and engagement in 60 min of daily MVPA, limited ST (≤2 h daily), and adequate sleep (9–11 h per night) whilst maintaining consistent bed and wake times.

Methods

Participants and recruitment

A convenience sample of four primary schools in Scotland were recruited following the receipt of ethical approval from the University of the West of Scotland Ethics Committee (no. 6610). One class per school was selected by the Head teacher based on the inclusion criteria (e.g., pupils aged 9–12 years old and being able to complete PA homework) and informed consent paperwork was issued to each child in the four classes ($n = 128$; 69 girls). Due to a low return-rate of consent from one class, an additional class from this school was selected by the Head teacher ($n = 30$). The reason for the lower return rate was unclear. In total, 158 children were provided with informed consent paperwork for themselves and their parent/guardian to sign. From the 158 children, 71 children ($n = 31$ girls) and their parents provided consent. The flow of pupil participants throughout the study can be found in the CONSORT Flow diagram (Figure 1). School classrooms ($n = 5$) were randomised into intervention ($n = 3$) and control ($n = 2$) groups with data collected from 71 participants. Schools were blinded to this information until pre-intervention measures were collected.

Intervention

The limited effects of previous school-based interventions could be attributed to the use of "top-down" approaches whereby researchers design interventions with limited input from stakeholders (Rütten et al., 2019). The HH intervention was developed in collaboration with school Head teachers ($n = 4$) who were consulted throughout the development of the HH programme. Various activities were also piloted by a mother and her child (aged 9) to ensure they were appropriate. The Head teachers within the intervention arm were then provided with 8 weeks of provisional HH activities and asked to choose their preferred 6 weeks of activities, comment on their appropriateness and recommend any revisions before the programme was finalised. The HH intervention was also informed by recommendations from parents of low SES, ensuring that home-based joint parent and child activities can be implemented with flexibility and without financial burden on families (Donnelly et al., 2019).

The HH pilot intervention included homework activities which aimed to improve both activity-related behaviours across the whole day and key dietary behaviours. The PA activities were informed by the World Health Organisation (WHO) recommendations for children aged 5–17 years that most of children's daily activity should be aerobic, and vigorous-intensity activities should be incorporated including activities which strengthen muscle and bone at least 3 times per week (World Health Organization WHO, 2010). Additional activities encouraged children to break-up SB by standing or moving, limit recreational ST to no more than 2 h per day, have adequate sleep durations of between 9 and 11 h per night and maintain consistent bed and wake times (Tremblay et al., 2016). The activities did not require any equipment or large spaces and were mapped in-line with the Scottish Curriculum for Excellence (CfE) (Education Scotland Health and wellbeing, 2019). The development of the HH intervention was informed by Self-determination theory (SDT) (Deci & Ryan, 1985) (SF 2). The intervention aimed to develop children's motivation to lead healthier lifestyles by meeting their three basic psychological needs: autonomy (i.e., feeling one has choice and is willingly endorsing one's behaviour), competence (i.e., the experience of mastery and being effective in one's activity), and relatedness (i.e., the need to feel connected and a sense of belongingness with others). Satisfying children's three needs has been shown to be predictive of PA participation and positive health behaviours (Breslin et al., 2017).

HH workbooks (SF 3) were provided to children on a Monday, Wednesday, and Friday to encourage habitual involvement in the activities over an 8-week period from February – April 2019 (i.e., Winter – Spring), which included 2 Easter holiday weeks. Additional activities and health promotion reminders were also provided in the workbooks for the days when the child did not receive HH. Parents were required to sign off each activity that they completed with their child which the teachers subsequently recorded in their logbook, to be used as

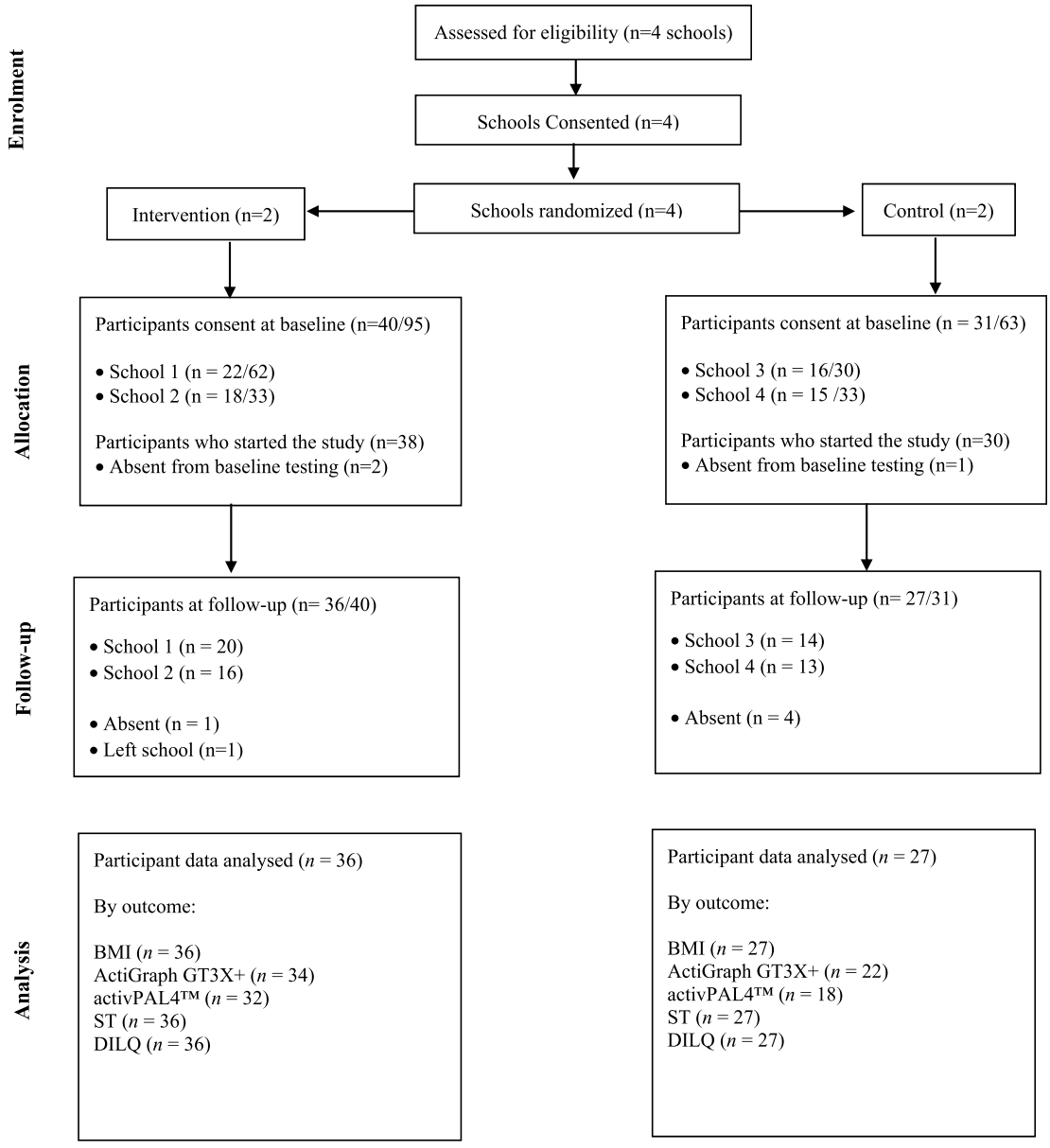

Figure 1. CONSORT flow diagram of the recruitment, adherence, and analysis process of pupils. *Note*. SIMD = Scottish Index of Multiple Deprivation; BMI = body mass index; ST = screen time; DILQ = Day in the Life Questionnaire.

a measure of fidelity. If a child completed the weekly HH activities, their teacher would place a happy face sticker on their HH workbook at the end of each week as a small reward to foster adherence (Buchan et al., 2019; Donnelly et al., 2019).

Measures

Process and implementation measures

Intervention feasibility and acceptability

Data collection took place between February 2019 (pre-intervention tests) and May 2019 (post-intervention tests). The feasibility of the study will be evaluated via recruitment and retention rates along with teacher and pupil interviews to determine the acceptability of the intervention (the extent to which it was considered it to be appropriate). Individual interviews were conducted with the teachers who delivered the HH intervention ($n = 3$). The interview guide (SF 4) covered the following topics: implementing HH, completion of activities, preferred activities, and recommendations to improve HH. Thematic analysis was used in order to represent teacher's experiences of the intervention (Braun & Clarke, 2006). The primary investigator who had previous experience of qualitative research conducted all interviews, listened to the recorded audio files, and transcribed them verbatim. Finally, a deductive-inductive approach was applied to our thematic analysis to explore teacher perceptions of HH within apriori topics whilst remaining open to emergent themes. Teachers were provided with the opportunity to review the themes through thematic tables.

Many SDT-related questionnaires such as the Basic Psychological Need Satisfaction Scales (BPNSS) and the Autonomy Support Questionnaire (ASQ) (Legate et al., 2012) have yet to be validated in younger children. Furthermore, in

studies with child samples which do employ SDT questionnaires, such as the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) (van der Kaap- Deeder et al., 2020), the authors state that the use of the questionnaire is a limitation of the paper, due to questionnaires' well-known disadvantages including the lack of detail in the responses collected (Kelley et al., 2003; van der Kaap-Deeder et al., 2015). Therefore, to explore the experiences of pupils who participated in the HH intervention, pupils were randomly selected to take part in write, draw, show and tell (WDST) groups ($n = 15$, 5 from each intervention classroom). The WDST method provides children with alternative ways of expression and enables a deeper exploration of children's perceptions beyond a verbal interview (Knowles et al., 2013). WDST group interviews were informed by a procedural checklist (Noonan et al., 2016) and the WDST group interview guide was discussed between the authors before being finalised (SF 5). The group interviews took place in a quiet area in the school (M duration = 40.84 min). The pupils were asked about their general participation in PA to explore whether HH was embedded as part of their PA. During the write and draw activity the primary investigator separately engaged children in informal conversations to allow them to articulate what they were drawing and why. Once children had completed their drawings, they were asked questions concerning the HH intervention and their need satisfaction during it.

This WDST approach generated three separate sources of data (Chaput et al., 2014); a frequency count (show activity) (Australian Government Department of Health, 2019), visual data (write and draw activity) and (Tremblay et al., 2016) verbatim data (tell activity and children's write and draw narratives) and were analysed using methods from Noonan and colleagues (Noonan et al., 2016). "Tell" data were analysed through a deductive-inductive process which was framed by the three basic psychological needs with researchers also open to emergent ideas.

Fidelity

The intervention teachers were provided with a logbook to record the specific days in which the children completed HH activities as a measure of fidelity.

Participant characteristics

Home postcodes were obtained to calculate the SES of the families involved via the Scottish Index of Multiple Deprivation (SIMD) online calculator (Scottish Government, 2016) to provide relative decile scores between 1 and 10 (1 the most deprived areas, 10 the least deprived areas). For each child, mass was measured barefoot to the nearest 0.1 kg with an electronic scale (Seca Digital Scales, Seca Ltd, Birmingham, UK) whilst stature to the nearest 0.1 cm using a portable stadiometer (Seca Stadiometer, Seca Ltd, Birmingham, UK) (Cole et al., 1995). BMI was then calculated as the mass in kilograms divided by the square of the stature in metres, from which BMI z-scores of participants were determined and classified as healthy weight or obese/overweight relative to the UK 1990 BMI population reference data (Cole et al., 1995) using software provided by the Child Growth Foundation (Pan & Cole, 2010).

Intervention efficacy

Physical activity

Each child was provided with an ActiGraph GT3X+ (ActiGraph, LLC, Pensacola, FL, USA) accelerometer and instructed to wear the device 24 h per day for 7 days, except during any water-based activities, on the non-dominant wrist. Written instructions for care and placement of the monitors were provided to parents. All devices were initialized to capture data at 80 Hz prior to distribution.

Data were downloaded using ActiLife v6.13.3 (ActiGraph, Pensacola, FL, USA) and saved in raw format as gt3× files. The gt3× files were subsequently converted to time-stamp free.csv files which were exported into R and processed using the GGIR package v2.0–0. GGIR removed abnormally high values, detected non-wear time and auto-calibrated the raw accelerometer signals using local gravity as a reference (Migueles et al., 2019). Finally, GGIR calculated Euclidean Norm Minus One (ENMO) over 5 sec epochs expressed in milli-gravitational units (mg). Participant files were removed from further analysis if files had a post-calibration error greater than 0.01 g. Files with less than 1 day of valid wear (defined as ≤16 h per day) were also excluded from subsequent analysis. The activity outcomes reported included average acceleration (AvAcc) and the intensity gradient (IG) (Rowlands et al., 2018). AvAcc provides a measure of the volume of activity whereas the IG describes the intensity distribution of accelerations and together detail both the volume and intensity of activity undertaken across the monitoring period using all the acceleration data. The minimum acceleration value above which a person's most active mins is accumulated, for example, 30 min ($M30_{ACC}$) or 60 min ($M60_{ACC}$) was also recorded (Rowlands et al., 2019). Reporting these metrics can help facilitate the pooling of accelerometer data across studies employing different devices and make use of the entire data set (Rowlands et al., 2019). Time spent in MVPA was defined as the time accumulated above an acceleration of 201 mg (Hildebrand et al., 2014).

Sedentary behaviour

The activPAL4™ micro (PAL Technologies Ltd., Glasgow, UK), was used to quantify sitting time, standing time, stepping time, the number of sit-to-stand transitions as well as time spent sitting (≥60 min). The activPAL4™ was placed in a nitrile sleeve to waterproof the device and was attached to the children's right thigh using Hypafix tape (Hypafix®). Children were instructed to wear the device for 24 h per day across a 7-day period. From the raw activPAL4™ data, event files were generated and processed using Processing PAL software (Version 1.3). To quantify sleep and non-wear time, the default setting in Processing PAL was employed, which uses a validated algorithm to detect sleep and non-wear for continuous (24 h) wear protocols (Winkler et al., 2016). Participants were included in subsequent analysis if they provided a minimum of 1 day of valid recording, defined as a day with ≥10 h of wear time during identified waking hours (Tudor-Locke et al., 2015).

Day in the life questionnaire (DILQ)

The 23-item DILQ encourages the child to recall their activities from the previous day, including everything they consumed (Edmunds & Ziebland, 2002). The number of daily servings of fruit and vegetables was totalled with a point awarded for each fruit and vegetable recalled by the child. The DILQ has been validated with 7–9 year old (Edmunds & Ziebland, 2002) and 6–11-year-old children (Sharps & Robinson, 2015, 2016).

Screen time questionnaire

Children were asked to report how many hours they engaged in ST for mobile phone/tablet use, viewing television and playing on computer/video games which did not require them to be active. The hours were then summed up to provide a weekly score.

Quantitative data

All analyses were conducted using M Plus 7 (Muthén & Muthén, 2012). The analysis was performed based on an intention to treat (ITT) basis, where participants were included in the analysis if they had data at either baseline or post measurement. Maximum likelihood estimations with 50 iterations was used to impute the missing data following guidance from Enders (Enders, 2010). Linear regression models were applied to investigate the effect of intervention group on post-test scores (after controlling for pre-test scores, SIMD, and BMI z-scores). The nested nature of data within school classes ($n = 5$) was also controlled for using the TYPE=COMPLEX function (which considers the variance accounted for by cluster – in this case school class – membership). As this pilot RCT was not appropriately powered to detect statistically significant differences between groups, Coefficient β effect sizes were calculated to demonstrate the effects alongside tests of statistical significance. Coefficient β effect sizes can be categorised as weak (<0.2), medium (0.2–0.5) and strong (≥0.5) (Acock, 2018). The mean differences with 95% confidence intervals (CI) were also estimated. Also, Wald chi square tests were conducted as follow-up tests to compare pre-test and post-test scores within each group whilst controlling for the nested nature of the data.

Results

Descriptive characteristics of the participants can be found in Table 1. The average SIMD score of the families recruited for this study was 5.38 ± 2.76. Our recruitment strategy seems to have been appropriate in the recruitment and retention of families from low SES with 43.5% of participants from SIMD ≤ 4 being retained in this study which many studies struggle to achieve (Robinson et al., 2016). No significant differences were observed for SIMD between the control and intervention groups.

HH fidelity and acceptability

Two teachers completed their logbook in full and one teacher completed their logbook up until the 2nd week. This meant that from Week 2 onwards, we had missing data on pupil completion of the HH activities ($n = 19$; 47.50%). Therefore, the completion rates of HH activities across the intervention period should be viewed with caution (Table 2). Nevertheless, it was apparent that completion of the Yoga, Fitness and Nutrition, and Dance homework activities were greater than the Holiday Games, Walking and Play homework activities (Table 2). Completion rates ranged from 58% in Week 1 to 33% in Week 8. Teachers believed that the novelty of the activities may have worn off towards the end of the intervention which may explain the lower completion rates.

Pupils' perceptions of their PA

From their drawings, pupils PA was *structured*, such as attending clubs, or *unstructured*, such as playing in their garden (SF 6). Pupils discussed various active ingredients to PA; enjoyment, choosing their favourite activity and limiting technology use for social interactions (e.g., interactions with siblings, parents, sports coach, and teammates). Although parents were mentioned, HH was not a specific activity within their drawings.

Positive outcomes associated with HH

Teachers and pupils provided information surrounding the positive outcomes associated with HH (Table 3). Teachers suggested that they enjoyed implementing HH activities and easily got into a HH routine. Teachers also noted that the intervention was easy to implement and was well matched to the CfE. Teachers

Table 1. Descriptive characteristics of participants.

		Intervention (n=40)	Control (n = 31)	Overall (n=71)
Age (years)		10.0 ± 0.3	10.6 ± 0.5	10.3 ± 0.5
BMI (kg/m^2)		18.13 ± 3.80	18.89 ± 3.02	18.46 ± 3.47
Sex, n (%)	Male	19 (47.5%)	13 (41.9%)	32 (45.1%)
	Female	21 (52.5%)	18 (58.1%)	39 (54.9%)
SIMD decile, n (%)	SIMD 1	5 (12.5%)	3 (9.7%)	8 (11.2%)
	SIMD 2	5 (12.5%)	3 (9.7%)	8 (11.2%)
	SIMD 3	1 (2.5%)	2 (6.5%)	3 (4.2%)
	SIMD 4	6 (15%)	6 (19.3%)	12 (16.9%)
	SIMD 5	1 (2.5%)	3 (9.7%)	4 (5.6%)
	SIMD 6	2 (5%)	4 (12.9%)	6 (8.5%)
	SIMD 7		4 (12.9%)	4 (5.6%)
	SIMD 8	16 (40%)	2 (6.5%)	18 (25.4%)
	SIMD 9	3 (7.5%)	4 (12.9%)	7 (9.9%)
	SIMD 10	1 (2.5%)		1 (1.4%)

SIMD: Scottish Index of Multiple Deprivation.

Table 2. Completion of HH activities based on teachers' fidelity logbooks.

Weekly HH activities	Completion of weekly HH activities
	n (%)
Week 1 – Yoga	23 (Schaap et al., 2018)
Missing	*2 (Okely et al., 2022)*
Week 2 – Fitness and nutrition	16 (Migueles et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 3 – Dance and nutrition	16 (Migueles et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 4 – Walking	11 (Buchan et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 5 (Holiday week) – Games and colouring	11 (Buchan et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 6 (Holiday week) – Games and colouring	11 (Buchan et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 7 – Play	11 (Buchan et al., 2019)
Missing	*19 (Sharps & Robinson, 2015)*
Week 8 – Games and nutrition	13 (Kelley et al., 2003)
Missing	*19 (Sharps & Robinson, 2015)*

Note. Total no. of intervention pupils ($n = 38$).

Table 3. Teacher and pupils' positive perceptions of happy homework.

Theme	Subtheme	Example quote
Teacher perceptions		
Content	Useful and appropriate content	
	Activities well-matched to curriculum	*I was really keen to take part because when I looked at what the sort of activities . . . I though they well-matched the curriculum and the age and stage of the children so I thought they would enjoy doing it – Teacher 1*
	Links HWB messages from school to home	
	Challenges	
	Enjoyable for the children	
Preferred activities	Yoga	*I actually liked all of them for different reasons. I'd say the week 1 yoga, that ties into things I was saying before that I was trying to do about more mindfulness or maybe more relaxing . . . - Teacher 1*
	Dance	
	Walking	
	Workout week – spelling workout	
Encouraging habitual activity	Liked the idea of puzzles instead of work over the Easter Holiday period.	
	Hoped HH kept the children thinking of HWB whilst on Holiday	
	Completed well over the Easter Holiday period.	*They really quite liked the colouring in and that seemed to be quite well done . . . well some of them weren't but you could tell most of them weren't rushed – Teacher 2*
	Could have been made optional for children who go on holiday over the Easter Holiday period	
Implementation	Class got into routine	*. . . we kinda worked that in with our usual homework and it was quite good just having that as my fourth task every week and the kids knew what was coming up – Teacher 1.*
	Teacher enjoyed implementation	
	Explained well for the children	
	Homework was provided for the teacher	
Teacher-pupil relationship	Making relationships stronger	
	Encouraging pupils to be more active	*I probably made more of a point of trying to encourage the children to do it which is obviously a good thing to be encouraging them to be as active as possible – Teacher 1*
Pupil perceptions		
Activities	Well planned	
	Amount of homework given	
	Preferred active tasks	*I agree with everyone else the active ones make you more, want to go and be more active. The written ones, you're just sitting down writing . . . - Girl 8*

Note. HH = Happy Homework; HWB = health and wellbeing.

discussed that the HH strengthened teacher-pupil and parent–child relationships, encouraged children to be more active, and combined school-based activities with home-life.

Teachers and pupils also outlined negatives and barriers associated with HH including general attitudes to homework completion, additional commitments, and parent employment (Table 4). Pupils discussed specific additional commitments and their involvement in extra-curricular clubs as barriers to the completion of HH activities.

The teachers said that prior to HH they gave little or no health and wellbeing homework to the pupils, with some teachers having never considered administering health and wellbeing homework. Each teacher suggested that because of HH, they recognised the importance of health and wellbeing homework.

Table 4. Negative perceptions and barriers teachers and pupils perceived regarding happy homework.

Theme	Subtheme	Example quote
Teacher perceptions		
General homework	Completion of general homework is not a priority to the school or teachers	
	Unsure of the benefits of homework	
	Completion of homework is dependent upon children's circumstances	
	Health and wellbeing homework isn't given the same importance as other curriculum areas.	*So, no, I would say they put more importance on their traditional homework they would get like your spelling words, your maths . . . your calculations' - Teacher 1*
Completion of HH activities	Higher completion rates in early weeks	
	Novelty wore off	*I feel like the participation kinda tailed off. They were quite enthusiastic at the start but its similar with most things, they get used to it and the novelty wears off – Teacher 2*
	A lot of paper – environmentally friendly	
Barriers to completion of HH	Parent attitudes	
	Clubs	*In this class, I do have a lot of children . . . go to the after-school clubs like the netball and the football. In fact, I have one girl who, on a Thursday night, goes to three different things so she's very busy. So, some of them when I was coming back saying "have you got it? Have you handed it in?" some of them were saying 'I was at this club this night and I couldn't do it – Teacher 1*
	Holidays	
	Home-life	
HH was not age-appropriate	Games	*Some of the games I think were maybe a wee bit young. Obviously, you weren't meant to know that, but they were maybe a bit young for the kids we had – Teacher 2*
HH provided extra work	Extra work for teachers	
	Time consuming for parents	*I think it's quite time consuming for the parents as well because they're just looking to make their life easy . . . a lot of them are working full-time, you know both parents, so it's all about making it quite easy for them.- Teacher 2*
HH stickers	Clashing views (class-by-class basis)	
	Enthusiastic initially	*Initially, they seemed quite enthusiastic about the stickers but then it kinda tailed off. But then, maybe the aged range they're at, the stickers aren't the same novelty for them – Teacher 2*
	Not an enticement	
Pupil perceptions		
Barriers	Lifestyle and family events	*Like some people might have like a really serious sport they do and they're training like every day of the week for like 4 hours or something so like when you come back it's like "right I have to do it now" – Girl 6*
	Clubs	
	Time-consuming	
	Parent employment	

Table 5. Pupils perceived autonomy in happy homework.

Theme	Sub-theme	Example quote
Options in Happy Homework	Days	*I don't know if this makes sense but one night, I got in really late and I had to do Happy Homework and I was like to my mum "I have to do it" and she was like "don't do it just now" and I was like' no I have to'. And when I thought about it more, I thought I'd just leave it till tomorrow and my mum was fine with that. . . – Girl 1*
	Time	*I like the ones that provided you with an option because if there was one you didn't really want to do at the time, they you could have like the option to do another one so then if you, then when you want to do the other one you can do the other one as well – Boy 6*
	Activities – choice	*I prefer the ones like options. Em, so you have like more options you don't just need to do that it gives you like more opportunity to do that. . . if you had one option and you didn't like it you have one option you have to do but you might not like it a lot or as much. But if you have 2 options then you've got that one option you can go to say I really like that, or I don't like that. So, if you do more than 2 options, maybe like 4 or 5 options, you could do, it would make . . . if you liked all of them you might decide "aw I want to do all of them" so you might be more active that night if you've got, if you don't do as much sports you could be like aw ill just do this one. It might not be as much but its more active you could do all of them if you wanted to be more active – Girl 6*
	Activities – prescriptive	*I think in some of the activities there is a choice between some and then in others like, it will tell you to go do this or that, like it was a set activity for some of them you had to do which would be good in some ways. Like some of them would be really good but some would be like not challenging but like made you have to go out your way to do it, and not like quick. . .- Girl 6*
Pressure to complete Happy Homework	No pressure	
	Pressure from teacher	*When the teacher didn't get a lot in, she got quite annoyed, and we felt pressured to do it – Boy 1*
	Competing interests/ activities	*After sport . . . like if you have a club on. If it's like late on like 7 or 8 your mum or dads like it's a school night get to bed. And you're like having to do it. So, if there's more options you could be like that one's going to be quicker, I could do that one – Boy 7*

Nonetheless, teachers suggested that health and wellbeing homework was not given the same importance as other areas of the curriculum and that the completion of homework in general was not a high priority to the schools or the teachers.

Application of SDT in HH

Pupils provided feedback about the HH intervention and their three basic psychological needs (Chaput et al., 2014); autonomy in HH (Table 5) (Australian Government Department of Health,

Table 6. Pupils perceived competence in happy homework.

Theme	Subtheme	Example quote
Capability	Capable	*Em, I felt quite capable. Like your mum and dad might say aw you done that wrong but you're kinda in a smaller group, so I felt more capable – Girl 3*
	Balanced level of difficulty	*Yeah. I don't want to say it was easy. Sometimes it was challenging but sometimes it was easy . . . I found the written ones easy, like relatively easy, but the like most of the active ones like the em, the alphabet exercise like I have quite a, like 7 letters in my name so that's a lot of exercise – Boy 6*
Happy Homework challenges	Fun	
	Aimed at younger population	
	Good idea	
	Competitiveness	*I mean it wasn't, it didn't have to be that challenging like cause you kinda wanna win. The plank one was quiet, it was like a fun challenge if you know what I mean – Girl 6*
Overcome Happy Homework challenges	Read over it – understand more	*Cause the one that was like the sugar one, like the teaspoon. At first, we didn't really understand how much it was and what it was and sometimes some packets might not say like the certain amount on it. So, it's hard to like, it was like your favourite snacks to have, but some of your favourite snacks might not have it so it's good to see you're looking to see what ones are good for you. At first, we didn't really get it but after you done it, after you thought about it and read the question more it was getting more clear – Girl 6*
	Determined to try my best	
Sense of accomplishment	Proud	
	Special occasions	
	Completed all 8 weeks	
	New skills	*I have like accomplished some skills that I wasn't able to do before like . . . – Girl 6*
	Interest in new activities	*I wasn't really calm before, and I wasn't really into yoga. But now I've tried it I actually quite like it – Girl 3*
	Fun to complete compared to maths	
	Made sure went back to compete all activities	*That I had finished them. I missed one week because I wasn't in school, I was away somewhere but obviously I couldn't hand it in but after the last week I just did that because I would've felt like I just left that one – Boy 6*

Table 7. Pupils perceived relatedness: physical activity participation and interactions during happy homework.

Theme	Subtheme	Example quote
Participate in PA with most	Siblings	
	Cousins	*Most of the time I'll just do it with . . . em, my cousins, and em, I don't go to any clubs anymore. I used to go to loads but now I don't – Girl 1*
	Pet	*This sounds really really strange, but em, my aunties dog . . . he loves to chase after his ball and he loves to have a race because he's really fast because he's a cocker spaniel and its really fun because you'll just run with him and he will give you this wee grin when you run past and he's got the ball and he will look up at you – Girl 2*
	Friends	
	Dad	*Eh my dad . . . he's quite active and he's the only person in my family that comes cycling or running . . . I'm not entirely sure [why] . . . probably because we can go a lot longer distance that if I was just with my friends – Boy 1*
	Mum	*My mum because usually she drags me out of bed to go a run . . . because usually my friends don't want to come out to play. They just video-chat me. They are more social – Girl 4*
Parent/family participant in Happy Homework	Mum (majority)	*Yeah . . . usually my mum would work from home, but my dad doesn't work from home at all . . . [Inaudible] – Boy 3*
	Dad	*My mum helped me with the last couple, but my dad did the yoga one, but he couldn't do it and he fell flat on his face [laughing] – Girl 3*
	Siblings	
	Gran	
	Cousins	
Experience of family participation in Happy Homework	Seeing parents active	*It was good, it was the first time I've ever saw either of my parents do the plank . . . I liked doing it – Boy*
	Competitiveness	*With your parents it's making you more competitive to beat them. Em, and then it's like fun because you're having that time with them. So, it's fun to have more time doing stuff – Girl 6*
	Fun	
	Sometimes not enough people to play games	
	Took parent away from technology	*Yeah, because my dad's always on his phone. He practically doesn't do anything with me so . . . he does the homework with me. Usually, daily he's on his phone and never really speaks to me. So, with the happy homework he actually does it with me and its better – Girl 4*
	Brought family together	*It was kinda like fun and happy cause like, my parents are like divorced and he came to do the homework with me because I asked him, so I was kinda happy . . . yeah . . . happy because I like finally saw my mum and dad like together so like it was nice – Girl 4*

2019), Competence in HH (Table 6) (Tremblay et al., 2016), Relatedness based on interactions within PA participation during HH tasks (Table 7) and (Carson et al., 2016) Relatedness regarding pupils perceived level of support during HH tasks (Table 8). Regarding autonomy, children indicated that they experienced having choice over the activities to do in HH but also faced some pressure from their teachers to complete their HH. In relation to competence, children indicated that they felt capable and motivated by the activities set in HH but did not feel the tasks were overly challenging. Regarding relatedness, children highlighted seeing their parents being active and participating in exercises for the first time. Furthermore, children indicated that HH activities brought their families together, especially those whose parents did not normally engage in activities with their children and spent a long time on their mobile phones. These findings suggest that HH met

Table 8. Pupil perceived relatedness: perceived level of support during Happy Homework and parent–child relationship after Happy Homework.

Theme	Subtheme	Example quote
Supported/cared for	Encouraged to complete activities	*Yeah, I felt supported. When they did have the time to come over and help me, they were telling me like, say it was the plank one, they would tell me that I could do it and I was able to do it – Girl 8*
	Parent wanted to join in Usually hates homework – felt happy spending time with family	*Yeah, because like they support you on your homework. Usually, I don't want to do homework but when I had to do that, when I was doing it with them, I felt happy . . . because usually I hate homework . . . . because I spent time with my family and stuff like that – Girl 4*
	Helping to complete activities Boost of confidence	*I remember like for a couple of weeks i'd just be doing it myself because my mum and dad had to work but then they had like time to do one with me, so I wasn't by myself doing it. My mum and dad were doing it. So, it wasn't just me doing it this time. And they helped me do it. . . and then like when you're doing a plank and them supporting you yeah like that. It boosts your confidence – Boy 6*
Relationship after Happy Homework	The same Spend more time together now	*We got closer . . . because we were spending more time together . . . my dad comes out the back with me to play football . . . yeah, because he used to say he didn't have any time – Boy 4*
	Participate in sports together now	*Em, yeah because when it was all done and stuff like that, they wanted to do more sports with me and stuff like that – Girl 4*
	Fall out over losing	*It makes you angry when you lose to your parents. It makes you fall out [laughing] – Boy 7*
	Get along better	*Well, me and my dad kinda get competitive with each other. So, if I won against him, he would always want to have a re-match or something like that. But yeah, in the end if he won, he'd be happy. But like it kinda depends how it goes. Like if he wins, he will be really happy, but he won't let go of it. But then it would kinda improve after it because we became like . . . just like we kinda got along a wee bit better – Girl 7*

children's three basic psychological needs, however pressure for the children to complete the tasks could be reduced. The pupils suggested that they would like HH to continue following the intervention, suggesting a positive impact on autonomous motivation.

Key recommendations to improve HH

The researchers wanted to gain key recommendations to improve the resource prior to a full-scale trial both from teachers and pupils (Table 9). Ultimately, teachers and pupils seemed keen to have HH continue in their classrooms. Nevertheless, both teachers and pupils offer key recommendations to allow for the development of future HH resources.

Teacher recommendations

Teachers suggested that HH should be incorporated into normal day activities that pupils will be doing already and suggested that they would be happy to work more closely with the research team to offer further perspective on the design and delivery of HH. In the meantime, teachers also provided suggestions around the delivery of HH, indicating that it would be easier to have parents sign for completion of the tasks in one place and easier for teachers to hand the resource out once per week and collect it back at the end of the week. Teachers also suggest providing autonomy to schools to decide upon their own "school-specific" reward system, which varies from school to school.

Pupil recommendations

Pupil recommendations echo's those of their teachers in many ways as they indicated reducing the structure of the tasks and have students focus less on when they are moving or completing tasks, and more on playing and being active on any day they choose. Students also provided insightful recommendations around moving HH to a digital platform. Students also believed the introduction of technology to HH would enable them to properly record the completion of activities.

Changes in outcome measures

Completion rates for outcome measures can be seen in Figure 1. Of the participants who consented to the study, 56 (79%) met the wear-time criteria for the ActiGraph devices (n = 34 intervention arm) whereas 50 (70%) met the wear-time criteria for the activPAL4™ devices (n = 32 intervention arm). No accelerometer device was lost during the intervention. After controlling for pre-intervention scores along with SIMD and pre-intervention BMI-Z scores, there were significant differences post-intervention between the intervention and control groups across several variables (Table 10).

Physical activity

There were no significant differences post-intervention between the PA of the intervention and control groups, as measured by the ActiGraph accelerometers. The intervention group did increase their average acceleration, MVPA and M60 between pre- and post-test (P = 0.084–0.073). The control also increased activity as measured by these variables but to a smaller amount. At post-intervention, a difference in mean stepping time between groups (P < 0.001) was observed with the intervention group having significantly more stepping time than the control group post-intervention. Indeed, follow-up tests suggested that there was a significant increase in stepping time within the intervention group (P < 0.001) which was not observed for the control group.

Sedentary behaviour

There was a difference between time spent sitting for long bouts (>60 min per day) between the groups (P = 0.03) with the control group lower in comparison to the intervention group at post-intervention. Follow-up tests revealed that between pre- and post-test results there were significant

Table 9. Key recommendations to improve happy homework.

Theme	Subtheme	Example quote
Teacher recommendations		
Everyday approach – normal		*The only thing I can really think of is . . . trying to make it a bit more, as part of their normal day. Things they might be doing kinda anyway. Em, I know that would probably be really hard to think of things like that. But the walking one was a really good example of that because they would be building that into their day anyway. And if they weren't, they might not see it as too onerous to try and to try and do. - Teacher 1*
Streamline implementation	Signing in one place	*You had them signing it Monday, Wednesday, Friday. I get that, but maybe just one day for the parents to sign it like on a Thursday just to say this is when it's done . . . obviously, with health and wellbeing you're trying to get them to do it on a daily basis but even if that is the case, they're still only getting it signed on the Thursday night – Teacher 3*
	Hand out once a week	*Em, based on what we do with homework, we would give it out once a week and it would be expected, say you hand it out on Monday and collect in on Friday. Because generally speaking the homework we do is out on Monday in on a Friday. Um, so with the wee kinda activities Monday, Wednesday, Friday, rather than on Friday morning like "you need to sign, you need to sign" like, wee things . . . - Teacher 3*
	Holiday challenges instead of homework	*Even a challenge instead of actual homework. You know so, "your challenge this holiday weekend is to . . . " and then a generic be active for 15 mins and get it signed off – Teacher 3*
Teachers	Research team could work more closely with classroom teachers on content planning	*The only thing I would say is it might be worth em, depending on what age range your targeting at, so maybe you could discuss with us, with teachers or whatever, think about the level of certain things so like the games and things like that. Upper school and lower school will be interested in completely different things. Em, so that's an option if it's going to be games they want to play, we could maybe have some ideas of the activities they could do – Teacher 2.*
	Rewards specific to school	*So yeah, probably finding on a school-by-school basis what they're reward systems like and behaviour systems – Teacher 1*
Continue promoting it		*Gee-wiz . . . em . . . I don't know. Em . . . I think it is just constantly flogging at it. I don't know. I think nowadays everyone just accepts everything to be done for them. So how will you manage to get people to recognise they need to take responsibility for their own development and their own health and wellbeing? Rather than it being something that is handed out to them. But I think you're kinda battling against the tide with it – Teacher 3*
Incorporate equipment		*I know that in P6 we do "bikeability", so I don't know if anything involving bikes but then you have the whole equity thing if not everyone has a bike so there's issues like that – Teacher 1*
Pupil recommendations		
Increase autonomy support	Some activities – go out and play (less structured)	
	Any days (less structured)	*I just feel like if we didn't have days when we had to do it, em, it would be a little bit better – Girl 1*
	More options – activities	*After sport . . . like if you have a club on. If it's like late on like 7 or 8 your mum or dads like it's a school night get to bed. And you're like having to do it. So, if there's more options you could be like that one's going to be quicker, I could do that one – Boy 7*
Increase autonomy in ways to completion Happy Homework activities	Ways to prove you have completed the activities	*I think we should have to like to do something to show that we've done it. I know that like, I only got my mum to sign it once I done it but some people just go their mum to sign it so oh yeah I've done it . . . yeah to make people want to do it because they're so to their electronics or like if they've got a phone you could say like call a friend or text a friend to go out and play for 15 minutes. So, say you called, say I called Anna, you could write like who did you go out with, who did you call, and then at school the next day, when you've told to prove you could ask Anna, did Zara actually call you – Girl 7*
	Digitally (computer-based)	

decreases in sitting for long bouts for the control group (P = 0.05), but no significant differences in sitting time for the intervention group. There was a difference in the number of sit-to-stand transitions between the groups ($P < 0.001$) with the control group demonstrating more sit-to-stand transitions than the intervention group at post-intervention. Interestingly, follow-up tests revealed that between pre- and post-test results, there was a decrease in sit-to-stand transitions in the intervention group (P = 0.02) whilst the control group increased their sit-to-stand transitions (P = 0.032). There was no significant difference in ST between groups. However, follow-up tests revealed that the ST of the control group increased between pre-test and post-test (P = 0.04) whilst the ST of the intervention group did not change significantly.

Dietary behaviour

There was a difference between the fruit and vegetable intake between groups (P = 0.01) with the intervention group having higher fruit and vegetable intake in comparison to the control group post-intervention. Follow-up tests showed that fruit and vegetable intake between pre- and post-test decreased within the control group (P = 0.000) but there were no significant changes in the intervention group.

Sleep

There was also a difference in sleep duration between groups (P = 0.02) with the intervention group having higher sleep duration in comparison to the control group at post-

Table 10. Changes in outcome measures from pre- to post-intervention.

	Control (mean, SD)		Intervention (mean, SD)		The effect of intervention group on post-test scores (after controlling for pre-test scores, SIMD, and BMI-Z Score)				
Outcome	Pre	Post	Pre	Post	β (Standardised regression coefficient)	Standard Error	Two-tailed P Value	Confidence interval levels (M, 95%CI)	
ActiGraph GT3X+									
AvAcc (*mg*)	42.62 (11.17)	45.22 (13.88)	41.50 (10.88)	43.98 (15.92)	0.00	0.08	0.98	−0.13	0.13
IG	−1.03 (0.13)	−1.02 (0.17)	−1.05 (0.13)	−1.05 (0.16)	−0.03	0.08	0.76	−0.16	0.12
MVPA (min.d^{-1})	55.66 (20.36)	61.87 (28.16)	53.09 (19.33)	58.05 (29.73)	−0.01	0.08	0.87	−0.14	0.12
M60 (*mg*)	197.05 (58.35)	209.29 (83.82)	195.80 (64.78)	213.71 (104.16)	0.04	0.07	0.57	−0.08	0.15
M30 (*mg*)	337.78 (125.71)	351.24 (156.80)	322.82 (124.69)	348.31 (183.01)	0.04	0.08	0.58	−0.08	0.17
ActivPAL									
Sitting time (hrs/day)	8.70 (.84)	8.63 (0.70)	9.13 (0.84)	8.71 (0.89)	0.01	0.19	0.98	−0.30	0.31
Standing time (hrs/day)	2.81 (0.69)	3.01 (0.56)	2.60 (0.63)	2.82 (0.44)[a*]	−0.04	0.16	0.82	−0.31	0.23
Stepping time (hrs/day)	2.28 (0.57)	2.20 (0.26)	2.14 (1.47)	2.44 (0.22)	0.32[b**]	0.09	0.00	0.17	0.48
Sit-to-stand transitions	85.51 (20.17)	92.47 (14.71)[a*]	88.63 (20.17)	82.97 (14.71)[a*]	−0.35[b**]	0.11	0.00	−0.52	−0.17
Sit 60 mins plus (hrs/day)	1.15 (0.52)	0.83 (0.91)[a*]	1.27 (0.69)	1.18 (0.51)	0.31[b*]	0.14	0.03	0.08	0.54
Sleep Duration (hrs/day)	10.16 (0.52)	9.92 (0.51)	9.90 (0.80)	10.04 (0.64)	0.27[b*]	0.11	0.02	0.09	0.45
Questionnaires									
Weekly Screen time (hr/week)	28.45 (19.48)	33.55 (16.48)[a*]	41.51 (32.13)	34.76 (19.67)	−0.03	−0.13	0.85	−0.24	0.19
DILQ	1.83 (1.44)	1.28 (1.49)[a**]	1.54 (1.42)	1.54 (1.44)	0.14[b**]	0.051	0.01	0.06	0.24

Note. BMI = Body Mass Index; AvAcc = Average Acceleration; IG = Intensity Gradient; MVPA = Moderate-to-vigorous physical activity; DILQ = Day in the Life Questionnaire. β Effect size weak (<0.2), medium (0.2–0.5) strong (≥0.5).
[a]Significant differences between pre and post scores whilst controlling nested nature of the data [a*]($P < 0.05$) [a**]($P < 0.001$).
[b]Significant effect of group on post test scores whilst controlling for pre-test scores, BMI, SIMD and nested nature of the data [b*]($P < 0.05$) [b**]($P < 0.001$).

intervention. Follow-up tests revealed a decrease in the hours of sleep for the control group between pre- and post-test, and an increase in hours of sleep for the intervention group.

Discussion

The primary aim of this study was to explore the feasibility, acceptability, and potential efficacy of HH, a pilot randomised control trial to encourage children's positive dietary behaviours and engagement in 60 min of daily MVPA, limited ST (≤2 h daily), and adequate sleep (9–11 h per night) whilst maintaining consistent bed and wake times. HH was implemented by all participating teachers. From the 158 participants who were provided with informed consent, a recruitment rate of 45% and retention rate of 89% was observed with 79% and 70% of participants providing PA and SB data.

Adherence of HH activities reduced as the intervention progressed with some activities preferred over others. Previous research in compulsory homework-based interventions has found similar outcomes regarding adherence (Duncan et al., 2019). Incentives have been used to encourage participation in school-based interventions, including rewards as employed in this study, but also financial incentives (Martin et al., 2014) and donations to charity (Hunter et al., 2015). Previous research has demonstrated good adherence to the intervention when provided with incentives such as monetary gifts to their school upon meeting intervention goals (e.g., achieving a 2% weight loss goal) (Yoo et al., 2017). Future school-based interventions should therefore consider the use of incentives where possible to enhance compliance to their study aims.

One intervention teacher failed to complete their logbook which was used to examine intervention fidelity. Indeed, incomplete logbooks have been noted as a limitation in previous interventions which included a homework element (Campbell et al., 2015). A recent systematic review measuring the implementation fidelity of school-based obesity prevention programmes suggests that logbooks, observations and questionnaires were the most common methods of measuring fidelity (Schaap et al., 2018). However, there is no agreed consensus on the optimum methods used for assessing fidelity in such programmes (Schaap et al., 2018). With two of the intervention teachers completing their logbook in full, this fidelity measure seems appropriate for some teachers but not others. Future research should consult teachers prior to selecting fidelity measures and consider additional measures, alongside logbooks that intervention teachers may be more likely to complete such as phone applications.

Findings suggested that being involved in the HH theory-based intervention strengthened teacher-pupil and parent–child relationships. HH was found to be needs supportive and had a substantial and positive effect on family life. Findings suggested that HH promoted the importance of having a healthy lifestyle, mapped to CfE. Teachers suggested HH allowed them to connect with pupils' home lives. Barriers to

completing HH activities perceived by children included parent attitudes and employment, as well as children's additional extra-curricular commitments. Teachers indicated that in general not enough importance was placed on health and well-being homework at school. To gain the benefits associated with HH, structural changes may be required to ensure that health-related homework tasks are seen by teachers, parents, and children as a key area of learning.

With regard to the efficacy of HH, we examined the preliminary effects of HH on children's activity, sleep, and dietary behaviours. Previous studies which included non-compulsory homework tasks within their intervention found no significant effects on executive function, SB, or fruit and vegetable consumption (Aadland et al., 2019; Kipping et al., 2014). In contrast, a recent study which employed an 8-week homework and an in-class teaching PA module found increases in children's PA, particularly outside of school and on weekends (Duncan et al., 2019).

Intervention group effects were observed for stepping time, whilst no differences were found for MVPA, and accelerometer measured PA. M30 and M60 demonstrated medium effects of intervention group. With a larger sample size, these findings may have been significant. Medium-sized effects of group on sitting (≥60 min) was observed, with the control group significantly sitting for less time, whilst the intervention group did not change significantly in sitting time whilst significantly reducing their sit-to-stand transitions. This finding is surprising and could be explained by the possibility that subtle compensation effects took place, whereby children who increased their engagement in PA via HH also subconsciously counterbalanced this activity by increased SB (Ridgers et al., 2014, 2015). The long-term assessment of HH with a larger sample is needed to understand its effects on PA and SB. Small-to-medium intervention effects were observed for diet and ST for the intervention group, however it is important to highlight that these effects were observed as the control group outcome measures decreased for diet and increased for ST, and the intervention group did not change significantly. For sleep, the control group showed a decrease in hrs, whereas the intervention group showed an increase in hrs, which were both approaching significance. These findings indicate that HH may protect children against worsening lifestyle behaviours related to diet, ST, and sleep. It is important to note that HH was delivered over the Easter break which may have prevented the interventions group's diet and sleep from worsening during this period whereby the children were not in their usual routine.

Strengths and limitations

A notable strength of this study is the design of HH activities which were developed in conjunction with head-teachers and were underpinned by a theoretical model of behaviour change. Additional strengths include the objective measurement of PA and SB alongside in-depth, qualitative data from pupils and teachers which confirmed that the intervention was feasible and acceptable for teachers to implement. Key recommendations provided by teachers and pupils surrounding acceptability will also strengthen the design of future larger trials. Limitations of this study relate to the incomplete fidelity information regarding the completion of HH activities from one of our intervention teachers. Additionally, the consideration of 24 h movement behaviours could have been reflected in the analysis, including patterns of these behaviours or compliance.

Conclusion

HH activities were implemented into the curriculum successfully over the 8-week intervention period. Acceptability decreased throughout the course of the intervention, with qualitative investigations providing recommendations to improve HH acceptability. The HH intervention seemed to satisfy children's competence, relatedness, and autonomy by providing choice through enjoyable and challenging tasks which brought families together, who typically did not engage in PA together prior to HH. There were some positive intervention effects on measures of PA, sleep, and diet, although sitting for long periods remained the same. Few studies have implemented interventions in which homework activities play a significant role. Given the promising findings noted here, future studies over a longer period that include larger sample sizes are recommended to evaluate intervention efficacy.

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ORCID

Samantha Donnelly http://orcid.org/0000-0002-1735-0600
Duncan S. Buchan http://orcid.org/0000-0002-4320-4615
Gillian McLellan http://orcid.org/0000-0002-1676-4916
Ross Roberts http://orcid.org/0000-0003-0268-1228
Rosie Arthur http://orcid.org/0000-0003-0651-4056

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