condition received both the BM and FMS lessons, therefore receiving double the dose of the other intervention groups.

The BM lessons were delivered in the classroom and incorporated: self-monitoring (increasing children's awareness of time spent in physical activity and screen behaviours); the health benefits of physical activity; awareness of the home and community physical activity, and sedentary behaviour environments; decision-making and identifying alternatives to screen behaviours that included designing their own physical activity games; intelligent TV viewing and reducing viewing time; advocacy of reduced screen time through poster displays and role plays; use of pedometers; and group games including all children in the BM condition at each of the schools (see Table 1). From Lessons 11 to 14, children completed a weekly contract undertaking to switch off one television programme per week over the 4-week period (that is, they switched off one programme for the week of Lesson 11, two programmes for Lesson 12 and so on). A newsletter was sent home to parents of children in the BM or combined BM/FMS condition asking them to sign their child's switch-off contracts each week to confirm that the nominated programme was turned off, and after Lesson 14 parents were encouraged to help their child maintain the switch-off.

The FMS lessons were delivered either in the indoor or outdoor physical activity facilities at each school (dependent on the weather and accessibility). Through games and activities developed for this intervention (based on previously published materials),[29] these lessons focused on mastery of six FMS. The interventionist taught the skills with an emphasis on enjoyment and fun through games and maximum involvement for all the children. Most lessons focused on at least two skills. The six skills were selected on the basis that they are commonly used in children's games, sports and physical activities. More detail on the FMS lesson content is provided in Table 1.

Table 1 Lesson content for the behavioural modification (BM) and fundamental motor skills (FMS) conditions

Lesson	BM	FMS
1	Introduction to 'Switch-Play'	Run and throw
2	Patterns of sedentary behaviour (SB)[a]	Throw and dodge
3	Self-monitoring SB	Run and strike
4	Physical activity and health	Vertical jump and throw
5	Patterns of physical activity behaviour	Dodge and kick
6	The home environment	Run and strike
7	The community environment	Throw and dodge
8	Decision-making	Kick and vertical jump
9	Identifying alternative activities	Dodge and throw
10	Increasing physical activity	Throw and kick
11	Intelligent viewing and decreasing SB[b]	Throw and strike
12	Intelligent viewing[b] and TV advertising	Throw and vertical jump
13	Advocacy of decreased SB—role plays[b]	Run and kick
14	Perform advocacy plays[b]	Dodge and strike
15	Advocacy of decreased SB—posters	Vertical jump and strike
16	Complete advocacy posters	Throw and run
17	Increasing physical activity—pedometers	Kick and dodge
18	'Switch-Play' games	Vertical jump, run and kick
19	Present posters to younger grades	Dodge, run, strike and kick

[a]Sedentary behaviour—TV viewing, computer use and electronic game use. [b]'Switch-off challenge' from one TV programme in Lesson 11 to four programmes in Lesson 14.

Outcome measures

Body mass index. Children's weight and height without shoes were measured in private. Two trained staff members (not blinded to group assignment) collected children's height and weight at each of the four time points. On each occasion, children's height and weight were measured twice and the average reading was used in data analyses. BMI ($kg\,m^{-2}$) was calculated and converted as recommended for analysis of longitudinal adiposity data.[30] This involves subtracting the sex–age population median (based on US data)[31] from the child's raw BMI score. For convenience, these BMI units of difference from the sex–age population median will hereafter be referred to simply as BMI. Children were also categorized as healthy or overweight/obese based on International Obesity Task Force definitions.[32]

Objectively assessed physical activity. Physical activity was assessed using Manufacturing Technology Inc. (MTI), Florida, USA, Actigraph Model, AM7164-2.2C accelerometers. Children wore the MTI on a belt positioned over the right hip during waking hours, except when bathing or swimming, for 8 days at each of the four measurement points. For each child, the first and last days of accelerometer data were discarded due to incomplete data (administering and collecting the monitors) and possible reactivity effects on the first day. Only children with at least 3 complete days of accelerometer data, including 1 weekend day (with at least 10 h of data per day), were included in the analyses. Extreme accelerometer counts (for example, $>4\,000\,000$ counts per day) were also excluded from the analyses as this indicated a possible unit malfunction. As well as computing an average daily movement count, movement count thresholds based on an age-specific energy expenditure prediction equation were applied to the data to calculate the average time spent in moderate- (3.0–5.9 metabolic equivalent units of rest (METs)) and vigorous-intensity (>6.0 METs) physical activity.[33] The time spent in each intensity of activity on each day was summed and divided by the total number of days on which the accelerometer was worn.

Self-reported screen behaviours. Children completed a questionnaire at baseline and post intervention, and at 6- and 12-month follow-up periods during classroom time under the supervision of the investigators (not blinded to group assignment), who were available to assist students with any questions or problems. Children reported the usual time (hours/minutes) Monday–Friday and Saturday–Sunday in TV viewing, computer use and playing electronic games. Each of these variables was summed and divided by seven to calculate average minutes per day spent watching TV, using

Table 2 Baseline values for outcome variables by gender and intervention group

	Total	*Controls*	*BM*	*FMS*	*BM/FMS*
BMI[a] (mean, s.d.)					
Boys	3.4 (3.6)	4.5 (3.3)	3.3 (3.8)	3.3 (3.2)	2.8 (4.0)
Girls	2.6 (3.5)	2.8 (4.1)	3.1 (3.3)	3.0 (3.7)	1.8 (3.1)†
Overweight/obese[b] (%, 95% CI)					
Boys	46.9 (38.6–55.4)	56.3 (37.7–73.6)	43.8 (26.4–62.3)	50.0 (32.9–67.1)	40.0 (25.7–55.7)
Girls	37.6 (29.8–45.9)	43.3 (25.5–62.6)	44.1 (27.2–62.1)	36.8 (21.8–54.0)	29.8 (17.3–44.9)
TV viewing (min week^{-1}) (mean, s.d.)					
Boys	959.8 (650.4)	823.8 (676.2)	1037.7 (778.3)	976.2 (618.1)	988.2 (548.7)
Girls	866.7 (543.4)	730.0 (520.0)	977.3 (530.6)	892.5 (583.8)	849.8 (530.2)
Computer use (min week^{-1}) (mean, s.d.)					
Boys	143.3 (218.1)	125.0 (153.7)	200.0 (263.1)	110.4 (164.2)	141.2 (255.0)
Girls	164.2 (255.4)	161.4 (274.4)	147.3 (183.5)	155.4 (266.8)	186.6 (286.7)
Electronic games use (min week^{-1}) (mean, s.d.)					
Boys	583.5 (645.5)$^{\#}$	520.6 (595.6)	585.8 (620.0)	758.5 (740.0)	480.5 (604.4)
Girls	197.3 (354.1)	256.8 (447.3)	206.4 (362.9)	108.6 (149.4)	227.3 (398.7)
Counts per day ($\times 10^3$) (mean, s.d.)					
Boys	543.1 (235.7)$^{\#}$	481.1 (127.3)	543.3 (268.6)	594.7 (354.7)	551.7 (150.1)
Girls	425.3 (138.4)	397.8 (101.7)	433.4 (129.6)	453.6 (153.1)	414.9 (151.4)
Moderate PA (min day^{-1}) (mean, s.d.)					
Boys	131.2 (35.9)**	124.1 (27.8)	123.1 (34.1)	133.9 (43.9)	140.4 (34.8)
Girls	112.5 (33.5)	107.1 (27.6)	118.3 (28.9)	118.4 (42.0)	107.1 (31.9)
Vigorous PA (min day^{-1}) (mean, s.d.)					
Boys	25.4 (22.8)$^{\#}$	19.9 (11.0)	24.2 (18.5)	33.6 (39.5)	24.4 (13.6)
Girls	14.2 (8.9)	12.2 (7.1)	13.8 (9.4)	16.1 (8.2)	14.2 (10.0)
PA enjoyment (mean, s.d.)					
Boys	0.63 (0.54)*	0.56 (0.59)	0.57 (0.54)	0.84 (0.43)	0.55 (0.54)
Girls	0.78 (0.45)	0.79 (0.33)	0.75 (0.51)	0.88 (0.46)	0.72 (0.46)
FMS z-scores (mean, s.d.)					
Boys	0.52 (0.83)$^{\#}$	0.28 (0.83)	0.66 (0.68)	0.51 (0.78)	0.59 (0.93)
Girls	−0.50 (0.89)	−0.95 (0.60)	−0.28 (0.89)	−0.27 (0.94)	−0.60 (0.91)

Abbreviations: BM, behavioural modification; BMI, body mass index; CI, confidence interval; FMS, fundamental movement skills; PA, physical activity. [a]BMI/sex–age population median.[31] [b]Age- and sex-specific internationally accepted cut points.[32] *$P<0.05$, **$P<0.01$, $^{\#}P<0.001$ significant differences by gender across intervention groups (adjusting for clustering). $^{\dagger}P<0.05$ significant difference by intervention group within gender (adjusting for clustering).

a significant positive average difference over time between boys in the BM/FMS and control groups in vigorous-intensity physical activity from baseline to post intervention. These differences were not maintained with the inclusion of the 6- and 12-month follow-up data. Among girls, there were significant positive average differences in movement counts and in moderate-intensity physical activity between the BM and control groups from baseline to post intervention and over the four time points (Table 5).

Screen behaviours

There were significant intervention effects between baseline and post intervention for children's TV viewing min week^{-1} among children in the BM group compared with those in the control group (Table 3). However, this was in the undesired direction, with BM children reporting 229 min week^{-1} more in TV viewing on average over time compared with the control group. These effects were maintained with the inclusion of 6- and 12-month follow-up data. There were no significant intervention effects on other screen behaviours.

There was a significant group*gender interaction for time spent playing electronic games ($P<0.001$). However, when the data were reanalysed separately by gender, there were no significant effects from baseline to post intervention or over the four time points of the study on electronic games use among boys or girls (data not shown).

Enjoyment of physical activity

There were significant average differences in physical activity enjoyment between baseline and post intervention, with children in the FMS group reporting higher average

Table 3 Intervention[a] and maintenance effects[b] (coefficient, 95% confidence intervals (CIs)) on screen time (min week^{-1}), physical activity (PA; min day^{-1})[c], fundamental movement skills (FMS)[d], enjoyment of PA, body mass index (BMI)[e] and weight status

	BM		*FMS*		*BM/FMS*	
	Baseline to post intervention[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]
Odds ratios (95% CI)[f]						
Overweight/obese (unadjusted)	0.78 (0.39 to 1.57)	0.78 (0.39 to 1.57)	0.76 (0.38 to 1.50)	0.76 (0.39 to 1.50)	0.53 (0.28 to 1.03)	0.53 (0.28 to 1.03)
Overweight/obese (adjusted)[g]	0.88 (0.36 to 2.15)	0.65 (0.35 to 2.10)	0.62 (0.26 to 1.48)	0.66 (0.28 to 1.56)	**0.36 (0.15 to 0.86)***	**0.38 (0.16 to 0.89)***
β-coefficients (95% CI)						
BMI (unadjusted)	−0.40 (−1.11 to 0.30)	−0.42 (−1.07 to 0.23)	−0.50 (−1.25 to 0.25)	−0.45 (−1.19 to 0.29)	**−1.30 (−2.29 to −0.31)***	**−1.30 (−2.24 to −0.35)****
BMI (adjusted)[f]	−0.06 (−1.23 to 1.12)	−0.15 (−1.29 to 0.99)	−0.86 (−1.94 to 0.23)	−0.77 (−1.80 to 0.26)	**−1.88 (−3.22 to −0.53)****	**−1.53 (−2.82 to −0.24)***
TV viewing (min week^{-1})	**229.3 (16.6 to 442.0)***	**239.9 (27.6 to 452.2)***	149.4 (−20.7 to 319.5)	142.6 (−33.6 to 318.9)	137.0 (−17.4 to 291.5)	141.9 (−15.6 to 299.5)
Computer use (min week^{-1})	29.5 (−46.9 to 105.9)	31.7 (−46.2 to 109.6)	−9.5 (−102.8 to 83.8)	−11.8 (−107.5 to 83.7)	21.9 (−68.7 to 112.4)	21.4 (−71.7 to 114.4)
Electronic games (min week^{-1})	−8.5 (−180.0 to 163.1)	−8.5 (−179.7 to 162.7)	28.5 (−269.1 to 326.0)	22.8 (−277.3 to 323.0)	−42.4 (−236.2 to 151.5)	−44.0 (−237.6 to 149.6)
Counts per day ($\times 10^3$)	**47.0 (24.2 to 69.8)**#**	**47.5 (24.6 to 70.4)**#**	**76.6 (35.2 to 118.0)**#**	**76.1 (33.4 to 118.9)**#**	40.8 (−9.9 to 91.4)	40.1 (−9.8 to 90.1)
Moderate PA (min day^{-1})	5.3 (−2.0 to 12.6)	4.3 (−3.6 to 12.2)	**10.4 (2.8 to 18.1)****	**9.5 (1.4 to 17.6)***	7.7 (−5.1 to 20.6)	6.7 (−6.4 to 19.8)
Vigorous PA (min day^{-1})	**2.8 (0.3 to 5.4)***	**2.8 (0.2 to 5.4)***	**7.8 (3.4 to 12.3)****	**7.7 (3.2 to 12.2)****	3.1 (−0.58 to 6.7)	3.0 (−0.59 to 6.6)
PA enjoyment	−0.23 (−0.27 to 0.22)	−0.02 (−0.26 to 0.23)	**0.18 (0.00 to 0.35)***	**0.19 (0.01 to 0.36)***	−0.05 (−0.29 to 0.20)	−0.04 (−0.28 to 0.20)
FMS *z*-scores	0.47 (−0.17 to 1.11)	0.48 (−0.15 to 1.11)	0.44 (−0.14 to 1.02)	0.45 (−0.11 to 1.02)	0.35 (−0.36 to 1.06)	0.36 (−0.35 to 1.06)

Abbreviations: BM, behavioural modification; MVPA, moderate-to-vigorous intensity physical activity. [a]Generalized estimating equation (GEE) coefficient at baseline and post intervention, adjusted for clustering by school class. [b]GEE coefficient at baseline and post intervention, 6- and 12-month follow-up periods, adjusted for clustering by school class. [c]Accelerometer. [d]FMS *z*-scores. [e]BMI units of difference from US sex- and age-adjusted population median.[31] [f]Referent category: not overweight/obese. [g]Adjusted for food-frequency intake (high energy drinks, sweet and savoury snacks, confectionery and fast food) and MVPA. *$P<0.05$, **$P<0.01$, #$P<0.001$. Bold values denote statistical significance.

Table 4 Intervention[a] and maintenance effects[b] (coefficient, 95% confidence intervals) on physical activity (PA; counts per day or min day^{-1})[c] and enjoyment of PA among boys

	BM		*FMS*		*BM/FMS*	
	Baseline to post intervention[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]
Counts per day ($\times 10^3$)	**61.5 (21.7 to 101.4)****	**61.6 (12.4 to 110.9)***	**112.8 (59.1 to 166.5)**#**	**114.0 (52.8 to 175.2)**#**	72.1 (−7.7 to 151.9)	66.2 (−20.7 to 153.0)
Vigorous PA (min day^{-1})	**4.5 (0.91 to 8.0)***	**4.4 (0.44 to 8.4)***	**13.8 (8.7 to 18.9)**#**	**13.8 (8.4 to 19.1)**#**	**5.7 (0.21 to 11.2)***	4.8 (−1.2 to 10.7)
PA enjoyment	0.03 (−0.26 to 0.31)	0.03 (−0.25 to 0.32)	**0.30 (0.10 to 0.51)****	**0.32 (0.11 to 0.52)****	0.02 (−0.28 to 0.33)	0.03 (−0.27 to 0.34)

Abbreviations: BM, behavioural modification; FMS, fundamental movement skills. [a]Generalized estimating equation (GEE) coefficient at baseline and post intervention, adjusted for clustering by school class. [b]GEE coefficient at baseline and post intervention, 6- and 12-month follow-up periods, adjusted for clustering by school class. [c]Accelerometer. *$P<0.05$, **$P<0.01$, #$P<0.001$. Bold values denote statistical significance.

enjoyment scores over time compared with those in the control group (Table 3). These effects were maintained with the inclusion of physical activity enjoyment data across all four time points. There was a significant group*gender interaction for enjoyment of physical activity ($P=0.001$). Table 4 shows that there were significant positive differences in physical activity enjoyment between baseline and post intervention among boys in the FMS group compared with those in the control group. These effects remained after the inclusion of the 6- and 12-month follow-up data.

Fundamental movement skills

There were no significant intervention effects on FMS *z*-scores between baseline and post intervention or over the four time points. There was, however, a significant group*gender interaction for FMS ($P<0.001$). Table 5 shows FMS between baseline and post intervention, where compared with girls in the control group, girls in the BM and the FMS groups recorded significantly higher average FMS *z*-scores over time. These positive differences remained with the inclusion of data from all four time points.

Unintended outcomes

From baseline to post intervention, there were no effects on unintended outcomes of the intervention such as children's happiness with their body shape and body weight, or eating to gain weight or lose weight in the last month. However, when a group*gender interaction term was included in the model, gender appeared to moderate the intervention effects on satisfaction with body shape and with body weight

Table 5 Intervention[a] and maintenance effects[b] (coefficient, 95% confidence intervals) on physical activity (PA; counts per day or min day^{-1})[c] and fundamental movement skills (FMS) among girls

	BM		*FMS*		*BM/FMS*	
	Baseline to post intervention[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]	*Baseline to post intervention*[a]	*Baseline to 12-month follow-up*[b]
BMI (unadjusted)[d]	−0.01 (−0.05 to 0.03)	−0.01 (−0.07 to 0.04)	−0.02 (−0.07 to 0.03)	**−0.07 (−1.12 to 0.02)****	**−0.03 (−0.08 to 0.02)**	**−0.07 (−0.13 to −0.01)***
BMI (adjusted)[e]	−0.07 (−0.03 to 0.17)	−0.01 (−0.14 to 0.12)	0.13 (−0.02 to 0.29)	−0.08 (−0.22 to 0.05)	0.01 (−0.50 to 0.13)	**−0.15 (−0.31 to −0.00)***
Counts per day ($\times 10^3$)	**36.5 (0.29 to 72.7)***	**39.3 (9.4 to 69.1)***	56.2 (−18.6 to 131.0)	58.0 (−11.8 to 127.8)	180.3 (−17.3 to 53.3)	21.6 (−10.3 to 53.5)
Moderate PA (min day^{-1})	**12.1 (3.9 to 20.3)****	**11.1 (3.8 to 18.4)****	11.4 (−4.5 to 27.3)	10.2 (−4.7 to 25.1)	1.1 (−7.5 to 9.8)	0.3 (−7.7 to 8.3)
FMS *z*-scores	**0.76 (0.11 to 1.41)***	**0.75 (0.11 to 1.40)***	**0.78 (0.27 to 1.29)****	**0.76 (0.27 to 1.26)****	0.51 (−0.16 to 1.18)	0.49 (−0.17 to 1.15)

Abbreviations: BM, behavioural modification; BMI, body mass index; MVPA, moderate-to-vigorous intensity physical activity. [a]Generalized estimating equations (GEE) coefficient at baseline and post intervention, adjusted for clustering by school class. [b]GEE coefficient at baseline and post intervention, 6- and 12-month follow-up periods, adjusted for clustering by school class. [c]Accelerometer. [d]BMI units of difference from US sex- and age-adjusted population median.[31] [e]Adjusted for food-frequency intake (high energy drinks, sweet and savoury snacks, confectionery and fast food) and MVPA. *$P<0.05$, **$P<0.01$, #$P<0.001$. Bold values denote statistical significance.

($P<0.01$). When stratified by gender, boys in the FMS group (B = 0.56, 95% CI: 0.19 to 0.93, $P=0.003$) and combined BM/FMS group (B = 0.59, 95% CI: 0.12 to 1.05, $P=0.014$) recorded significantly higher satisfaction with their body shape between baseline and post intervention compared with boys in the control group. This effect was maintained over the four time points. Among girls, there were no effects on the unintended outcomes that were assessed.

Discussion

This intervention aimed to prevent excess weight gain among 10-year-old children, to prevent declines in physical activity and to reduce screen behaviours. The intervention also aimed to increase enjoyment of physical activity and to improve FMS. Consistent with previous screen behaviour intervention studies,[16,17] this study found favourable outcomes for children's BMI and weight status. On average, between baseline and post intervention, and including 6- and 12-month follow-up data, children in the combined BM/FMS group recorded significantly lower BMI compared with children in the control group. These differences were strengthened with the inclusion of food-frequency and physical activity data across all the time points. Adjusted analyses also found that children in the BM/FMS group were more than 60% less likely to be overweight or obese on average over time (baseline and post intervention, and over the four time points) compared with those in the control group.

Unlike previous screen behaviour interventions,[16,17,39] this intervention was not effective in reducing screen behaviours, with children in the BM group reporting higher mean time per week watching TV between baseline and post intervention compared with children in the control group. This difference may be due to a failure of the intervention to reduce children's TV viewing, instead increasing children's awareness and engagement with that behaviour (an undesired outcome). However, it may also be because a self-reported measure of children's TV viewing was used. As children learnt about the pros and cons of TV viewing and how to monitor their viewing and turn off the TV, their accuracy in reporting this behaviour may have improved over time. Baranowski *et al*.[40] call this phenomenon a 'response shift bias', suggesting that based on learning effects, there is a differential favourable shift in the accuracy of reporting among children in the intervention group compared with those in the control group. Although the screen behaviour self-reported measure used in this study has shown acceptable reliability and concurrent validity (compared with parental proxy reporting), an objective or log or diary measure of these behaviours may have yielded different results.

There were no intervention effects on electronic games or computer use. This may be because the intervention focused more strongly on TV viewing. The intervention programme included self-monitoring of the screen behaviours and lessons focused on reducing time spent in these behaviours; however, the behavioural contracts focused only on switching off the TV. Although children were encouraged not to exchange TV viewing for computer use (apart from educational instruction) or playing electronic games, the intervention programme did not employ a specific BM technique for reducing electronic games or computer use. Robinson[17] reported separately the intervention effects on time children spent watching videotapes and playing video games and found significant reductions in self-reported video game playing among children in the intervention group compared with the control group. He did not, however, assess their computer use. These behaviours have different correlates[34] and therefore future interventions need to tailor programmes to target reductions in specific sedentary behaviours.

The significant effects on physical activity were a unique aspect of this intervention, with previous screen behaviour interventions not reporting a significant impact on children's physical activity.[16,17,39] The average effect across time between the control and the FMS groups in the current study was approximately 10 min day^{-1} in moderate-intensity