

A translational research intervention to reduce screen behaviours and promote physical activity among children: Switch-2-Activity

JO SALMON^{1*}, MICHELLE JORNA¹, CLARE HUME¹,
LAUREN ARUNDELL¹, NATALIE CHAHINE²,
MYRTHE TIENSTRA^{3,4†} and DAVID CRAWFORD¹

¹Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Deakin University, 221 Burwood Hwy, Burwood 3125, Australia ²Western Region Health Centre, Footscray, Australia ³Wageningen University, Wageningen, The Netherlands ⁴School of Exercise and Nutrition Sciences, Deakin University, 221 Burwood Hwy, Burwood 3125, Australia

*Corresponding author. E-mail: jsalmon@deakin.edu.au

†While on student exchange at the Centre for Physical Activity and Nutrition Research.

SUMMARY

Translational or implementation research that assesses the effectiveness of strategies to promote health behaviours among children that have been previously tested under 'ideal' conditions is rarely reported. Switch-2-Activity aimed to examine the effectiveness of an abbreviated programme delivered by teachers targeting children's television viewing, computer use, physical activity and potential mediators of behaviour change. Fifteen schools from disadvantaged areas in Melbourne, Australia agreed to participate in the study (43% school-level response rate). Out of the 1566 Grades 5 and 6 (9–12 year old) children invited to take part in the study, 1048 (67% response rate) provided informed consent. Schools were randomized to either an intervention or wait-list control condition. Teachers delivered six lessons, which included strategies such as self-monitoring, behavioural contracting and budgeting of screen time. Children completed a self-report

survey at baseline and post-intervention examining screen-based behaviours, physical activity, self-efficacy and behavioural capability. Teachers reported implementation of and attitudes to the programme. Seventy-one per cent of teachers delivered at least four of the six lessons. Most teachers reported that the materials were easy to follow and deliver; however, many teachers reported modifying the materials in some way. Among boys, there were favourable small intervention effects on weekend screen time [(coefficient = -0.62, 95% 95% confidence interval: -1.15, -0.10, p = 0.020)]. The intervention also had significant positive effects on children's self-efficacy for reducing television viewing and on behavioural capability (television viewing styles). Future studies that assess the translation of efficacious programmes and that test whether such programmes are equally effective in different settings (e.g. in the family setting) are urgently required.

Key words: physical activity; television viewing; screen behaviour; translational research

INTRODUCTION

With increases in the prevalence of paediatric obesity and associated diseases in recent decades (Fagot-Campagna *et al.*, 2001; Wang and Lobstein, 2006), there has never been a more

urgent need for evidence of effective and efficacious strategies to promote relevant health behaviours among children. High levels of sedentary behaviour (e.g. television viewing, computer use, time spent in sitting) and low levels of physical activity are likely to be major contributors to the

obesity epidemic (Amisola and Jacobson, 2003; Biddle *et al.*, 2004).

Reviews of the intervention literature suggest that there are efficacious strategies for promoting physical activity and reducing sedentary behaviour in children. A narrative review of the efficacy of strategies promoting physical activity among young people identified 76 intervention studies (57 delivered in the school setting, 9 delivered in the family setting and 10 delivered in the primary care/community setting), 40 of which reported some positive effects on physical activity (Salmon *et al.*, 2007). A review of studies examining the efficacy of reducing children's sedentary behaviour found six studies implemented in the clinical care setting and six studies conducted in the population setting had some positive effects with most studies targeting reductions in television viewing or time spent in front of small screens (i.e. computers, electronic/video games, television; de Mattia *et al.*, 2007). The majority of these studies have been delivered as randomized controlled trials delivered under ideal conditions, so whether they would be readily translated for implementation in the 'real world' is unknown.

It has been argued that randomized controlled trials (RCTs) 'are applicable to only a minority of health promotion interventions' [(Green and Tones, 1999), p. 135]. It can also be argued that conducting an RCT under 'ideal conditions' is the most appropriate test for the efficacy of strategies to promote positive changes in health behaviour, which should then be followed by implementation or translational research that demonstrates effectiveness in the 'real world' (Woolf, 2008). However, this research sequence is rarely followed.

While the review by Salmon *et al.* (Salmon *et al.*, 2007) found that 10 out of 12 studies that used a curriculum-only approach to promoting physical activity among children and adolescents in the classroom had no or indeterminate effects, recent theoretically framed interventions have shown promise from such approaches. A recent Australian curriculum-based cluster RCT, 'Switch-Play', based on principles of social cognitive theory (Bandura, 1986) and behavioural choice theory (BCT) (Rachlin, 1989) aimed to reduce children's screen-based behaviours, promote physical activity and prevent excess weight gain (Salmon *et al.*, 2005a; Salmon *et al.*, 2008). While 'Switch-Play' found significant effects on children's body

mass index and weight status and also reported positive effects on children's physical activity and enjoyment of physical activity (all of these outcomes were maintained at 12-months follow-up), the intervention was delivered under controlled and ideal conditions [i.e. the entire programme was delivered by one specialist physical education (PE) teacher]. Thus, it is not known whether the 'Switch-Play' intervention would be an effective programme if delivered under 'real-world' conditions by classroom teachers. It is therefore important to examine the effectiveness (i.e. whether the intervention can be successfully delivered in the 'real world') of the intervention when delivered by general classroom teachers with no additional training in PE and health.

This study aimed to examine the effectiveness of a translational intervention study involving an abbreviated cognitive behaviour change programme ('Switch-2-Activity') on children's screen-based behaviours (TV viewing, computer use, playing electronic games) and physical activity. In addition to determining the effect of the intervention on behaviour, recent reviews have argued that targeting and assessing intervention effects on potential mediators of behaviour change is important for increased understanding of mechanisms of change (Lubans *et al.*, 2008; Salmon *et al.*, 2009). Based on findings from the literature (Dishman *et al.*, 2004; Lubans *et al.*, 2008; Salmon *et al.*, 2009), two key constructs from social cognitive theory (SCT) were targeted in this effectiveness trial: behavioural capability (a person's belief that they have the necessary skills to perform a behaviour) and self-efficacy (a person's confidence in their ability to perform a behaviour under adverse conditions).

METHODS

Procedures

Methods and findings of this study are presented in accordance with the CONSORT guidelines for reporting of RCTs (Begg *et al.*, 1996). In 2006, using convenience sampling, schools were recruited from an existing fruit consumption programme ('Fresh Kids') run in 35 schools located in low socioeconomic areas of metropolitan Melbourne, Victoria, Australia. Fifteen schools in the 'Fresh Kids' programme

agreed to participate in the current study (43% school-level response rate). All Grade 5 and 6 (9–12 year old) students ($n = 1566$) in these schools were eligible to participate and were invited to take part in the evaluation of the study. It was estimated that 200 children per group would be sufficient to detect a change in TV viewing of 30 min/week over 3 months with a significance of $\alpha = 0.05$ and power = 80%. Accounting for within-school clustering (sample inflated by 10%), and for loss to follow-up (15%), it was estimated that about 250 children per group would be adequate to detect a change in TV viewing and physical activity. The study was approved by the Deakin University Human Research Ethics Committee, the Department of Education Victoria and the Catholic Education Office. School principals approved the inclusion of the programme into the school curriculum to be delivered to all Grade 5 and 6 classes; however, participation in assessment procedures required active consent from a parent or guardian on behalf of the child (an ethics requirement in Australia). All children, including those who did not return consent forms, were given a small gift (bouncy ball) for participating in the study.

Randomization procedures and study timelines

Using the method of randomly permuted blocks (<http://www.randomization.com>), schools were assigned to either deliver the programme in Term 2 (intervention group; Autumn/Winter) or to a wait-list control group (to be delivered after Term 2 at the teachers' discretion). Baseline data collection occurred in the first 2 weeks in April 2006, teachers were required to deliver the six lessons over the following 7 weeks, and post-intervention data collection occurred in the last 2 weeks of June 2006, immediately following intervention delivery.

Intervention

The intervention 'Switch-2-Activity' was based on the behavioural modification arm of the 'Switch-Play' intervention (Salmon *et al.*, 2008). As the mastery of fundamental motor skills component of the 'Switch-Play' programme was based on an existing resource, which is available for all primary school teachers in Victoria, Australia (Department of Education Victoria, 1996), it was considered more pertinent to assess the novel behavioural modification components. Out of the original 19-lesson programme, six sessions were selected based on the results of the process evaluation (Salmon *et al.*, 2005a). The programme targeted changes in screen behaviours and physical activity directly, as well as through potential mediators of change.

The six lessons utilized behaviour change strategies such as self-monitoring, behavioural contracting and budgeting of television viewing, and was based on constructs from BCT; Rachlin, 1989) and SCT; Bandura, 1986). Table 1 outlines the six lessons, the construct on which they were based and the strategy employed. These included: (i) introduction to physical activity and health; (ii) patterns of TV viewing and self-monitoring; (iii) selective TV viewing (teaching children to select what programme they want to watch, and switching off after the completion of that programme) and behavioural contracting where children nominate one programme to switch off per week until they switch off four programmes and sign a contract to commit to this; (iv) decision-making and behavioural contracting (switch off two programmes that week); (v) identifying alternative activities and development of 'Switch-2-Activity' games and behavioural contracting (switch off three programmes that week); and (vi) walking (using one pedometer provided to each class) and 'Switch-2-Activity' games and activities developed by the children

Table 1: Intervention components

Lesson	Construct	Strategy
Introduction to physical activity and health	Knowledge	Education and awareness-raising
Patterns of TV viewing	Knowledge	Awareness-raising and self-monitoring
Selective TV viewing	Behavioural capability	Behavioural contracting ^a
Decision-making skills	Behavioural choices	Intelligent viewing
Identifying alternative activities	Skill building	Active alternatives when switching off
Switch-2-Activity games and pedometer	Social support	Team-based games and activities

^aBehavioural contracting continued in lessons 4, 5 and 6, with the number of shows to be switched off increasing each week.

and behavioural contracting (switch off four television programmes that week). After the initial lesson, the beginning of each subsequent lesson involved a summary and brief discussion of what was learnt in the previous lesson. In order to examine the 'real-world' application of the 'Switch-2-Activity' programme, lesson plans were provided in a folder that also contained the pedometer to classroom teachers who had received no additional training on delivery of the programme. Teachers were requested to incorporate these lessons as part of the school curriculum.

Measures

Children completed a self-report survey, administered by the classroom teacher at baseline and post-intervention examining their demographics, screen-based behaviour, physical activity and potential mediators of change, including self-efficacy for reducing TV viewing and increasing physical activity, and behavioural capability (TV viewing styles).

Demographic characteristics

Children reported their sex, age, teacher's name, school grade and school.

Self-reported screen-based behaviours

Using a valid and reliable instrument children reported the usual time (h/min) on Monday to Friday and Saturday and Sunday spent watching TV, playing electronic games and using the computer (Salmon et al., 2005b). Each of these variables were summed across weekdays and divided by five to calculate average minutes per weekday, were summed for weekend days and divided by two to calculate average minutes per weekend day, and were summed across seven days to calculate average minutes per day. Screen time per weekday, weekend day and per day was calculated by summing time spent in watching TV, electronic games and computer use. As previously reported, all of these items showed test-retest intra-class correlations ≥ 0.6 and acceptable convergent validity compared with parental proxy report (Salmon et al., 2005b).

Self-reported physical activity

Children reported the usual time on Monday to Friday and Saturday and Sunday in 30 different

physical activities in a typical week (e.g. basketball, netball, swimming, walking to school, riding a bicycle) using a previously validated and reliability tested survey (Telford et al., 2004). Each of these variables were summed across weekdays and divided by five to calculate average minutes per weekday, were summed for Saturday and Sunday and divided by two to calculate average minutes per weekend day, and were summed across 7 days to calculate average minutes per day spent in moderate- to vigorous-intensity physical activity (MVPA) using definitions of physical activity intensity as described previously (Telford et al., 2004).

Potential mediators of behaviour change

SCT posits that self-efficacy for behaviour change may be a key potential mediator of intervention success (Dishman et al., 2004; Salmon et al., 2009). Items examining children's self-efficacy for reducing TV viewing were adapted from a previously published questionnaire (Saunders et al., 1997). Children were asked to report ('yes' or 'no') whether they thought they could watch less TV than they currently do in the next month in four different situations: 'I think I could watch less TV even if I have no homework'; '... even if there was nothing else to do'; '... even when I'm missing my favourite show'; and '... even when it's raining'. Positive responses were summed for a TV viewing self-efficacy score (range 0–4; Chronbach's $\alpha = 0.68$). Self-efficacy for increasing physical activity was also examined. This was determined by summing positive responses to four questions: 'I think I could do physical activity no matter how busy my days are'; '... no matter how tired I feel'; '... even if it's hot or cold outside'; and '... even if I have a lot of homework' (range 0–4; Chronbach's $\alpha = 0.45$).

Behavioural capability from SCT can be defined as having the knowledge and skills to perform a behaviour (Glanz et al., 2002) and has also been suggested as a potential mediator of behaviour change (Salmon et al., 2009). Based on a previously published scale (Salmon et al., 2006), behavioural capability was operationalized as TV viewing styles. Children responded to seven questions, including 'When the show I wanted to watch is finished I turn the TV off and go do something else'; 'Before I switch on the TV I find out what's on by

looking in the TV guide'; and 'I sit and watch TV no matter what is on', with response options on a four-point scale (4 = always, 3 = most of the time, 2 = sometimes, 1 = never). These scores were summed to indicate overall TV viewing style (range 7–28; Chronbach's alpha = 0.64).

Process evaluation measures

Teachers from the intervention schools who delivered the intervention materials participated in one-on-one interviews at the end of the study that explored whether they delivered all aspects of the 'Switch-2-Activity' programme; which lessons and why (or why not); the comprehensiveness and ability of the lessons to engage the children; whether programme taught the children something new that is not currently covered in the school curriculum; potential improvements to the programme and if they thought all children should receive this programme or elements of this programme. Children in the intervention schools completed additional survey questions regarding their knowledge about and enjoyment of the programme, and any changes they had made as a result of the 'Switch-2-Activity' lessons. Children also reported if they had difficulties in switching off and replacing their TV viewing with other pastimes, and social support for switching off.

Statistical analyses

All analyses were performed using Stata Version 10. Differences between intervention and control groups were assessed at baseline and post-intervention using independent *t*-tests. Generalized estimating equations (GEE), also known as population-averaged panel-data models, were used to analyse the effects of the intervention. GEE provides a method of analysing correlated data, where participants are measured at baseline and post-intervention; and can account for clustered data, where participants share a common characteristic, such as belonging to the same school class (Liang and Zeger, 1986). In addition, GEE can accommodate missing data, assuming that they are randomly missing.

The outcome data for time spent in TV viewing, computer use, electronic games, screen time and MVPA were skewed and were square root transformed prior to analyses. The xtgee

function was employed adjusting for group \times time interactions, baseline variables and clustering by school (the unit of randomization). To assess the effectiveness of the intervention, only children whose teachers delivered at least four of the six lessons were included in analyses ($n = 309$ out of 436; 71%) and compared with children in the control group ($n = 472$). To inform the magnitude of the intervention, the biased corrected (Hedges) effect size was assessed as the standardized difference between the two group means (Cohen, 1988). To test if sex-moderated intervention effects, sex \times group interactions were analysed for each of the outcome variables. Where sex was found to moderate the effects of the intervention, the sample was stratified and analyses were performed separately for boys and girls.

RESULTS

Profile of participants

Informed consent was received from 1048 children (67% response rate). Flow of participants through all stages of the study is presented in Figure 1. Data were unavailable (some children left the school) or incomplete (child away on the day) for 91 children, resulting in a final baseline sample size of 957 (42% boys), aged 10.3 (SD = 0.62) years (range 9–12 years). Attrition at the follow-up assessment was low (6%), with data from 908 children available at follow-up.

Table 2 shows descriptive baseline and post-intervention data (raw means) by intervention and control group. At baseline, independent *t*-tests showed that intervention group children spent significantly more time using the computer on weekdays than those in the control group; however, this finding was reversed for time spent using the computer on weekend days. At post-intervention, independent *t*-tests found that the intervention group children spent less time watching TV on weekend days and using the computer on weekdays, reported higher self-efficacy for reducing TV viewing, higher self-efficacy for physical activity and higher scores for TV viewing styles compared with children in the control group. Differences between intervention and control groups at baseline were controlled for with the additional inclusion of baseline data in all GEE analyses.

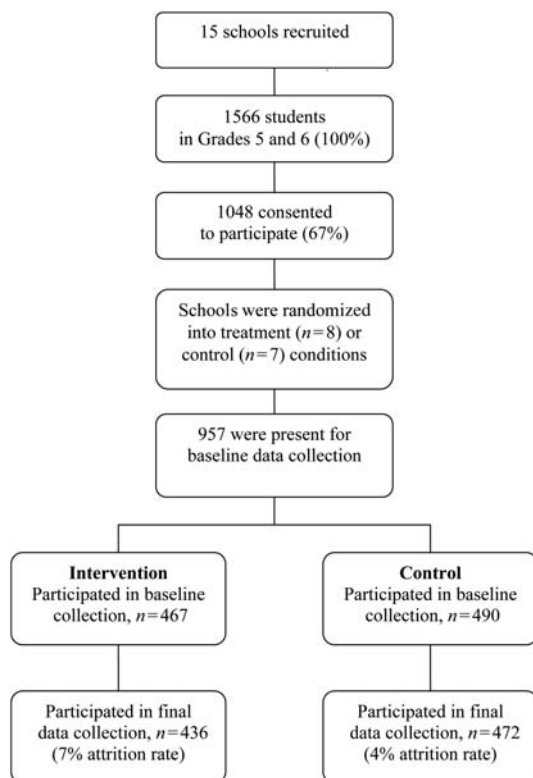


Fig. 1: Flow of participants through each stage of the intervention.

Screen-based behaviours

There were no significant intervention effects on TV viewing, computer use, electronic games use or overall screen time for the sample as a whole (Table 3). However, sex was a significant moderator of the intervention on screen time, so analyses were stratified by that variable. Among boys, there were favourable intervention effects on weekend screen time [coefficient = -0.62 , 95% confidence intervals (CI): -1.15 , -0.10 , $p = 0.020$; Cohen's $d = 0.2$], which is approximately 20-min difference in change scores over time between intervention and control groups. However, there were no significant intervention effects on screen time among girls.

Physical activity

Between baseline and post-intervention, there were no significant intervention effects on time spent in self-reported MVPA among children in the intervention group compared with those in the control group. Nor were there any significant interactions by sex.

Physical activity and TV viewing self-efficacy

The intervention had significant effects on self-efficacy for reducing TV viewing with the

Table 2: Mean values for outcome variables by group at baseline and post-intervention

	Pre		Post	
	Control	Intervention	Control	Intervention
TV viewing (min/weekday) (mean, SD)	89.8 (83.2)	86.2 (82.0)	92.7 (96.4)	92.1 (90.4)
TV viewing (min/weekend day) (mean, SD)	127.5 (113.0)	131.2 (132.8)	134.0 (139.1)	120.2 (155.8)*
TV viewing (min/day) (mean, SD)	97.5 (78.4)	100.6 (84.4)	105.8 (99.3)	101.2 (99.3)
Computer use (min/weekday) (mean, SD)	20.8 (32.4)	24.0 (45.0)*	30.2 (53.6)	24.3 (43.9)*
Computer use (min/weekend day) (mean, SD)	43.1 (64.8)	33.8 (54.6)*	46.6 (82.1)	46.6 (85.6)
Computer use (min/day) (mean, SD)	26.8 (37.0)	24.7 (37.1)	34.6 (57.1)	31.0 (53.2)
Electronic games use (min/weekday) (mean, SD)	24.7 (37.2)	21.1 (32.8)	31.8 (56.1)	28.0 (60.2)
Electronic games use (min/weekend day) (mean, SD)	55.5 (78.8)	51.9 (89.3)	60.7 (97.6)	50.3 (104.3)
Electronic games use (min/day) (mean, SD)	33.7 (45.1)	28.6 (42.5)	39.8 (62.1)	34.1 (66.7)
Screen-based entertainment ^a (min/weekday) (mean, SD)	138.1 (112.2)	130.9 (112.9)	156.5 (152.9)	143.2 (141.9)
Screen-based entertainment ^a (min/weekend day) (mean, SD)	232.3 (186.5)	214.4 (193.2)	249.1 (236.1)	212.9 (247.1)
Screen-based entertainment ^a (min/day) (mean, SD)	159.4 (116.0)	152.3 (115.6)	187.0 (163.3)	166.6 (162.1)
MVPA (min/weekday) (mean, SD)	125.0 (99.6)	125.8 (93.5)	130.3 (123.8)	142.1 (112.3)
MVPA (min/weekend day) (mean, SD)	118.8 (138.8)	123.8 (123.5)	112.6 (161.2)	127.3 (158.5)
MVPA (min/day) (mean, SD)	122.8 (101.2)	124.7 (90.4)	125.0 (120.4)	137.6 (111.1)
Physical activity self-efficacy score (0–4) (mean, SD)	2.5 (1.1)	2.5 (1.2)	2.4 (1.3)	2.5 (1.1) [#]
TV viewing self-efficacy score (0–4) (mean, SD)	1.9 (1.4)	2.4 (1.4)	2.0 (1.5)	2.7 (1.3)*
TV viewing style (7–28) (mean, SD)	19.1 (3.3)	19.8 (3.1)	19.2 (3.8)	20.1 (3.2)**

^aSum of TV viewing time, computer use and electronic games.

* $p < 0.05$, ** $p < 0.01$, [#] $p < 0.001$ independent t -tests assessing differences between groups at baseline and post-intervention.

Table 3: Intervention effects^a (coefficient, CI) on screen time, physical activity (MVPA), self-efficacy and TV viewing styles

	Coefficient (95% CI)
TV viewing (min/weekday)	-0.08 (-0.35, 0.18)
TV viewing (min/weekend day)	-0.12 (-0.50, 0.26)
TV viewing (min/day)	-0.02 (-0.27, 0.24)
Computer use (min/weekday)	0.03 (-0.06, 0.12)
Computer use (min/weekend day)	-0.14 (-0.37, 0.08)
Computer use (min/day)	-0.03 (-0.12, 0.06)
Electronic games use (min/weekday)	-0.12 (-0.25, 0.02)
Electronic games use (min/weekend day)	-0.17 (-0.39, 0.05)
Electronic games use (min/day)	-0.11 (-0.25, 0.03)
Screen-based entertainment ^b (min/weekday)	-0.10 (-0.31, 0.12)
Screen-based entertainment ^b (min/weekend day)	-0.24 (-0.60, 0.12)
Screen-based entertainment ^b (min/day)	-0.08 (-0.27, 0.12)
MVPA (min/weekday)	0.02 (-0.19, 0.24)
MVPA (min/weekend day)	0.12 (-0.23, 0.48)
MVPA (min/day)	0.03 (-0.19, 0.26)
Physical activity self-efficacy score (0-4)	-0.01 (-0.07, 0.06)
TV viewing self-efficacy score (0-4)	0.10 (0.02, 0.19)*
TV viewing style ^c (7-28)	0.12 (0.02, 0.22)*

^aGEE coefficient pre- and post-intervention, adjusted for clustering by school class and baseline values. Coefficient based on transformed data for TV viewing, computer use, electronic games, screen-based behaviour and MVPA time.

^bIncludes the sum of time spent in TV viewing, computer use and electronic games.

^cThe higher the score indicates a favourable TV viewing style.

* $p < 0.05$.

children in the intervention group reporting higher average change scores compared with children in the control group (Table 2). The effect size was moderate (Cohen's $d = 0.5$). There were significant sex \times group interactions for TV viewing self-efficacy. When data were re-analysed stratified by sex, there were significant positive effects on self-efficacy for reducing TV viewing for those in the intervention compared with the control group among boys (coefficient = 0.11, 95% CI: 0.03, 0.20, $p = 0.011$; Cohen's $d = 0.4$) and also among girls (coefficient = 0.13, 95% CI: 0.01, 0.25, $p = 0.033$; Cohen's $d = 0.4$). However, there were no significant intervention effects on physical activity self-efficacy.

Behavioural capability

There were significant positive intervention effects on behavioural capability (operationalized as TV viewing styles) with children in the intervention group registering a higher behavioural capability score over time compared with children in the control group (Table 2). The effect size was small (Cohen's $d = 0.3$). Sex of the child moderated the intervention effects on behavioural capability. After stratifying by sex, these effects were significant among girls only (coefficient = 0.19, 95% CI: 0.04, 0.35, $p = 0.016$; Cohen's $d = 0.3$).

Process evaluation

In addition to examining the effectiveness of the 'Switch-2-Activity' intervention, the fidelity and feasibility was also explored. In this research-to-practice trial, teachers were provided with the intervention materials but no additional training was offered.

Teachers' delivery and perceptions of the intervention

There were 33 teachers from the 8 intervention schools, 22 of the teachers consented to be interviewed. Seventy-one per cent of teachers delivered at least four of the six lessons. In qualitative interviews after the post-intervention data were collected, most teachers reported that the materials were easy to follow and deliver; however, many teachers reported modifying the materials in some way. For example, one teacher added a 30-min walk with a family member to the programme and both child and family member had to write their reflections on the walk. In addition to the survey, the teachers suggested that children could complete a diary as a reference to monitor their changes in behaviour from the beginning to the end of the programme. The pedometer lesson was considered to be most popular among the students. Most teachers reported that they did not have enough time to deliver all lessons and suggested integrating the programme into the existing curriculum. For example, some teachers integrated scenarios and role playing into the drama curriculum, and integrated counting steps and pedometers into math lessons. Also, they thought the programme could complement other health-related projects that were state

based or other curriculum initiatives (e.g. life education).

Some teachers also modified the switch-off contracts. For example, in the first week of the switch-off challenge, one teacher asked children to switch off two shows over the weekend and a further two shows the following week, effectively halving the duration of the switch-off component from 2 weeks to 2, but still reducing the same amount of TV viewing as children who completed the switch-off over 4 weeks. Several teachers asked children who did not watch much TV to switch off computer games. Furthermore, teachers noticed that some children replaced their TV viewing with electronic games, even though they were encouraged in the lessons not to.

Teachers recommended a stronger emphasis on reducing overall sedentary behaviour instead of only reducing television viewing and to reinforce exchanging sedentary behaviours with physical activities. The timing of the switch-off was also important; children had difficulties with being active if they elected to switch off a television programme during the evening when it was dark. Teachers suggested, therefore, discussing alternative physical activities earlier in the intervention programme, or encouraging children to switch off during daylight hours. Teachers felt that the contract and the decision-making activities gave the children more independence.

Children's awareness and perceptions of the intervention

Four-hundred and twenty-nine children from the intervention group responded to the process evaluation questions. Approximately 80% of children reported enjoying the programme, and over 70% felt that the programme had made a difference to their TV viewing. Approximately half of the sample thought that it was easy or very easy to find something else to do when they switched off, with over 60% of children suggesting no one helped them to switch off.

DISCUSSION

Translational research that assesses the effectiveness of strategies to promote health behaviours among children that have been previously tested under 'ideal' conditions is rarely reported. Based on the behavioural modification component from

the 'Switch-Play' intervention, this study aimed to examine the effectiveness of an abbreviated cognitive behavioural programme delivered by teachers targeting children's sedentary behaviour, physical activity and potential mediators of behaviour change. While this brief intervention did not result in changes in children's behaviour (apart from intervention boys reporting less screen time on weekend days compared with boys in the wait-list control group), there were significant positive effects on children's self-efficacy for reducing TV viewing and on children's behavioural capability (TV viewing style). Previous studies have found these constructs from SCT to be important potential mediators of change in children's physical activity (Lubans *et al.*, 2008; Salmon *et al.*, 2009); however, to our knowledge this is the first study to report intervention effects on these constructs for reducing TV viewing among children.

There may be several reasons why this intervention had lower impact than the original Switch-Play study: Switch-2-Activity involved an abbreviated programme; therefore, the intervention 'dose' was lower; the 'Hawthorne' effect may be less likely as the programme was delivered by regular class teachers rather than by a specialist university research team; the programme may have had a larger effect if the classroom teachers were trained; and the measures used to assess behavioural outcomes were self-reported rather than objective. While it may not be expected that short-term educational strategies would result in significant changes in children's behaviour (Salmon *et al.*, 2007), it would be feasible to expect shifts in potential mediators of behaviour change.

Boys in the intervention group reported a difference of approximately 20 min in weekend screen time compared with boys in the control group. Although this was a small effect, previous interventions targeting these behaviours have reported success in reducing the time children spend in screen-based behaviours (de Mattia *et al.*, 2007). Also consistent with previous interventions (Gortmaker *et al.*, 1999; Robinson, 1999), the current study found no significant effects on physical activity among boys or girls. This is in contrast to the group RCT 'Switch-Play' that reported significant intervention effects on children's physical activity (Salmon *et al.*, 2008). Although 'Switch-2-Activity' was a derivative of the 'Switch-Play' programme, not all aspects of that latter study

were incorporated in the present intervention (i.e. the fundamental motor skill programme was excluded), and the focus of the intervention materials in 'Switch-2-Activity' was primarily on reducing screen time. This suggests that brief curriculum-based programmes are unlikely to have significant effects on children's physical activity, which is consistent with previous reviews of the literature (Salmon *et al.*, 2007). However, based on the process evaluation and changes in mediators of children's TV viewing the translation of the intervention into practice could be deemed as successful.

At the end of the six-lesson programme, children in the intervention group reported significantly higher TV viewing self-efficacy scores and significantly improved behavioural capability (TV viewing styles) compared with control children. While physical activity self-efficacy has been frequently studied, fewer interventions have targeted children's self-efficacy for reducing TV viewing, which aims to increase children's confidence that they can watch less TV under challenging circumstances (e.g. even if it is raining or when they have no homework). In addition, based on the BCT, the intervention took children through decision-making scenarios where alternative activities could be undertaken if the weather was inclement for example. Behavioural capability has not been as frequently targeted as self-efficacy. While these constructs might appear similar, the former emphasizes children's knowledge and skills when performing a particular behaviour. Teaching children how to be effective or 'intelligent' TV viewers, that is increasing skills such as selective viewing or reducing 'channel surfing' are TV viewing skills that children are not often taught. These findings imply that even with a short-term programme, it is possible to achieve some positive effects on potential mediators of behaviour change.

It has been argued that for interventions to succeed the most effective strategies target changes in theoretical constructs (mediators) that are important for behaviour change such as behavioural processes and self-efficacy (Baranowski *et al.*, 1998). The findings from the current study suggest that although the intervention was effective in improving children's behavioural capability and self-efficacy for reducing their TV viewing this did not result in a shift in behaviour. It may be that these theoretical constructs do not lie on the intervening pathway between the intervention and behavioural outcome, or it may be

that there are particular conditions (such as the intervention dose or duration which was reduced from 19 to 6 lessons) that are required in order to effect behaviour change. Previous reviews have reported self-efficacy to be an important mediating variable in physical activity interventions with adolescents (Salmon *et al.*, 2009; Lubans *et al.*, 2008); however, few studies, including the present one, have examined mediating pathways statistically in physical activity interventions with children. It is not only important that interventions use theory to implement and evaluate programme, it is also critical that interventions are used to test theories (Rothman, 2004).

Process evaluation data revealed that most of the teachers delivered nearly all of the lessons. However, many teachers modified the materials and incorporated the lessons into other aspects of the curriculum. This is likely to be due to the lack of additional training for teachers to supplement the intervention materials, and several teachers commented in the process evaluation that they integrated some of the programme materials due to the challenges of fitting extra lessons into the already-crowded school curriculum. Despite these modifications, improvements in boys' self-reported sedentary behaviour and in potential mediators of behaviour change among boys and girls were demonstrated. Modifications and adaptations of intervention materials are very likely common practice when a scientifically designed and tested programme is disseminated to teachers or health professionals. This highlights the importance of translational research (Woolf, 2008), although further studies are needed to test this translational research model with larger-scale programmes, particularly those aiming to achieve changes in health outcomes such as weight gain prevention trials.

The use of self-report measures of sedentary behaviour and physical activity and the associated recall biases is a limitation of this study. Further, the psychometric properties of some items (e.g. self-efficacy for physical activity) were less than ideal; although valid and reliable instruments were used to measure both behaviours in an attempt to limit measurement error. The small number of potential mediators of behaviour change that were assessed may also be a limitation. Strengths of the study included the large sample size, which increases the likelihood of having adequate power to detect intervention effects, the intervention was delivered to children attending schools in low

socioeconomic areas, and the relatively high response rate within schools.

In medicine, translational research is defined as the conversion of basic research to application at the clinical level (Zerhouni, 2003). In public health, it may refer to the translation of applied research findings to policy, practice or use in the community (Woolf, 2008; Ogilvie et al., 2009). We were unable to identify any studies that have examined the translation of an intervention from an efficacy to an effectiveness trial in children's physical activity and sedentary behaviour. The current study suggests that teachers are able to deliver a curriculum-based programme that had short-term effects on self-efficacy and behavioural capability that may lie on the mediating pathway of behaviour change among children. Future studies that assess the translation of more comprehensive programmes are needed, and testing whether such programmes are equally effective in different settings (e.g. in the family setting) is also urgently required.

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