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To cite this article: Mai O'Leary, Elaine Rush, Seán Lacey, Con Burns & Tara Coppinger (2019): Project Spraoi: two year outcomes of a whole school physical activity and nutrition intervention using the RE-AIM framework, Irish Educational Studies

To link to this article: <https://doi.org/10.1080/03323315.2019.1567368>

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 Published online: 20 Feb 2019.

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Project Spraoi: two year outcomes of a whole school physical activity and nutrition intervention using the RE-AIM framework

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(Received 8 March 2018; accepted 20 December 2018)

We aimed to assess the impact of Project Spraoi: a school-based physical activity (PA) and nutrition intervention that reached 473 primary school children and 43 school staff in Cork (Ireland). Four primary schools (2 intervention, 2 control) with similar characteristics participated and for 2 school years, intervention schools were assigned an 'Energizer', who promoted PA and healthy eating. A subsample of children from the intervention schools ($n = 106$) and matching controls ($n = 125$) had measures of body mass, waist circumference, blood pressure, fitness, nutritional knowledge/attitudes and PA recorded at baseline and after 2 school years. Process evaluation techniques assessed the impact of the intervention on teachers, parents and children. Analysis of covariance revealed the intervention was associated with smaller waist circumference relative to gender and age ($p < 0.0005$), slower resting heart rate ($p = 0.003$) and favourable nutritional attitudes among 10 year olds. No significant change across other variables or among 6 year olds was found. Teachers, parents and children reported positive outcomes for PA behaviour and nutritional knowledge/attitudes. Project Spraoi has shown to improve heart rate and prevent further gains in fat mass amongst older aged children. The positive impact of the intervention supports the need for its continued delivery, particularly as children age.

Keywords: school; interventions; physical activity; nutrition; health

Introduction

The global prevalence of childhood obesity is expected to reach 60 million by 2020 (De Onis, Blössner, and Borghi 2010). Given the wide range of associated health complications (World Health Organisation 2003), the issue is now an accepted public health crisis (Karnik and Kanekar 2012). A global shift in decreased physical activity (PA) and diet towards energy dense foods are recognised as the principal causes of this epidemic (World Health Organisation 2003). Currently, one in four children in Ireland are overweight or obese (Currie et al. 2012); four out of five children do not meet the recommended guideline of 60 min moderate to vigorous PA (MVPA) per day (Woods et al. 2010) and many do not meet the healthy eating recommendations for fruit and vegetables (Currie et al. 2012). These behaviours are

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unlikely to change as children move into adolescence and adulthood (World Health Organisation 2016), therefore prevention and early treatment efforts are crucial (World Health Organisation 2003).

Intervention strategies are being used in an attempt to prevent obesity in children (Bleich et al. 2017). Studies have shown positive outcomes from interventions that target the promotion of both PA and healthy eating (Brown et al. 2016; Wang et al. 2015). Although findings support programmes delivered in the school environment (Bleich et al. 2017), to date, there are no multicomponent interventions being delivered in Ireland that aim to improve both PA and nutritional knowledge and attitudes among children. In New Zealand (NZ), however, one such intervention has been in existence since 2004. 'Project Energize' (www.projectenergize.org.nz) is a fully evaluated school based health promotion intervention (Project Energize, Sport Waikato, and Auckland University of Technology 2015). Positive changes have been reported for fitness, nutritional behaviour and amongst those categorised as overweight and/or obese among children involved in Project Energize (Project Energize, Sport Waikato, and Auckland University of Technology 2015).

In response to the success of this programme, and the need for intervention among Irish children, a school based health promotion programme, based on Project Energize, has been developed. 'Project Spraoi' (www.cit.ie/projectspraoi) aims to promote increased PA, improve nutritional knowledge and attitudes and through the adoption of these behaviours, improve the health of Irish primary school children. Based on Project Energize which utilised the Social Ecological Model of Health Behaviour (Sallis, Owen, and Fisher 2008), Project Spraoi aims to target multiple layers of influence by engaging with the child, their school friends and family, the school and the community, in order to support and promote increased PA and improved nutritional knowledge and attitudes.

The larger Project Spraoi Randomised Control Trial (ISRCTN92611015) was initiated in primary schools in Cork, Ireland, in September 2013 and to date, has involved 11 schools. A team of researchers are conducting distinct research projects in the areas of PA levels, nutritional knowledge and attitudes, dietary intake, sedentary behaviour, fundamental movement skills and qualitative techniques. The current study, while part of the larger RCT, will evaluate the impact of the intervention by describing the 2 year outcomes of PA and nutritional knowledge and attitudes across 2 intervention schools in comparison to 2 control schools in Cork, using the RE-AIM (Reach, Efficacy/Effectiveness, Adoption, Implementation, Maintenance) framework (Glasgow, Vogt, and Boles 1999). The RE-AIM framework is a widely accepted model which frames strategies to design, implement and evaluate interventions in the real world setting. It has been recommended to help researchers direct the process of evaluation (Ng and de Colombani 2015) of: reach, which captures the proportion of the target population who participate in an intervention; effectiveness, which refers to the extent to which the intervention has a positive effect on relevant outcomes; adoption which generally relates to the representativeness of the setting the intervention is conducted in and the agents who initiate the programme; implementation which indicates the extent to which the programme is delivered as intended; and maintenance, which captures the sustainability of an intervention.

Methodology

Study design

Intervention and methodological evaluation material used in Project Energize (NZ) was made available for use in Project Spraoi (Graham et al. 2008). As part of the current study, principals of 8 schools in Cork were contacted in 2013 and a full outline of the study's aim and proposed methods were discussed. Four schools who expressed a willingness to participate in the 'Project Spraoi' initiative, and were not currently participating in another PA and/or healthy eating/nutrition intervention, were recruited using a convenience sampling approach. A more detailed explanation of the study design and inclusion criteria has been published elsewhere (Copping et al. 2016).

Four schools with similar demographic characteristics relating to gender (mixed), school socio-economic status (SES) (low SES and middle/high SES), area of residence (urban/rural), school size (number of pupils) (Keane et al. 2014) and proximity (<20 km) to the research Institute were selected, recruited, matched and randomly assigned as intervention ($n = 2$) or control ($n = 2$). Two schools were purposively selected for evaluation based on low SES classification. Low SES primary schools in Ireland are referred to as DEIS (delivering equality of opportunity in schools) under the Department of Education and Skills school support programme and are classified based on a combination of parent employment status, number receiving free book grants, levels of local authority accommodation, prevalence of lone parents, travellers and large families (Archer and Sofrioniou 2008).

Control schools were given no additional resourcing or information; however, no restrictions were placed on initiatives that they may have pursued themselves throughout the duration of the intervention. At follow up evaluation, a control school staff member was asked to complete an information sheet detailing any initiatives they had engaged in over the duration of the 2 school years. All evaluation measures at baseline (September/October 2013) and follow up (May/June 2015) were undertaken at the same time points in control and intervention schools. Ethical approval was attained from Cork Institute of Technology's Research Ethics Committee in September 2013.

Participants

All children aged 6 years ($N = 125$) and 10 years ($N = 111$) that were attending the four schools at baseline, were invited to participate in the evaluation. These age groups were chosen on the basis that they mark sensitive periods of growth for the child (mid-childhood and early adolescence) (Cameron and Demerath 2002; Graham et al. 2008). Parental consent was provided by 231 (98%) children with 46% allocated to the intervention group (2 schools: 1 rural middle/high SES and 1 urban low SES) and 54% to the control group (2 schools: 1 rural middle/high SES and 1 urban low SES).

Testing measures and protocol

Anthropometric (height, body mass and waist circumference), physiological (blood pressure (BP)), cardiorespiratory fitness (CRF) (time taken to complete a 550 m run) and nutritional knowledge and attitudes (via questionnaire) measures were used to assess the effectiveness of the intervention; adopting the evaluation methods

of 'Project Energize' (Graham et al. 2008). An indoor room within the school was reserved for anthropometric, physiological and nutritional knowledge and attitudes measures. This room was usually a classroom, the hall or the library and an outdoor surface was used for the CRF test measure (grass, artificial turf). Full details of the testing protocol are presented in Supplementary Table 1 and were previously reported (Coppinger et al. 2016). All measures were replicated pre- and post-intervention and were undertaken by a team of 5 researchers trained in child health related data collection.

The nutritional knowledge and attitudes questionnaires were based on the 'National Survey of Children and Young People's Physical Activity and Dietary Behaviours in NZ: 2008/9' (Clinical Trials Research Unit 2010). Six year old participants were asked to rate on a 5 point Likert-type scale whether foods (water, milk, soft drinks, fruit and vegetables, snacks and fast foods) were very healthy to very unhealthy. Ten year old participants completed a separate interviewer-administered questionnaire examining knowledge and attitudes to healthy eating. The attitude item involved asking participants how important healthy eating is using a 4-point Likert scale ranging from caring 'very much' to 'not at all'. The knowledge item was assessed in relation to responses to 2 open ended questions on what it means to eat healthily and the benefits of healthy eating. The responses to these questions were listed but not shown to participants, with interviewers matching responses to a list of predetermined statements.

PA behaviour was objectively measured over 7 days using triaxial accelerometers (Actigraph; model 7164, GT3X and wGT3X+, Fort Walton Beach, FL, USA). Data was collected at 30 Hz / 5 second epochs to minimise error that may occur when longer epochs are used (McClain et al. 2008). A reminder SMS text message was sent to consenting parents/guardians each morning in order to promote wear time adherence (Belton et al. 2013). The minimum wear time criteria was a 600 min/day threshold which has been shown to give adequate reliability and power (Mattocks et al. 2008; Riddoch et al. 2004). Minutes of PA of different intensities was calculated using cut points developed by Evenson et al. 2008 with participants of similar ages (Evenson et al. 2008). Mean daily minutes in MVPA were calculated and adherence to the recommended PA guidelines (Department of Health and Children and Health Services Executive 2009) was based on the proportion of children achieving 60 min of MVPA per day.

Standard deviation scores (SDS) have been recommended when comparing group means and modelling weight over time (Must and Anderson 2006). Therefore, body mass index (BMI) SDS and waist circumference SDS by gender and age were calculated using the British 1990 reference population (Cole, Freeman, and Preece 1995) and McCarthy, Jarrett, and Crawley (2001) waist circumference percentiles (McCarthy, Jarrett, and Crawley 2001), respectively. The British reference values were used due to (i) no Irish reference values, (ii) the proximity of the country with Ireland, and (iii) this approach having previously been used in 'Project Energize', NZ. Blood pressure SDS were computed using Jackson BP centiles (Jackson, Thallange, and Cole 2007). International Obesity Task Force age and gender specific criteria were used to categorise children as thin, normal weight, overweight or obese (Cole and Lobstein 2012).

Intervention components

At study commencement (October 2013), an Energizer was assigned to the intervention schools to assist in the delivery of the project (Rush et al. 2013). A detailed description of the Energizer's recruitment and training is available elsewhere (Coppinger et al. 2016). The Energizer worked with each intervention school to develop a tailored action plan to be delivered over 2 school years, based on the PA and nutritional needs identified by the school. Key elements of the project were the promotion of (i) twenty minutes 'huff and puff' (MVPA) each day in school time, and (ii) healthy eating lessons to improve nutritional knowledge and attitudes. The Energizer provided professional development for school staff by modelling PA and healthy eating sessions, providing staff with resources and assisting in organising and implementing PA and healthy eating related initiatives in the school. For example, the Energizer modelled quick and easy games for teachers to implement across the school day; classroom games for days when children could not go outside due to inclement weather and healthy eating lessons with lesson summary resources for teachers to reiterate healthy eating points with children. Schools were assisted by the Energizer in organising a bike day to promote safe cycling, a pedometer challenge to promote increased steps, a healthy eating day to promote consumption of fruit and vegetables and a parents day to promote PA and healthy eating. The amount of time the Energizer visited the intervention schools varied depending on the schools needs but a maximum of 1.5 days a week was recommended (Coppinger et al. 2016). Strategies to link with parents and the community included parent-teacher activities (parent-teacher meetings and school open nights), educational evenings (healthy eating talks) and cultural/religious school events (Holy Communion and Confirmation). In one such instance, the Energizer helped school children to provide healthy snack recipes and samples to parents at the school parent-teacher meetings. The Energizer also acted as a link between the school and organisations with a PA or nutrition focus e.g. the Local Sports Partnership (LSP) offered a 6 week rock-climbing programme in conjunction with Rockclimbing Ireland. The Energizer created the link between the LSP and the schools and assisted in schools signing up and participating in available programmes. Resource materials such as manuals for class teachers, posters, laminated cards and fridge magnets for children to take home, were made available to schools to reinforce the PA and healthy eating goals and messages of the intervention.

Process evaluation

A process evaluation was used to assess the effectiveness, implementation and adoption of the programme on the teachers, parents and children who received the intervention. The choice of methods followed guidelines set out by the Medical Research Council (Moore et al. 2015) and were influenced by considerations of feasibility, including limitations of available resources and likely respondent burden. Teachers and parents were selected for process evaluation measures by the respective school Principals. At two time points (at the interim and end-point of intervention delivery), participating teachers ($n = 9$) completed a short questionnaire to assess the effectiveness of the intervention. At the end of the 1st year of delivery (June 2014), teachers ($n = 9$) took part in a semi structured interview and the information gathered was used to guide the project implementation for year 2. These interviews were structured

around the programme strengths, weaknesses, opportunities and threats. In addition, a semi structured interview was carried out with teachers ($n = 5$) and with parents ($n = 3$) at the intervention end (June 2015), which consisted of questions that aimed to assess the extent of adoption of the intervention. All interviews were carried out at the schools by the principal investigators (CB, TC) of Project Spraoi, who were not involved in the delivery of the intervention. In addition, participants ($n = 293$) completed a draw and-write task. This was administered in the classroom, by the class teacher, who was provided with instructions by the researcher. A further 8 participants (2 boys and 2 girls from the 6 year old cohort and 2 boys and 2 girls from the 10 year old cohort) were randomly selected to take part in an interview to allow for explanation of their draw and write responses.

Data processing and analysis

Quantitative data were stored and analysed using IBM SPSS (Statistical Package for Social Studies), Version 22. Separate analyses were conducted for 6 and 10 year olds. Data was deemed to fit a normal distribution using the Kolmogorov-Smirnov ($n \geq 100$) or Shapiro-Wilk ($n < 100$) goodness-of-fit tests. Mean and standard deviation scores was calculated for each continuous measure (height, body mass, BMI SDS, waist circumference SDS, BP SDS, resting heart rate, 550 m run times and MVPA). Frequencies were used to summarise categorical variables (BMI and level of attainment of 60 min of MVPA).

Analysis of covariance (ANCOVA) was used to evaluate changes in each age sample-standardised body composition (BMI SDS, waist circumference SDS), physiological scores (BP SDS), cardiorespiratory fitness and MVPA values at 2 years, with adjustment for corresponding baseline values (covariate) and between treatment groups (intervention v control). Data were also examined for interactions by school cluster using a 2 factor nested ANOVA. A binary logistic regression analysis was used to evaluate the effect of treatment group (intervention v control) on categorical variables (BMI and level of attainment of 60 min of MVPA) at 2 years treating school using dummy variable. Questionnaire data (Six questions) for 6 year olds was combined and an accumulated value was calculated based on responses to a Likert-type scale (1 = very unhealthy; 5 = very healthy). For 10 year olds, questionnaire data on participant's attitude was analysed using the McNemar's test to compare the proportion answering 'very much', 'some', 'a little' or 'not at all' on the importance of healthy eating from pre- to post-intervention. Two scores were calculated in relation to 10 year olds knowledge of eating healthily by calculating an accumulated value for each question. These accumulated values were based on the number of listed responses provided (a higher score indicating greater knowledge). Nutritional attitude was then assessed by comparing the change in the proportion of 10 year olds who answered 'very much', 'some', 'a little' or 'not at all' for the importance of healthy eating from pre- to post-intervention and nutritional knowledge was assessed using an ANCOVA to detect the change in accumulated values for each age group at 2 years, with adjustment for corresponding baseline values (covariate) and between treatment group (intervention v control). All statistical testing were performed using 5% level of significance and effect size was presented using partial eta squared.

All interview data was audio recorded, transmitted to computer and transcribed verbatim. An inductive approach (Thomas 2006) was used for analysing process

evaluation data. After reviewing the transcripts, using content analysis, direct quotations were extracted to highlight themes which were then categorised into the effectiveness, adoption and implementation components of the RE-AIM framework (Wozniak et al. 2012). Data from drawings was inductively analysed (Thomas 2006) by identifying images and children's narratives for PA and healthy eating related activities.

A total of 7 participants had left their school at the time of follow-up evaluation, resulting in 224 (97%) children being measured 2 school years later (May/June 2015). A total of 28 values were missing for BP measurements due to values falling outside the testing protocol (Coppinger et al. 2016) on 2 or more occasions ($n = 23$ at baseline and $n = 5$ at follow up). Missing values ($n = 26$) for the 550 m run test were due to: (i) children being absent on both the days of testing and a subsequent call back day ($n = 12$ at baseline and $n = 2$ at follow up); (ii) dropping out/unable to complete the test ($n = 6$ at baseline and $n = 1$ at follow up); (iii) a physical disability ($n = 2$ at baseline and $n = 2$ at follow up) or (iv) an injury ($n = 1$ at follow up). At baseline, a total of 87 (73%) 6 year old children and 95 (86%) 10 year old children achieved the minimum wear time criteria for accelerometer data analysis (Riddoch et al. 2004). At follow up, 72 (60%) of 6 year olds and 83 (75%) of 10 year olds met the minimum wear time criteria.

Results

Reach

The intervention was delivered to all (100%) children ($N = 473$) and reached all school staff ($N = 43$) in the 2 intervention schools, over 2 school years. A subsample of 106 6 and 10 year old children from the intervention schools and a matching subsample of children ($n = 125$) from the control schools were invited to participate in the evaluation.

Effectiveness

The effectiveness of the intervention was assessed based on any change in participants' selected health measures and nutritional knowledge and attitudes, as well as teacher responses to questionnaire and from interviews.

Waist circumference and blood pressure

Among 10 year old participants, the intervention was associated with more favourable outcomes for waist circumference SDS (-0.39 , 95% CI -0.60 , -0.19 , $p < 0.0005$), (intervention – control) and heart rate (-5.8 , 95% CI -9.7 , -2.0 , $p = 0.003$), (intervention – control) (Table 1). These findings remained statistically significant when adjusted for by school (waist circumference SDS $p < 0.0005$; heart rate $p = 0.002$). A slower gain (statistically insignificant) in SBP SDS was found among 10 year olds in the intervention group, which was found to be statistically significant when adjusted for by school factor ($p = 0.021$).

Among 6 year olds, there was a statistically significant difference between groups for waist circumference SDS (0.27, 95% CI 0.03, 0.52, $p = 0.028$), (intervention – control); with more favourable results (slower gain in waist circumference) in the control group (Table 2). When adjusted by school, this finding remained statistically significant ($p = 0.017$). Similar to older children, a slower gain (statistically

Table 1. Changes in health measures among 10 year old intervention relative to control participants over 2 school years.

	Intervention		Control		Effect of Intervention					
	<i>n</i>	2 year adjusted mean change ^c	<i>n</i>	2 year adjusted mean change ^c	(Intervention v's control)	95% CI	<i>P</i> ^a	η_p^2	<i>P</i> ^b	η_p^2
BMI SDS	46	0.48	63	0.52	-0.04	-0.20, 0.12	0.639	0.002	0.275	0.011
Waist C SDS	46	0.74	63	1.13	-0.39	-0.60, -0.19	<0.0005	0.124	<0.0005	0.123
Systolic BP SDS	42	-0.90	58	-0.59	0.34	-0.76, 0.76	0.172	0.019	0.021	0.055
Diastolic BP SDS	42	0.59	58	0.43	0.16	-0.24, 0.56	0.437	0.006	0.707	0.001
Heart Rate (bpm)	42	73.1	58	79.0	-5.8	-9.7, -2.0	0.003	0.087	0.002	0.094
Run Time (secs)	42	161.8	54	163.2	-1.4	-6.8, 4.0	0.605	0.003	0.591	0.003
MVPA (minutes)	29	66.3	45	70.1	-3.8	-12.2, 4.7	0.379	0.011	0.371	0.012

^a*P* value for difference between groups at 2 years analysed by a one way ANCOVA adjusted for baseline measure.

^b*P* value corrected for the clustering of children by school.

^cAdjusted for baseline measure mean at 2 years.

Table 2. Changes in health measures among 6 year old intervention relative to control participants over 2 school years.

	Intervention		Control		Effect of Intervention (Intervention v's control)	95% CI	P^a	η_p^2	P^b	η_p^2
	n	2 year adjusted mean change ^c	n	2 year adjusted mean change ^c						
BMI SDS	57	0.58	58	0.50	0.08	-0.07, 0.22	0.282	0.010	0.220	0.014
Waist C. SDS	57	0.85	58	0.58	0.27	0.03, 0.52	0.028	0.042	0.017	0.051
Systolic BP SDS	43	-0.61	52	-0.95	0.34	-0.07, 0.75	0.103	0.029	0.048	0.043
Diastolic BP SDS	43	0.20	52	-0.02	0.23	-0.11, 0.56	0.187	0.019	0.153	0.023
Heart Rate (bpm)	43	85.5	51	84.8	0.7	-2.8, 4.1	0.700	0.002	0.844	0.000
Run Time (secs)	50	198.9	48	200.0	-1.1	-10.3, 8.1	0.812	0.001	0.332	0.010
MVPA (mins)	34	71.9	32	76.6	-4.7	-14.1, 4.8	0.328	0.015	0.249	0.022

^a P value for difference between groups at 2 years analysed by a one way ANCOVA adjusted for baseline measure.

^b P value corrected for the clustering of children by school.

^cAdjusted for baseline measure mean at 2 years.

insignificant) in SBP SDS was found among 6 year olds in the intervention group ($p = 0.103$), which was found to be significant when adjusted for by school ($p = 0.048$).

Cardiorespiratory fitness and MVPA levels

For the 550 m run, the intervention group had a more favourable, but not statistically significant, effect relative to the control group; with 6 year olds and 10 year olds in the intervention group 1.1 seconds ($p = 0.812$) and 1.4 seconds faster ($p = 0.605$), respectively. For MVPA, the control group had a higher adjusted mean change (not statistically significant) at follow-up than the intervention group across both 6 year olds (76.6 min versus 71.9 min, $p = 0.328$) and 10 year olds (70.1 min versus 66.3 min, $p = 0.379$).

BMI and PA categories

There were no statistically significant changes in BMI categories for both age cohorts and groups at 2 years (Table 3). The percentage of participants achieving the 60 min MVPA guideline (Department of Health and Children and Health Services Executive 2009) increased significantly for both age cohorts and groups over the intervention period, with the exception of the 6 year old intervention group (53.5–62.2%), (Table 3) but no statistically significant change was found.

Nutritional knowledge and attitudes questionnaires

For accumulated nutritional knowledge and attitudes scores, 6 year olds in the intervention group had a more favourable but not statistically significant, effect relative to the control; with 6 year olds in the intervention improving their accumulated score by 0.44 (Table 4). There was no significant change in the proportion of 10 year olds who cared 'very much' for the importance of healthy eating for both groups from pre- to post-evaluation (Table 5). Among 10 year olds there was a statistically significant difference in accumulated nutritional knowledge scores on what it means to eat healthily (-0.63 , 95% CI $-1.04, -0.21$, $p = 0.003$); with more favourable results in the control group (Table 6). While for accumulated nutritional knowledge scores on the benefits of healthy eating, 10 year olds in the intervention group had a higher adjusted mean change at follow-up than the control (2.18 versus 2.04) (Table 6).

Results from process evaluation: teacher questionnaires and interviews

At the interim and end-point of intervention delivery, a selection of teachers ($n = 9$) from the intervention schools completed a brief questionnaire. At both time points, 100% of teachers either strongly agreed (67% at time 1, versus 78% at time 2) or agreed (33% at time 1, versus 22% at time 2) that Project Spraoi was having a positive impact on children's PA levels and nutritional knowledge and attitudes during school hours. This was in agreement with interview data, where teachers stated that the 'fitness of the children has improved', 'children are fitter, especially the older children' and 'nutrition lessons are getting through to the kids'.

Table 3. Difference in health categories among 6 and 10 year old between intervention and control participants over 2 school years.

Pre	6 year olds							10 year olds								
	n	Control			Intervention			n	Control		Intervention		n	Intervention		
		n	Post	P	P	Pre	Post		Pre	P ^a	P ^b	Pre		Post	Pre	Post
% Overweight/obese	57	20.7	22.8	58	25.8	17.2	0.165	0.426	46	25.1	19.6	63	25.4	27.0	0.156	0.316
% Not overweight/obese		79.3	77.2		74.2	82.8				74.9	80.4		74.6	73.0		
% Achieving PA guidelines	34	53.5	62.2	32	45.5	79.4	0.070	0.086	29	37.5	62.5	45	34.5	58.8	0.566	0.959
% Not achieving PA guidelines		46.5	37.8		54.5	20.6				62.5	37.5		65.5	41.2		

^aP values for effect of treatment group on categorical variables at 2 years using binary logistic regression.

^bP values for effect of treatment group on categorical variables at 2 years treating school as dummy variable using binary logistic regression.

Table 4. Changes in nutrition knowledge and attitudes among 6 year old intervention relative to control participants over 2 school years.

	Intervention		Control		Effect of Intervention (Intervention v's control)	95% CI	P ^a	η_p^2	P ^b	η_p^2
	n	2 year adjusted mean change ^c	n	2 year adjusted mean change ^c						
Accumulated Knowledge & Attitudes Score:	57	26.7	57	26.2	0.44	-0.24,1.11	0.206	0.014	0.626	0.304

^aP value for difference between groups at 2 years analysed by a one way ANCOVA adjusted for baseline measure.

^bP value corrected for the clustering of children by school.

^cAdjusted for baseline measure mean at 2 years.

Table 5. Change in nutrition attitude among 10 year old intervention and control participants over 2 school years.

How important do you think healthy eating is:	Intervention				Control			
	<i>n</i>	Pre %	Post %	<i>P</i> ^a	<i>n</i>	Pre %	Post %	<i>P</i> ^b
Very much	46	95.7	95.7	1.000	62	98.4	95.2	0.625
Some		4.3	4.3			1.6	4.8	

^a*P* values for difference in nutritional attitudes categories among intervention participants between baseline and 2-year follow up using Mc Nemar change test.

^b*P* values for difference in nutritional attitudes categories among control participants between baseline and 2-year follow up using Mc Nemar change test.

Adoption

Programme adoption related to how the intervention resulted in changes of behaviour among children and teachers. This was assessed using data from the semi structured interviews with teachers at the end of year 1 ($n = 9$), at the end-point of the intervention ($n = 5$) and with parents at the end-point of the intervention ($n = 3$). This was undertaken in conjunction with data obtained from interviews with children ($n = 8$), following on from the draw and-write task at the end-point of the intervention.

The following comments by teachers identified the extent that the intervention components resulted in change to children's behaviour:

- After the cycle race last summer ... now kids are cycling to school.
- They're after bringing in healthier lunches, they know exactly what's good and what's bad for them.
- Children are asking can we go outside for 10 min for fitness.
- The children have a different mind-set ... for example, 1 child won't have a sugary drink now but will ask their parent to add an orange segment to their water instead.

Interview data from parents supported that of teachers and revealed that the intervention was having a positive impact on the nutritional knowledge and attitudes of their children. One parent stated that 'nobody drinks fizzy drinks in our house anymore'. In addition, parents felt that their children were 'listening to the Energizer on what they should eat to keep healthy, more so than us as parents'.

Children also provided examples of how the programme changed their nutritional knowledge and attitudes:

- Now I always drink milk and water instead of coke and 7up. (8 year old child).
- I felt I had a bit more knowledge of what I should eat and what drinks I should have. (12 year old child).

A recurrent theme from the interviews with teachers was the impact of the intervention on assisting and supporting them to promote PA and healthy eating. Teachers identified elements such as up-skilling workshops and creating links with external

Table 6. Changes in nutrition knowledge among 10 year old intervention relative to control participants over 2 school years.

Accumulated Knowledge Score:	Intervention		Control		Effect of Intervention (Intervention v's control)	95% CI	<i>P</i> ^a	η_p^2	<i>P</i> ^b	η_p^2
	<i>n</i>	2 year adjusted mean change ^c	<i>n</i>	2 year adjusted mean change ^c						
What it means to eat healthily	46	2.62	62	3.25	-0.63	-1.04, -0.21	0.003	0.079	0.021	0.050
Benefits of healthy eating	46	2.18	62	2.04	0.14	-0.16, 0.44	0.363	0.008	0.270	0.012

^a*P* value for difference between groups at 2 years analysed by a one way ANCOVA adjusted for baseline measure.

^b*P* value corrected for the clustering of children by school.

^cAdjusted for baseline measure mean at 2 years.

organisations as components of the intervention which were particularly helpful. For example, one principal identified that 'there was a lot of up-skilling from Spraoi ... we were put in touch with things we wouldn't have found ourselves'.

The primary barrier to programme adoption was the promotion of 20 min 'huff and puff' (MVPA) each day in school. One teacher felt that there were 'too many other things on the curriculum' and stated that 'twice a week and 10 min on other days was a more realistic target'. Another teacher commented that 'it depends on the stage of the school year ... November to January are slower months' suggesting more time would be available for the programme during these months.

Implementation

Assessment of the fidelity of the programme i.e. the extent to which the intervention was implemented as intended, was examined based on the Energizers' school records and the responses of children, teachers and parents obtained during process evaluation.

Energizer school records

The action plans developed by the Energizer based on the PA and nutritional needs identified by the school were delivered over 2 school years. The Energizer modelled classes and supported each class teacher on a weekly basis. Classes modelled included ideas for 'Huff and Puff' fitness activities, dance, 'rainy day' games, circuits and sport-related games. Each school received 3 integrated nutrition lessons on the importance of replacing sugary drinks with milk and water, the importance of eating breakfast and the foods groups that contribute to a balanced diet (Department of Health 2016). Support was given to the class teachers in the form of curriculum based materials and manuals to match lessons and classes modelled. Fridge magnets matched to the 3 lessons were provided to all children to put on their fridges at home. Laminated cards ($n = 20$) and posters ($n = 5$) were displayed on school noticeboards and in school newsletters to reinforce nutrition lessons and a registered nutritionist delivered a health eating session for parents of each participating school.

Both schools requested, and were offered, a continuing professional development (CPD) workshop on gymnastics which was attended by all school staff ($N = 43$) during year 1 of intervention delivery. At the start of year 2, staff of both schools identified the need to develop a school healthy eating policy. This was co-ordinated and written up by the Energizer in conjunction with the individual school and completed by the end of year 2. The Energizer co-ordinated the delivery of programmes ($n = 4$) with a PA and/or healthy eating focus offered to schools by the local sports partnership. In addition, the Energizer promoted and assisted in local community events ($n = 2$).

A very strong recurring theme from the process evaluation was that the participants, teachers and parents all responded positively to the implementation methodology of Project Spraoi. A total of 293 children participated in the draw and-write task (June, 2015), where they were asked to draw about Project Spraoi and afterwards write about their drawing. In 290 drawings, participants either drew or wrote about a PA or healthy eating related activity or wrote about the programme 'being fun' or 'enjoyable' or 'loving the Energizer', indicating the positive impact the project was having. Samples of participants' drawings and text are displayed in [Figures 1 and 2](#).

What Project Spraoi means to me...



It keeps you fit and it gets
you going. eat healthy

Figure 1. Sample write and draw.

Of the 293 participants, 8 took part in a semi structured interview where they discussed their drawings, its associated text and the intervention in general. Data from the interviews revealed that the implementation of Project Spraoi was perceived as being

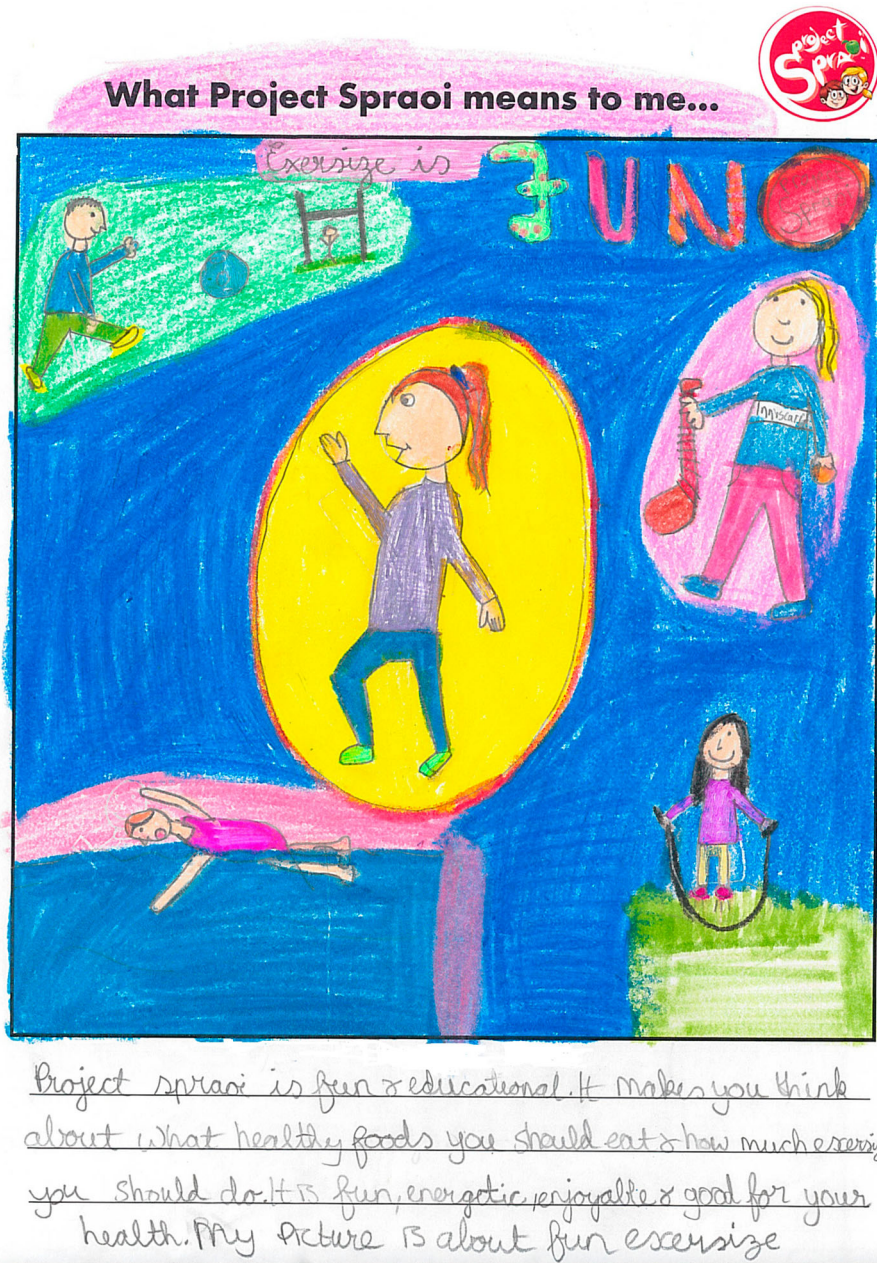


Figure 2. Sample write and draw.

positive because they found it 'fun', it made them 'fit' and 'healthy', further validating the findings from the drawings and text. This was captured in an interview with a 12 year old child who described their drawing:

- These are some of the fun games but we also learn about getting healthy, how to get fit and I'm happy in Project Spraoioutside of school and with Spraoi too. (12 year old participant)

Teachers reported feeling confident in delivering the PA sessions that were modelled by the Energizer, while children reported enjoying the content of these lessons and learning from the lessons:

- You were taking notes when you got back (from 'Huff and Puff' lesson) because it created the lesson in action. (Teacher).
- I loved the games. (8 year old participant).
- My favourite thing about Project Spraoi was learning but having fun at the same time. (12 year old participant).

Resource materials to reinforce the PA and healthy eating goals of the intervention were valued by teachers, parents and children. One teacher commented that the 'resources were excellent', 'very well laid out' and 'easy to follow'. Parents identified that the laminated cards provided on the school newsletter and the fridge magnets that were sent home provided 'helpful lunch ideas'. While an 8 year old child commented that they 'loved the fridge magnets'.

At the end of the 1st year of intervention delivery one junior class teacher felt 'the nutrition lessons were too long' and suggested shortening the duration of the nutrition element and adding the extra time onto a PA lesson, as an area for intervention improvement. The Energizer adapted the nutrition lessons accordingly in year 2 of the programme. In order to promote the implementation of 20 min of 'huff and puff' MVPA each day in school, a teacher suggested developing a clock-themed poster for the classroom so children could actively remind the class teacher of the 20 min PA goal. This tool was designed (Figure 3) and also implemented in year 2 of the programme.

Discussion

The current study aimed to assess the impact of a multicomponent intervention that was delivered in Irish primary schools. Studies have shown that school based interventions can have a positive effect on participant's PA (Drummy et al. 2016), and nutritional knowledge and attitudes (Wang, Stewart, and Chang 2017). Comprehensive evaluation of the impact of interventions to prevent childhood obesity requires examination of a programme using the RE-AIM framework (Glasgow, Vogt, and Boles 1999).

The intervention reached 473 children and 43 school staff across 2 primary schools (1 rural school and 1 urban low SES school) in Cork, Ireland. Positive results were found for waist circumference SDS (-2.25 cm mean difference) among 10 year old participants, which are similar to results found in a German school based multi-component intervention, undertaken among 7 year olds (Brandstetter et al. 2012). The additional finding in the current study that significantly lower resting heart rates were present among 10 year olds in the intervention group ($p = 0.003$), compared to the control group, was also similar to that found in previous research. Thivel et al. (2011) reported significantly lower resting heart rates among 6 and 10 year old

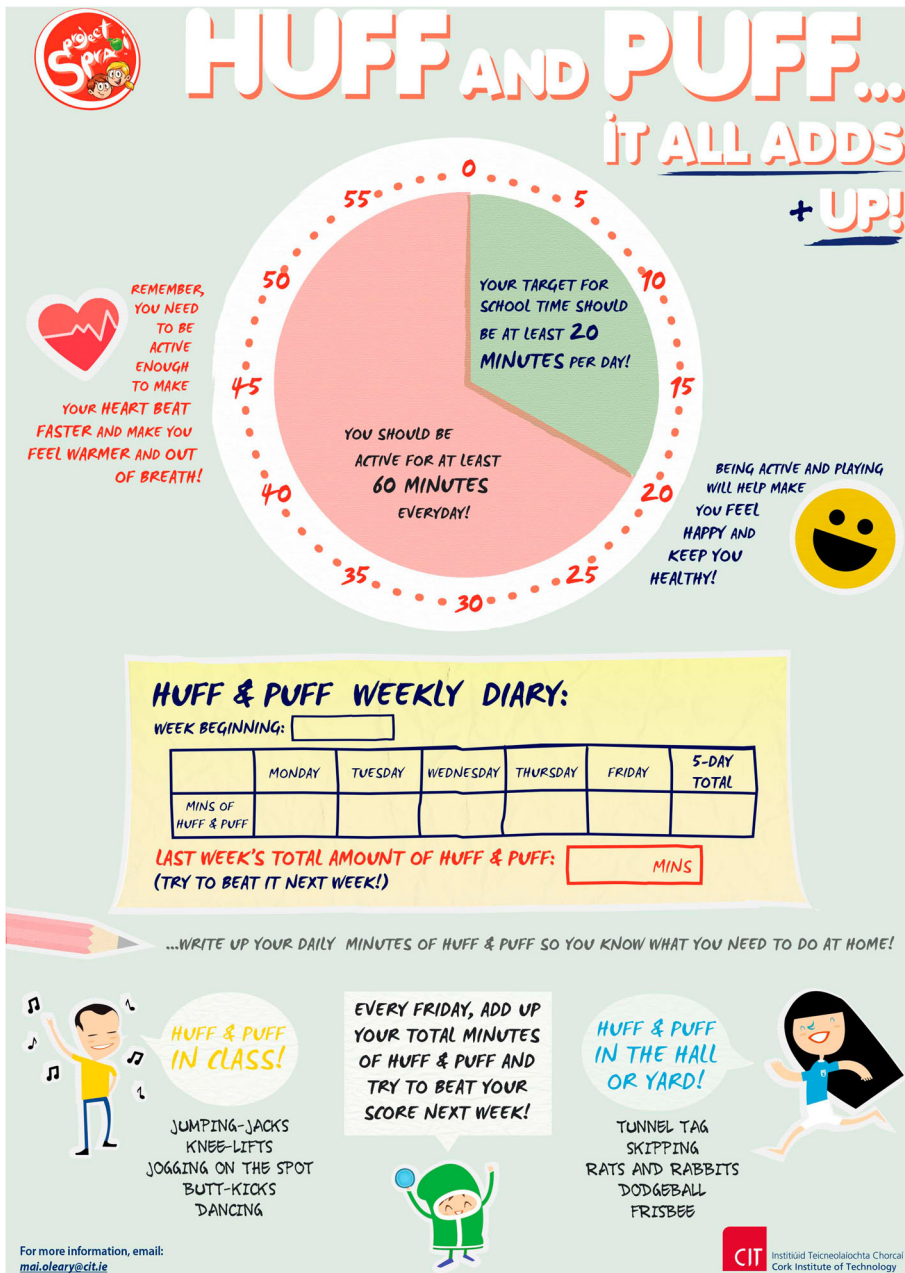


Figure 3. Clock themed poster.

French primary school children who participated in a 6 month PA intervention (Thivel et al. 2011). Such findings suggest that Project Spraoi may be effective in improving heart rate and preventing further gains in fat mass amongst older aged children; both of which are important health markers to consider when trying to prevent childhood obesity and promote overall health amongst young people. The lack of effect of

the intervention on younger age children evaluated as part of this study could be due to what Niederer et al. (2009), suggests as, the weak to moderate reproducibility of many measures in younger age groups (Niederer et al. 2009). In addition, parents have high levels of control over their younger age children's health behaviour (Hingle et al. 2010) which could have impacted the current findings. Nonetheless, small differences to experience or environment among younger age children could foster healthy change in future behaviour (Smith and Thelen 2003). Continued delivery of the intervention over a longer time period could therefore reveal positive findings among younger age children.

Cardiorespiratory fitness and MVPA increased in both intervention and control groups, but the statistical analysis did not show any group effect. Previous research also reported significant improvements in aerobic fitness among intervention and control participants (Thivel et al. 2011). A possible explanation is that enrolment in the programme, regardless of whether being an intervention or control school, could have been a prompt for behaviour change (McCarney et al. 2007). In order to clarify if this was the case in the current study, the control schools were asked to complete an information sheet detailing any initiatives that they undertook during the two year intervention period. This revealed that one of the control schools was promoting active travel to school as part of the National Environmental Award Programme (An Taisce Environmental Education Unit 2016), which could partly explain some of the improvement in run times and MVPA scores. Another possibility is that the effect of the intervention could have been diluted by other end of school year events; given follow up measurements took place in May/June each year. Irish primary schools undertake state exams, cultural events, school tours and other end of year events during May and June. In order to overcome this challenge in future work, a need for larger sample sizes that are powered to detect small differences across groups are required (Peirson et al. 2015) and follow up evaluation should consider end of school year events. It should also be noted that when the 10 year olds from one of the control schools wore their accelerometers at baseline, there was a period of inclement weather (Met Eireann 2013). Seasonal variation has been known to impact children's PA (Atkin et al. 2016). Ideally, it would have been preferential for all participants to have received the monitors at the same time point but due to the limited number of accelerometers, distribution had to be staggered. Nevertheless, the positive change in participant's fitness and MVPA across intervention and control groups constitutes an important finding, given that fitness has been shown to be a powerful indicator of health status among children (Boddy et al. 2012; Marques et al. 2017).

Among 10 year olds, attitudes towards healthy eating remained unchanged in the intervention and control group. This could be explained by the high levels reached by both groups at baseline, leaving little room for change. Nutritional knowledge on the benefits of healthy eating increased in both groups from pre- to post-intervention. In addition, teachers reported that the intervention had a positive impact on children's PA levels and their nutritional knowledge, attitude and behaviour during school hours. These results signify an important finding, given that greater responsibility for dietary choices takes place as children enter adolescence (Todd et al. 2015). Consequently, although it is not possible to say definitively that Project Spraoi is helping to promote the current nutritional behaviours of participants, it could be argued that as participants age and they begin to purchase food independently away from their

primary caregivers, the knowledge they have gained may help to promote healthier nutritional behaviours that could benefit their lifelong health.

Process evaluation provided strong evidence to support the continued delivery of the programme, along with important insights on some of the benefits and challenges encountered during the implementation stage, which has been deemed vital for informing practice and policy (Moore et al. 2015). Following the Social Ecological Approach (Sallis, Owen, and Fisher 2008), multiple levels of influence (child, school staff, parents, school and community) were considered and addressed. Both the teachers and parents felt the children adopted a variety of health enhancing behaviours as a result of the intervention. In addition to the positive influence on children, teachers reported benefitting from the engagement with relevant external organisations created by the Energizer during the intervention, which supports previous work by Burke et al. (2015) who identified community partnerships as vital components to overall success in community based interventions aimed at reducing obesity (Burke et al. 2015). Some teachers identified adopting the promotion of the 20 min 'huff and puff' everyday element of the programme as unmanageable. Amini et al. (2015) also found that the limitation of time in the school curriculum was an obstacle for sustainability for all school based interventions aimed at controlling childhood obesity (Amini et al. 2015). It has been proposed that if teachers received additional training and support, more time could be dedicated to teaching PA and nutrition (Centre for Disease Control and Prevention 1996) and far greater success rates for interventions aimed at improving the health of children could be achieved (Story et al. 2000). Furthermore, if existing teachers were offered training on how to integrate PA and nutritional activities into the existing school day e.g. cross curricular learning and activity breaks (Drummy et al. 2016), further time related barriers in future interventions could be overcome.

Strengths and limitations

To date, no multicomponent intervention has been delivered in an Irish primary school setting targeting both the promotion of PA and healthy eating. The intervention was inclusive of all children and staff in the schools and extended beyond the classroom to the wider school, parents and community. A second strength was the comprehensive evaluation of the intervention, which included objective measurement of selected health markers. Few Irish studies have measured objective PA data relating to younger age groups (5–6 year olds) (Belton et al. 2010; Kelly et al. 2005), and combined with the additional anthropometric and physiological measures obtained, unique, valuable literature has been added to the field. Furthermore, the addition of process evaluation measures supports and underpins the conclusions drawn, including benefits and challenges of the intervention (Moore et al. 2015). The examination of the impact of the intervention across the dimensions of the RE-AIM framework is also beneficial (Glasgow, Vogt, and Boles 1999), as modifications to programme implementation are often not addressed in traditional evaluations (Gaglio, Shoup, and Glasgow 2013). Specifically, the adjustments made to the programme throughout the intervention period, such as shortening the duration of the nutrition lessons for younger age groups and developing a clock-themed poster for classrooms as a PA prompt, provides the programme with the potential to deliver pragmatic interventions that are easier to apply to the real world (McGoey et al. 2016).

One study limitation was the small number of schools recruited, making the findings difficult to generalise at school level; nevertheless, the intervention successfully reached 473 school children. Also, despite the value of objectively measured PA, it is possible that the children who fulfilled the wear time criteria may have altered their habitual level of PA as a result of wearing the measurement device (Dossegger et al. 2014). A more direct measure of children's food intake may have added to the assessment of the intervention effectiveness. This has been considered for evaluation as part of the larger RCT. A further limitation was that control schools were not limited in any other initiatives that they wished to undertake and as highlighted by Tones (1997), this can lead to uncertainty when using a comparison group (Tones 1997). It is also possible that due to the small sample size, specifically for PA data among 10 year olds in the intervention group, the study failed to detect a significant effect that could have been present. Nonetheless, early childhood and adolescence is a time in which lasting habits are established; thus interventions implemented during these periods have the potential to have a significant influence on lifelong health (Gluckman et al. 2009). Furthermore, since interventions tend to be of too short a duration (World Health Organisation 2012), the finding that some positive trends in PA behaviour and nutritional knowledge and attitudes were emerging in this study supports the need for longer duration interventions so that potential differences in health markers can be detected (Lazarus et al. 2000). New Zealand's Project Energize has shown these findings (Rush et al. 2016), whilst also being cost effective, efficient and sustainable as a childhood obesity prevention programme (Rush et al. 2014).

Conclusion

Project Spraoi has shown a positive influence on the PA behaviour and nutritional knowledge and attitudes of children. The comprehensive evaluation of the intervention, utilising the RE-AIM framework, documents the feasibility of delivering a multi-component intervention in an Irish primary school setting and important insights into elements of programme success, as well as challenges to implementation, have been made available. The programme has shown promise in improving health, particularly amongst 10 year olds at critical development periods. By allowing for the continued delivery of the programme, an opportunity exists to positively impact the long-term health of Irish children. Sufficient funding needs to be invested in Project Spraoi to allow for the expansion of the intervention and assessment of its long-term impact.

Acknowledgements

This work was supported by Cork Institute of Technology. The authors would like to thank the participating children and their parents, as well as the staff of the participating schools.

Supplemental data

Supplemental data for this article can be accessed [10.1080/03323315.2019.1567368](https://doi.org/10.1080/03323315.2019.1567368).

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