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Effectiveness of a behavioural incentive scheme linked to goal achievement in overweight children: a cluster randomized controlled trial

Julie Redfern[1,2*], Gemma Enright [1], Karice Hyun[1] ,Simon Raadsma[3], Margaret Allman-Farinelli [4], Christine Innes-Hughes[5], Santosh Khanal[5] Sarah Lukeis[6] , Chris Rissel[5], Hui-Yih Chai[3] and Alex Gyani[3]

Affiliation

[1] Faculty of Medicine and Health, Westmead Applied Research Centre, Westmead Clinical School, The University of Sydney, Australia
[2]The George Institute for Global Health, UNSW Medicine
[3]Department of Premier and Cabinet, Behavioural Insights Team, NSW Government, Sydney, Australia
[4]Charles Perkins Centre, School of Life and Environmental Sciences, The University of Sydney, Australia
[5]NSW Office of Preventive Health, Ministry of Health, Sydney, Australia
[6]Better Health Company, Melbourne, Australia

[*]**Corresponding author:** Julie Redfern, Professor, The University of Sydney at Westmead Hospital, Westmead, Australia, Tel: +61 (02) 8890 9214, E-mail: julie.redfern@sydney.edu.au

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Abstract

Background: The prevalence of childhood overweight and obesity is becoming an increasing concern worldwide. This study aimed to determine effectiveness of a structured goal setting incentive scheme, delivered within a community program, on health outcomes in overweight children at 6 and 18 months.

Methods: Single-blind, cluster randomized controlled trial with 10 weeks, 6 month and 18 month follow-up. Community weight-loss programs for children were randomized to (i) standard program plus incentive scheme (intervention) or (ii) standard program alone (control). Primary outcome was mean BMIz score at 18 months. Secondary outcomes included anthropometric and behavioural measures.

Results: A total of 37 sites (33 urban and 4 regional) and 512 children were recruited. Compared to baseline, at 18 month follow-up, the total cohort achieved significant reductions in the mean BMIz score (1.7 v 1.0, p<0.001), median screen time (16.5 v 15.8 hours/week p=0.0414), median number of fast food meals per week (1.0 v 0.7, p<0.001) and significant increases in physical activity (6.0 v 10.0 hours/week, p<0.001) and self-esteem score (20.7 v 22.0, p<0.002). There were no significant differences between the control and intervention groups at any follow-up time-points. There were significantly more participants in the intervention than control group who completed 10 sessions of the weight management program (23% v 13%, p=0.015).

Conclusions: The incentive scheme, delivered in addition to the standard program, did not have a significant impact on health outcomes in overweight children. However, the intervention increased program attendance and overall cohort achieved sustained improvements in clinical and lifestyle outcomes.

Keywords: Incentives, Children, Weight Loss, Nutrition, Physical Activity, Community, Obesity, Cardiac, Prevention, Translation

Abbreviations: BMI-Body Mass Index, UK MEND-United Kingdom Mind Exercise Nutrition Do, NSW-New South Wales, LHD-Local Health Districts, RCT-Randomized Controlled Trial, CONSORT-Consolidated Standards of Reporting Trials, SMART-Specific Measurable Achievable Relevant and Timely, PACES- Physical Activity Enjoyment Scale, SD- Standard Deviation, IRQ- Interquartile Intervals, GEE- Generalised Estimating Equation

Introduction

The high prevalence of childhood overweight and obesity is a major public health problem. It has implications for current and future health services, both for weight management and treatment of associated co-morbidities. In 2016, 340 million children and adolescents (worldwide) were estimated to be overweight or obese [1]. Most importantly, being overweight as a child increases the risk of obesity in adulthood and accelerates the risks of associated and life-threatening conditions such as cardiovascular disease [2,3]. The extent of the epidemic and its short and long-term effects on physical and psychological health have made the prevention and treatment of childhood overweight and obesity a high priority [4,5]. Public health and community services are integral

in preventing and managing childhood obesity [6] and strategies informing interventions for health-related behavior change in children are becoming increasingly important.

Community-based weight management programs are an important response to address childhood overweight and obesity. The United Kingdom Mind Exercise Nutrition Do it (UK MEND) program is an evidence based community-based child weight management program with efficacy in weight outcomes [7,8]. The MEND trial (n=117) demonstrated that the intervention group had a significantly reduced waist and BMI measures as well as improvements in physical activity and self-esteem [8]. Based on these findings and due to the growing burden of childhood obesity in New South Wales (NSW, Australia), MEND was translated into a community context by NSW Health in 2009. The program was named Go4Fun® and has an emphasis on reaching disadvantaged communities and accordingly, low socioeconomic and regional areas [9]. It is a community-based, multidisciplinary family focused program that targets weight-related behaviours and self-esteem of children aged 7 to 13 years who are overweight or obese and their familes [10]. The program is managed by the NSW Office of Preventive Health with the Better Health Company being responsible for centralised service provision and the NSW local health districts (LHDs) deliver the 10 week program. While the Go4Fun® program has demonstrated short and medium term health benefits for those who complete it, opportunities to improve retention and completion, goal setting and outcomes and sustained outcomes after the program have been identified and there is limited data pertaining to sustainability [9].

An opportunity for optimising behaviour change amongst children might be via the use of incentives. There is mounting evidence in adults for the role of incentives in enhancing health-related behaviour change [11-13]. However there is a high level of heterogeneity across study designs, incentive strategies and a lack of long-term follow up have prevented firm conclusions on the most effective incentive strategy for behaviour change. Several uncontrolled studies, with short-term follow-up, found positive results associated with incentivising health behaviours in children [14-16]. Other small randomised trials have used a combination of psychological strategies and low value incentives to encourage behaviour change in exercise behaviour [17,18] and fruit and vegetable consumption [19,20]. These findings suggest that the use of extrinsic rewards or incentives may have potential but to date this is a relatively unexplored strategy. Therefore, this study aimed to determine the effectiveness of a structured goal setting incentive scheme on health outcomes in overweight children for 18 months.

Materials and Methods

Study design

Single-blind, pragmatic cluster RCT within the context of the existing 10 week Go4Fun® program with end of program (10 weeks), 6 and 18 month follow-up (**Figure 1**). Community weight-loss programs (sites) for children were randomized to either the (i) standard program plus an enhanced goal setting and structured incentive scheme (intervention) or (ii) standard program alone (control). Detailed methods are described elsewhere [21]. The original protocol was to collect outcomes at 10-week and 6 months and 12-months, however, for financial and logistical reasons data was collected at baseline, 10 weeks, 6 months and 18 months. The Consolidated Standards of Reporting Trials (CONSORT) statements for cluster randomized controlled trials (RCTs) [22] and for non-pharmacological interventions [23] were followed and the trial registered (ACTRN12615000558527). Ethics approval was obtained from the Sydney South Western LHD Research and Ethics Office (HREC/13/LPOOL/157). Written informed consent was obtained from the parent/guardian for each child.

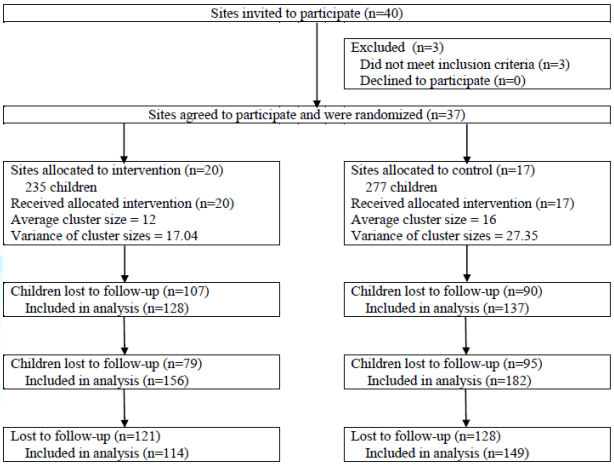

Figure 1: Flow of sites and participants through the incentives RCT

Eligibility/Recruitment

Sites: All local health districts (LHDs) across NSW, Australia where the standard Go4Fun® program was delivered were invited to participate. To be eligible sites needed to (i) be currently delivering the standard Go4Fun® program, (ii) have an enrolment average of at least 10 children per site per term in the year prior to study commencement and (iii) be willing to participate in the trial and adhere to standardized procedures for duration of the trial.

Participants: Children were eligible to attend according to the following criteria; (i) aged 7 to 13 years, (ii) body mass index > 85th percentile for their age and gender25 (iii) enrolled in and meet the criteria to participate in Go4Fun® program at a participating site and (iv) parent/guardian provide written and informed consent.

Randomization

Eligible sites were randomized to either deliver the intervention(standard Go4Fun® plus incentives) or control (standard Go4Fun® alone) program for 10 weeks. Randomization was conducted using a computer generated sequence (1:1) with stratification according to LHD to ensure equal representation across the various areas of NSW between groups. The allocation sequence was concealed from the study personnel. Although individual participants were not blinded to their group allocation, to minimise bias participants were instructed not to reveal their group allocation to the blinded outcome assessors during the follow-up assessments.

Control sites

Sites randomly allocated to the control arm continued to deliver the standard and well-established Go4Fun® program. The standard program is delivered by trained health professionals and consists of weekly face-to-face group sessions (one per week) for 10 weeks during

the school term. Exercise sessions involve one hour of activities that progressively develop strength, fitness and self-esteem [9] Nutrition sessions include healthy eating advice, food label reading and recipes [9] Behavior change sessions include goal setting, problem solving and role modeling [9] Through preliminary focus groups consensus was reached to ensure standardization of Go4Fun® between sites. It was also agreed that all children could receive a water bottle (contingent on attending one session), bouncy balls (three sessions) and skipping ropes (10 sessions).

Intervention sites

Sites randomly allocated to the intervention arm delivered the standard Go4Fun® program plus the enhanced goal setting and structured incentive scheme. The incentive scheme was developed via an iterative process combining literature review, focus groups and consensus meetings with stakeholders, building on the existing goal-setting approaches [21]. At the intervention sites participating children participated in an enhanced goal setting component and received standardised incentives for reaching certain levels of goal attainment. That is, for the intervention, participants set specific, measurable, achievable, relevant, and timely (SMART) [24] behavioural goals and achieving these goals resulted in the incentive being provided. This approach emphasised the importance of enhancing the goal setting process, including resetting/stretching them if they were achieved too easily, in the program as well as linking goal achievement to incentives [24]. The goal setting component and incentive scheme were developed and agreed upon during the preliminary work for this study with an overview of the goal setting enhancement and incentives being as follows.

Goal setting: At the third session in the program children and their parent/guardian in the intervention group were provided with an enhanced resource (handout and poster) to guide them through jointly setting an exercise and a nutrition goal (child and parent/guardian in collaboration). Examples included 'I will play soccer for 30 minutes on three days a week at the park with dad' and 'I will try a new vegetable two times a week for dinner on Wednesday and Sunday nights'.

Goal attainment incentives: Children received milestone based incentives for achieving their set goals. There were three levels as follows: (i) vegetable slicer once two exercise and two nutrition goals were achieved; (ii) sports store voucher (value $AU10) once four exercise and four nutrition goals were achieved and (iii) height adjustable tennis set (value of $AU20) once six exercise and six nutrition goals were achieved. In addition, Go4Fun® leaders prompted participating children on a weekly basis to review and reset their goals as needed.

Goal attainment reminders via text message and lottery style incentive: At session 9 of the 10 week program, children and parents in the intervention group were encouraged to set goals to be achieved after the program finished and parents/ guardians received weekly mobile phone text message reminders to support and encourage children to achieve their goals (and set new ones where relevant). Parents/guardians were encouraged to text back with goal achievements that were rewarded with a ticket entry (maximum of 8 tickets/month) into a site-wide prize draw for a family pass to a local zoo that was drawn at six months.

Outcomes

The primary outcome was mean difference in BMIz scores between control and intervention groups at 6 and 18 month follow-up. BMIz scores indicate how many units (of the standard deviation) a child's BMI is above or below the average BMI value for their age and sex. BMIz scores were calculated from raw BMI measures using the Centers for Disease Control growth reference data [26]. Secondary outcomes included anthropometric measures (body weight, waist circumference) assessed according to standardized procedures [27] and behavioural and self-esteem detailed below. Similar to BMIz scores, waist measures in centimetres were converted to a waist circumference z score based on reference data [26]. An adapted version of the Rosenberg Self-Esteem Scale was used to assess self-esteem measures of the participant children because this scale has been tested for reliability and validity in numerous different languages [28]. The Rosenberg Self Esteem Scale is a 10-item scale that measures global self-worth by measuring both positive and negative feelings about the self with items answered using a 4-point scale format [28]. The scale is scored by reversing 5 items and summing the scores with higher scores representing higher self-esteem and there is a maximum score of 40.28 The Physical Activity Enjoyment Scale [29] (PACES) was used to assess physical activity and this tool has been found to have good internal consistency, item-total correlations and validity in primary school children [29]. The full PACES score was only able to be collected at 18 months due to program time constraints at the earlier time-points. For nutrition assessment, relevant questions were selected from the NSW Centre for Public Health Nutrition recommendations for nutrition questions [30]. The proportion of participants achieving the Australian guidelines [31,32] for physical activity (>60 minutes/day), screen time (< 2 hours/day), fruit (2 serves/day) and vegetable (5 serves/day) consumption were also analysed.

Data collection process

Data were collected for as many consenting participants at baseline, end of program, six and 18 months by research assistants blinded to site allocation. Research staff conducting the assessments were trained in measuring anthropometric measures including height, weight and waist circumference, using standardized procedures [27]. Participants were contacted by blinded research assistants to attend the follow-up sessions and data were entered into a secure online database. Wherever possible face-to-face assessments were conducted either in a local community centre or in the participant's home. Where this was not possible data was collected via a telephone call.

Statistical considerations

For sample size estimations, intraclass correlation was calculated based on preliminary data (214 individuals) across the recruited 40 sites and was found to be 0.16 for BMIz score. To detect a between group difference of 0.24 (±0.43) in BMIz score (based on outcome data from a previous Australian RCT examining 12 month weight loss outcomes in children) [33]. 12 participants from each of the 40 sites (20 intervention, 20 control) were required to achieve 80% power based on an alpha of 0.05.

Analysis was conducted at the individual level and followed the intention-to-treat principle. The control and intervention groups were compared on baseline characteristics, program attendance and response to the self-esteem and the physical activity enjoyment questions. Continuous variables were reported in means and standard deviations

(SD) for normally distributed variables, and median and interquartile intervals (IQI) for skewed variables. Categorical variables were reported in number and percentages. For univariable comparison, unadjusted regression within the framework of generalised estimating equation (GEE) for continuous variables and Rao-Scott chi-square test for categorical variables were used to account for the clustering effect of the sites. The outcomes were compared between the timepoints (baseline, 10 weeks, 6 months and 18 months) to see the effect of the Go4Fun® program across time. Test for trend was performed for normally distributed continuous and binary outcomes. For normally distributed continuous outcomes, unadjusted regression within the framework of GEE with time as a continuous variable was used, and for the binary outcomes, Cochran-Armitage trend test was used. For the multivariable analysis of the primary outcome, the adjusted regression within the framework of GEE was used to compare the mean difference in BMIz score at 18 months between control and intervention groups. This model was adjusted for the baseline characteristics including age, gender, attendance of all 10 sessions, indigenous status, highest education qualification of father, highest education qualification of mother, sole parent household, self-esteem score and physical activity ≥ 60 minutes per day.

Sensitivity analysis were performed by repeating the main analysis using multiple imputation to include patients with missing outcome data. We assumed that the data were missing at random [34]. where the missing elements of the data can be predicted by observed data. Thirty imputations were generated using the fully conditional specification method [35].General linear model and logistic regression model were used for continuous and binary outcomes, respectively, within the framework of GEE. SAS 9.4 for Windows (SAS Institute Inc. Cary, NC, USA) and statistical significance of $P < 0.05$ were used for all analyses.

Results

A total of 37 sites (33 urban and 4 regional) and 512 children were recruited for the study. The study ran from February 2015 to February 2017. End of program (10 weeks) follow-up assessments were conducted for 265/512 (52%) children, 6 month follow-up assessments were conducted for 338/512 (66%) children and 18 month follow-up was conducted for 263/512 (51%) children (Figure 1). At 6 month follow-up, reasons for loss to follow-up included; being uncontactable (n=70), not interested or too busy (n=59), family problems (n=18), away on holiday (n=9), child unwilling to attend (n=10), illness (n=2), language barrier (n=1) and other (n=5). At 18 month follow-up, reasons for loss to follow-up included; being uncontactable (n=82), not interested or too busy (n=87), family problems (n=17), away on holiday (n=6), child unwilling to attend (n=14), illness (n=2), language barrier (n=2), other (n=39). Baseline and demographic data are summarized in Table 1. The intervention and control participants were well matched across age, gender, anthropometric and lifestyle measures (**Table 1**).

Program attendance

The median number of sessions attended by the total cohort was 7.5 (interquartile interval: 4.0, 9.0) out of a total of 10 possible sessions scheduled per week. Median number of sessions attended after 10 weeks was significantly greater in the intervention than control group (8.0 (4.0, 9.0) v 7.0 (4.0, 9.0)) sessions, p=0.029). In the total cohort, 71% attended at least 5 (half) of the program sessions but only 18% attended all 10 scheduled sessions. There were significantly more participants in the intervention than control group who participated in all 10 sessions (23% v 13%, p=0.015).

	Control	**Intervention**	**Total cohort**
	(n=277)	**(n=235)**	**(n=512)**
Female, n (%)	146 (53)	125 (53)	271 (53)
Age, mean (SD) years	9.8 (1.75)	9.7 (1.76)	9.7 (1.75)
Indigenous, n (%)	20/277 (8)	6/235 (3)	26/512 (5)
Sole household, n (%)	61/277 (23)	43/235 (20)	104/512 (22)
Non-English language at home, n (%)	140/277 (48)	117/235 (53)	256/512 (50)
BMI, mean (SD) kg/m^2	25.3 (4.08)	25.0 (3.86)	25.2 (3.98)
BMIz, mean (SD)	2.0 (0.47)	2.0 (0.43)	2.0 (0.45)
Waist circumference, mean (SD) cm	83.5 (11.10)	83.7 (10.54)	83.6 (10.84)
Physical activity/week, median (IQI) hrs	6.6 (3.0, 12.0)	5.0 (3.0, 9.0)	6.0 (3.0, 10.7)
< 60 minutes/day, n (%)	131/258 (51)	135/209 (65)	266/467 (57)
Screen time/week, median (IQI) hours	17.0 (11.0-25.0)	16.0 (11.0-22.0)	16.5 (11.0-23.0)
> 2 hours/day, n (%)	147/245 (60)	119/196 (61)	266/441 (60)
Serves of fruit/week, median (IQI)	10.3 (7.0-14.0)	14.0 (7.0-14.0)	10.5 (7.0-14.0)
< 2 serves/day, n (%)	128/244 (52)	93/191 (49)	221/435 (51)
Serves of vegetables/week, median (IQI)	7.0 (7.0-14.0)	7.0 (5.0-14.0)	7.0 (5.0-14.0)
< 5 serves/day, n (%)	219/222 (99)	178/180 (99)	397/402 (99)
Fast food meal/week, median (IQI)	1.0 (0.4-1.0)	1.0 (0.4-2.0)	1.0 (0.4-2.0)
Cup of soft drink/week, median (IQI)	3.0 (1.5, 7.0)	3.0 (2.0, 7.0)	3.0 (1.5, 7.0)
Self-esteem score, mean (SD)	20.6 (5.24)	20.7 (5.44)	20.7 (5.32)
PACES score, mean (SD)	24.5 (5.21)*	25.4 (4.25)*	24.9 (4.84)*

SD, standard deviation; BMI, body mass index; IQI, interquartile interval; *Score out of 30;

Table 1: Baseline characteristics of the participating children

Difference in overall cohort over 18 months

The total cohort achieved a significant reduction in BMIz score from baseline to end of the program and the improvement was maintained for 18 months (**Table 2**). The total cohort also had significant reductions in screen time, number of fast food meals and cups of soft drink per week over the 18 months (Table 2). Further, the total cohort achieved a significantly greater median hours of physical activity per week, a significantly greater median serves of vegetables per week, a significant improvement in the proportion achieved the recommended

level for physical activity and a significantly improved mean self-esteem score over the 18 months (Table 2).

Difference between groups

There was no significant difference in any of the primary or secondary outcomes between the control and intervention groups at 10 weeks, 6 months or 18 months (**Table 3**). Further, after adjusting for the baseline demographic characteristics, the BMIz scores at 18 months between the control and intervention groups remained similar (p=0.704).

Self-esteem and physical activity enjoyment

At baseline the majority of children felt happy/satisfied with themselves (90%), felt they had a number of good qualities (94%), felt they were able to do things as well as most other children (88%), who did not feel useless (58%), who felt that were as good as everyone else (80%), who did not feel like a failure (73%) and who had a positive feeling about themselves (88%). In the total cohort, the mean self-esteem score was 20.7 (±5.3) at baseline then increased to 23.5 (±4.9) at end of program and 22.8 (±5.3) at 6 months and was reduced slightly at 18 months to 22.0(±4.8). However, there was no significant difference in self-esteem score between the control and intervention groups at any of the follow-up time-points (Table 3).

	Baseline (n=512)	**10 weeks (n=265)**	**6 months (n=338)**	**18 months (n=263)**	**p-value**
Weight, mean (SD) kg	51.5 (13.89)	50.1 (13.28)	54.7 (14.57)	59.3 (14.13)	<.0001 [+]
Height, mean (SD) cm	141.8 (11.07)	142.0 (10.89)	147.2 (11.41)	152.3 (11.22)	<.0001 [+]
BMI, mean (SD) kg/m^2	25.2 (3.98)	24.4 (3.80)	25.1 (7.84)	25.3 (4.00)	0.5080 [+]
BMIz score, mean (SD)	2.0 (0.45)	1.9 (0.50)	1.8 (0.53)	1.7 (0.52)	<.0001 [+]
Waist circumference, mean (SD) cm	83.6 (10.84)	81.5 (10.92)	83.4 (10.52)	84.3 (11.16)	0.2645 [+]
Physical activity (hrs/week), median (IQI)	6.0 (3.0, 10.7)	10.2 (6.0, 19.5)	9.0 (4.3 16.0)	10.0 (4.2, 18.0)	<.0001
Physical activity <60 minutes/day, n (%)	266/467 (57)	64/239 (27)	133/338 (39)	102/262 (39)	<.0001 [+]
Screen time (hours/week), median (IQI)	16.5 (11.0, 23.0)	12.0 (8.5, 20.0)	14.5 (9.0, 24.0)	15.8 (10.0, 22.0)	<.0001
Screen time >2 hours per day, n (%)	266/441 (60)	100/233 (43)	138/271 (51)	132/262 (55)	0.1057 [+]
Serves of fruit/week, median (IQI)	10.5 (7.0, 14.0)	14.0 (14.0, 14.0)	14.0 (7.0, 14.0)	14.0 (7.0, 14.0)	<.0001
<2 serves per day, n (%)	221/435 (51)	50/237 (21)	121/326 (37)	122/249 (49)	0.4117 [+]
Serves of vegetables/week, median (IQI)	7.0 (5.0, 14.0)	14.0 (7.0, 21.0)	7.0 (7.0, 14.0)	7.0 (7.0, 14.0)	<.0001
<5 serves per day, n (%)	397/402 (99)	224/237 (95)	313/322 (97)	252/256 (100)	0.3543 [+]
Fast food meal/week, median (IQI)	1.0 (0.4, 2.0)	0.7 (0.2, 1.0)	0.7 (0.2, 1.0)	0.7 (0.2, 1.0)	<.0001
Cups of soft drink/week, median (IQI)	3.0 (1.5, 7.0)	0.0 (0.0, 2.0)	2.0 (1.0, 4.0)	1.0 (0.0, 2.0)	0.0009
Self-esteem score, mean (SD)	20.7 (5.32)	23.5 (4.86)	22.8 (5.25)	22.0 (4.76)	<.0001 [+]
PACES score, mean (SD)	24.9* (4.84)	26.2* (4.47)	25.0* (4.36)	66.9** (11.67)	<.0001 [+]

SD, standard deviation; BMI, body mass index; NS, no significant difference; IQI, interquartile interval.

*Score out of 30; **Score out of 80; [+] p-value for trend

Table 2: Study outcomes for total cohort at 10 weeks, 6 months and 18 months

For physical activity enjoyment, only 6 questions were collected at baseline, end of program and 6 months and the full set of PACES questions was collected at 18 months. Of those collected at baseline, the majority of children reported that they enjoyed being active (94%), felt a sense of success with activity (91%) and felt good when active (92%) while only the minority reported feeling frustrated when active (25%) and disliking being active (14%). At 18 months, most children reported that, when active, they enjoyed it (87%), found it pleasurable (85%), felt energetic (74%) and that they got something out of it (85%). However, there was a proportion that felt bored (22%), sad (6%), or and not interested (11%) when active.

Sensitivity analysis

After imputing the missing data using multiple imputations, the effect of the intervention on BMIz at 18 month follow up was also not statistically significant (p=0.7932).

Discussion

In this pragmatic cluster RCT, we found that enhancement and systematising of an incentive program to an existing community-based weight management program for children did not significantly decrease BMIz scores in the intervention compared to the control group. We did however find that the incentives program increased program attendance and that the overall cohort achieved significant improvements in clinical and behavioural measures over the 18 month period of the study. As is common in studies with this population, we had high rates of loss to follow-up.

Our results are similar to others showing that it is difficult to achieve significant improvements in BMI measures in children when comparing groups. Our study aligns with previous individual RCTs of similar size showing no significant difference in BMIz scores at follow-up in similar populations [36]. It is important to note that while BMIz is an objective measure and is clinically significant and

considers growth rates of children, it was not initially intended to be an outcome measure for clinical research and it may not be sensitive to change with varying interventions [37]. However, it is measurable in routine community settings and it does provide objective information. Nonetheless, we did show an improvement in the overall cohort over the 18 months of the study which is consistent with other Go4Fun research [38]. Similarly, a Cochrane review found reductions in BMIz score (between 0.17 to 0.24) after one year of lifestyle intervention in children younger than 12 years are possible [39].

As is common amongst studies recruiting children with health conditions such as obesity, we found recruitment and retention a major challenge in this research. The loss to follow-up was an issue despite extensive efforts from our research team who are experienced with delivery of childhood obesity programs and related research. Much effort was made to contact all families using multiple means of contact, to offer home and phone follow-ups but to do this within ethical constraints (for example, no more than 3 messages left on parents phones). These are almost always challenging for weight management trials involving adults [40]. But are further inflated for studies where the participants are young children and many were from disadvantaged areas [41]. A previous study investigated quantitative and qualitative reasons for lack of participation in research by children and the results were complex and multifactorial with burden and unfamiliarity with research being key outcomes [42]. Of course these challenges are much greater when the study is examining obesity and targeting a population associated with potential socioeconomic disadvantage [43] Importantly, these are the vulnerable populations and the current research aimed to tackle a highly sensitive and challenging area of health. In addition, the challenges faced in terms of follow-up are aligned with general retention in weight loss programs aimed at children and perhaps are a symptom of the broader issue. Despite, the challenges, it is important researchers continue to seek solutions for addressing this major area of health. However, further health services and qualitative research is needed to draw out themes and potential solutions for others facing similar challenges. Larger studies are

	10 weeks (end of program)			6 months			18 months		
	Control (n=128)	Intervention (n=137)	p value	Control (n=182)	Intervention (n=156)	p value	Control (n=149)	Intervention (n=114)	p-value
BMI, mean (SD) kg/m^2	24.5 (3.61)	24.3 (4.01)	0.8247	25.5 (10.20)	24.8 (3.75)	0.4326	25.3 (3.87)	25.3 (4.18)	0.817
BMIz, mean (SD)	1.9 (0.5)	1.8 (0.5)	0.7278	1.8 (0.53)	1.8 (0.53)	0.6788	1.7 (0.50)	1.7 (0.55)	0.7746
Waist circum, mean (SD) cm	81.9 (10.39)	81.1 (11.50)	0.5664	83.3 (10.31)	83.6 (10.79)	0.8476	84.5 (11.69)	84.1 (10.51)	0.7539
Activity/wk, median (IQI) hrs	12.0 (7.5, 20.0)	9.5 (6.0, 18.0)	0.0578	9.4 (4.8, 18.0)	9.0 (4.0, 15.0)	0.2241	11.0 (6.0, 20.0)	7.4 (3.0, 17.0)	0.0078
< 60 minutes/day, n (%)	30/126 (24)	34/113 (30)	0.4343	67/182 (37)	66/156 (42)	0.2913	48/149 (32)	54/113 (48)	0.0002
Screen time/wk, median (IQI) hrs	12.0 (8.5-19.0)	12.5 (8.0-20.0)	0.7575	14.5 (9.0-22.0)	14.5 (9.0-26.5)	0.4341	16.0 (9.7-23.0)	15.5 (10.5-21.5)	0.8592
> 2 hours/week, n (%)	52/123 (42)	48/110 (44)	0.837	74/146 (51)	64/125 (51)	0.9401	76/139 (55)	56/103 (54)	0.9707
Serves of fruit/wk, median (IQI)	14.0 (14.0-18.0)	14.0 (14.0-14.0)	0.8188	14.0 (7.0-14.0)	14.0 (7.0-14.0)	0.758	7.0 (7.0-14.0)	14.0 (7.0-14.0)	0.6188
< 2 serves/day, n (%)	28/123 (23)	22/114 (19)	0.5733	67/174 (39)	54/152 (36)	0.6501	66/141 (47)	56/108 (52)	0.4552
Serves of veges/wk, median (IQI)	14.0 (7.0-21.0)	14.0 (7.0-21.0)	0.0268	7.0 (7.0-14.0)	7.0 (7.0-14.0)	0.3384	7.0 (7.0-14.0)	7.0 (7.0-14.0)	0.5015
< 5 serves/day, n (%)	116/124 (94)	108/113 (96)	0.5265	161/170 (95)	152/125 (100)	UA	142/143 (100)	110/113 (100)	UA
Fast food meal/wk, median (IQI)	0.9 (0.2-1.0)	0.4 (0.2-1.0)	0.1669	0.5 (0.2-1.0)	0.7 (0.2-1.0)	0.4256	0.7 (0.2-1.0)	0.7 (0.2-1.0)	0.9939
Cups soft drink/wk, median (IQI)	0.5 (0.0-2.0)	0.0 (0.0-2.0)	0.843	2.0 (1.0-4.0)	2.0 (1.0-5.0)	0.872	1.0 (0.0-2.8)	1.0 (0.0-2.0)	0.691
Self-esteem score, mean (SD)	23.5 (4.92)	23.4 (4.82)	0.8386	23.0 (5.11)	22.4 (5.25)	0.393	22.2 (4.81)	21.7 (4.72)	0.7596
PACES score, mean (SD)	26.1 (4.43)	26.3 (4.53)	0.9278	25.0 (4.47)	25.1 (4.26)	0.9107	66.9 (10.93)	66.9 (12.54)	0.8397

SD, standard deviation; BMI, body mass index; circum, circumference; wk, week; hrs, hours; veges, vegetables; UA, unavailable

Table 3: Comparison of study outcomes between control and intervention groups at 10 weeks, 6 months and 18 months

needed to confirm the findings and generate more evidence in the area of behaviour change and overweight children.

Our trial suggests that in this cohort the incentives program did not significantly improve clinical or behavioural outcomes over 18 months. It is possible therefore that the extrinsic rewards are in themselves not a solution for changing behaviour in children. For complex personal, emotional, social and physical reasons it can be challenging to find factors that 'motivate' children who are overweight [44]. Some research suggests that individual factors such as whether the child is introverted or extroverted can be a factor that impacts on motivation to be physically active [44]. The present study did not tailor the incentives or their delivery according to individual child/family characteristics and hence this could be an area for future research. The lack of a significant difference between the groups but an overall cohort improvement may have indicated the goal-setting [24,45]. In both groups was successful and reduced differentiation between the groups. Further, it may also have been the nature of the rewards themselves delivered in this current program. Simple, inexpensive and 'healthy' incentives were chosen and perhaps these were not powerful enough to drive behavior change. Interestingly, the family zoo passes were chosen based on a lottery system where those who achieved more goals secured more 'tickets to enter' and this reward was perhaps a more powerful incentive. Future qualitative work will explore the perceived value of individual rewards in the context of weight loss.

Through this trial several areas of potential program improvement were identified. They include the need for revision of data collection questions and processes within existing programs. This will improve the utility and efficiency of data collection and ultimately contribute to improved performance and quality of the program and its outcomes. The study also highlighted the importance of benchmark reporting between sites to identify local and system level areas for improvement. The study highlighted the importance of implementation of strategies targeting reach and completion of weight management programs. This is a common problem for initiatives but an area in need of continual quality improvement and evaluation. The availability of healthy incentives for the children and their families could offer one strategy for achieving this based on our findings.

The trial was pragmatic and there were difficulties in recruiting children and minimizing loss to follow-up that are not atypical of studies in this population. Our goal was to be as integrated with the existing program as possible but this did mean we were required to adapt to site-based procedures and therefore we were unable to collect the full dataset for questionnaires such as PACES at baseline and end of program. BMI, waist circumference and BMIz scores were used as a measure of obesity rather than objective measurement of body composition for practical data collection reasons. The pragmatic nature of the study meant that some sites already had some simple incentives in place and this was difficult to control although we are confident the impact of this was minimal. A strength of the study was that local sites and families were involved in design of the incentives and their implementation. Although we used 'healthy' incentives such as physical activity equipment and family outings, perhaps a different incentives structure (e.g., where individual children could set their own rewards) may have been more beneficial. The incentives intervention did improve attendance at program sessions, but the study was not designed to increase reach of the program and this is an area that requires further research. In this study, we had original proposed doing final follow-up at 12 months but for financial and logistical reasons this was extended to 18 months. Whilst not ideal this change enabled slightly longer follow-up although ideally even longer follow-up (e.g, 5-10 years) would be useful.

Conclusions

The incentive scheme, delivered in addition to a standard weight-loss program in this trial, did not have a significant impact on health outcomes in overweight children at 6 or 18 months. Despite only about two-thirds of the total cohort attending more than half the program sessions, the children in the total cohort had a variety of significant improvements in clinical, lifestyle and self-esteem measures that were maintained for 18 months. The incentives program was associated with significantly greater attendance and completion of the program. An important area of focus moving forward is to expand the reach of community weight management programs so as to maximise the number of children who are able to benefit. Further research could determine the impact of incentive schemes amongst different cohorts and using a different structure of incentives that are more sustained.

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Author Disclosure Statement

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Authors Contributions

JR, AG, SR conceived the original concept of the study and the intervention. GE, SL supported details of recruitment and data collection. KH and SK performed the sample size calculations and will lead analysis of the results. JR and GE drafted the protocol. GE, MAF, CIH, SL, CR, HYC and AG supported intervention development. All authors contributed to the scientific design of the study and the protocol development, are involved in the implementation of the project and have read and approved the final manuscript.

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