Title: 12 month changes in dietary intake of adolescent girls attending schools in low-income communities following the NEAT Girls cluster randomized controlled trial

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Abstract

Poor dietary habits and obesity are more prevalent in lower socio-economic status (SES) communities. The NEAT Girls cluster randomized controlled trial was a school-based obesity prevention program targeting adolescent girls in low SES schools in NSW, Australia. The aim was to evaluate the 12-month impact of key nutrition program messages on dietary intake and food behaviors. Diet was assessed using a validated semi-quantitative food frequency questionnaire (FFQ). Individual foods were categorized into nutrient-dense or energy-dense, nutrient-poor food groups and the percentage contribution to total energy intake calculated. Participants were aged 13.2 ± 0.5 years (n=330). There were no statistically significant group-by-time effects for dietary intake or food related behaviours, with 12-month trends suggesting more intervention group girls had improved water intakes (59% consuming ≤ three glasses per day to 54% at 12 months vs. 50% to 61% in controls, $p = 0.052$), with a greater proportion consuming < one sweetened beverage per day (24% to 41% vs. 34% to 37% in controls, $p = 0.057$).

Further research including more intensive nutrition intervention strategies are required to evaluate whether dietary intake in adolescent girls attending schools in low SES communities can be optimised.

Key words:

Female, adolescent, diet, intervention, obesity prevention

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INTRODUCTION

The comparison of dietary intake from two national nutrition surveys from 1985-1995 in Australian children and adolescents highlighted that reported energy intake had increased by 11-15% and was likely to have contributed to the rise in the prevalence of overweight and obesity over the same time period(Cook PA, Coles-Rutishauser I, & Allsopp R, 2001). However, results of cross-sectional studies have been mixed in terms of the relationship between weight status and dietary patterns in adolescents, with a review of diet and weight status across 34 countries suggesting that no relationship exists(Janssen et al., 2005). While this evaluation is confounded by the varying methods used to assess dietary intake and that under-reporting increases with adiposity(Rangan, Flood, & Gill, 2011; Rasmussen et al., 2007; Scagliusi et al., 2009), the results highlight that poor dietary habits are common in adolescence(Delva, O'Malley, & Johnston, 2006; Matthys et al., 2006; Utter, Scragg, Mhurchu, & Schaaf, 2007). The 2007 National Nutrition and Physical Activity Survey found that 51% of 9-13 year olds and just one percent of 14-16 year olds met the age specific recommendations for fruit intake in the Australian Guide to Healthy Eating (AGHE) of one serve per day for 4-13 year olds and three serves per day for 14-16 year olds. The proportion of 9-13 year olds and 14-16 year olds consuming two or more serves of vegetables/day (including potatoes) was 17% and 11% respectively and fell to just 2% for both groups when potatoes were excluded(Commonwealth Scientific Industrial Research Organisation, Preventative Health National Research Flagship, & Univeristy of South Australia, 2008; Kellet, Smith, & Schmerlaib, 1998). This is a major public health concern as dietary patterns that do not align with national guidelines are associated with higher morbidity and mortality(Wirt & Collins, 2009) and increased healthcare expenditure. The financial cost of obesity in Australia was estimated at over $8.2 billion in 2008 (Access Economics, 2008).

Dietary intake(Patterson, Warnberg, Kearney, & Sjostrom, 2009) has been shown to track from childhood into adolescence increasing the risk of premature Type 2 diabetes and cardiovascular disease (CVD)(Biro & Wien, 2010; Ledoux, Hingle, & Baranowski, 2011; Reilly, Ness, & Sherriff, 2007; Tailor, Peeters, Norat, Vineis, & Romaguera, 2010; Wake et al., 2010). The school based Project Eat cohort of >2500 adolescents in the USA reported socioeconomic position (SEP) and peer support to be positively associated with fruit and vegetable intake and negatively associated with fast food intake(Cutler, Flood, Hannan, & Neumark-Sztainer, 2011). There is evidence that adolescent girls of low SEP are more likely to follow unhealthy eating patterns, including breakfast skipping and higher intakes of energy-dense, nutrient-poor foods(Delva et al., 2006). Therefore, the aim of this paper was to report the impact of a school-based obesity prevention program targeting adolescent girls of low socio-economic position on dietary intake and behaviours.

METHODS

Study Design and Data Collection

The Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) study was a 12-month cluster randomized controlled trial (RCT) of a school based obesity prevention program targeting teenage girls from schools in areas of social and economic disadvantage. The intervention methods and 12-month outcomes for body composition and physical activity has been reported elsewhere (Dewar et al., In press; Lubans et al., 2010; Lubans, Morgan, et al., 2012). In summary, the intervention resulted in small non-significant reductions in BMI and body fat (bioelectrical impedance), but no impact on physical activity. The current analysis examined the impact on dietary intake. Data were collected at each school with physical measurements obtained first, then dietary intake self-reported under ‘exam-like’ conditions. Ethics approval was obtained from the University of Newcastle Human Research Ethics Committee and the New South Wales Department of Education and Training Human Research Ethics Committee.

Written informed consent was obtained from school principals, parents and assent from participants.

Participants and Recruitment

Students (n=357) were recruited from 12 government secondary schools located in the bottom 50% of the Socioeconomic Index for Areas (SEIFA)(NSW Labour Economics Office, 2008) measure of relative disadvantage in the Hunter, Newcastle and Central Coast regions of New South Wales, Australia. Female students in the second year of high school education who had been identified by their physical education teachers as being disengaged from physical education classes and/or not participating in an organized team or individual sport were recruited. Approximately 99% of eligible female students from each school consented and participated in the program as reported previously (Lubans, Morgan, et al., 2012). Based on their physical activity profiles and the clustering of health behaviors, including poor dietary pattern, high screen-time and inactivity among adolescents(Plotnikoff et al., 2009), these girls were considered to be at a high risk of obesity.

Schools allocated to the wait-list control group were provided with equipment packs and a condensed version of the intervention following the completion of 24-month assessments.

Intervention

Bandura's Social Cognitive Theory (SCT) (Bandura, 1986) provided the theoretical framework for the intervention's development. Specifically, the program adopted strategies to target the following psychological, behavioral and environmental influences on physical activity and dietary behavior: self-efficacy, social support, behavioral strategies, perceived physical environment, outcome expectations (perceived benefits) and expectancies (value placed on perceived benefits)(Lubans et al., 2010).

Each participant received a NEAT Girls physical activity and nutrition handbook that included 10 weeks of health information and home challenges designed to promote healthy eating and physical activity. To promote social support in the home environment, additional home challenges were also outlined in the handbook for parents. The handbook was focused on 10 key health messages, provided current Australian dietary and physical activity guidelines for adolescents, and a resource for daily self-monitoring of specific dietary and physical activity behaviours (e.g. daily servings of fruit and vegetables). **Table 1** summarizes how the program nutrition messages were integrated during the 10-week delivery of health information by teachers in the intervention schools. Specifically the nutrition messages targeted increases in fruit and vegetable consumption, daily breakfast, eating evening meals at a dinner table, monitoring portion size, drinking water, reducing sweetened beverages and reducing energy-dense nutrient-poor (EDNP) snacks. Table 1 also indicates the outcome measure used to evaluate how changes in the behaviours targeted by each message were ascertained.

Three practical nutrition workshops were delivered in the school food labs by dietitians (n =2) or final year under graduate dietetic student (TS) and were assisted by Physical Education teachers. These workshops reinforced the dietary-specific key health messages promoted in the handbook, and focused on providing dietary information and strategies designed to develop lifetime nutrition skills that facilitate the maintenance of a healthy weight. Tasks included the energy balance concept pertaining to kilojoule intake and expenditure, interpreting food labels, modifying recipes to reduce energy density of meals and snacks, appropriate portion sizes and the preparation of inexpensive healthy snacks and meals.

Other dietary-focused intervention strategies included parent newsletters and text messaging. Four newsletters provided parents of study participants with information and strategies to support healthy eating and physical activity behaviors in the home environment. For example, each newsletter included recipes for inexpensive and healthy meals and snacks, and provided suggestions for healthier alternatives to popular less healthy snacks and drinks. Regular text messages encouraged participants to implement targeted physical activity and healthy eating behaviors (e.g., 'Have you eaten some fruit today? Fresh fruit, dried fruit or canned fruit can count'). Text messages also provided information and strategies to support these behaviors (e.g., 'Snack fact: did you know that a Mars Bar contains 1145 kilojoules. A banana has only 320 kilojoules and makes you feel fuller for longer').

Dietary intake

The primary outcome was the percentage energy contributed from nutrient-dense, core food groups and EDNP food groups. Dietary intake was assessed using the Australian Child and Adolescent Eating Survey (ACAES) FFQ, which was previously evaluated for reliability and validity in Australian school students aged nine to 16 years(T. Burrows, Berthon, Garg, & Collins, 2012; T. L. Burrows, Warren, Colyvas, Garg, & Collins, 2009; Watson, Collins, Sibbritt, Dibley, & Garg, 2009). Comparative validity was evaluated by comparing nutrient intakes from food records with the FFQ using correlation, Kappa statistics and Bland-Altman plots and reproducibility by comparing two administration of the FFQ over a five month period. Validity correlation coefficients ranged from 0.03 for retinol to 0.56 for magnesium in the transformed, energy-adjusted, deattenuated nutrient data. Greater than 50% of participants were classified within one quintile for all nutrients, with 0-7% grossly misclassified, demonstrating reasonably accuracy for ranking individuals. Correlation coefficients for

reproducibility ranged from 0.18 for vitamin A to 0.50 for calcium for transformed, energy-adjusted, deattenuated nutrient data.

ACAES is semi-quantitative and evaluates usual intake of 120 food and beverage items over the previous six months by self-report, with 15 supplementary questions addressing food behaviours and hours spent in sedentary behaviour. Age group specific portion size data was obtained from unpublished data from the Australian Bureau of Statistics (ABS)(Australian Bureau of Statistics, 2009) and the 1995 National Nutrition Survey(Australian Bureau of Statistics, 1998) and 'natural' serve sizes for items such as a slice of bread. The frequency consumption options ranged from 'never' to '4 or more times per day' for foods, and up to '7 or more glasses per day' for drinks. Nutrient intakes were derived from the following databases without modification (Australian AusNut, All Foods, Revision 14 and AusFoods, Brands, Revision 5; 1999 Food Standards Australia New Zealand, Canberra, Australia) to generate group mean daily intake of twenty macro-and micronutrients intakes, using FoodWorks (version 3.02.581 Xyris Software Australia, Highgate Hill, Queensland). Specific FFQ questions were aggregated into food group representing nutrient-dense (core) food groups and EDNP (non-core) food groups, defined according to items in the Australian Guide to Healthy Eating and used to calculate the percentage contribution of food groups and subgroups to total energy intake(Kellet et al., 1998). Mis-reporting was defined based on the methods of Field et al. with <500kcal/day (2,090kJ) and >5000kcal/day (20,900kJ) per day removed from the dataset (24 removed at baseline and 18 removed at post-test) (Field et al., 2004; Field, Gillman, Rosner, Rockett, & Colditz, 2003).

Anthropometric measures

Anthropometric measures were obtained by trained research assistants. Weight was measured to the nearest 0.1kg using portable digital scales (Model no. UC-321PC, A&D Company Ltd,

Tokyo, Japan). A portable stadiometer was used to obtain height measurements to the nearest 0.1cm (Model no. PE087, Mentone Educational Centre, Australia). Body Mass Index (BMI) was calculated as weight (kg) divided by height (meters) squared and then categorized into underweight, healthy, overweight or obese categories using US reference data(Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007; Kuczmarski, Ogden, & Guo, 2002).

Sample Size

The sample size calculation for the NEAT Girls study was based on change in body mass index (BMI)(Cole, Faith, Pietrobelli, & Heo, 2005) and adjusted for the clustered nature of the data (intra-cluster correlation coefficient of 0.01)(Amorim, Bangdiwala, McMurray, Creighton, & Harrell, 2007). It was calculated that 30 participants from 12 schools would be needed to detect a between group difference of one BMI unit(Robinson et al., 2008). The calculations were based on an alpha level of 0.05, power of 80% and a 20% drop-out.

Data Analysis

Differences between groups at baseline were examined using chi squares and independent samples t-tests in PASW Statistics 17 software (SPSS Inc. Chicago, IL) and alpha levels were set at $p < 0.05$. Data were checked for normality and those that were not normally distributed were transformed using the square root function. Statistical analyses followed the intention to treat principle and were conducted using mixed models, which have the advantage of being robust to the biases of missing data. Data were analyzed using the PROC MIXED statement for continuous variables and the PROC GLIMMIX statement for dichotomous variables in SAS V9.1 (SAS Institute Inc Cary NC). It has been suggested that if the ICC are small and there is no meaningful difference among groups, the data may be analysed at the individual level(Heck, Thomas, & Tabata, 2010; Tabachnick & Fidell, 2007). Due to the relatively small

number of clusters and the low ICC values, the mixed models were not adjusted for the clustered nature of the data. Sub-group analyses were conducted with participants who were classified as overweight or obese at baseline for all dietary outcomes.

RESULTS

All 12 schools were retained in the study over the 12-month period, but 63 girls were not available for 12-month assessments; 153(85.5%) and 141(79.2%) girls were retained in the control and intervention groups, respectively (Figure 1). Participants who dropped out of the study or were not available for assessments had higher baseline BMI values (mean [SD], 23.81 [4.52] versus 22.39[4.56], p=0.025) values than study completers. At baseline, 172 and 158 participants provided useable FFQ data in the control and intervention groups, respectively. From this number, 150 (control group) and 126 (intervention group) participants provided useable data at post-test.

Baseline demographic characteristics of the NEAT Girls participants are summarized in table 2. The majority of the girls were of an Australian cultural background, with 43% either overweight or obese at baseline. The impact of the NEAT Girls intervention on body composition and physical activity has been reported elsewhere (Dewar et al., In press; Lubans, Morgan, et al., 2012). In summary, the intervention resulted in small non-significant reductions in BMI and body fat (bioelectrical impedance), but no impact on physical activity.

Table 3 reports the baseline, 12 month and 12 month post intervention change in total energy intake along with the proportion of total energy derived from key food group targeted in the intervention nutrition messages. Table 3 demonstrates the percentage of energy from EDNP foods was high at over 44% in both groups at baseline and this remained high and unchanged at 12 months. Table 4 summarizes the proportion of girls reporting specific dietary behaviors

by group over the 12-months. There were trends suggesting that more adolescent girls in the intervention group increased their water intake with a greater reduction in the proportion consuming ≤ three glasses water per day compared to the control girls (59 to 54% vs. 50 to 61%, p = 0.052). There was also a trend towards a reduction in soda consumption in the intervention group versus controls with a greater increase in the proportion consuming less than one sweetened beverage per day compared to the control girls (24 to 41% vs. 34 to 37%, p = 0.057). There was no other between group differences after 12 months.

The intervention effects on dietary outcomes among participants classified as overweight or obese at baseline were not statistically significant. However, there was a notable reduction in the proportion of participants consuming pre-packaged snacks more than three times a day in the intervention group (from 44.9% to 28.8%) compared to the control group (from 28.9% to 36.5%), which approached statistical significance (group-by-time p-value = 0.052).

DISCUSSION

The prevalence of overweight and obesity in this group of girls is high compared to 2007/08 Australian data where the prevalence of overweight in adolescent girls was 20% and obesity was 6%(Australian Bureau of Statistics, 2009). This highlights that amongst adolescent girls from low SES communities, the prevalence is almost twice that in the community generally. This pattern is consistent with a secular trend using data from 30 000 children aged 2–18 year from 1971 to 2002 in the US National Health and Nutrition Examination Surveys in which the relationship between SES and overweight in over, was found to be even more marked amongst white girls(Wang & Zhang, 2006).

Of concern is that when the dietary patterns are scrutinized, the majority of teenage girls from schools in low income communities consume close to half of their total daily kilojoule intake

305 from EDNP foods. This is in stark contrast to the recommended maximum of approximately
306 12% of energy intake, based on the Australian Guide to Health Eating(Kellet et al., 1998).
307 This mismatch increases the likelihood of excessive energy intakes, long-term sub-optimal
308 nutrient intakes and development of diet related chronic conditions such as osteoporosis, type
309 2 diabetes and cardiovascular disease(Erkkila & Lichtenstein, 2006; Esterle et al., 2009).
310 Although time effects were demonstrated for a number of food items, including percentage
311 energy from vegetables, candy and take-out foods, there were no statistically significant
312 between group differences over time. In the current study a greater proportion of the girls
313 reported having take-out weekly or more often (> 60%) compared to national nutrition survey
314 data within low SES population groups where 40% of girls in a similar age group consumed
315 take-out once a week or more often(Cancer Council Australia & National Heart Foundation,
316 2011). The 12-month trends suggesting that adolescent girls in the intervention group
317 increased their water intake and reduced soda consumption are encouraging and suggest that
318 the program message from Week 8 to 'Drink more water and swap sugary drinks for sugar-
319 free drinks' is the message that the girls were most able to implement. This is an important
320 trend given recent data indicating that adolescent girls from lower SES groups do consume
321 greater amounts of sugar sweetened soda compared to those from higher SES
322 categories(Cancer Council Australia & National Heart Foundation, 2011). Given the data is
323 only a trend, this does require further examination in future studies. However, given the data
324 is only a trend, this requires further examination in future studies. However, in a meta-
325 analysis of 11 prospective cohort studies of sugar sweetened beverages (SSB) intake
326 (n=310,819 and 15,043 cases of type 2 diabetes) those in the highest intake quantile (1-2
327 servings/day) had a 26% greater risk of developing type 2 diabetes (relative risk [RR] 1.26
328 [95% CI 1.12-1.41]) and a 20% greater risk of metabolic syndrome (RR 1.20 [1.02-1.42])
329 over time. This highlights the importance of targeting reductions in SSB intake even if small,

as a strategy to reduce obesity-related chronic disease risk. There were no between group differences found after 12 months for any of the other dietary outcomes examined.

Our null findings for dietary intake are similar to those by Rosenkranz et al 2010 who randomized junior Girl Scout troops to either standard care or a lifestyle intervention program, administered by the troop leaders(Rosenkranz, Behrens, & Dzewaltowski, 2010). The intervention, modelled on SCT, consisted of an educational curriculum, Troop meeting policies and badge assignments. The intervention group troop meetings actively promoted healthy eating and physical activity. Dietary intake was assessed using a fruit and vegetable index calculated from a questionnaire measuring consumption frequency and daily servings. Following the seven-month intervention period, there was no difference in fruit, vegetables, sugar sweetened beverage consumption or BMI z-score(Rosenkranz et al., 2010). By comparison Neumark-Sztainer et al (2010) found that in the 'New Moves' RCT, conducted in six US secondary schools over nine months, that there was no change in BMI or % body fat amongst female students randomized to a behaviour-focused intervention program(Neumark-Sztainer et al., 2010). There was no objective change in dietary intake, assessed by a single 24-hr recall. However, sedentary behaviours, portion control, self-image and weight-control behaviours improved significantly compared to the control group, as did the stage-of-change and goal-setting for positive eating and physical activity(Neumark-Sztainer et al., 2010). Portion control was the only specific dietary behaviour to change and while this was not evaluated in the current study, due to the use of a semi-quantitative FFQ, the magnitude of the trends towards changes in consumption frequency suggest that additional strategies are required to enhance the impact of school based physical activity and nutrition intervention. Interestingly, one approach adopted by the NEW Moves study that did show promise was the use of individualized counselling component (Flattum, Friend, Story, & Neumark-Sztainer,

2011). The individualized sessions, which incorporated motivational interviewing strategies, allowed girls to personalize the intervention by setting their own targeted behavioural goals based on personal needs (e.g., to increase breakfast frequency when low breakfast intake was established at baseline). Hence the promotion of strategies for healthy eating that were redundant to the individual could be eliminated. Flattum et al (2011) concluded that this approach was feasible following an 80% compliance rate of girls who participated in ≥5 motivational interviewing sessions, and 95% of girls who reported satisfaction with the individualized approach. Hence the authors encouraged further research into this approach as a potential way to enhance behaviour change (Flattum et al., 2011).

The current findings highlight the challenges of working with adolescent girls to change dietary behaviours implicated in unhealthy weight gain. There are several possible explanations for the null findings reported. Besides the absence of an intervention effect on dietary outcomes, insufficient power to detect changes in dietary intake may have been problematic. In addition, it is possible that poor participation rates and program compliance may have compromised intervention dose. For instance, only 9% of the healthy eating and physical activity home challenges were completed by intervention girls, and attendance rates for the nutrition workshops (65%) was moderate(Lubans, Morgan, et al., 2012). Even though girls rated the nutrition workshops as the second most enjoyed component of the NEAT Girls program, teachers communicated constraint by other school-based responsibilities which may have adversely impacted the full delivery of some intervention components such as the workshops. This suggests that while a more intensive intervention may be less feasible in these schools, future studies need to find ways in which to optimise exposure and engagement with the nutrition component within school-based intervention, in order to maximise program impact and achieve sustainability. This could potentially include enhancing the opportunities

for exposure to the program messages through use of technology, such as a program website that would allow the students and their parents to greater access and exposure to the intervention components. Meanwhile, all parental newsletters (n = 4) and text messages (n = 58) were sent to valid addresses and phone numbers for 75% and 91% of intervention girls respectively. However, data was not collected to determine what proportion of newsletters and text messages were actually received and read. Parents play an important and powerful role in shaping adolescent eating behaviors through shared genes, environments and experiences(Savage, Fisher, & Birch, 2007). Parents influence these food patterns and behaviours through food availability and restriction, role modelling, family traditions and feeding practices with lower levels of parental education, particularly maternal education associated with poorer dietary habits amongst adolescents(Nilsen, Krokstad, Holmen, & Westin, 2010). The current study suggests parents need more guidance in terms of parenting strategies to optimise nutrient intakes, weight status and health given that the eating behaviours of their adolescent daughters that they have most control, such as the number of meals eaten in front of television and whether vegetables are served with the evening meal did not improve. These aspects of NEAT could be enhanced in future studies, particularly given that a systematic review has identified frequency of shared family meals as strongly related to the nutritional health of adolescents(Hammons & Fiese, 2011).

Inaccurate measurement of dietary intake may also be a contributing factor to the null findings. Use of an FFQ may have resulted in intakes of specific foods being missed due to omission from questionnaire items, or have led to misreporting of intake in association with higher weight status(Collins, Watson, & Burrows, 2010). The repeat administration of the FFQ may also have distorted reporting due to increased awareness of their diet intake over

time. However, the advantage of using an FFQ, particularly in adolescent girls, is that they have a lower respondent burden compared to other methods(Magarey et al., 2011) .

Finally, we have previously shown that self-efficacy is positively associated with healthy eating and inversely associated with unhealthy eating, intention did not predict dietary behaviors(Lubans, Plotnikoff, et al., 2012). Guided by the SCT, the NEAT Girls intervention was designed to target individual and intrapersonal level constructs to improve healthy eating through strategies such as texting and parental newsletters for social support and nutrition workshops for developing dietary self-efficacy. Future studies need to examine alternative mechanisms of dietary behaviour derived from integrated and socio-ecological models where individual, intrapersonal and broader environmental level strategies are combined.

While the current NEAT Girls study was not powered to detect changes in dietary intake measures, small changes in intake and dietary behaviors may be important, given that even small reductions in energy intake of approximately 100 kcal/day, along with small increases in physical activity help prevent weight gain(Plotnikoff et al., 2009). Targeting small changes across a range of behaviours is important as poor dietary behaviours and low physical activity levels have been reported to cluster in adolescents (Plotnikoff et al., 2009) and larger trials powered for dietary change as a primary outcome are needed.

The main limitations in the current analysis are related to the use of an FFQ as the dietary intake assessment method. It is possible that the ACAES FFQ was not sensitive enough to identify between-group differences, considering the complexity of dietary intake and hence capturing dietary behaviours. While, the FFQ has been validated against plasma carotenoids as biomarker of child fruit and vegetable intake(T. Burrows et al., 2012; T. L. Burrows et al.,

2009) and for fatty acids using red blood cell membrane fatty acids (ref), it has not been validated for food or water intakes and this could be a future research focus. Conversely, results need to be interpreted with caution due to a potential halo effect with the girls over-reporting their intakes of healthier foods and under-reporting intakes of energy-dense, nutrient-poor foods, particularly at baseline(Collins et al., 2010; Magarey et al., 2011). Given that under-reporting is greater in those who are overweight or obese compared with those in the healthy weight range(Rangan et al., 2011; Rasmussen et al., 2007; Scagliusi et al., 2009), results need to be interpreted with caution. In order to reduce the impact of mis-reporting of energy, the dietary data were expressed predominantly as the percentage contribution of food group to total energy intake, as has been recommended(Cook PA et al., 2001; Hirvonen, Mannisto, Roos, & Pietinen, 1997). Of note is that that the ACAES FFQ has been able to detect changes in dietary intake after both one (T. Burrows, Warren, Baur, & Collins, 2008) and two years (T. Burrows, Janet, & Collins, 2011) following a child obesity intervention. Meanwhile, a strength of the current study is that it was conducted within the usual school environment and utilized a cluster RCT across a large number of schools located in areas of socio-economic disadvantage.

The NEAT Girls obesity prevention trial suggests that the behaviours to target in future studies should be related to sweetened beverages and that this behaviour may be the most amenable to change in adolescent girls. However the lack of statistically significant findings suggest that either the intervention did not target other behaviours strongly enough or that the dietary intake tool was not sufficiently sensitive to detect changes. Alternatively, consumption patterns of specific foods may be more dependent on the behaviour of other members of an adolescent girl's environment such as peers, siblings, parents or care givers.

CONCLUSION

Future obesity prevention trials adequately powered to detect dietary intake change and vary the intensity of the nutrition intervention components are warranted in adolescent girls, either in combination with physical activity education or directed at nutrition through other curriculum components.

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