ARTICLE

Preventing Obesity Among Adolescent Girls

One-Year Outcomes of the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) Cluster Randomized Controlled Trial

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Objective: To evaluate the impact of a 12-month multicomponent school-based obesity prevention program, Nutrition and Enjoyable Activity for Teen Girls among adolescent girls.

Design: Group randomized controlled trial with 12-month follow-up.

Setting: Twelve secondary schools in low-income communities in the Hunter and Central Coast regions of New South Wales, Australia.

Participants: Three hundred fifty-seven adolescent girls aged 12 to 14 years.

Intervention: A multicomponent school-based intervention program tailored for adolescent girls. The intervention was based on social cognitive theory and included teacher professional development, enhanced school sport sessions, interactive seminars, nutrition workshops, lunch-time physical activity sessions, handbooks and pedometers for self-monitoring, parent newsletters, and text messaging for social support.

Main Outcome Measures: Body mass index (BMI, calculated as weight in kilograms divided by height in meters squared), BMI *z* score, body fat percentage, physical activity, screen time, dietary intake, and self-esteem.

Results: After 12 months, changes in BMI (adjusted mean difference, –0.19; 95% CI, –0.70 to 0.33), BMI *z* score (mean, –0.08; 95% CI, –0.20 to 0.04), and body fat percentage (mean, –1.09; 95% CI, –2.88 to 0.70) were in favor of the intervention, but they were not statistically different from those in the control group. Changes in screen time were statistically significant (mean, –30.67 min/d; 95% CI, –62.43 to –1.06), but there were no group by time effects for physical activity, dietary behavior, or self-esteem.

Conclusions: A school-based intervention tailored for adolescent girls from schools located in low-income communities did not significantly reduce BMI gain. However, changes in body composition were of a magnitude similar to previous studies and may be associated with clinically important health outcomes.

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OBESITY PREVENTION IS A global health priority[1] because pediatric weight status is associated with a range of adverse health outcomes[2] and obese youth are at an elevated risk for obesity in adulthood.[3] The prevalence of child and adolescent obesity has increased considerably during the past 30 years and current estimates suggest that approximately a quarter of youth in developed nations are overweight or obese.[4,5] Although there is evidence to suggest that levels of obesity have plateaued in recent years,[6] this trend has not been observed among youth living in low-income communities.[7,8]

Schools have been identified as important institutions for the promotion of healthy lifestyles[9] and provide access to populations at risk for obesity, such as adolescents living in low-income communities. Although evidence for the long-term effects of school-based obesity prevention programs is limited,[10] recent high-quality studies have demonstrated that these interventions can prevent unhealthy weight gain in youth.[11-13] Multicomponent school-based interventions targeting groups at risk for obesity can be effective, but further testing in long-term rigorously designed studies is needed.[9,14]

The importance of designing and implementing obesity prevention programs for preadolescent and adolescent girls living in low-income communities has emerged in the literature.[15-17] The physical activity decline associated with adolescence is steeper among girls[18] and unhealthy weight gain is often observed in this cohort.[19,20] The aim of the current study is to evaluate the effects of the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) program,[21] a 12-month school-based group randomized controlled trial designed to prevent unhealthy weight gain in adolescent girls living in low-income communities. This article reports the 12-month intervention effects.

METHODS

STUDY DESIGN AND PARTICIPANTS

Ethics approval for the study was obtained from the relevant university and school board human ethics committees. School principals, parents, and study participants provided written informed consent. The design, methods, and characteristics of participants at baseline have been reported in detail elsewhere.[22] In summary, NEAT Girls was a group randomized controlled trial, and the design, conduct, and reporting of the trial adhere to Consolidated Standards of Reporting Trials guidelines.[23] Baseline assessments were conducted in May through June 2010 and 12-month (immediate posttest) assessments were completed in May through June 2011.

The intervention was designed for adolescents from schools located in low-income communities, and the Socio-Economic Indexes for Areas of relative socioeconomic disadvantage were used to identify eligible secondary schools. The Socio-Economic Indexes for Areas (scale, 1=lowest to 10=highest) summarize the characteristics of people and households within an area. State-funded government secondary schools located in the Hunter and Central Coast areas in New South Wales, Australia, with a Socio-Economic Indexes for Areas score of 5 or less (bottom 50%) were considered eligible for inclusion. Eighteen schools in the Central Coast and Hunter regions met our eligibility criteria and all of these schools were invited to participate. Twelve secondary schools were recruited and eligible study participants were adolescent girls in grade 8 (second year of secondary school).

SAMPLE SIZE CALCULATION AND RANDOMIZATION

The sample size calculation was based on change in body mass index (BMI, calculated as weight in kilograms divided by height in meters squared).[24] Assuming an α of 0.05, power of 80%, and a 20% dropout rate, we calculated that we would require 30 participants from each of the 12 schools to detect a between-group difference of 1 BMI unit[25] using a BMI standard deviation of 1.5,[12] and an intraclass correlation coefficient of 0.01.[26] Following baseline assessments, the 12 schools were matched (ie, 6 pairs of schools) based on their geographic location, size, and demographics.[27] An independent researcher then randomized each pair to either the NEAT Girls intervention or control groups.

INTERVENTION

The NEAT Girls intervention was informed by the Program X pilot study[28,29] and a detailed description of the intervention has been reported previously.[22] The intervention was guided by Bandura's social cognitive theory[30] and targeted evidence-based psychological (ie, self-efficacy, outcome expectations, and outcome expectancies), behavioral (ie, goal setting and self-monitoring), and environmental (ie, teacher, family, and peer support) influences on physical activity and nutrition behavior change.[31,32] The intervention included the following components: enhanced school sport sessions, interactive seminars, nutrition workshops, lunch-time physical activity sessions, handbooks and pedometers for self-monitoring, parent newsletters, and text messaging for social support. To facilitate the implementation of the NEAT Girls program, school champions (ie, teachers responsible for the delivery of the program) from the intervention schools attended a 1-day training workshop at the local university. The intervention was focused on promoting lifetime physical activities, reducing sedentary behaviors, and encouraging low-cost healthy eating, and it was delivered during 4 school terms (ie, 12 months) at no additional financial cost to the school or students. All intervention schools were provided with a standard equipment pack (value=US $1300), which consisted of a range of equipment (eg, elastic tubing resistance training devices, fitness balls, and yoga and Pilates resources) designed to support the promotion of lifetime physical activities.

NEAT Girls was based on well-defined messages designed to promote physical activity and healthy eating and reduce sedentary behavior,[22] which were reinforced using the intervention components. The enhanced school sport sessions (60-80 minutes) were delivered by teachers and involved a range of activities organized into 4-week units. For the first school term, the enhanced school sport sessions included an information component (10-15 minutes) delivered by teachers from the study schools. Members of the research team delivered 3 interactive seminars that focused on the benefits of physical activity and healthy eating as well as key behavioral messages. Participants were provided pedometers[33] and handbooks and were encouraged to use these resources to monitor their lifestyle physical activity participation.

Three practical nutrition workshops were delivered in the study schools by accredited practicing dietitians. The sessions were designed to provide students with the confidence to select, prepare, and consume healthy low-cost foods. Parents of participants were sent study newsletters at 4 periods during the 12-month intervention. The first newsletter reported their children's time spent in physical activity, sedentary behaviors, and self-reported fruit and vegetable consumption. All of the newsletters included information to increase awareness and encourage parents to support their children's physical activity and dietary behaviors. To reinforce the targeted behaviors, the girls were sent text messages weekly during the second and third terms and biweekly during the fourth term of the program's delivery (eg, "Sitting down for long periods of time is bad for you, but what makes it worse is that people often eat junk while sitting down in front of the TV. Try to avoid eating dinner while watching TV").

To assist in the recruitment of schools and prevent resentful demoralization or compensatory rivalry,[27] the control group was provided with equipment packs and a condensed version of the intervention following the completion of 24-month assessments.

ASSESSMENTS AND MEASURES

Data collection took place in the study schools and was conducted by trained research assistants blinded to group allocation at baseline only.

Primary Outcome Measures

Body mass index was the primary outcome.[2] Weight was measured in light clothing without shoes using a portable digital scale (Model No. UC-321PC; A&D Company Ltd) and height was measured using a portable stadiometer (Model No. PE087; Mentone Educational Centre). Body mass index weight categories were based on BMI *z* scores, which were calculated using the LMS method.[34] Body fat percentage was determined using the Imp SFB7 bioelectrical impedance analyzer.[35]

Secondary Outcome Measures

The 90° push-up and the prone support tests[36] were used to provide measures of upper body muscular endurance and core abdominal isometric muscular endurance, respectively. Participants wore Actigraph accelerometers (MTI models 7164, GT1M, and GT3X)[37] for 7 consecutive days. Trained research assistants fitted the monitors and explained the monitoring procedures to participants.[38] Participant data were included in the analyses if accelerometers were worn for 600 minutes or more on 4 days or more (including 1 weekend day)[39] and age- and sex-specific cut points were used to categorize activity intensity.[40] Dietary intake was assessed using the previously validated Australian Eating Survey food frequency questionnaire and total energy (ie, total kilocalories per day and total kilocalories per kilogram per day) was presented as a summary variable to represent dietary intake.[41] The Adolescent Sedentary Activity Questionnaire was used to provide a self-report of screen time (ie, watching television/videos/DVDs and using computers and electronic communication).[42] Participants completed selected scales from Marsh's Physical Self-description Questionnaire (ie, perceived body fat, physical self-esteem, and global self-esteem).[43]

Process Evaluation

A detailed process evaluation was conducted and included attendance/reach (ie, attendance at enhanced school sport sessions, lunch-time physical activities and nutrition workshops, and percentage of students who provided postal addresses and mobile phone numbers and were sent all 4 newsletters and 58 text messages), intervention fidelity (ie, 24 randomly selected sessions were observed by a member of the research team), and program satisfaction (ie, girls completed detailed process evaluation questionnaires at the completion of the study). Although the enhanced school sport sessions were designed to be flexible in delivery, the fidelity of each session was assessed using the following criteria (yes=1, no=0): (1) Was there 60% or greater student attendance at the session? (2) Was the session delivered by the school champion? (3) Did the school champion deliver the session using the program handbook? (4) Did the session follow the basic structure outlined in the handbook?

STATISTICAL ANALYSES

Differences between groups at baseline were examined using chi squares and independent sample *t* tests in PASW Statistics 17 (SPSS Inc) software and α levels were set at $P < .05$. 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.[44] The models were specified to adjust for the clustered nature of the data and the analysis conducted using established models.[27] The mixed models were analyzed using the PROC MIXED statement in SAS version 9.1 (SAS Institute Inc).

RESULTS

School and participant recruitment, enrollment, and flow are provided in the **Figure**. Twelve schools were recruited and 357 participants were assessed at baseline, representing 99.2% of the targeted sample size (**Table 1**). There were no statistically significant differences between intervention and control groups for any of the outcomes at baseline. Sixty-three girls were unavailable for 12-month assessments; 153 (85.5%) and 141 (79.2%) girls were retained in the control and intervention groups, respectively. The girls who dropped out of the study had higher baseline BMI (mean [SD], 23.81 [4.52] vs 22.39 [4.56]; $P = .03$) and BMI *z* score (mean [SD], 1.11 [1.06] vs 0.73 [1.15]; $P = .02$) values than those who completed the study.

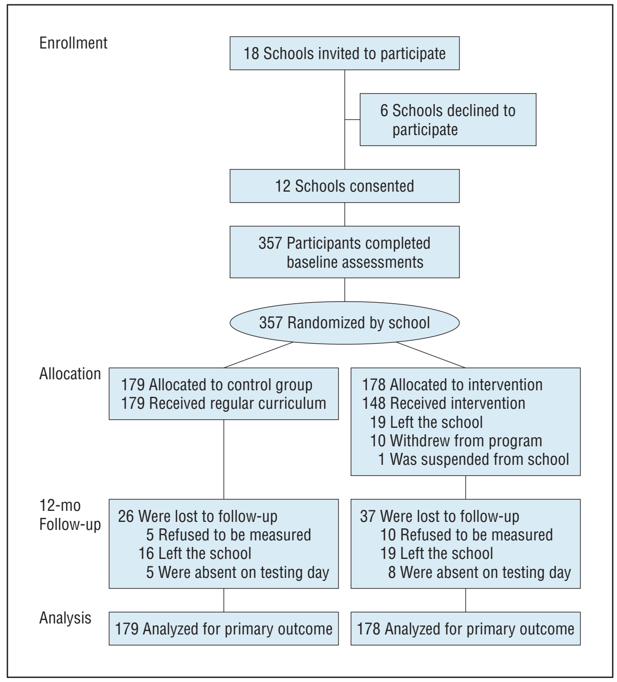

Figure. Flowchart of participants throughout the study.

PRIMARY AND SECONDARY OUTCOMES

Outcomes are reported in **Table 2**. Changes in body composition were all in favor of the intervention group, but there were no statistically significant between-group differences in BMI (primary outcome), BMI *z* score, or body fat percentage. Girls in the intervention group reported significantly less screen time than girls in the control group (mean, −30.67 min/d; 95% CI, −62.43 to −1.06). Compliance with our accelerometer monitoring was poor (ie, a mean [SD] of 191 [53.5%] and 89 [24.9%] participants wore accelerometers for 600 minutes or more on 4 or more days including a weekend day at baseline and posttest, respectively) and there were no differences between groups on any of the physical activity outcomes. Muscular fitness, dietary intake, physical self-perceptions, and self-esteem remained relatively stable during the study period for both intervention and control girls with no differences between groups.

INTERVENTION IMPLEMENTATION AND PROCESS OUTCOMES

A total of 148 girls received the intervention (83.1%). Students' mean (SD) attendance at school sport sessions was

Table 1. Characteristics of Study Sample

Characteristics	Control (n=179)	NEAT Girls (n=178)	Total (N=357)
Age, mean (SD), y	13.20 (0.45)	13.15 (0.44)	13.18 (0.45)
Participants born in Australia, No. (%)	174 (97.2)	175 (98.3)	349 (97.8)
English language spoken at home, No. (%)	176 (98.3)	176 (98.9)	352 (98.6)
Cultural background, No. (%)[a]			
Australian	153 (85.5)	152 (85.4)	305 (85.4)
Asian	1 (0.6)	3 (1.7)	4 (1.1)
European	18 (10.1)	18 (10.1)	36 (10.1)
Other	7 (4.0)	4 (2.2)	11 (3.1)
Socioeconomic position, No. (%)[b]			
1-2	47 (26.4)	28 (15.8)	75 (21.1)
3-4	28 (15.7)	59 (33.1)	87 (24.5)
5-6	96 (53.6)	87 (49.2)	183 (51.3)
7-8	6 (3.4)	3 (1.7)	9 (2.5)
9-10	1 (0.6)	0	1 (0.3)
Weight, mean (SD), kg	58.37 (13.78)	58.41 (14.15)	58.39 (13.95)
Height, mean (SD), m	1.61 (0.07)	1.60 (0.06)	1.60 (0.07)
BMI, mean (SD)	22.59 (4.49)	22.70 (4.68)	22.64 (4.58)
BMI *z* score, mean (SD)[c]	0.78 (1.17)	0.82 (1.12)	0.80 (1.14)
BMI category, No. (%)[c]			
Underweight	1 (0.6)	1 (0.6)	2 (0.6)
Healthy weight	99 (55.3)	103 (57.9)	202 (56.6)
Overweight	50 (27.9)	43 (24.2)	93 (26.1)
Obese	29 (16.2)	31 (17.4)	60 (16.8)

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).
[a] One participant did not report her cultural background.
[b] Socioeconomic position by population decile using Socio-Economic Indexes for Areas of relative socioeconomic advantage and disadvantage based on home post code. 1 is the lowest and 10 the highest. Two participants did not report home post code.
[c] BMI *z* score and categories based on LMS method.

60.6% (26.0%). On average, girls attended 65.0% (25.1%) of the nutrition workshops, 24.6% (28.1%) of the optional lunch-time sessions, and completed 8.8% (25.7%) of the home physical activity and nutrition challenges. Intervention delivery fidelity was found to be 74.0%. All 4 of the parental newsletters were sent to valid addresses for 74.5% of girls in the intervention group. A total of 58 text messages were sent to 91% of girls in the intervention group. Overall, girls were satisfied with the program (mean [SD], 3.52 [1.24]; rating scale, 1=strongly disagree to 5=strongly agree). The enhanced school sport sessions (41.7%) and the nutrition workshops (38.7%) were the 2 intervention components enjoyed most by girls. No injuries or adverse effects were reported during the activity sessions or assessments.

COMMENT

NEAT Girls is a multicomponent school-based obesity prevention program targeting adolescent girls from secondary schools located in low-income communities. The intervention effects on body composition were small and not statistically significant but have potential clinical importance. Girls in the intervention group spent 30 minutes per day less in screen-based activities than their control group peers. High levels of screen time are associated with a range of adverse health consequences,[45] and our findings have important implications that may help address the increasing burden of pediatric and adolescent obesity observed in areas of social and economic disadvantage.

Behaviors, attitudes, and physical morbidity that develop during adolescence have profound implications for current and future health,[46] yet surprisingly, few adolescent obesity prevention interventions have been designed and evaluated. The challenges of working with adolescents[46] may explain both the small number of studies and their modest results. Small differences can be meaningful at the population level, and the favorable changes in BMI *z* score (mean, −0.08; 95% CI, −0.20 to 0.04) and body fat percentage (mean, −1.09; 95% CI, −2.88 to 0.70) observed in our study may have both clinical significance and important public health implications. A recent longitudinal study[47] found that a 1% increase in body fat percentage was related to increases of 1.042 mg/dL and 0.621 mg/dL (to convert to millimoles per liter, multiply by 0.0259) in total cholesterol in boys and girls, respectively. Similarly, the school-based diabetes risk reduction intervention, known as the HEALTHY study, resulted in a small but statistically significant reduction in BMI *z* score (ie, −0.05), which was accompanied by smaller increases in fasting insulin levels. Increases in body fat during youth are consistently associated with adverse changes in plasma lipids[47,48] and further examination of the health implications of weight gain during this period will help to determine the clinical importance of intervention effects.

A number of recent obesity prevention interventions targeting adolescent and preadolescent girls have been evaluated in school and community settings. The New Moves intervention was similar in size and intervention design to the NEAT Girls program, but improvements in body composition were half the magnitude to those observed in our study (adjusted differences in BMI and body fat percentage were −0.10 and −0.46, respectively). The Stanford and Memphis GEMS interventions[15,17] were 2 well-designed obesity prevention interventions targeting unhealthy weight gain in preadolescent girls from low-income communities. The interventions resulted in positive changes in secondary outcomes (eg, reduced fasting total cholesterol levels and depressive symptoms), but there were no treatment effects for BMI. Although both schools and community settings offer promise for the prevention of obesity in youth, more work is needed to translate the strong effects typically observed in small-scale efficacy studies to large-scale effectiveness trials.

Girls in the intervention group did not increase their physical activity, but significant differences in screen time were observed during the study period. The large reductions in self-reported screen time represent one-quarter of participants' daily limit and such changes have important health implications. Young people spend 2 to 4 hours per day in screen-based recreation and 5 to 10 hours per day sedentary, both of which are associated with a range of adverse health consequences.[45] Targeting time spent in sedentary behavior has emerged as an effective

Table 2. Changes in Primary and Secondary Outcomes Measures and Group Differences

Measure	Baseline, Mean (SD)		12 Months, Mean (SD)		Adjusted Difference in Change (95% CI)[a]
	Control Group (n=179)	Intervention Group (n=178)	Control Group (n=153)	Intervention Group (n=141)	
BMI	22.59 (4.49)	22.70 (4.70)	23.37 (4.68)	23.30 (4.71)	−0.19 (−0.70 to 0.33)[b]
BMI *z* score	0.78 (1.16)	0.82 (1.12)	0.81 (1.17)	0.76 (1.16)	−0.08 (−0.20 to 0.04)[b]
Body fat (%)	28.31 (6.76)	29.58 (6.54)	32.55 (5.87)	32.72 (5.85)	−1.09 (−2.88 to 0.70)[b]
Push-up test, repetitions[c]	11 (6 to 16)	10 (6 to 16)	10 (6 to 16)	11 (7 to 19)	2.38 (−2.47 to 7.22)[b]
Prone support test, s[c]	36.8 (25.6 to 64.2)	44.0 (28.4 to 67.0)	42.8 (26.0 to 62.0)	50.0 (31.8 to 69.0)	−4.44 (−17.93 to 9.04)
Accelerometer counts/min[c,d]	363.0 (313.2 to 568.9)	388.6 (310.8 to 459.7)	360.1 (265.0 to 452.6)	322.1 (270.5 to 392.7)	−46.19 (−123.26 to 31.88)
MVPA, min/d[c,d]	32.0 (24.7 to 42.1)	33.5 (20.5 to 40.1)	25.0 (16.5 to 41.7)	21.5 (15.9 to 28.9)	−4.28 (−13.82 to 5.25)
Daily screen time, min/d[c]	220.7 (162.7 to 341.8)	240.0 (161.8 to 368.6)	248.6 (177.9 to 355.7)	231.4 (161.8 to 375.4)	−30.67 (−62.43 to −1.06)[b]
Weekday screen time, min/d[c]	209.0 (156.0 to 289.0)	216.0 (142.5 to 349.5)	236.0 (156.0 to 333.5)	222.0 (142.5 to 326.1)	−25.39 (−54.14 to 3.36)[b]
Weekend screen time, min/d[c]	255.0 (150.0 to 420.0)	300.0 (178.8 to 450.0)	300.0 (180.0 to 608.0)	285.0 (180.0 to 420.0)	−42.90 (−100.41 to 14.61)[b]
Daily energy intake, kcal/d	2241.2 (1259.8)	2598.8 (1763.6)	2233.8 (1551.9)	2524.8 (1610.0)	−62.0 (−464.2 to 340.3)[b]
Daily energy intake per kcal/kg/d[c]	36.7 (106.4 to 214.2)	35.6 (110.4 to 222.3)	33.1 (93.9 to 193.6)	35.7 (98.4 to 226.5)	−0.52 (−7.31 to 6.27)[b]
Perceived body fat, low=1 to high=5	3.88 (1.51)	3.75 (1.48)	3.78 (1.46)	3.84 (1.49)	0.19 (−0.10 to 0.47)[b]
Physical self-esteem, low=1 to high=5	3.74 (1.25)	3.71 (1.26)	3.63 (1.17)	3.75 (1.28)	0.17 (−0.15 to 0.48)[b]
Global self-esteem, low=1 to high=5	4.28 (1.01)	4.16 (1.09)	4.29 (0.99)	4.09 (1.10)	−0.08 (−0.30 to 0.14)

Abbreviations: BMI, body mass index calculated as weight in kilograms divided by height in meters squared; MVPA, moderate-to-vigorous physical activity.
[a] Adjusted mean difference and 95% confidence interval between NEAT Girls and control groups after 12 months (intervention minus control).
[b] Changes in favor of the intervention group.
[c] Data were transformed owing to non-normality; median and interquartile ranges provided.
[d] 191 and 89 participants wore accelerometers for 600 min or more on 4 or more days including a weekend day at baseline and posttest, respectively.

strategy for preventing unhealthy weight gain in youth.[49,50] Screen time is associated with unhealthy dietary behaviors in youth[51] and the reductions in screen time observed in the intervention group may have helped to reduce energy intake. Although we did not observe clinically important changes in total energy intake, this could be owing to the lack of sensitivity in the food frequency questionnaire used in our study.

Culturally appropriate obesity prevention interventions appear to be more effective than those that disregard cultural identity.[21] Although NEAT Girls was not targeted toward a specific cultural group, the importance of addressing cultural uniqueness is relevant to our study and we employed a number of strategies to ensure that the intervention was tailored and relevant to the participants. For example, the intervention logo and materials were branded and tailored to appeal to adolescent girls. A variety of novel strategies were used to engage girls in the interactive seminars (eg, game show format) and participants were encouraged to bring their own music to be played on a portable digital music player in the enhanced school sports sessions. The enhanced sports sessions focused on lifetime activities that are appealing to adolescent girls and the nutrition workshops involved the preparation of inexpensive healthy snacks and meals. Both the enhanced school sports sessions and the nutrition workshops were rated favorably by girls, but the attendance at sessions was not as high as anticipated. NEAT Girls involved parental newsletters and home challenges to engage parents in the intervention, but we did not survey parents and cannot determine whether parental behaviors and support changed as a result of the intervention.

The strengths of this study include the group randomized controlled trial design, the monitoring of intervention compliance, the unique study population, and the high level of participant retention. However, there are some limitations that should be noted. First, despite employing a number of strategies to improve monitoring compliance, only a small number of participants provided useable accelerometer data at baseline (53.5%) and posttest (24.9%). Second, dietary intake was assessed using a food frequency questionnaire, which lacks sensitivity to detect small changes in energy intake. Third, we underestimated the school-level intraclass correlation coefficients for the body composition variables in the NEAT Girls study, which resulted in reduced statistical power. Given the higher than expected intraclass correlation coefficients and the small number of clusters, we conducted additional statistical analyses that adjusted for the clustered nature of the data but did not include time as a random effect in the statistical models. In these models, we found a significant intervention effect for body fat percentage ($P = .02$) and a marginally significant effect for BMI *z* score ($P = .10$). Finally, screen time was measured using self-report and the results may be influenced by experimenter expectancies and evaluation apprehension.

In summary, the NEAT Girls intervention resulted in small improvements in body composition and large reductions in self-reported screen time. Our findings demonstrate the potential for multicomponent school-based interventions for the prevention of unhealthy weight gain in adolescent girls attending schools in low-income communities.

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REFERENCES

1. Wang LY, Chyen D, Lee S, Lowry R. The association between body mass index in adolescence and obesity in adulthood. *J Adolesc Health*. 2008;42(5):512-518.
2. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics*. 1998;101(3, pt 2)(supp):518-525.
3. Singh AS, Mulder C, Twisk JWR, van Mechelen W, Chinapaw MJM. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9(5):474-488.
4. Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. *Obes Rev*. 2003;4(4):195-200.
5. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. *JAMA*. 2010;303(3):242-249.
6. Olds TS, Tomkinson GR, Ferrar KE, Maher CA. Trends in the prevalence of childhood overweight and obesity in Australia between 1985 and 2008. *Int J Obes (Lond)*. 2010;34(1):57-66.
7. Stamatakis E, Wardle J, Cole TJ. Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *Int J Obes (Lond)*. 2010;34(1):41-47.
8. Hardy LL, King L, Espinel P, Cosgrove C, Bauman A. *NSW Schools Physical Activity and Nutrition Survey (SPANS) 2010: Full Report*. Sydney, Australia: New South Wales Ministry of Health; 2011.
9. Brown T, Summerbell C. Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obes Rev*. 2009;10(1):110-141.
10. Jones RA, Sinn N, Campbell KJ, et al. The importance of long-term follow-up in child and adolescent obesity prevention interventions. *Int J Pediatr Obes*. 2011;6(3-4):178-181.
11. Foster GD, Linder B, Baranowski T, et al; HEALTHY Study Group. A school-based intervention for diabetes risk reduction. *N Engl J Med*. 2010;363(5):443-453.
12. Singh AS, Chin A Paw MJM, Brug J, van Mechelen W. Dutch obesity intervention in teenagers: effectiveness of a school-based program on body composition and behavior. *Arch Pediatr Adolesc Med*. 2009;163(4):309-317.
13. Lubans DR, Morgan PJ, Aguiar EJ, Callister R. Randomized controlled trial of the Physical Activity Leaders (PALs) program for adolescent boys from disadvantaged secondary schools. *Prev Med*. 2011;52(3-4):239-246.
14. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes (Lond)*. 2008;32(12):1780-1789.
15. Klesges RC, Obarzanek E, Kumanyika S, et al. The Memphis Girls' health Enrichment Multi-site Studies (GEMS): an evaluation of the efficacy of a 2-year obesity prevention program in African American girls. *Arch Pediatr Adolesc Med*. 2010;164(11):1007-1014.
16. Neumark-Sztainer DR, Friend SE, Flattum CF, et al. New moves-preventing weight-related problems in adolescent girls: a group-randomized study. *Am J Prev Med*. 2010;39(5):421-432.
17. Robinson TN, Matheson DM, Kraemer HC, et al. A randomized controlled trial of culturally tailored dance and reducing screen time to prevent weight gain in low-income African American girls: Stanford GEMS. *Arch Pediatr Adolesc Med*. 2010;164(11):995-1004.
18. Nader PR, Bradley RH, Houts RM, McRitchie SL, O'Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. *JAMA*. 2008;300(3):295-305.
19. Berkey CS, Rockett HR, Colditz GA. Weight gain in older adolescent females: the internet, sleep, coffee, and alcohol. *J Pediatr*. 2008;153(5):635-639, 639, e1.
20. Eissa MA, Dai S, Mihalopoulos NL, Day RS, Harrist RB, Labarthe DR. Trajectories of fat mass index, fat free-mass index, and waist circumference in children: Project HeartBeat! *Am J Prev Med*. 2009;37(1)(suppl):S34-S39.
21. Wilson DK. New perspectives on health disparities and obesity interventions in youth. *J Pediatr Psychol*. 2009;34(3):231-244.
22. Lubans DR, Morgan PJ, Dewar D, et al. The Nutrition and Enjoyable Activity for Teen Girls (NEAT girls) randomized controlled trial for adolescent girls from disadvantaged secondary schools: rationale, study protocol, and baseline results. *BMC Public Health*. 2010;10(652):652. doi:10.1186/1471-2458-1110-1652.
23. Moher D, Hopewell S, Schulz KF, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *BMJ*. 2010;340:c869. doi:10.1136/bmj.c1869.
24. Cole TJ, Faith MS, Pietrobelli A, Heo M. What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile? *Eur J Clin Nutr*. 2005;59(3):419-425.
25. Robinson TN, Kraemer HC, Matheson DM, et al. Stanford GEMS phase 2 obesity prevention trial for low-income African-American girls: design and sample baseline characteristics. *Contemp Clin Trials*. 2008;29(1):56-69.
26. Amorim LD, Bangdiwala SI, McMurray RG, Creighton D, Harrell J. Intraclass correlations among physiologic measures in children and adolescents. *Nurs Res*. 2007;56(5):355-360.
27. Murray DM. *Design and Analysis of Group-Randomised Trials*. New York, New York: Oxford University Press; 1998.
28. Lubans DR, Morgan PJ, Callister R, Collins CE. Effects of integrating pedometers, parental materials, and e-mail support within an extracurricular school sport intervention. *J Adolesc Health*. 2009;44(2):176-183.
29. Lubans DR, Morgan PJ, Callister R, Collins CE, Plotnikoff RC. Exploring the mechanisms of physical activity and dietary behavior change in the program x intervention for adolescents. *J Adolesc Health*. 2010;47(1):83-91.
30. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, New Jersey: Prentice-Hall; 1986.
31. Lubans DR, Foster C, Biddle SJH. A review of mediators of behavior in interventions to promote physical activity among children and adolescents. *Prev Med*. 2008;47(5):463-470.
32. Cerin E, Barnett A, Baranowski T. Testing theories of dietary behavior change in youth using the mediating variable model with intervention programs. *J Nutr Educ Behav*. 2009;41(5):309-318.
33. Lubans DR, Morgan PJ, Tudor-Locke C. A systematic review of studies using pedometers to promote physical activity among youth. *Prev Med*. 2009;48(4):307-315.
34. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320(7244):1240-1243.

35. Lubans DR, Morgan PJ, Callister R, et al. Test-retest reliability of a battery of field-based health-related fitness measures for adolescents. *J Sports Sci*. 2011; 29(7):685-693.
36. Cooper Institute for Aerobics Research. *The Prudential FITNESSGRAM: Test Administration*. Dallas, Texas: Cooper Institute for Aerobics Research; 1992.
37. Treuth MS, Schmitz K, Catellier DJ, et al. Defining accelerometer thresholds for activity intensities in adolescent girls. *Med Sci Sports Exerc*. 2004;36(7):1259-1266.
38. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. *Med Sci Sports Exerc*. 2005;37(11)(suppl): S531-S543.
39. Trost SG, Pate RR, Freedson PS, Sallis JF, Taylor WC. Using objective physical activity measures with youth: how many days of monitoring are needed? *Med Sci Sports Exerc*. 2000;32(2):426-431.
40. Freedson P, Pober D, Janz KF. Calibration of accelerometer output for children. *Med Sci Sports Exerc*. 2005;37(11)(suppl):S523-S530.
41. Watson JF, Collins CE, Sibbritt DW, Dibley MJ, Garg ML. Reproducibility and comparative validity of a food frequency questionnaire for Australian children and adolescents. *Int J Behav Nutr Phys Act*. 2009;6:62.
42. Hardy LL, Booth ML, Okely AD. The reliability of the Adolescent Sedentary Activity Questionnaire (ASAQ). *Prev Med*. 2007;45(1):71-74.
43. Marsh HW, Richards GE, Johnson S, Roche L, Tremayne P. Physical self-description questionnaire: psychometric properties and a multimethod analysis of relations to existing instruments. *J Sport Exerc Psychol*. 1994;16:270-305.
44. Mallinckrodt CH, Watkin JG, Molenberghs G, Carroll RJ, Lilly E. Choice of the primary analysis in longitudinal clinical trials. *Pharm Stat*. 2004;3(3):161-169. doi:10.1002/pst.124.
45. Salmon J, Tremblay MS, Marshall SJ, Hume C. Health risks, correlates, and interventions to reduce sedentary behavior in young people. *Am J Prev Med*. 2011; 41(2):197-206.
46. Steinbeck K, Baur L, Cowell C, Pietrobelli A. Clinical research in adolescents: challenges and opportunities using obesity as a model. *Int J Obes*. 2009;33(1):2-7.
47. Dai S, Fulton JE, Harrist RB, Grunbaum JA, Steffen LM, Labarthe DR. Blood lipids in children: age-related patterns and association with body-fat indices: Project HeartBeat! *Am J Prev Med*. 2009;37(1)(suppl):S56-S64.
48. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics*. 1999;103(6, pt 1):1175-1182.
49. Epstein LH, Roemmich JN, Robinson JL, et al. A randomized trial of the effects of reducing television viewing and computer use on body mass index in young children. *Arch Pediatr Adolesc Med*. 2008;162(3):239-245.
50. Epstein LH, Paluch RA, Gordy CC, Dorn J. Decreasing sedentary behaviors in treating pediatric obesity. *Arch Pediatr Adolesc Med*. 2000;154(3):220-226.
51. Pearson N, Biddle SJ. Sedentary behavior and dietary intake in children, adolescents, and adults; a systematic review. *Am J Prev Med*. 2011;41(2):178-188.

Announcement

The *Archives of Pediatrics & Adolescent Medicine* will devote its May 2013 issue to pediatric hospital medicine. We are interested in a broad range of research related to hospital care, including clinical and comparative effectiveness research on the inpatient management of pediatric diseases. We invite all hospital-based pediatricians, including hospitalists, emergency medicine physicians, neonatologists, and intensivists, to submit manuscripts, preferably by September 15, 2012.