CHILDHOOD OBESITY
October 2011 | Volume 7, Number 5

DOI:10.1089/chi.2011.0043

ORIGINAL ARTICLE

Sustained Body Mass Index Changes One and Two Years Post MATCH: A School-Based Wellness Intervention in Adolescents

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Abstract

Background: Few school interventions to curb childhood obesity have impacted BMI. This study assesses the effect on BMI of Motivating Adolescents with Technology to Choose Health (MATCH).

Methods: A single-site cohort intervention study with pre/post design and longitudinal follow-up was used to assess the effect of MATCH at one middle school with high obesity prevalence in rural North Carolina. MATCH, a teacher-initiated, interdisciplinary, wellness education program modeled on social cognitive theory that was adapted to the standard course of study, includes self-evaluation and goal setting for behavior change and physical activity. Participants included two cohorts entering 7th grade in 2006 and 2007. Primary outcomes are BMI *z*-score and BMI percentile for age/gender. "Success" is defined as decrease in BMI *z*-score postintervention for the combined overweight and obese (all-overweight) subgroup.

Results: At baseline, 25% and 15% were overweight and 36% and 32% were obese in Cohort 1 ($n = 92$) and Cohort 2 ($n = 105$), respectively. Immediately postintervention and during follow-up, each cohort significantly reduced all-overweight BMI *z*-score and BMI percentile. Median change in BMI *z*-score and BMI percentile, and success rates were as follows: in Cohort 1, −0.08, −0.2, and 72% (postintervention); −0.08, −1.0, and 72% (15-month follow-up); and −0.17, −2.4, and 75% (30-month follow-up), respectively; and in Cohort 2, −0.04, −0.1, and 66% (postintervention) and −0.1, −0.8, and 71% (15-month follow-up), respectively. BMI measures in the healthy weight subgroup changed minimally postintervention for Cohort 1 only (median change *z*-score, BMI percentile, −0.1, −4.7).

Conclusions: MATCH is a promising obesity intervention within existing curriculum with sustained improved weight status.

Introduction

Childhood obesity is well-recognized as a pressing medical problem with projected long-term health and economic consequences.[1–3] Low socioeconomic,[4] rural,[5,6] and minority populations are known to have particularly high risk.[7,8] The school setting is often noted to be a logical setting for intervention to reach the largest number of children,[9,10] with attention shifting to middle schools to target young adolescents.

Several well-designed school-based interventions have been tested with mixed results.[10] Specifically in middle schools, Planet Health® showed lifestyle behavioral improvements and some changes in BMI, particularly in girls,[11] and was replicable and cost-effective.[12,13] More recently, an intervention specifically for girls, New

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Descriptions of preliminary postprogram and 15-month MATCH results have been presented previously at the following meetings: Pediatric Academic Societies 2009, American College of Preventive Medicine 2009, Weight of the Nation 2009 (poster), and National Initiative for Children's Healthcare Improvement 2009; and the 30-month preliminary results were presented at meetings of the Pediatric Academic Societies 2010 and The Obesity Society 2010.

Moves, demonstrated positive behavioral changes.[14] The HEALTHY study was an extensive resource-intensive intervention that showed decreased waist circumference and insulin levels compared to controls, but no significant difference in BMI or percentage of healthy weight students.[15] Finally, the "Choice, Control and Change" curriculum in New York City is a thorough, educational, and behavioral theory-based program within the science curriculum that showed significant health behavior changes in participants.[16] Each of these interventions was designed by researchers as group education sessions added to existing school curricula and none measured weight status over time.

Motivating Adolescents with Technology to Choose Health (MATCH), a middle school-based wellness intervention for seventh graders, was built on two core ideas: (1) A feasible intervention in schools needs to incorporate educators' primary priority of meeting educational goals;[17,18] and (2) an effective intervention in young adolescents needs to create internal motivation within students so they engage in the learning process. We sought to determine the effect of MATCH on two successive cohorts' BMI measures and whether any changes were sustained at 15 and 30 months. We hypothesized that MATCH would be successful because it provides opportunities for active application, goal setting, and skill building for positive behavioral change, and because, unlike most other school-based educational programs, MATCH is a curriculum modeled on social cognitive theory (SCT) that is integrated across academic subjects and teaches the standard course of study through wellness concepts.

Methods

Setting and Participants

In the 2006–2007 and 2007–2008 school years, all students enrolled in regular 7th grade classes at Williamston Middle School (WMS) completed the intervention within their routine school activities. WMS is located in Martin County, North Carolina, a rural county with 24,000 residents; 43% of residents are African American and 23% live in poverty, compared to 21% and 11%, respectively, in the rest of North Carolina.[19] The student population at WMS has approximately 400 students, with over two-thirds African American and over 60% participating in the federally subsidized school lunch program. Since 2006, WMS school has complied with the North Carolina Healthy Active Children Policy[20] providing daily physical activity (PA) for all students. This is achieved through a designated 25-min noontime PA period. Renovated tennis courts provided half-court basketball, walking track, jump rope, and four-square areas. Sports equipment was available to provide additional choices. Because students were enrolled in physical education for only one semester, this period provided daily PA for all students.

Study participants included students returning signed parental consent and student assent forms to have their demographic and BMI measures included for analysis. This study was approved by the University Medical Center Institutional Review Board (#07-0741) at the Brody School of Medicine and the Committee for the Protection of Human Subjects (#08-1268) at the University of North Carolina at Chapel Hill.

Intervention

After review of published school-based interventions, one author (T.H.) designed MATCH to incorporate selected intervention and educational components, provide monitored PA, use classroom teachers to teach multidisciplinary lessons within the curriculum as was also done in Planet Health®,[11] and apply SCT with age-appropriate intervention and motivational strategies. SCT is one of the most widely applied behavioral theories in health promotion[21,22] and is applied in successful dietary change interventions for children in clinical settings.[23] SCT proposes that a person's behavior, environment, and characteristics constantly interact to influence each other. Important features of interventions based on SCT are developing the knowledge and skills needed to change behavior, expecting positive outcomes related to behavior change, developing self-efficacy to perform new health behaviors, and learning self-regulatory skills.[21] Additional concepts are reinforcements and observational learning or modeling. MATCH follows an intentional progression of goals, lessons, and activities that fit SCT, categorized as the four "ates" of MATCH: Evaluate, Educate, Motivate, and Activate, as summarized in Table 1. MATCH was designed to teach a conceptual understanding of positive dietary and physical activity habits and the potential effects on health status across multiple academic disciplines. Various components of the academic day work in an interdisciplinary fashion to build wellness knowledge

Table 1. Intervention Components of Motivating Adolescents with Technology to Choose Health (MATCH)

Key steps of MATCH: The 4 "*ates*"	Specific component of intervention
Evalu*ate*	Height, weight, blood pressure, calculate BMI, determine percentile for age
	Fitness testing
	Health behavior survey, baseline only
Educ*ate*	14-Week interdisciplinary wellness lessons and activities aligned with North Carolina Standard Course of Study (see Table 2)
Motiv*ate*	Individual goal setting with action plans
	Peer accountability contracts
	Recognition bulletin board
	Age-appropriate rewards/incentives (e.g., rubber wrist bands with school colors; T-shirt; certificates)
	Rewards day at end (healthy treats, games)
Activ*ate*	Daily 20 min physical activity; self tracking of physical activity

and skills, and, at the same time, to meet basic educational standards. Students find the tasks and activities of MATCH motivating because they are personalized, offer a sense of autonomy in learning, and require active application and participation by students.

The 14-week MATCH program fits within the seventh grade North Carolina Standard Course of Study. Key educational and technological components and contact hours are outlined in Table 2; contact hours for MATCH totaled 55 hours. Using a "body systems" approach within the science curriculum as the framework, students calculated their own BMIs and categorized themselves according to CDC BMI Percentile for Age standards.[24] All children received the same intervention regardless of weight category; the only time weight status that was noted for the student is the child's self-categorization completed privately within a lesson. Students used math skills to establish individual goals for incentive-based rewards. Students completed a 48-hr dietary recall and nutritional analysis, and entered daily PA data and pedometer steps into spreadsheets to compute caloric expenditure. The concept of energy balance was taught using a checkbook register. General lesson content was delivered in Cornell Note–style format.[25]

Nutrition lessons focused on understanding individual energy needs, caloric content, and sources of macronutrients. Label-reading skills and activities to develop portion control, reduce sugar-sweetened beverages, and develop good decision-making skills at fast food restaurants were taught for real-life applications. Cross-curricular writing requirements were met using health-related persuasive writing topics in language arts. Students periodically self-evaluated the effectiveness of behavioral strategies through journal reflections, with course corrections according to individual weight category, fitness, or behavioral goals. Motivational poster and essay contests and a "Fitness Leader" bulletin board provided student recognition. A fun "Rewards Day" at the program end provided opportunity for a day of PA, nutritious snacks, and recognition to participants for special achievements (*e.g.*, most improved for a fitness measure, essay contest winners, step count goals attained).

The MATCH program is designed specifically to reach rural, socioeconomically poor, and minority children. Lessons use examples relevant to the students' environment and home resources, suggest physical activities available in the community or rural settings, and include PA opportunities designed to be particularly age and culturally relevant (*e.g.*, use of dance and video-based activities).[26]

Design

The intervention was a single-site cohort intervention study with pre/post design and longitudinal follow-up.

Measures

Table 2. MATCH Educational Components

School subject (contact hours)	Sample components of MATCH	Technology components
Science (40)	Energy balance Weight categories Health effects of overweight/obesity Cardiovascular system, risk factors/warning signs of cardiovascular disease Pulmonary system/effects of smoking Gastrointestinal/nutrition, nutrients, nutrient analysis, energy needs, label reading, meal planning Endocrine system, diabetes	Used Microsoft PowerPoint to create presentations Created database to store nutritional information for favorite fast foods Accessed mypyramid.gov website Used computer software to create presentations
Math (1)	Ratios and proportions Percent increase/decrease, calculating target heart rate for exercise, BMI calculation, check book registry	
Language arts (3)	Reading comprehension, wellness topics Persuasive writing (wellness topics) Peer accountability contracts Self-evaluation of behaviors and journaling Final reflective essay	Used computing software to create obesity brochures Used word processor to type essays
Technology (4)	Spreadsheet for exercise log and caloric expenditure, time usage, calculating target heart rates, pedometer challenge Create database tables of favorite fast foods, personal data/fitness test, sorting, querying	Used spreadsheet software to create spreadsheets and perform calculations Used pedometers to track number of steps Used database software to create tables of personal information and perform functions
Health and physical education (6)	Fitness testing Age-appropriate physical activity	Used pedometer to track number of steps Played interactive activity video games
Social studies (1)	Obesity webquest	Used Internet searches

Age was recorded at the date of the baseline measurement and was calculated from the student date of birth as recorded in school files. Gender, ethnicity, and participation in the federally subsidized school lunch program were also recorded in the school files, with ethnicity provided by parent report upon school registration. Height and weight measures before (November) and immediately after (early May) intervention (with shoes off, wearing the standard school uniform of khaki pants and polo shirt) were completed privately following routine school procedures and using a calibrated scale. Measures were done by a school nurse in the intervention year. Longitudinal follow-up measures at 15 (Cohorts 1 and 2) and 30 (Cohort 1 only) months were performed by a trained member of the research team. BMI was calculated from height and weight measures, and BMI *z*-score and BMI percentile for age and gender were determined from the standardized CDC charts.[24] Baseline weight category was assigned based on current CDC definitions: Underweight, <5thpercentile; healthy weight, 5–<85thpercentile; overweight, 85–<95thpercentile; obese, ≥95thpercentile). The proportion of participants in each weight category by cohort was calculated at baseline and again at the 15-month time point.

Statistical Analysis

Descriptive statistics (means; standard deviations [SD]; proportions) were calculated for baseline participant characteristics for each cohort. The cohorts were kept separate for analyses because the proportion of students at baseline in the overweight and obese categories was different. The data was partitioned based on baseline weight category into healthy weight and all-overweight (overweight and obese combined). Medians and interquartile ranges (IQR) were calculated, and changes from baseline in BMI *z*-score and BMI percentile were assessed using the signed-rank test. Success rates were calculated; success was defined as the same or lower BMI *z*-score at follow-up in healthy weight individuals and a lower BMI *z*-score in the all-overweight individuals. Descriptive statistics (median; IQR) were calculated for those who were considered successful to describe the impact of MATCH on their BMI. Baseline measures for those who were missing follow-up data at 15 months and 30 months were compared using the Wilcoxon rank sum test. No formal adjustments were made for multiple comparisons; however, to be conservative, p values <0.01 were considered statistically significant, whereas p values between 0.01 and 0.05 were suggestive of statistical significance. All analyses were carried out using SAS version 9.2 (Cary, NC).

Results

Baseline characteristics of the study participants for both Cohort 1 and Cohort 2 are shown in Table 3. The study groups include students from Cohort 1 (n = 92, of 105 eligible 7th graders) and Cohort 2 (n = 105 of 106 eligible 7th graders). Retention rates at each remeasure time point for Cohorts 1 and 2, respectively were: Immediately postintervention, 100%, 100%; 15 months, 85%, 86%; and 30 months (Cohort 1 only), 55%. The two cohorts were similar: Average age of 13.0 years; majority female, black, and participating in federal lunch program; about one-third obese. More students in Cohort 1 were overweight than in Cohort 2, 24% versus 15%. To assess if this was indicative of a trend for the school population, we tracked student characteristics of MATCH participants the following year, and the weight status measures were more similar to Cohort 1 (n = 113, 24% overweight, 38% obese).

Results for individuals classified as all-overweight at baseline (Cohort 1, n = 54, and Cohort 2, n = 50) are presented in Table 4. Significant decreases were seen in both BMI *z*-score and BMI percentile, immediately postintervention for participants in both Cohorts 1 and 2, and these improvements were maintained or increased during the 15-month and 30-month (only Cohort 1) follow-ups. Success rates in Cohorts 1 and 2 were 72% and 66%, respectively, immediately post-MATCH, 72% and 71% at 15 months post-MATCH, and 75% at 30 months post-MATCH in Cohort 1. Of those successful, we calculated

Table 3. Baseline Participant Characteristics, Cohorts 1 and 2

Variable	Cohort 1 (n = 92) (of 105 students in 7th grade in 2006–2007)	Cohort 2 (n = 105) (of 106 students in 7th grade in 2007–2008)
	Mean (SD)	**Mean (SD)**
Age (years)	13 (0.7)	13 (0.7)
BMI	24.7 (6.4)	24.2 (6.6)
BMI percentile for age and gender	79.6 (24.2)	76.1 (23.3)
BMI *z*-score	1.2 (1.0)	1.0 (1.0)
	***n* (%)**	***n* (%)**
Gender		
Female	47 (51%)	63 (59%)
Male	45 (49%)	43 (41%)
Race		
White	31 (34%)	39 (37%)
Black	57 (62%)	65 (61%)
Other	4 (4%)	2 (2%)
Participate in federal lunch program		
Yes	58 (63%)	55 (52%)
No	34 (37%)	51 (48%)
Weight status*		
Healthy weight	38 (41%)	55 (52%)
Overweight	22 (24%)	16 (15%)
Obese	32 (35%)	34 (32%)

*Weight category determined by CDC definitions based on BMI percentile for age and gender: underweight, <5thpercentile; healthy weight, 5–<85thpercentile; overweight, 85–<95thpercentile; obese, ≥95thpercentile.

SD, Standard deviation.

Table 4. Results in Subgroup Including Only the Overweight and Obese Students (Combined). Intervention Success* Rates and Changes at Follow-Up Measures in Body Mass Index (BMI) *z*-Score and BMI Percentile (for Age and Gender)

	Cohort 1: 7th grade 2006–2007			Cohort 2: 7th grade 2007–2008	
	Postintervention *n* = 54	15 months later (as 8th graders) *n* = 43	30 months later (as 10th graders) *n* = 28	Postintervention *n* = 50	15 months later (as 8th graders) *n* = 41
Percent of students remeasured	100%	85%	55%	100%	86%
Success* rate, *n* (%)	39 (72%)	31 (72%)	21 (75%)	33 (66%)	29 (71%)
BMI *z*-score change from baseline, median (IQR)	–0.08** (–0.16, 0.00)	–0.08** (–0.33, 0.02)	–0.17*** (–0.47, 0.01)	–0.04** (–0.15, 0.01)	–0.10** (–0.32, 0.04)
BMI percentile change from baseline, median (IQR)	–0.2** (–1.8, 0.0)	–1.0** (–3.7, 0.1)	–2.4** (–6.4, 0.1)	–0.1** (–2.0, 0.0)	–0.8** (–3.5, 0.1)

*Success defined for overweight/obese participants as BMI *z*-score lower at follow-up measure than at baseline.
**$p \leq 0.01$; ***$p \leq 0.05$; *p* values calculated based on signed-rank test.
IQR, Interquartile range.

the absolute changes in BMI from baseline in the overweight and obese subgroups. For Cohort 1, the median (IQR) BMI change in both the overweight and obese groups decreased postintervention: −0.8 (−1.6, −0.3) for overweight; −0.7 (−1.2, 0.0) for obese. The overweight and obese individuals successful at the 15-month follow-up had a median (IQR) change in BMI of −0.1 (−0.9, 0.5) and −0.7 (−1.8, 1.3), respectively; and those successful at the 30-month follow-up had a median (IQR) change in BMI of −0.5 (−1.5, 0.7) for overweight and −0.5 (−2.4, 1.9) for obese. For Cohort 2, postintervention the median (IQR) BMI changes for the successful overweight and obese subgroups were −0.6 (−1.0, −0.2) and −0.5 (−1.5, −0.1), respectively, and at the 15-month follow-up were −0.5 (−0.9, 0.8) and −0.1 (−1.3, 0.8).

Of note, when looking at the healthy weight subgroup for each cohort, immediately postprogram, Cohort 1 showed statistically significant decreases in BMI *z*-score and percentile—median (IQR) −0.1 (−0.3, 0.0), −4.7 (−9.8, 0.3) ($p < 0.001$)—but for Cohort 2 there was no significant change. For both cohorts there were no significant changes at the 15- or 30-month (Cohort 1 only) follow-ups in any BMI measure (data not shown).

The overall distribution of weight categories improved for both cohorts over time, with several students changing to improved weight status categories. When determining the weight categories of only participants with a 15-month measure completed, for Cohort 1 ($n = 78$) the percent healthy weight went from 45% at baseline to 53% at 15 months; percent overweight decreased from 26% to 19%, with 7 of 20 students overweight at baseline changing to healthy weight at 15 months; percent obese decreased from 29% to 28%, with 3 of 23 changing categories (2 to overweight and 1 to healthy weight). For Cohort 2 ($n = 87$), the percent healthy weight increased from 53% to 59%; the percent overweight decreased from 17% to 16%, with 8 of 14 students overweight at baseline changing to healthy weight at 15 months; the percent obese decreased from 30% to 25%, with 8 of 26 changing categories to overweight from obese. No child in the healthy weight category at baseline changed to underweight.

To assess if students missing follow-up measures at each time point differed from those with measures, we compared the baseline characteristics of those with and without follow-up measures. For Cohort 1, the ones missing 15-month measures were significantly heavier at baseline with median (IQR) BMI 22.6 (15.6, 44.6) (with data, $n = 78$) versus 28.1 (15.4, 41.7) (missing 15-month, $n = 14$), $p = 0.02$, but not at 30 months with median (IQR) 22.7 (15.6, 41.4) (with data, $n = 51$) versus 24.3 (15.4, 44.6) (missing 30-month, $n = 41$), $p = 0.2$. For Cohort 2, the ones missing measures at 15 months were not statistically different in BMI at baseline, with median (IQR) 22.1 (19.2, 26.3) (with data, $n = 87$) versus 23.5 (20.2, 32.2) (missing 15-month, $n = 18$), although some of those with greatest BMI change postprogram were not remeasured. For those missing the 15-month measure, nearly all were missing because of students moving or school transfer. For the ones available for measures in 10th grade (30 month follow-up), there were more students who declined being remeasured and we did not systematically assess their reasons for refusal.

Discussion

Most previous middle school–based interventions showed only nominal, if any, result on weight status. In this study, participants in the first two cohorts of the MATCH program as a group improved in proportion of students at a healthy weight and achieved remarkable improvements in BMI *z*-score and BMI percentile for age and gender. More importantly, these study results occurred in a very low-resource school with students at highest risk for obesity and its complications. For some participants, the positive effect on weight status not only persists, but may actually increase in magnitude, over time.

Although not measured in this study, we suspect the

observed, sustained changes in weight status may suggest that some subset of MATCH participants has learned key skills that are applied in their daily lifestyle choices and achieve a healthier energy balance for weight maintenance or reduction. Although the median effect size in change in BMI *z*-score seems small (*e.g.*, −0.08), some students had remarkable individual changes in BMI (range −1 to −2), demonstrating improvement in their weight status overtime with definite clinical significance. This program, taught as part of existing school lessons, may have triggered lifestyle change such that health and educational objectives are met simultaneously, but further future study with assessment of lifestyle behavior change will need to be done.

Limitations

Although the results are promising, this study has several limitations. The intervention occurring at a single site with no control or comparison group and a small number of participants calls both causality and generalizability into question. However, there are few controlled studies showing even short-term BMI changes, and it is unlikely that significant numbers of students would improve their weight status in a short period due to other means, especially in such a low-resource community. Because postmeasures of lifestyle behaviors were not collected, conclusions cannot be drawn about what behaviors, if any, the MATCH participants changed or if any particular lessons or intervention components were more effective than others. Finally, the teacher who created and administered the bulk of the intervention may be uniquely qualified, given his background in exercise physiology, wellness, coaching, and research, and may be unusually dynamic in his ability to motivate students such that other individuals would not be able to replicate his intervention and teaching style.

A potential source of bias in the study's results is that about 15% of students in each cohort were not remeasured at 15 months and just over half were measured at 30 months. The students missing follow-up measures tended to have larger BMI than those who had follow-up measures. If those students that have benefited most from MATCH had results comparable to those remeasured in the same baseline weight category, then the results of this study would be attenuated and the true impact of MATCH is actually greater than what was observed. However, if these students did not respond with improved BMI measures, then the true impact of MATCH is overestimated by the observed data.

Despite these limitations, however, there are several strengths in the intervention and the study design. MATCH is evidence-based from both wellness and educational standpoints. The intervention having been created by an experienced teacher to fit within the existing course of study is unprecedented. This not only brings credibility to the specific educational components but also greatly enhances intervention feasibility and acceptability to teachers and school administrators. The success in a setting of a low-resource, rural, minority school informs efforts in high-risk areas and also suggests the intervention would be likely to work in other areas with similar low resources or in those with greater resources. Similar results demonstrated in successive cohorts strengthen the findings, and the longitudinal follow-up of two cohorts also adds strength to the results. There seems to be little doubt that a real effect occurred for a number of MATCH participants, but many questions still remain about why, how the effect occurred, and if the effect can be replicated.

It is possible that middle school is an especially opportune time to inspire behavior change. Because, as Erikson teaches, individuals at this stage of development are tackling identity versus role confusion,[27] they may be especially interested in behaviors that help them identify as a healthy individual. It is also possible that positive peer pressure plays a role in encouragement to stay on (healthy) task. When compared with other previous efforts in the middle grades, the curriculum reported by Contento most closely resembles MATCH, and it convincingly improved several health behavior measures.[16] That program was even more intentionally designed to apply educational, behavior change, and motivational theories in lessons, but MATCH may represent a more practical program because it is interdisciplinary and taught within existing curricula. Finally, because students' BMI did not rebound over the intervening summer the way other studies have found occurs,[28] although we cannot verify it with measures in this study, it is possible that students were learning skills that translated into their daily lives or even helped them to be a "change agent" within their family and helped them sustain change during nonschool times.

Conclusion

On the basis of its first 2 years, MATCH is a promising middle school–based obesity intervention warranting further study of many interesting avenues of inquiry. Future work should assess replicability in different settings, effect on lifestyle behavior change, individual effectiveness of various components, feasibility of expansion to other settings and with other teachers, whether MATCH improves learning or attention in addition to weight trajectories, and verifying the role of conjectured SCT constructs and assessment of the concept of the student developing as a "change agent" in the family. There is emerging evidence that improved fitness may have a positive effect on learning.[29,30] If educators and health promotion proponents can partner to achieve health and educational goals simultaneously by implementing one educational model in the middle grades, this presents a tremendous opportunity for long-term impact for a very large number of children.

Acknowledgments

The authors would like to acknowledge the several Martin county businesses that contributed a combined total of $6,500 of funding and supplies for MATCH. We also thank the Martin County school system personnel who supported and participated in this work, and particularly administrative leadership during 2006–2008, including Superintendent Dr. Thomas Daly and Williamston Middle School Principal Clay Wagner. We also extend appreciation to our supportive research team of Yancey Crawford and Gayatri Surwade at East Carolina University, and, at the University of North Carolina at Chapel Hill, Joanne Finkle, and to Dr. Michele Wallen for her thoughtful review of the manuscript and assistance with determination of contact hours.

Dr. Lazorick's work was funded in part by a grant from the Robert Wood Johnson Foundation Physician Faculty Scholar Program and Dr. Perrin was funded by a National Institutes of Health K23 career development award (5K23 HD051817).

Author Disclosure Statement

The authors have no competing financial interests.

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