

Slowing BMI Growth Trajectories in Elementary School-Aged Children

The Northeast Iowa Food and Fitness Initiative

Loren L. Toussaint, PhD; Kristin Housholder, BA; Katelyn Janssen, BA; Ann Mansfield, MSN; Brian A. Lynch, MD

This project examines the Northeast Iowa Food and Fitness Initiative, a policy-, community-, and school-based effort to slow children's body mass index (BMI) growth over 6 years. Kindergarteners (K) to fifth graders (5) from 10 different school districts participated (N = 4101). Students with 0 to 1 years of initiative exposure showed greater growth in BMI compared with children who had 2 to 6 years of exposure, resulting in K-5 BMI savings of 1.5 points (6 lb) for median-height boys and girls. Results suggest that changes to policies, communities, and schools may provide effective obesity reduction in children.

Key words: childhood obesity, food and fitness, pediatric, policy, school health

APPROXIMATELY 17% of adolescents in the United States were classified as obese during the years of 2011-2012.¹ More importantly, children currently living in the United States are projected to become the most obese population of adults in history.^{2,3} Complications faced by children who are obese increase with the severity of obesity and have the potential to significantly lower a child's current and future quality of life.^{2,4,5} Some of the more concerning complications include hypertension, obstructive sleep apnea, type 2 diabetes, hyperlipidemia, and nonalcoholic fatty liver disease.^{3,4} Children who are obese also face the risk of becoming adults with obesity and facing other serious health conditions such as coronary artery disease, pancreatic cancer, diabetes, or a variety of other chronic diseases.^{4,6-8} The ultimate consequence of

obesity for today's children is that, for the first time in modern history, children may live a shorter life than their parents.³ Childhood obesity is a pressing societal issue.

Recent studies have revealed that a host of environmental changes (eg, policy change and familial environment) can reduce a child's body mass index (BMI).⁹ There is evidence that school-based obesity interventions can improve health behavior and obesity level in children.¹⁰⁻¹⁴ Because of this evidence, the Institute of Medicine recommends using schools to intervene for obesity.¹⁵ In addition, there is high interest by parents and other stakeholders in school-based obesity management.¹⁶⁻¹⁸

The primary aim of the present study is to extend previous research on childhood obesity by examining the impact of the Northeast Iowa Food and Fitness Initiative, a regional rural initiative focused on policy-, community-, and school-based environmental changes, on BMI trajectory in elementary school-aged children over 6 years. A distinctive feature of the design is the 6-year longitudinal BMI data available for a large cohort of elementary school-aged children exposed to anywhere between 0 and 6 years of the initiative. Although there are a number of previous longitudinal studies on children's BMI, those studies are lacking the year-by-year consistent comparison for greater than 5 years, and few, if any, studies are able to examine the effects of an obesity initiative over time.¹⁹⁻²² We hypothesized that students who experienced greater length of exposure to the Northeast Iowa Food and Fitness Initiative in their schools (possibly as little as 1 year through 6 years) would show slower rates of growth in BMI across the kindergarten through fifth-grade years.

Author Affiliations: *Luther College, Decorah, Iowa (Drs Toussaint and Mansfield and Mss Housholder and Janssen); and Pediatric and Adolescent Medicine, Mayo Clinic, Rochester, Minnesota (Dr Lynch).*

The authors of this study would like to thank the W.K. Kellogg Foundation and Northeast Iowa Food and Fitness Core Partners; Luther College Center for Sustainable Communities, Iowa State University Extension & Outreach, Upper Explorerland Regional Planning Commission, Northeast Iowa Community College, and Community Foundation of Greater Dubuque. The authors would also like to thank all 10 school districts that collaborated with the researchers on this project to help make it possible.

Funding received for this work supported the implementation of the initiative and did not support research.

The authors declare no conflict of interest.

Correspondence: Loren L. Toussaint, PhD, Luther College, 700 College Dr, Decorah, IA 52101 (touslo01@luther.edu).

Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.

DOI: 10.1097/FCH.0000000000000151

METHODS

Northeast Iowa Food and Fitness Initiative

The Northeast Iowa Food and Fitness Initiative works to make their region a place where every day all people have access to healthy, locally grown foods and abundant opportunities for physical activity in the places where they live, learn, work, and play. Developed in 2009, the initiative works in 6 different adjacent rural counties, serving more than 100 000 people. The initiative is made up of schools, community members, and organizations working to provide improved access to healthier foods and physical activities within the communities of 18 school districts, targeting childhood obesity as one of the foremost issues (see <http://www.iowafoodandfitness.org/>). There are 4 strategic points of intervention.

The first and foremost point of intervention, and the focus of this study, is the schools. The initiative works to establish school district policies and practices that support healthy living of children, families, and community members. School-based wellness teams that include school personnel, youth, and community members set wellness agendas in schools, and the initiative works to build capacity of those teams. Outreach from Luther College to the schools, as a Northeast Iowa Food and Fitness Initiative partner, utilizes AmeriCorps and Food-Corps service members. Core themes of this work include (1) supporting school wellness activities, (2) Farm to School (see www.farmtoschool.org) programming including nutrition education, school gardens, and healthy changes in school food options, and (3) developing opportunities for physical activity throughout the school day including active classrooms, increased recess, and walking mileage assessments.

The second strategy aims to ensure that caregivers and parents provide preschool children with health-promoting food and active play. This is accomplished through early childhood teacher education, parent grocery shopping and cooking classes, developing natural playgrounds, and the development of early childhood wellness policies.

The third strategy focuses on the development of networks to ensure local, health-promoting food is available and affordable in all communities, neighborhoods, and institutions. This involves building capacity for local food producers and creating a network for food aggregation and distribution. In addition, the initiative aims to address food access issues for families in communities by supporting the development of Farmer's Markets and Food Box programs.

The final strategy aims to assist communities in shaping a built environment that supports abundant

opportunities for physical activity and play. This is accomplished through developing and encouraging such things as Regional Safe Routes to School Programming (see www.saferoutestoschools.org), Walking School Buses, and bike rodeos. The initiative also supports building broader community coalitions to increase opportunities for play and physical activity (eg, parks and trails).

Participants

Data from 4101 elementary school-aged children (ages 4-12 years) were available from 10 school districts in the 6 county regions of the initiative. Eight of the 18 schools included in the initiative were not able to supply the necessary data (eg, BMI) to be included in this analysis, yet those schools remained involved in the broader initiative work. The sociodemographics of students attending the elementary schools receiving the Northeast Iowa Food and Fitness Initiative during the 2015-16 school year are presented in the Table. These data are publically available (see https://www.educateiowa.gov/education-statistics#Student_Demographic_Information) and do not directly represent our study sample, which was spread over cohorts between 2008 and 2015 (race/ethnicity and qualification status for free/reduced lunch was not available in our de-identified database). The amount of exposure to the Northeast Iowa Food and Fitness Initiative was dependent on when the student completed elementary school relative to the 2009 initiative start date. Students who completed elementary school in 2008 or before had 0 year of exposure ($n = 395$) to the initiative. BMI data on this cohort were collected by the schools before the initiative began from 2000 to 2008. Those who completed elementary school in 2009, 2010, 2011, 2012, 2013, and 2014 had 1, 2, 3, 4, 5, and 6 years of exposure, respectively. Sample sizes for students experiencing 0, 1, 2, 3, 4, 5, and 6 years of exposure to the Food and Fitness Initiative were 395, 701, 696, 593, 631, 625, and 460, respectively. Students from each exposure cohort were followed up longitudinally from kindergarten through fifth grade. Hence, the first cohort experienced no exposure to the initiative in their 6 years of elementary education whereas the second cohort experienced 1 year, the third cohort experienced 2 years, and so on. The last cohort experienced exposure to the initiative programming beginning in kindergarten and lasting through sixth grade.

Data collection

Nurses at 10 participating schools collected and recorded height and weight data using school scales and stadiometers. In coordination with

TABLE. Student Sociodemographic Characteristics (2015-2016) for Food and Fitness Schools With BMI Data and Without BMI Data^a

Variable	Frequency in 10 Schools With BMI Data (%)	Frequency in 8 Schools Without BMI Data (%)	Statistical Difference
Sex			$P = .80$
Male	3678 (51.53)	2940 (51.31)	
Female	3459 (48.47)	2790 (48.69)	
Total pre-K-12	7137 (100)	5730 (100)	
Qualify for free/reduced lunch ^b			$P < .001$
Do not qualify	4106 (61.5)	3106 (57.5)	
Qualify	2571 (38.5)	2296 (42.5)	
Total grades K-12	6677 (100)	5402 (100)	
Race/ethnicity			$P < .001$
Hispanic	291 (4.08)	491 (8.57)	
Native American	15 (0.21)	14 (0.24)	
Asian	38 (0.53)	17 (0.30)	
Black	77 (1.08)	94 (1.64)	
Pacific Islander	7 (0.10)	1 (0.02)	
White	6527 (91.45)	5037 (87.91)	
Multiracial	182 (2.55)	76 (1.33)	
Total grades pre-K-12	7137 (100)	5730 (100)	

^aThis table represents pre-K-12 data from the 2015-16 school year at schools participating in the Northeast Iowa Food and Fitness Initiative and does not directly represent our study population of 4101 K-5 elementary school children who were distributed among cohorts between 2008 and 2015.

^bData on free/reduced lunch are not available for pre-K, as many of these programs do not include lunch.

district superintendents, principals, and school nurses, archival paper and electronic data were identified, organized, and entered into an Excel spreadsheet by a team of regional initiative interns and volunteers. Student health data were de-identified and coded to enable connecting each student's year-to-year data. These data were entered into the Excel spreadsheet along with birth year (age), sex, amount of initiative exposure (0-6 years), grade, school name, and age at grade level (children vary in age within the same grade). No research consent/assent was needed, as the data were collected by school staff as a part of their routine procedure and the investigative team only had access to de-identified data. Institutional ethics approval from Luther College was obtained for this study.

Data analysis

Linear growth models were used to examine rates of change in BMI from kindergarten to fifth grade. Years of initiative exposure was examined to determine whether it impacted (ie, moderated) the rate of change in BMI. Sensitivity analyses were used to identify the necessary length of exposure to initiative work to differentiate BMI growth rates between

groups. This involved a process of examining differences in growth rates between groups of 0 versus 1 to 6 years of exposure, 0 and 1 year of exposure versus 2 to 6 years of exposure, 0, 1, and 2 years of exposure versus 3 to 6 years of exposure, and so on. All results were adjusted (ie, controlled) for effects of sex, school, and age. Statistical significance was set at $P < .05$.

RESULTS

Schools that did not supply BMI data were similar to those that did in percentage of males/females ($P = .80$). Statistically significant ($P_s < .001$), though very small, differences in the frequency of students who qualified for free/reduced lunch and race/ethnicity were observed between schools that did and did not supply BMI data. In comparison to the 10 schools that supplied BMI data, those schools that did not supply BMI data had more students who qualified for free/reduced lunch (42.5% vs 38.5%) and had more Hispanic students (8.6% vs 4.1%) (see the Table). These differences were the result of one of the 8 schools that did not have BMI data that was distinctly different in

sociodemographic characteristics from all other 17 schools in the initiative.

Average kindergarten BMI was 16.76 for the total sample. For each grade-level advance, there was a corresponding 0.32 increase in BMI ($P < .001$). Boys were 0.27 BMI points greater than girls ($P < .001$) and schools differed on average BMI by 0.04 to 0.58 BMI points ($P < .001$).

Number of years of exposure to the Northeast Iowa Food and Fitness Initiative impacted the rate of growth in BMI ($P < .01$), and the impact of programming did not differ across sex or school when they were tested as moderators ($P_s > .11$). Examining the effects of varying levels of exposure revealed that 0 and 1 year of exposure to initiative work in the schools was comparable in terms of rates of growth in BMI, but 2 to 6 years of exposure to initiative work resulted in significantly slower rates of growth in BMI ($P < .05$). Therefore, we chose to compare the children with 0 to 1 year of exposure to those with 2 to 6 years in the analysis (see the Figure). Children exposed to initiative work for 1 year or less showed an annual BMI growth rate of 1.02, which translates to about 5 BMI points increase from kindergarten through fifth grade. Children exposed to initiative work for 2 to 6 years showed an annual BMI growth rate of 0.67, which translates to about 3.4 BMI points increase from kindergarten through fifth grade. This is a considerable savings given that about a 1.5-point BMI difference in the fifth grade equates to approximately

6 lb saved (not gained) for both boy and girl fifth graders of median height.

DISCUSSION

Our study evaluated the effect of the Northeast Iowa Food and Fitness Initiative, a comprehensive public policy-, community-, and school-based childhood obesity intervention, on BMI growth trajectory in elementary school-aged children. The results of our study demonstrated a significantly slower rate of BMI growth in children exposed to more years of the initiative, and the effect was consistent for boys and girls and all schools. These robust results suggest that multifaceted public health and school interventions can slow the development of obesity in children.

Research has shown that elementary school years are important in the early development and possible progression of childhood weight problems.^{16,17,23} Community and school environments play a substantial role in encouraging healthy behaviors and deflecting the swell of obesity in young children.²⁴⁻²⁶ The present findings support existing work in this area, suggesting that important changes can be made at the policy-, community-, and school levels to slow the growth of BMI in elementary school-aged children. Other school-based obesity prevention interventions have shown some effectiveness, but often the approaches are quite limited and focused on one or two points of intervention such as increasing physical activity or decreasing screen

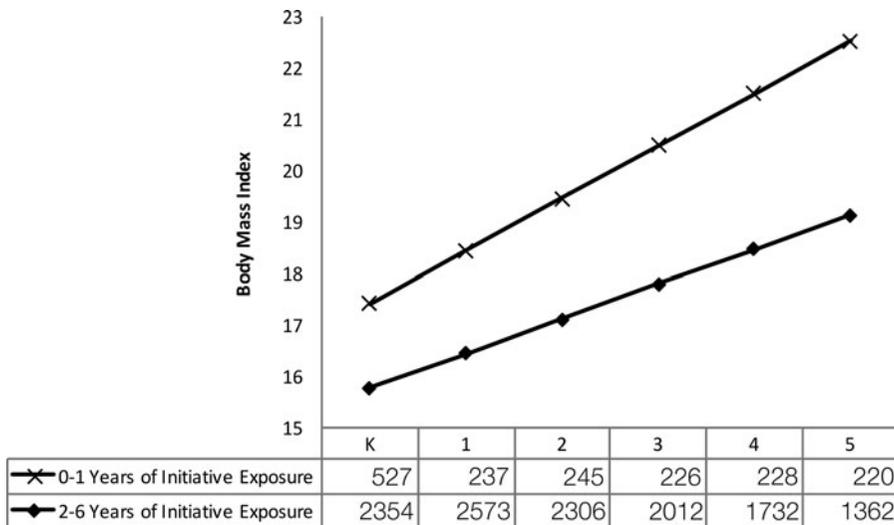


Figure. Kindergarten to fifth-grade BMI growth trajectories for 0 to 1 and 2 to 6 years of exposure to the Northeast Iowa Food and Fitness Initiative. All results were adjusted (ie, controlled) for effects of sex, school, and age. Although the total number of students was 4101, the actual number of BMI measurements at each grade level for each group is listed below the grade level on the horizontal axis. Number of BMI measurements ranged between 2881 (kindergarten) and 1582 (grade 5).

time.²⁷⁻³⁰ The present work provides evidence of successful intervention at multiple levels of public policy, community-built environment, and areas of school policy and activity.

This was a multisector collaboration working for change in the community and particularly at schools, with the goal of slowing the rate of increase in children's BMI. However, schools cannot and should not do this alone.³¹ Schools cannot bear the financial or logistical burden to accomplish healthy BMI for children. Nevertheless, schools should plan to contribute in-kind resources and seek grants and other sources of funding to support a healthy environment.¹⁸ Often health and physical education teachers are in the best position to evaluate how to positively influence the school environment, but so too are school cooks, nutritionists, counselors, and nurses.¹⁸ These same people should also be prepared to share expertise and advice on broader community issues that may run parallel to those in the school (eg, nutrition and physical activity). School principals and district superintendents need to maintain a collaborative relationship with the community and school partners to enhance budget, logistical, and resource contributions. Hence, schools can collaborate with other community sectors that impact children's health, including the food system, early childhood care, local government, hospitals, public health, and more.^{32,33} No one intervention in any sector of society is sufficient for mitigating a complex problem like childhood obesity. Schools can be a leading partner aligning their strategies to create policies, systems, and environments that support healthy living. A collaborative school-community approach to championing healthy kids likely stands the greatest chance for success.

Limitations

As with all studies of this type, there are limitations. First, our groups could not be randomly assigned. The Northeast Iowa Food and Fitness Initiative began in 2009. Hence, students fall into groups of 0 to 6 years of exposure based solely on when they completed their elementary education in their respective districts. That said, this design offers some notable advantages. First, having groups of 0 to 6 years of exposure provides, in effect, district-based, self-controls (ie, 0-1 year of exposure) of students within the same school districts. That is, those students who received more or less exposure to initiative work come from the same geographic and sociodemographic backgrounds and attended the same schools in the same communities, just at different times. Controlling geographic and community

differences is important because much of the initiative work focuses on using community resources more effectively to prevent obesity and engages local governments and organizations to support the work. Utilizing control sites from other communities would provide almost certain difficulties in matching on key variables such as these.

A second important limitation to consider is that this work was implemented by community stakeholders and hence our ability to control the dose delivered/received of initiative was limited. For some communities change came more swiftly than in others. All communities met minimum expectations for involvement and were invested in bringing about change, but the manner in which this occurred differed some from site to site. This limits our ability to identify a single process or outcome that is critical to facilitating obesity prevention. Perhaps the key process is the process itself that brings consciousness raising in the community that in turn promotes healthier policy and ultimately creates an environment where the healthy choice is the easy choice for children and their families.

A third limitation is that BMI data were recorded and housed in local school districts by school nurses. Although school nurses are trained to conduct such measurements and record them appropriately, there could have been some variability in measurement devices or recording procedures that introduced unwanted error into the data. Given the professionalism of the nurses in this initiative, this is unlikely, but a possibility that should be considered.

A fourth limitation was that BMI z scores or BMI percentile could not be accurately calculated because date of birth was not available to investigators as part of the de-identified dataset. Because we were comparing BMI growth rates in groups of children with similar age ranges, this limitation should not affect the validity of the results.

Last, there are aspects of this initiative that do impact children who are both younger and older than elementary school-aged children and we do not have data in these populations at this time. We plan to address the impact on BMI in other age groups with future studies.

CONCLUSIONS

The present study provides an evaluation of a comprehensive, regional, policy-, community-, and school-based initiative aimed at slowing the rate of BMI growth in elementary school-aged children. There were many methods employed in this multifaceted intervention and the end result has been that school children who were fortunate to experience 2 or more years of initiative work in their schools

enjoyed a 1.5-point BMI savings by the completion of elementary school years. This translates to a 6-lb savings by the fifth grade. Future research might examine whether these savings continue and, in fact, multiply as middle school, high school, and college years are encountered. Continued follow-up with these children might enable a better understanding of how community- and school-based interventions during the elementary school years offer extended protection over subsequent phases of life. Might early prevention efforts offer an “extended warranty” on healthy BMI and reduce risk of adult overweight and obesity with all their associated perils?

REFERENCES

1. Dietz WH. The response of the US Centers for Disease Control and Prevention to the obesity epidemic. *Annu Rev Public Health*. 2015;36:575-596.
2. Caprio S. Treating child obesity and associated medical conditions. *Future Child*. 2006;16:209-224.
3. Daniels SR. The consequences of childhood overweight and obesity. *Future Child*. 2006;16:47-67.
4. Sekhobo JP, Edmunds LS, Reynolds D, Dalenius K, Sharma A. Trends in prevalence of obesity and overweight among children enrolled in the New York State WIC Program, 2002-2007. *Public Health Rep*. 2010;125:218-224.
5. Shoup JA, Gattshall M, Dandamudi P, Estabrooks P. Physical activity, quality of life, and weight status in overweight children. *Qual Life Res*. 2008;17:407-412.
6. Nöthlings U, Wilkens LR, Murphy SP, Hankin JH, Henderson BE, Kolonel LN. Body mass index and physical activity as risk factors for pancreatic cancer: the multiethnic cohort study. *Cancer Causes Control*. 2007;18:165-175.
7. Anderson PM, Butcher KF. Childhood obesity: trends and potential causes. *Future Child*. 2006;16:19-45.
8. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obes Rev*. 2016;17(2):95-107.
9. Winckworth LC, Coren M. Environmental change as an effective treatment of severe childhood obesity. *J Paediatr Child Health*. 2013;49:E351-E352.
10. Katz DL. School-based interventions for health promotion and weight control: not just waiting on the world to change. *Annu Rev Public Health*. 2009;30:253-272.
11. Kothandan SK. School based interventions versus family based interventions in the treatment of childhood obesity—a systematic review. *Arch Public Health*. 2014;72(1):1.
12. Krishnaswami J, Martinson M, Wakimoto P, Anglemeyer A. Community-engaged interventions on diet, activity, and weight outcomes in US schools: a systematic review. *Am J Prev Med*. 2012;43(1):81-91.
13. Lavelle HV, Mackay DF, Pell JP. Systematic review and meta-analysis of school-based interventions to reduce body mass index. *J Public Health*. 2012;34(3):360-369.
14. Sobol-Goldberg S, Rabinowitz J, Gross R. School-based obesity prevention programs: a meta-analysis of randomized controlled trials. *Obesity*. 2013;21(12):2422-2428.
15. Institute of Medicine. Committee on Accelerating Progress in Obesity Prevention, Glickman D. *Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation*. Washington, DC: National Academies Press; 2012.
16. Datar A, Shier V, Sturm R. Changes in body mass during elementary and middle school in a national cohort of kindergarteners. *Pediatrics*. 2011;128:e1411-e1417.
17. Kubik MY, Lee J. Parent interest in a school-based, school nurse-led weight management program. *J Sch Nurs*. 2014;30:68-74.
18. Clarke J, Fletcher B, Lancashire E, Pallan M, Adab P. The views of stakeholders on the role of the primary school in preventing childhood obesity: a qualitative systematic review. *Obes Rev*. 2013;14(12):975-988.
19. Herman KM, Hopman WM, Craig CL. Are youth BMI and physical activity associated with better or worse than expected health-related quality of life in adulthood? The Physical Activity Longitudinal Study. *Qual Life Res*. 2010;19:339-349.
20. Llargo E, Franco R, Recasens A, et al. Assessment of a school-based intervention in eating habits and physical activity in school children: the AVall study. *J Epidemiol Community Health*. 2011;65:896-901.
21. Scheffler C, Schüler G. Analysis of BMI of preschool children—results of longitudinal studies. *Anthropol Anz*. 2009;67:53-63.
22. Snell EK, Adam EK, Duncan GJ. Sleep and the body mass index and overweight status of children and adolescents. *Child Dev*. 2007;78:309-323.
23. Melekoglu T. The effects of sports participation in strength parameters in primary school students. *Procedia Soc Behav Sci*. 2015;186:1013-1018.
24. Ensaff H, Canavon C, Crawford R, Barker ME. A qualitative study of a food intervention in a primary school: pupils as agents of change. *Appetite*. 2015;95:455-465.
25. Majid HAMA, Danis A, Sharoni SKA, Khalid M. “Whole School Environmental Mapping Framework and Observation” in preventing childhood obesity. *Procedia Soc Behav Sci*. 2015;201:102-109.
26. Mo-suwan L, Pongprapai S, Junjana C, Puetpaiboon A. Effects of a controlled trial of a school-based exercise program on the obesity indexes of preschool children. *Am J Clin Nutr*. 1998;68(5):1006-1011.
27. Donnelly JE, Jacobsen DJ, Whatley JE, et al. Nutrition and physical activity program to attenuate obesity and promote physical and metabolic fitness in elementary school children. *Obes Res*. 1996;4(3):229-243.
28. Gonzalez-Suarez C, Worley A, Grimmer-Somers K, Dones V. School-based interventions on childhood obesity: a meta-analysis. *Am J Prev Med*. 2009;37:418-427.
29. Gortmaker SL, Peterson K, Wiecha J, et al. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Arch Pediatr Adolesc Med*. 1999;153(4):409-418.
30. Jones RA, Lubans DR, Morgan PJ, et al. School-based obesity prevention interventions: practicalities and considerations. *Obes Res Clin Pract*. 2014;8:e497-e510.
31. Story M, Kaphingst KM, French S. The role of schools in obesity prevention. *Future Child*. 2006;16(1):109-142.
32. Galemore CA, Bowlen B, Combe LG, Ondeck L, Porter J. Whole school, whole community, whole child—calling school nurses to action. *NASN Sch Nurse*. 2016;31(4):216-223.
33. Lewallen TC, Hunt H, Potts-Datema W, Zaza S, Giles W. The whole school, whole community, whole child model: a new approach for improving educational attainment and healthy development for students. *J Sch Health*. 2015;85(11):729-739.