

NEEMA: A School-Based Diabetes Risk Prevention Program Designed for African-American Children

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Objective: To conduct formative assessment and preliminary biological impact of a school-based diabetes risk prevention program for African-American children during a 14-week study.

Methods: NEEMA is a school-based diabetes prevention program tailored for African-American children. The NEEMA is implemented via four social networks—classroom (Health and Physical Education Class), after school (Health Club), home (Family Fun Fair) and school cafeteria (Food Service Program). Formative assessment data were collected through semistructured interviews with physical education (PE) teachers and a pre-to-post design was used to measure biological impact. Fasting capillary glucose, height, weight, body mass index, percent body fat and fitness data were collected from a sample of 58 fourth-grade students. The six elementary schools had >40% African-American enrollment and were located in low-income neighborhoods.

Results: Face-to-face interview data revealed diabetes, obesity and food insufficiency as major health concerns among PE teachers. Teachers also cited large classes and short PE periods as major challenges for implementing the program. From baseline to follow-up, fitness laps increased from 16.40 (SD=9.98) to 23.72 (SD=14.79) ($p<0.000$), fasting capillary glucose decreased from 89.17 mg/dl (SD=10.05) to 83.50 mg/dl (SD=11.26) ($p<0.000$), and percent body fat decreased from 27.26 (SD=12.89) to 26.68 (SD=11.67) ($p<0.537$).

Conclusion: The NEEMA pilot study provided teacher feedback useful for revising the NEEMA health curricula and positive preliminary impact of the NEEMA PE class on children's fitness and blood glucose levels.

Key words: diabetes ■ obesity ■ fitness ■ African Americans ■ children's health

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An early report documenting that new cases of type-2 diabetes in children had surpassed type 1 came from a pediatric referral center in Ohio. The rates of type-2 diabetes in youth increased from 2% in early 1990s to 16% in mid 1990s.¹ African-American children were overrepresented in the new cases of type-2 diabetes. Although African Americans represented 15% of the population in the greater Cincinnati service area, 33% of the newly diagnosed and 69% of all youth with type-2 diabetes between the ages 10–19 years were African American. Other studies have also reported African-American youth's predisposition to type-2 diabetes.²⁻⁴

Diabetes risk factors, like type-2 diabetes, are also more prevalent in African-American than in non-Hispanic white youth. One such factor is elevated plasma insulin. In the Bogalusa Heart Study, 400 youth (65% non-Hispanic white and 35% black) between the ages of 5–17 years were examined for plasma insulin levels.⁵ African-American youth had age-adjusted insulin levels significantly higher than non-Hispanic white (10.7 and 8.9 μ U/ml). In a longitudinal cohort of the same study, 427 children aged 5–7 years had plasma insulin levels examined at baseline and again at three years.⁶ Over the three-year period, only black girls had significant higher values than any other race-gender group. Higher insulin levels in African-American children than in non-Hispanic white children have been reported by other investigators.⁷⁻⁹

Modifiable risk factors reported to be associated with type-2 diabetes, independent of each other, are overweight^{10,11} and low physical activity.^{12,13} Data from the Centers for Disease Control and Prevention Pediatric Surveillance showed that African-American children (>2 years of

age) had the largest absolute increase in overweight prevalence.¹⁴ From 1983–1995, African-American, non-Hispanic white and Hispanic children had a 2.6, 1.5 and 1.4 percentage point increase, respectively. Researchers with the National Heart, Lung and Blood Institute Growth and Healthy Study prospectively followed 1,213 African-American and 1,166 non-Hispanic white girls from the ages of 9 to the ages of 19 years.¹⁵ They used the Habitual Activity Questionnaire and metabolic equivalents to measure leisure-time physical activity. From baseline to year 10 of the study, activity scores declined 100% for African-American and 64% for non-Hispanic white girls. Other studies have also reported African-American children having higher prevalence of overweight¹⁶ and inactivity levels¹⁷ than non-Hispanic white children.

Because of the high levels of type-2 diabetes and diabetes risk factors, four African-American researchers translated the Bienestar (meaning “wellness” in Spanish) Health Program for African-American children and

named it the NEEMA (meaning “wellness” in Swahili) Health Program. The Bienestar curriculum, which consists of home, health class and physical education (PE), school food service and after-school components, has shown to impact favorably fasting capillary glucose (FCG), fitness levels and dietary fiber intake of Mexican-American children.^{18–20} In the present study, PE teachers were asked to comment on the health and PE classes, parent, food service and after-school NEEMA health program activities. Additionally, the children’s FCG, height, weight, percent body fat and fitness were collected before and after the seven-week intervention.

METHODS

Participants

The San Antonio [TX] Independent School District (SAISD) was the host school district for this study. The school district consists of 64 elementary schools, 16

Table 1. NEEMA program description and schedules

Programs	Description	Schedules
NEEMA Health and Physical Education Class (includes an instructor’s health and PE manual, a student’s health workbook, a pre/post exam and answer key)	The health curriculum is based on thematic instruction, experiential and multicultural learning. The 13 lessons cover nutrition, physical activity, self-esteem, self-control and diabetes. The PE curriculum is aimed at promoting MVPA.	Health and physical education classes are held 45 minutes a day, five days a week. One day is used to teach health education, and four days are for physical activities.
NEEMA Health Club (includes an instructor’s manual with student handouts)	The aim of the 18 sessions is to reinforce classroom learning and to promote leisure-time physical activity. Student participation is voluntary, and parents are encouraged to attend. Physical activities, aerobics, games, dancing, singing, and arts and crafts are a part of the activities.	The health club meetings are held once a week, Monday through Friday, for 45 minutes during school or for one hour after school from 3:15–4:15 pm.
NEEMA Family Fun Fair (includes a parent manual and parent handouts)	Designed to promote healthy choices for the entire family. Meetings consist of four activities: cooking demonstrations (nutrition and weight), Jazzercise, dancing classes (exercise and weight) and family games that reinforce healthy behaviors. Health fairs consist of nutritional and physical activity information as well as health screenings.	Parent presentations are held in conjunction with the school’s Parent Teacher Association meetings. Community health fairs with free health screenings are also held at various locations throughout the school year.
NEEMA School Food Service Program (includes an instructor’s manual and a food service staff workbook)	Seven cafeteria lesson plans designed to improve the nutrition knowledge of food service staff and lunch visits to effectively encourage students at lunch period to choose and eat more fruits and vegetables and less fatty foods.	Food service staff receive a weekly lesson, approximately 15 minutes long, held during staff breaks. Students receive weekly lunch visits during their scheduled lunch period in which encouragement is given to the children to make healthy menu choices.

middle schools and eight high schools. The ethnic breakdown in the elementary schools was 80% Hispanic, 15% African American and 5% other. With 57,108 students enrolled, the SAISD is the ninth largest school district in the state.

The minimum inclusion criteria needed for schools to participate were 40% African-American student enrollment and not being an alternative school. Fourth-grade students were selected for this study because at age 9, children experience a physiologic increase in blood glucose, insulin and body fat to sustain their growth for puberty.⁵ To observe biological changes, a stage with rapid growth and development is preferred. The six elementary schools selected for this study had African-American enrollment between 43% and 74% (60% average). Ninety percent of children attending these schools were classified as economically disadvantaged according to school district criteria. The schools were located in the Eastside of San Antonio, comprised of marginally served, socially challenged neighborhoods, lower-income residents and African Americans. The median household income for the Eastside and the rest of San Antonio, were \$28,000 and \$44,000, respectively.²¹

Design

The pre-to-post without control research design was used, and the unit of measure was the students. The University of Texas Health Science Center at San Antonio’s institutional review board approved the study on December 30, 2004, and the study began on January 31, 2005. The timeframe for baseline data collection, intervention implementation and follow-up data collection were three, seven and four weeks, respectively. All fourth-grade students were eligible to participate in the four program components, but only students with assent and parental consent participated in data collection.

Program Description

The NEEMA-coordinated school health program

was modeled after the Bienestar school-based diabetes risk prevention program. The Bienestar Health Program was developed in response to two San Antonio studies showing the increased rates of diabetes risk factors and type-2 diabetes among Mexican-American children.^{22,23} There are few reported interventions to prevent type-2 diabetes in minority youth. A large randomized intervention study targeting prevention of type-2 diabetes was the Bienestar.¹⁹ The Bienestar consists of a set of organized health programming sessions transmitted to children through social structures (home, health class, school cafeteria and after school) aimed at changing their health behaviors (increase physical activity and dietary fiber intake; and decrease saturated fat intake, refined sugar intake and sedentary time). Nearly 1,400 fourth-grade Mexican-American children from 27 elementary schools participated in this study. After one year follow-up, intervention youth showed significantly lower fasting glucose, higher fitness levels and higher dietary fiber intake than those in control schools. Results of other diabetes prevention programs designed for minority children have either not been reported²⁴ or had no effect on physiologic measures.²⁵ The Bienestar was selected for translation because of its impact on biological markers.

The four components of the Bienestar were translated into instructional materials more compatible with African-American family life and culture. The translation team was composed of an African-American researcher and three African-American staff members from the Social and Health Research Center with combined six years’ experience developing and implementing the Bienestar Health Program. The team modified pictures, names of people, activities, some language and foods in the curriculum to be more representative of the African-American culture and experience.

The four components of the NEEMA-coordinated school health program are presented in Table 1. The NEEMA health class and PE curriculum is based on thematic instruction, experiential and multicultural learning. The 13 lessons cover nutrition, physical activity, self-esteem, self-monitoring and diabetes education. The PE curriculum promotes moderate-to-vigorous physical activity. The NEEMA Health Club is designed to reinforce the lessons learned in health class and to promote leisure-time physical activity. Physical activities, including aerobics, games, dancing, singing, arts and crafts are some of the health club activities. Student participation is voluntary, and parents are encouraged to attend.

The NEEMA School Food Service Program is designed to improve the nutrition knowledge of food service staff. NEEMA staff also conducted weekly lunch visits to encourage students to choose and eat more fruits and vegetables during

Table 2. School and student characteristics at baseline

Characteristic	Number
School Level	
Number of schools	6
Students enrolled in fourth grade	269
Economically disadvantaged fourth-graders	241 (90)%
African Americans enrolled in fourth grade	162 (60)%
TAKS passing rate	48%
Student Level	
African-American students consented	68 (42%)
Female	38 (55.9%)
Male	30 (44.1%)
Age	10.54 ± 0.742
Overweight students (BMI ≥95th)	15 (22.1%)
Students with high FCG (≥100 mg/dl)	13 (19.1%)

lunch. The NEEMA Family Fun Fair is designed to promote healthy choices for the entire family. Family Fun Fair meetings consist of cooking demonstrations, dancing classes, family games and a health fair.

Evaluation Measures

To collect formative assessment data, 10 PE teachers from the six study schools were interviewed at the end of the seven-week intervention. PE teachers implemented the NEEMA Health Class and PE curriculum but were also asked to observe and comment on activities from parent, food service and after-school components. For this analysis, questions concerning the overall health of students, program diffusion, product identity and cultural appropriateness were asked, and only responses with ≥ 3 occurrences per teacher were record-

ed. If an elementary school had two PE teachers, the interviews were conducted simultaneously, but their responses were recorded separately. The interviews were conducted face to face, and the responses were recorded, transcribed and analyzed for frequency by the study staff.

To determine biological impact, height, weight, percent body fat and FCG were collected, and body mass index (BMI) was calculated. Students in indoor clothing and barefoot had their height measured using a wall stop measuring tape (Seca body meter; Seca Corp, Hanover, MD). The weight and percent body fat were measured using bioelectric impedance analysis (BIA; Tanita Corporation of American Inc., Arlington Heights, IL). For this analysis, students in indoor clothing remove their shoes and socks and step on the metal box. Within 30

Table 3. Feedback from PE teacher face-to-face semistructured Interviews (n=10)

What health concerns do you feel affect your students?	Frequency
Obesity	8
Diabetes	5
Food insufficiency leading to poor diet	4
What do you think of a program to help fourth-graders eat more fruits and vegetables, and get more active to prevent diabetes and obesity?	
It would be well accepted by school staff (great idea)	6
Focus on eating more fruits and vegetables	4
Focus on doing more physical activity	3
What sort of reaction might we expect from students, faculty and other staff in response to a program such as this?	
Supportive and positive reaction from school staff (good idea)	10
Students won't take it seriously	2
Adults would not be receptive	2
Can you suggest activities we may be able to use to get student body/school interested in the program?	
Have more interactive hands-on like sports contest and playful activities	10
Break students into teams	9
Have more incentives	4
What challenges do you face on a daily basis that may put a constraint on your ability to institute a program/curriculum such as NEEMA?	
Not enough time during PE period	10
Testing and other academic schedules interferes with PE time	2
Class size too large	2
What can be done to increase the likelihood that NEEMA materials are received positively by students and PE teachers?	
Program benefits should be explained to teachers at training	6
NEEMA staff should be consistent and organized with communication within the school	5
Have bazaars for the students to use their bucks more than once a year	4
What do you think of the name of the program?	
The name NEEMA is catchy; sparked interest; sounds great	10
Healthy Heroes and pictures are a good idea	6
Culturally appropriate for African-American children	2

seconds, the instrument prints out the student's weight and percent body fat.

Blood glucose was measured by FCG. Study staff sent home reminder notices, and classroom announcements were made the day before the FCG test to assure students fasted overnight. FCG levels were measured by collecting a drop of blood from the student's finger. The blood drop was placed in a reagent strip and inserted into an Ascencia Elite XL glucose monitor (Bayer Corp., Mishawaka, IN). Students with FCG <100 mg/dl were given a written notice explaining to parents that the student's test was normal. Students with FCG \geq 100 mg/dl were classified as having high blood glucose levels. These students were given a parent notice explaining the results and the need for a physician referral. The student's name was also provided to the school nurse for further follow-up and contact.

Physical fitness was measured by the 20-meter shuttle run test (20-MST).²⁶ The 20-MST involved running back and forth across a 20-m course timed to music played from a tape or CD. Beeps on the sound track indicated when a student should reach one end of the course. The test began at a slow pace, and each minute the pace increased. A student continued running until the pace could no longer be sustained for two successive laps. The number of laps finished was recorded at the end of the test. The test was administered to 15 students at a time by two study staff members. Students did two practice runs one day before the test.

Statistical Analysis

Baseline and follow-up data were entered into and analyzed with SPSS[®] version 14.0. Descriptive analyses were used to show school and student baseline characteristics as expressed by mean \pm SD. Because this was a pilot study to collect formative assessment and determine preliminary biological impact of a new culturally appropriate program, sample size was determined by resource availability and not by power calculations, and only African-American students were included in the final analysis. Paired t-test analyses compared student differences between baseline and follow-up measures. BMI was calculated by dividing weight (kilograms) by the

square of the height (meters). Students were classified as overweight if their age- and gender-specific BMI was \geq 95th percentile. Students were classified as having high blood glucose levels if their FCG was \geq 100 mg/dl.²⁷

RESULTS

School and student baseline characteristics are presented in Table 2. The total number of fourth-grade students enrolled in the six elementary schools was 269, and of these 90% were from economically disadvantage households and 60% were African American. The state competency examination (The Texas Assessment of Knowledge and Skills) passing rates for fourth-grade students in the six and in the state's elementary schools were 48% and 75%, respectively. This study targeted African-American students, and among the 162 African-American students enrolled, 42% gave assent and parent consent. The mean age was 10.54 (SD=0.74), and 56% were female. At baseline, 22% of students were overweight, and 19% had high blood glucose levels.

Semistructured Interview Sessions with PE Teachers

Feedback from PE teacher interviews is presented in Table 3. At the end of the seven-week intervention, 10 PE teachers from the six study schools were interviewed. Their ages ranged between 26–46 years; there were seven males and three females. The ethnic representation was three African Americans, four Hispanics, and three non-Hispanic whites. The frequency of comments is presented in descending order. The most frequent health concerns mentioned were obesity, diabetes and food insufficiency at home, leading to poor childhood nutrition. Most acknowledged that a health promotion program would be well accepted and supported by students and school staff. The instructional method more frequently recommended by the PE teachers was hands-on activities. The most frequent challenges they revealed were not enough time for health instruction, too much intrusion of academic tutoring into PE time and class sizes being too large. To improve program diffusion, the advice was adequate teacher training, have same NEEMA staff assigned to one school to improve

Table 4. Mean fitness, glucose, percent body fat and BMI level changes of students participating in the NEEMA school program (n=58)

Variable	Baseline	Follow-Up	t Value	df	P
Fitness					
Laps completed	16.40 \pm 9.98	23.72 \pm 14.79	-4.96	57	0.000
Glucose					
FCG	89.17 \pm 10.05	83.50 \pm 11.26	3.73	57	0.000
Body Composition					
% BF	27.26 \pm 12.89	26.68 \pm 11.67	0.62	57	0.518
Anthropometric					
BMI	20.30 \pm 5.29	20.81 \pm 5.57	-3.06	57	0.003

communication between NEEMA staff and school staff, and have more incentive activities for the students. For product identity, the NEEMA name was catchy and culturally appropriate for African-American children. The Healthy Heroes (health book cartoons) and pictures were well received.

Fitness, Glucose and Anthropometrics

Complete baseline and follow-up data were available for 58 African-American students (Table 4). The laps completed in the 20-MST increased from 16.40 (SD=9.98) at baseline to 23.72 (SD=14.79) at follow-up ($t(57)=-4.96, p<0.000$). FCG decreased from 89.17 (SD=10.05) to 83.50 (SD=11.26) between baseline and follow-up (paired sample $t=3.73, df=57, p=0.000$). Percent body fat and BMI moved in opposite directions. From baseline to follow-up, percent body fat decreased from 27.26 (SD=12.89) to 26.68 (SD=11.67) (paired sample $t=0.62, df=57, p=0.537$), and BMI increased from 20.30 (SD=5.29) to 20.81 (SD=5.57) ($t(57)=-3.06, p<0.003$).

DISCUSSION AND RECOMMENDATIONS

Given that 19% of African-American children in the present study screened positive for prediabetes indicates the strong need for early-age diabetes prevention programs. The NEEMA pilot study provided valuable teacher feedback useful for revising the instructional material and showed a positive impact on children's fitness and FCG levels. Over the seven-week intervention, participating children significantly increased fitness levels by 45% and decreased FCG by 6%. Among students with complete data, the number who screened positive for prediabetes decreased from nine (16%) at baseline to two (3%) at follow-up (not shown).

The aim of the study was to determine if the new NEEMA instructional material was culturally appropriate for African-American children. The feedback from teachers and comments expressed by children to the teachers were positive. PE teachers' comments on NEEMA programming were supportive of school-based lifestyle interventions but emphasized constraints by home, school and state actions. It was not surprising that teachers reported that the most frequent health concerns affecting children were obesity and diabetes, but it was surprising that food insufficiency at home was frequently mentioned. Recent studies have shown the paradox relationship between food insufficiency and obesity of children living in poverty.^{28,29} Investigators have suggested the low cost of added sugars and fat in snacks, fast foods and soft drinks are the cause for unhealthy outcomes.^{30,31}

PE teachers also expressed concerns about campus administrative practices such as pulling PE teachers from PE instruction to tutor academic and test-taking skills. State policies that failed to limit class size for PE and placed too much emphasis on competency testing were

challenges frequently expressed. Whereas state mandates limit the class size of core subjects (22 students to one teacher), there are no limits to health and PE class sizes. PE teachers discussed their difficulties trying to teach nearly 100 students in a gym and offered solutions for the challenges encountered. They recommended better teacher training, more interactive hands-on activities, breaking of students into smaller teams and more incentives for students. The revised NEEMA curriculum will have more hands-on activities, break students into small teams and provide more incentives to participate. Teacher training will be improved by providing training manuals and extending the hours of training.

Other well-designed studies have also shown the positive effects of early-age interventions on diabetes risk factors in youth.^{32,33} In a randomized, controlled study, a school-based lifestyle and fitness program was implemented to determine whether it could improve fitness levels and insulin sensitivity in overweight middle-school children.³² Fitness was measured by treadmill walk test, and insulin sensitivity was measured by fasting glucose-insulin ratios. At the end of the nine-month intervention, the intervention group showed a significant improvement in maximum oxygen consumption compared with their own baseline and with the control group. Similarly, the intervention group had significant improvements in measures of insulin sensitivity compared with the control group. In the STRIP study, 1,026 healthy seven-month-old infants were randomized to intervention and control groups and followed for nine years to determine the effects of a low-saturated-fat diet on insulin sensitivity.³³ Diet was measured by food records, and insulin sensitivity was measured by homeostasis model assessment of insulin resistance. This study showed that infants who were provided with dietary fat avoidance counseling starting at infancy were more likely to have improved insulin sensitivity at the age of nine years. Common characteristics of these two interventions were that they were tailored around the special needs of children and implemented in small class sizes. The NEEMA program demonstrated to be culturally appropriate for African-American children, and the revised NEEMA will have learning activities designed for small groups.

LIMITATIONS

A limitation of the study was lack of a randomized control. School-based interventions involve randomizing schools into treatment groups, and schools become the unit of measure. Students are clustered within schools, and mixed models are the method of analysis. Because the aim was formative assessment and preliminary impact of the program on biological markers, this study involved a small group, and biological measures were analyzed at the individual level.

The second limitation involved using BMI as an out-

come variable. Despite an increase in fitness, participating students showed an increase in BMI. Overweight is a primary cause for type-2 diabetes, and BMI is the value most widely used to measure it. This has been true for most age groups, but in prepubertal children, some studies are showing that BMI might not be as accurate because of the changes in lean to fat mass changes occurring in this age group.³⁴⁻³⁷ In the Fels longitudinal study, repeated measures of underwater weighing and BMI were collected in youth 8–18 years of age.³⁸ This study showed that the age-related increase in BMI from mid-childhood onward was attributable to increasing lean mass, rather than fat mass. Furthermore, if fitness is increased in rapidly growing children, bone and muscle mass develops, producing greater increases in BMI.³² This favorable outcome is what might have occurred in children from the present study since physical fitness increased and percent body fat decreased.

CONCLUSION

The NEEMA school-based diabetes prevention pilot study showed that the instructional material was culturally appropriate for African-American children and that the program had a positive effect on children's fitness and FCG levels. Although the school health program was well accepted by school staff, adverse influences from home, school administration and state education agencies were listed as barriers in the PE teacher interviews. Future studies to determine program efficacy should include a randomized control trial, a larger sample of schools and cluster analysis.

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