CNE Continuing Nursing Education Series

Obesity and Blood Pressure Trends in Rural Adolescents over a Decade

Marsha Howell Adams
Tracy M. Carter
Carol Ann Barnett Lammon
Alesa Hicks Judd
James Leeper
John R. Wheat

This study determined the association between overweight and obesity, demographic variables, elevated blood pressure, and frequency of health care referrals in rural adolescents. Annual school health screenings were conducted. Analysis is limited to student observations from 1996-2005, grades 9 through 12 (4,263 observations), using a repeated-measures, cross-sectional model. A significant upward trend revealed the odds of being overweight to be 1.43 times greater in 2005 compared to 1996. Rates of overweight and obesity were 23% and 17%, respectively. The greatest prevalence of obesity was among young adolescent non-Caucasian males. The odds of having elevated blood pressure was 6.9 times higher in obese versus normal-weight students. A significant association between overweight and receipt of referral for care was observed. Being overweight was significantly associated with poverty and the low education level of the head of the household. Interventions prior to adolescence are needed to reduce the rate of obesity and cardiovascular complications.

Adolescent obesity is on the rise and is associated in the literature with adverse health effects and with demographic factors that could help focus preventive efforts in the community. The literature suggests that rural and southern populations may be at special risk with respect to obesity (Centers for Disease Control and Prevention (CDC) (2007).

There has been a staggering increase in the prevalence of obesity over the last 25 years. The obesity rates of children up to 5 years of age are estimated to have increased from 5.0% to 13.9% between 1980 and 2004. Children, ages 6 to 11 have increased from 6.5% to 18.8%, and ages 12 to 19 years of age have increased from 5.0% to 17.4% (Ogden et al., 2006). In addition, *Healthy People 2010* has identified overweight/obesity as one of the top 10 health indicators affecting individuals and communities (CDC, 2006). These statistics hold major implications for our children and adolescents. Becoming obese during childhood and adolescence can predispose children to a number of health problems, such as hypertension, insulin resistance, and dyslipidemia (CDC, 2006). Resulting adult obesity is another problem that has been identified for children having a body mass index (BMI) greater than or equal to the 99th percentile (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). This study was conducted to assess the trend and magnitude of the adolescent obesity epidemic in a small, rural southern community, to study associated health status, and to assess demographic association.

Literature Review

A literature review was completed to document the importance of adolescent obesity as a target for prevention efforts and to understand the associated adverse health conditions and predictive demographic factors. Cited references were selected based on their apparent support for the concepts to be studied in this research project.

Childhood and adolescent obesity. BMI has been found to be a reliable indicator of body fat and an effective screening tool for children, and has been used to screen children for being overweight and obese. According to the CDC (2006), BMI-for-age is used to evaluate weight status according to a child's age and gender. It is plotted on a growth chart to obtain a percentile. Percentile ranking is important because the amount of body fat

Marsha Howell Adams, DSN, RN, CNE, is a Professor and Director of Undergraduate Programs, the University of Alabama Capstone College of Nursing, Tuscaloosa, AL.

Tracy M. Carter, PhD, is Director, Center for Educational Research and Development, University of Central Florida, College of Education, Orlando, FL.

Carol Ann Barnett Lammon, PhD, RN, is an Associate Professor and a Clinical Nurse Leader Curriculum Coordinator, University of Alabama, Capstone College of Nursing, Tuscaloosa, AL.

Alesa Hicks Judd, PhD, is the Associate Superintendent, Bibb County Board of Education, and the Bibb County Child Caring Foundation Chairperson, Centreville, AL.

James Leeper, PhD, is a Professor of Community and Rural Medicine, the University of Alabama, Tuscaloosa, AL.

John R. Wheat, MD, MPH, is a Professor of Community and Rural Medicine, and Director, Rural Medical Scholars Program, the University of Alabama, College of Community Health Sciences, Tuscaloosa, AL.

Objectives, the CNE posttest, and disclosure statements can be found on pages 395-396.

changes with age and differs between genders. Children at risk for being overweight are ranked between the 85th to 95th percentile, while children at risk for being obese are greater than or equal to the 95th percentile (CDC, 2006). In this study, the term "overweight" is used for BMI between the 85th and 95th percentiles, and "obesity" is used for BMI at or above the 95th percentile for age.

Adverse health conditions associated with adolescent obesity. Cardiovascular risks have a well-supported association with adolescent obesity. As the prevalence of obesity has risen in children and adolescents, a similar increase in cardiovascular risk factors has been noted. Obesity is associated with an increased risk for hypertension, hyperlipidemia, and a higher rate of cardiovascular disease mortality (Kim et al., 2005). Until recently, most hypertension in children could be attributed to secondary causes, including renal disease, endocrine disease, or vascular conditions (such as coarctation of the aorta). However, as childhood obesity rates have increased, the diagnosis of primary hypertension has become more prevalent, especially as the obese child approaches adolescence. Veug-elers and Fitzgerald (2005) reported up to 30% of obese children are hypertensive. However, Flynn and Alderman (2005) reported that approximately half of the patients seen in a pediatric hypertension referral clinic were diagnosed with primary hypertension. Two-thirds of these patients were teenagers, and approximately half of them were obese.

Ribeiro et al. (2003) found a significant increase in both systolic and diastolic blood pressure with childhood obesity. King, Meadows, Engelke, and Swanson (2006) reported that the incidence of obesity and related risk factors, such as elevated blood pressure, was higher in rural children than national averages, and Thorpe et al. (2004) reported similar findings for children residing in inner city areas. The relationship between increased BMI and hypertension is stronger for Caucasians; African Americans are more likely to exhibit elevated blood pressures even with normal BMI (King et al., 2006). Female children have greater rates of obesity than males, and therefore, greater risk for cardiovascular risk factors (Burke et al., 2005).

While the risk for obesity associated with hypertension increases as a child approaches adolescence (Flynn & Alderman, 2005; King et al., 2006), the increase in cardiovascular risk factors actually begins in infancy (Burke et al., 2005). Young-Hyman, Schlundt, Herman, DeLuca, and Counts (2001) reported the presence of metabolic syndrome (characterized by hyperinsulinemia, hyperlipidemia, and elevated blood pressure) in overweight and obese African-American children as early as 5 years of age. Autopsy results of adolescents who died from traumatic causes reveal increased incidence of asymptomatic coronary atherosclerosis in obese individuals (McGill et al., 2002). Hyperlipidemia and target organ damage, such as left ventricular hypertrophy, often present when primary hypertension is diagnosed in obese adolescents, provides evidence of long-standing undetected hypertension (Flynn & Alderman, 2005).

Childhood obesity is associated with numerous additional negative health consequences. The risk for developing type II diabetes mellitus was found to be associated with overweight in children (Burke et al., 2005; Center for Rural Pennsylvania, 2005; Kim et al., 2005). Lobstein, Baur, Uauy, and the IASO International Obesity TaskForce (2004) found childhood obesity to be associated with poor glucose tolerance and sleep apnea. Ebbeling, Pawlak, and Ludwig (2002) reported overweight in children to be associated with chronic inflammation, increased blood clotting tendency, asthma, endocrine disorders, and musculoskeletal and neurological complications. Overweight children have a 70% chance of becoming overweight adults, suffering even greater negative health consequences (Center for Rural Pennsylvania, 2005).

The social and psychological consequences of childhood obesity are evident in related literature. Lobstein et al. (2004) found that children who are overweight suffer from social exclusion and depression. Sharma (2006) reported that childhood obesity is linked to poor self-image, low self-esteem, eating disorders, and poor quality of life. The National Institutes of Health report on the devastating psychosocial consequences of obesity, explaining that the psychological burden may be the greatest adverse effect of obesity (Wardle, Williamson, Johnson, & Edwards, 2006).

Associated demographic factors. A number of demographic variables have been examined in investigation of the overweight and obese status of children and adolescents. Research indicates that prevalence of childhood and adolescent obesity status varies by geographic location, ethnicity, gender, age, income, and parent education.

A child living in the United States is more predisposed to becoming obese than children living in other parts of the world. According to Lobstein et al. (2004), the prevalence of being overweight is 10% in the age range of 5 to 17 years worldwide, including 2% to 3% considered to be obese. In North and South America, the prevalence of being overweight exceeds 32% for the same age range, including approximately 8% considered to be obese. Specifically, North America and some European countries have demonstrated the highest prevalence of overweight children and the highest annual increases.

Additional research indicates the relationship of geographic location to a child's predisposition to becoming overweight. King et al. (2006) found that CDC estimates for rural school age population of overweight children, or children at risk for becoming overweight, may be low. The study indicated that nearly one in two children participating in the study was either overweight or at risk of becoming overweight (King et al., 2006). Although Veugelers and Fitzgerald's (2005) study in Nova Scotia indicated a decreased risk of becoming overweight for children residing in urban areas, opposing research indicated increased risk for becoming overweight based on urban location. In a study conducted by Thorpe et al. (2004) involving elementary public school children living in New York City, 43% were found to be overweight, including one in four classified as obese.

Ebbeling et al. (2002) indicated that urban, poor children are more predisposed to becoming overweight. This study comparing 7th grade rural and urban children found that rural children weighed an average of 4 pounds more than urban children, and that 20% of rural children were overweight, in comparison to 16% of urban children.

The minority status of children living in the U.S. was found to be a predictor of becoming overweight. The prevalence of overweight in Hispanic and African-American groups was markedly higher than in Caucasian and Asian groups. In addition to a higher prevalence, the rising rate of incidence is more than double the rate of incidence for becoming overweight when comparing Hispanic and African-American children with Caucasian and Asian children (Ebbeling et al., 2002; King et al., 2006; Lobstein et al., 2004;

Thorpe et al., 2004). An additional study by Salbe, Weyer, Lindsay, Ravussin, and Tataranni (2002) indicated that the overweight prevalence rates for Native American children were higher than the general population, at 30% to 40%.

The majority of literature indicated no difference in percentages of obesity along gender lines. A study conducted in Nova Scotia found the prevalence of being overweight as 32.9%, the same for both boys and girls; however, a difference was found in incidence of obesity, with 10.9% of males being obese, while 9.9% of females were obese (Veugelers & Fitzgerald, 2005).

The relationship of income to obesity indicated that children from lower income homes have a higher prevalence of obesity (Burke et al., 2005; Lobstein et al., 2004), with prevalence of obesity rates in children as much as twice as high from low-income neighborhoods (Veugelers & Fitzgerald, 2005). Lamerz et al. (2005) indicated a lower risk of obesity in higher social groups and a relationship of socioeconomic status that impacts obesity increasing with age, but is already prevalent at 6 years of age. The Center for Rural Pennsylvania (2005) found that higher percentages of children from low-income homes are overweight or obese in both rural and urban areas.

The single most important factor in the prevalence of childhood obesity was found to be maternal level of education (Burke et al., 2005; Lamerz et al., 2005). Higher levels of parent education were shown to reduce the incidence of overweight or obesity (Lobstein et al., 2004; Veugelers & Fitzgerald, 2005).

This literature review supports the proposition that adolescent obesity is a growing epidemic and is associated with health effects that forecast adverse health consequences, particularly cardiovascular morbidity. It also supports the rationale that high-risk groups might be identified through knowledge of demographic and contextual factors. Relevant to this study, it provides a basis for expecting that a small rural southern community with a diverse population and socioeconomic disadvantages will manifest childhood and adolescent obesity and associated health conditions at a magnitude to justify community-based preventive actions.

Table 1.
Demographic Characteristics of Participants

	n	%
Grade Level		
9th	1,546	36.3
10th	1,053	24.7
11th	928	21.8
12th	736	17.3
Gender		
Male	2,029	47.6
Female	2,232	52.4
Race		
Caucasian	2675	63.1
Non-Caucasian	1,564	36.9
Head of Household Education Level		
Less than high school	339	8.8
High school	2,036	52.8
More than high school	1,480	38.4
Family Yearly Income		
Less than $15,999	1,076	34.3
$16,000 to $23,999	538	17.1
$24,000 to $31,999	382	12.2
$32,000 or more	1,142	36.4
Health Insurance Status		
Uninsured	342	9.8
Publicly insured	1,195	34.4
Privately insured	1,942	55.8
Weight Risk Category		
Normal weight	2,344	56.8
Underweight – 5th percentile	121	2.9
Overweight – 85th percentile or greater	704	17.1
Obese – 95th percentile or greater	955	23.2
Hypertensive Risk		
Not at risk	1,976	68.1
At risk $\geq$ 120/80	926	31.9

Purpose of the Study

Although the prevalence of overweight/obesity in children is increasing, early screening, detection, and treatment might reduce the burden of this health problem and its complications. The purpose of this study was to determine the association between adolescent overweight, obesity, and demographic variables; elevated blood pressure; and frequency of health care referrals in a rural adolescent population. The research questions were:

- What is the prevalence of overweight/obese rural adolescents, and has the prevalence changed over the past 10 years?
- Are there associations between being overweight or obese and having adverse health status indicators (such as elevated blood pressure and higher frequency of referrals for health care)?
- Are there associations between being overweight or obese and demographic variables, such as age, gender, ethnicity, and socioeconomic status (income, head of household, education)?

Study Design and Methods

The Child Caring Initiative is an action-based research study focused on rural school children's insurance and health status. This community-based study began in 1996 and conducts annual school-based health

Figure 1.
Overweight and Risks of Overweight: 1996-2005

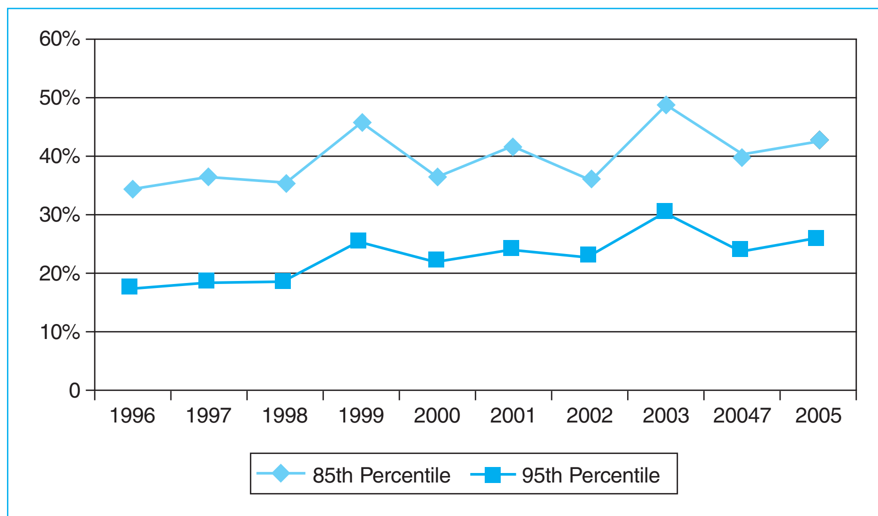

Table 2.
Relationship Between Overweight and Demographic Variables: Significant Findings

	Proportion at Risk	DF	Value	*p* Value
Age		5	17.6525	0.0034
14	44.4%			
15	42.9%			
16	39.1%			
17	35.8%			
18	37.2%			
19	43.6%			
Gender		1	12.3838	0.0004
Male	43.1%			
Female	37.7%			
Race		1	10.1386	0.0015
Caucasian	38.3%			
Non-Caucasian	43.4%			
Head of Household Education Level		2	10.7493	0.0046
Less than high school	46.7%			
High school	41.2%			
More than high school	37.5%			
Family Yearly Income		3	20.8027	0.0001
Less than $15,999	43.5%			
$16,000 to $23,999	39.4%			
$24,000 to $31,999	45.9%			
$32,000 or more	35.3%			

screenings composed of noninvasive, complete physical assessments of K-12 school children. The Institutional Review Board (IRB) of the university system and the county's Board of Education provided approval for the study. The study design is based on a longitudinal model; however, constraints in linking school children's data have limited the ability to conduct true repeated measures analyses to the first five years of the study. The current analysis is based on the first 10 years of observations (1996-2005), limited to students in grades 9 through 12, and is based on a repeated-measures cross-section model of analysis. Previous studies comparing the advantages of longitudinal versus repeated cross-sectional designs suggest that the latter is a cost-effective alternative to traditional longitudinal designs, does not suffer from loss of statistical power when there is ample subject replacement, and often is a better indicator of community change (Caplan, Lane, & Grimson, 1995; Yee & Niemeier, 1996).

Results

Demographic characteristics of participants. The current analysis is limited to health screening participants, grades 9 through 12, during the first 10 years of the Child Caring Initiative (1996-2005). The sample was based on 4,263 student observations. Table 1 shows the number of participants by grade. Fifty-two percent of participants were female, and approximately 37% were non-Caucasian. Sixty-three percent of participants lived in families with annual incomes below $32,000, and one-third came from families with income less than $15,999. Similarly, 62% of participants lived in families where the head of household education level did not extend beyond high school. Ninety-two percent reported some form of health insurance coverage; 34% had public health coverage (such as Medicaid or State Child Health Insurance Program [SCHIP]), and 55.8% reported private health insurance.

Prevalence of overweight. A high proportion of students were identified as being obese or overweight. On average, 40% of students were found to be obese (23%) or overweight (17%). Thus, the answer to question one shows a high prevalence similar to that reported in the literature (King et al., 2006).

Trend in prevalence of obesity. Figure 1 graphs the yearly prevalence from 1996 to 2005 of obesity and overweight in children. An upward trend with time is apparent, as anticipated from the literature, and the trend is significant ($p < 0.0001$). For example, the odds of being overweight were 1.43 times greater in 2005, compared to 1996.

Associations between obesity and adverse health conditions. Table 1 shows that 32% of adolescents had increased risk for hypertension. Table 2 and 3 show results of the analysis for

Table 3.
Relationship Between Overweight and Health Characteristics: Significant Findings

	Proportion at Risk	DF	Value	*p* Value
Hypertensive Risk		1	298.7592	< 0.0001
Not at risk	27.7%			
At risk ≥ 120/80	61.7%			
Receipt of Referrals		1	9.4161	0.0022
No referral	38.4%			
Received referral	43.2%			
Dental Referrals		1	9.1446	0.0025
No referral	39.4%			
Received referral	47.6%			
Primary Care Referrals		1	16.7649	< 0.0001
No referral	38.9%			
Received referral	47.7%			

association with increased weight. There was a significant association between overweight and hypertension ($p < 0.0001$). Among those identified as obese, the odds of having elevated blood pressure is 6.9 times that of those with normal weight.

As noted in Table 3, there were referrals made for 43% of the participants, consisting of primarily dental and primary care referrals. There was a significant association between overweight and receipt of referral for care ($p = 0.0022$). This association was present for referrals for both dental care ($p = 0.0025$), which identified cavities as the prevailing problem, and primary care ($p < 0.0001$), where there were a wide range of medical problems identified, such as strep throat, respiratory infections, increased pulse rate and blood pressure, and ear infections. Nearly 22% of students identified as overweight received a primary care referral, compared with 13% of those within normal weight limits. Question two was answered with affirmation of an association between obesity and adverse health conditions in this study population.

Associations between obesity and demographic characteristics. Chi-square tests of independence confirm there are associations between selected demographic characteristics and being overweight. Significant results are presented in Table 2. Specifically, there are significant associations between overweight and age, gender, race, and socioeconomic characteristics.

Age. There is a significant association between increased risk of overweight and age ($p = 0.0034$). Younger students are at greater risks of being overweight. For example, the odds of a 14-year-old being obese or overweight are 1.43 times that of a 17-year-old. Grade-level, used as a proxy for age, yields similar results ($p < 0.0001$). Twenty-six percent of 9th graders were identified as obese compared with 18% of 12th graders, resulting in an odds ratio of 1.73.

Gender. Males have a significantly higher risk of being overweight, compared with females ($p = 0.0004$). This association is most striking for students with BMI above the 95th percentile, with 26% of males obese compared with 21% of females.

Race. There is a significant association between overweight and race ($p = 0.0015$). Forty-three percent of non-Caucasians are obese or overweight, compared with 38% of Caucasians.

Socioeconomic characteristics. Being overweight is associated with both the level of education for the head of the household ($p = 0.0046$) and with annual family income ($p = 0.0001$). As the level of education increases for the head of the household, being overweight decreases. Nearly 47% of students in families whose head of household did not graduate high school were overweight, compared with 37.5% of those whose level of education went beyond high school. Among students identified as obese, students in families with less than a high school education have increased odds of 1.65 times being obese over those families with an education beyond high school. Similarly, there is an association between family income and overweight ($p = 0.0001$). As family income increases, overweight decreases. Among students identified as being overweight, 28% live in families earning less than $16,000 annually, compared with less than 20% of those with families earning $32,000 or more.

Clinical Implications

The results of this study present strong clinical implications for the future of rural adolescents. The local prevalence of being overweight and obese was found to be as high as anticipated by the literature describing an obesity epidemic and to be increasing significantly over time. Supporting previously published studies of rural children (King et al., 2006), rural adolescents in this study demonstrate overweight and obesity rates that exceed the national average. Mirroring national trends (CDC, 2006), this study demonstrated that obesity has been increasing among rural adolescents over the last decade.

The literature reflects that obesity rates have increased rapidly among adolescents (CDC, 2006; Ogden et al., 2006), predisposing them to future health problems, including adult obesity. An association between obesity and adverse health status is already apparent among the adolescents in this study, as demonstrated with high blood pressure and referrals for health care.

This study demonstrated similarities as well as differences in the patterns of obesity and obesity-related hypertension, when compared with previously published studies. Forty percent of rural adolescents in this sample have a BMI greater than or equal to 85%, and nearly 32% were found to have increased blood pressure greater than 120/80. This association was highly significant ($p < 0.0001$). These findings are consistent with previous studies (Flynn & Alderman, 2005; King et al., 2006), which note that the risk for obesity-associated hypertension increases as a child approaches adolescence. It is striking that among these rural adolescents identified as overweight in this study, the risk for having an elevated blood pressure was almost 7 times greater than that of normal weight peers.

In this study of children undergoing school-based health screenings, referrals for health care and both primary care and dental care were more frequent among children who are obese. This finding is supported in related lit-

erature in that overall, obesity in adolescence is associated with long-term negative health consequences (Kim et al., 2005).

Interventions to reduce the rate of obesity and resulting cardiovascular complications, such as hypertension, are clearly needed. Waiting until adolescence to intervene is much too late to prevent complications, such as target organ damage and hyperlipidemia (Flynn & Alderman, 2005; McGill et al., 2002; Young-Hyman et al., 2001). Interventions emphasizing a wholesome environmental context, healthy lifestyle choices, and early identification of at-risk children coupled with appropriate referrals must begin even earlier for optimal benefit. However, a discussion of effective interventions is beyond the scope of this study.

Associations exist between demographic variables and overweight and obesity in children in this study. Younger children were found to be at greater risk of becoming overweight and obese. This is similar to reports (Ogden et al., 2006) in which rural adolescents in the early teen years demonstrated the greatest risk for obesity. However, the literature is not uniform on this point. Kim et al. (2005) found that children are becoming overweight at younger ages and remaining overweight as they age. To the contrary, Burke et al. (2005) found that proportions of overweight increase with age.

A significant difference was found in regard to gender and overweight or obesity, with the incidence of overweight or obesity in males being markedly higher than that of females in the study, especially when BMI exceeds the 95th percentile. The majority of literature suggests no difference in obesity in regard to gender; however, studies exist to support the incidence of obesity as higher in males (Veugelers & Fitzgerald, 2005) as well as in females (Burke et al., 2005).

The current study found a significant association in regard to ethnicity and obesity, with non-Caucasians being significantly more at risk for becoming obese than Caucasian adolescents. This finding is strongly supported in the existing literature, with the prevalence of obesity becoming more problematic at earlier ages and in higher proportions in Hispanic and African-American populations (Ebbel-ing et al., 2002; King et al., 2006; Lobstein et al., 2004; Thorpe et al., 2004).

Socioeconomic factors, including the education level of the head of the household and family income, were found to be significant in regard to relationship to adolescents becoming overweight or obese. A higher level of head of household education was associated with a lower obesity and is supported in the existing literature (Lobstein et al., 2004; Veugelers & Fitzgerald, 2005). Higher family income levels were also associated with lower obesity and are broadly supported by other studies (Burke et al., 2005; Lobstein et al., 2004).

Recommendations

In conclusion, it was demonstrated that local rural community conditions reflect the reported epidemic nature of childhood obesity and its associations. The magnitude of the problem and associated health conditions is large enough to justify intervention at the local community level, and the associations appear stable enough to tailor intervention approaches. The data presented can serve as baselines for comparison with future studies of the effects of interventions. The researchers recommend placing this information in the hands of local community health advocates for appropriate community actions. A next step might be to analyze these data on adolescent obesity and its associations to see the relative magnitude of each covariant factor, and thus, to help prioritize strategic interventions.

Recommendations from this research to the local community include continuing annual school health screenings in order to collect data for longitudinal analysis and as the basis for interventions. Further, publicizing a summary of the findings of the school health screenings annually to the local community will raise awareness and inspire action. Replicating effective interventions at the community and local school level will begin to make a positive impact on the existing health status of children. Providing educational materials, information, and seminars will directly impact the knowledge level of local community members in a position to impact change. Facilitating inter-organizational efforts to address the concerns raised by the prevalence of childhood obesity and its long-term effects into adulthood will provide the support needed to effect community change. The prevalence of adolescent obesity, as reported in the related literature, merits the replication of successful interventions in communities.

References

Burke, V., Beilin, L., Simmer. K., Oddy, W., Blake, K., Doherty, D., et al. (2005). Predictors of body mass index and associations with cardiovascular risk factors in Australian children: A prospective cohort study. *International Journal of Obesity, 29,* 15-23.

Caplan, L., Lane, D., & Grimson, R. (1995). The use of cohort versus repeated cross-sectional sample survey data in monitoring changing breast cancer screening practices. *Preventive Medicine, 24,* 553-556.

Centers for Disease Control and Prevention (CDC). (2006). *Overweight and obesity: Overweight prevalence.* Retrieved August 25, 2008, from http://www.cdc.gov/nccdphp/dnpa/obesity/childhood/prevalence.htm

Centers for Disease Control and Prevention (CDC). (2007). *Overweight and obesity: U.S. obesity trends 1985-2007.* Retrieved August 25, 2008, from http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/

Center for Rural Pennsylvania. (2005). *Examining demographic, economic, and educational factors: Overweight children in Pennsylvania.* Retrieved August 25, 2008, from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1b/ad/92.pdf

Ebbeling, C., Pawlak, D., & Ludwig, D. (2002) Childhood obesity: Public-health crisis, common sense cure. *The Lancet, 360*(9331), 473-482.

Flynn, J., & Alderman, M. (2005). Characteristics of children with primary hypertension seen at a referral center. *Pediatric Nephrology, 20,* 961-996.

Freedman, D.S., Mei, Z., Srinivasan, S., Berenson, G., & Dietz, W. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bogalusa heart study. *Journal of Pediatrics, 150,* 12-17.

Kim, J., Must, A., Fitzmaurice, G., Gillman, M., Chomitz, V., Kramer, E., et al. (2005). Incidence and remission rates of overweight among children aged 5 to 13 years in a district-wide school surveillance system. *American Journal of Public Health, 95,* 1588-1593.

King, C., Meadows, B., Engelke, M., & Swanson, M. (2006). Prevalence of elevated body mass index and blood pressure in a rural school-aged population: Implications for school nurses. *Journal of School Health, 76*(4), 145-149.

Lamerz, A., Kuepper-Nybelen, J., Wehle, C., Bruning, N., Trost-Brinkhues, G., & Brenner, H. (2005). Pediatric highlight: Social class, parental education, and obesity prevalence in a study of six-year-old children in Germany. *International Journal of Obesity, 29,* 373-379.

Lobstein, T., Baur, L., Uauy, R., & the IASO International Obesity Task Force. (2004). Obesity in children and young people: A crisis in public health. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity, 5*(Suppl. 1), 4-42.

McGill, H., McMahan, C., Herderick, E., Zieske, A., Malcolm, G., Tracy, R., et al. (2002). Pathological determinants of atherosclerosis in youth (PDAY) research group. Obesity accelerates the progression of coronary atherosclerosis in young men. *Circulation, 105,* 2712-2718.

Ogden, C., Carroll, M., Curtin, L., McDowell, M., Tabak, C., & Flegal, K. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA, 295,* 1549-1555.

Ribeiro, J., Guerra, S., Pinto, A., Oliveira, J., Duarte, J., & Mota, J. (2003). Overweight and obesity in students and adolescents: Relationship with blood pressure, and physical activity. *Annuals of Human Biology, 30,* 203-213.

Salbe, A., Weyer, C., Lindsay, R., Ravussin, E., & Tataranni, A. (2002). Assessing risk factors for obesity between childhood and adolescence: Birth weight, childhood adiposity, parental obesity, insulin, and leptin. *Pediatrics, 110* (2), 299-305.

Sharma, M. (2006). School-based interventions for childhood and adolescent obesity. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity, 7,* 261-269.

Thorpe, L., List, D., Marx, T., May, L., Heigerson, S., & Frieden, T. (2004). Childhood obesity in New York City elementary school students. *American Journal of Public Health, 94,* 1496-1500.

Veugelers, P., & Fitzgerald, A. (2005). Effectiveness of school programs in preventing childhood obesity: A multilevel comparison. *American Journal of Public Health, 95*(3), 432-435.

Wardle, J., Williamson, S., Johnson, F., & Edwards, C. (2006). Depression in adolescent obesity: Cultural moderators of the association between obesity and depressive symptoms. *International Journal of Obesity, 30,* 634-643.

Yee, J., & Niemeier, D. (1996). *Advantages and disadvantages: Longitudinal versus repeated cross-section surveys [Project Battelle 94-16].* Retrieved August 25, 2008, from http://ntl.bts.gov/lib/6000/6900/6910/bat.pdf

Young-Hyman, D., Schlundt, D., Herman, L., DeLuca, F., & Counts, D. (2001). Evaluation of the insulin resistance syndrome in 5 to 10-year-old overweight/obese African-American children. *Diabetes Care, 24,* 1359-1364.