Evaluation of Technology to Identify and Assess Overweight Children and Adolescents

Bonnie Gance-Cleveland, Lynn H. Gilbert, Taynin Kopanos, and Kevin C. Gilbert

PURPOSE. *The current obesity epidemic has produced a generation of children that may be the first to have a life expectancy shorter than their parents. To address the obesity epidemic, experts have published recommendations for providers. Research suggests the publication of guidelines may not change provider behavior.*

DESIGN AND METHODS. *This study evaluates computer assistance for implementing obesity guidelines in school-based health centers.*

RESULTS. *Significant improvements in identification and assessment of obesity in children with technology support were noted.*

PRACTICE IMPLICATIONS. *Computer decision support shows promise for promoting the implementation of current recommendations by supporting providers in identifying, assessing, and providing tailored recommendations for children at risk of obesity.*

Search terms: *Childhood obesity, computer decision support, quality improvement*

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The prevalence of overweight youth in the United States nearly quadrupled from 1966 to 2004 (Ogden, Flegal, Carroll, & Johnson, 2002; Ogden et al., 2006). The increase in overweight is particularly alarming among poor, underserved, and minority children and adolescents (Freedman, Khan, Serdula, Ogden, & Dietz, 2006; Jago et al., 2006; Lee, Okumura, Davis, Herman, & Gurney, 2006). The epidemic is in fact a global phenomenon, affecting preschool and school-age children in at least 60 of the World Health Organization member countries (Wang & Lobstein, 2006). The lack of comparable data and consistent criteria limits cross-country research, but it is clear that childhood obesity is an international public health concern. In the United States, this dramatic increase in overweight children and adolescents has led to the emergence of associated comorbidities such as dyslipidemia, hypertension, type 2 diabetes, musculoskeletal disorders, respiratory conditions, emotional problems, and increased risk of cardiovascular disease and cancer as adults (Barnard, Gonzales, Liva, & Ngo, 2006; Buddeberg-Fischer, Klaghofer, & Reed, 1999; Harvie et al., 2005; Must et al., 1999; Ogden et al., 1997, 2006; Ramirez et al., 2004; Saltzman et al., 2008; Strauss & Pollack, 2003). Prevention of the chronic conditions related to childhood obesity depends upon the timely identification and assessment of children at risk of the obesity-related chronic illnesses.

Primary care providers face barriers in promoting the maintenance of healthy weights in children (Scott et al., 2004). The rising prevalence of obesity and difficulty in identifying, assessing, and maintaining healthy weight in children and adolescents led several national groups of experts to develop guidelines to improve prevention and management of obesity. The National Association of Pediatric Nurse Practitioners published the Healthy Eating and Activity

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Together clinical practice guidelines in spring 2006 (National Association of Pediatric Nurse Practitioners, 2006); the American Medical Association (AMA) convened the Expert Panel that published recommendations in December 2007 to guide the assessment, prevention, and management of overweight and obese children and adolescents (Barlow & the Expert Committee, 2007); and the National Institute of Child Health and Human Development convened the Pediatric Metabolic Syndrome Working Group in spring 2006 (Shaibi & Goran, 2008). Similar efforts to address this issue in other countries are evident in the guidelines developed by the Scottish Intercollegiate Guidelines Network (2003), the Registered Nurses Association of Ontario (2005), and the National Collaborating Centre for Primary Care (2006; UK), which attest to its global significance.

The publication of recommendations or guidelines, however, often has not changed provider behavior (Bauer, 2002; Cabana et al., 1999; Lomas et al., 1989; Mabry et al., 2005). Technology support for clinicians has been proposed to facilitate the identification, assessment, and guideline-based decision support for providers and produce individually tailored recommendations for patients based upon their risk-assessment profile. Identification and assessment of children, however, must occur before the implementation of guidelines. This quality improvement study examines the impact of technology support on the identification and assessment of obesity in children and adolescents who receive care in a school-based health center (SBHC).

Many underserved and minority children and adolescents access care for obesity and related chronic conditions through SBHCs (Center for Health and Health Care in Schools, 2002; Colorado Association of School-Based Health Centers, 2007; National Assembly on School-based Health Centers, 2008; The Arizona School-Based Health Care Council, 2005). SBHCs are unique partnerships between schools and community health organizations to provide comprehensive on-site medical care for acute and chronic illness and injury, mental health, and, sometimes, dental care to children and their families (Heuer, 2007; National Assembly on School-based Health Centers, 2006). Research suggests that SBHCs decrease the use of emergency departments for non-urgent care and decrease time missed from work and school (Gance-Cleveland & Yousey, 2005; Young, D'angelo, & Davis, 2001). Quality improvement strategies in SBHCs have been shown to improve prevention services, including well-child visits and immunization rates; however, their effectiveness in addressing obesity-related illnesses has not been well investigated (Gance-Cleveland, Costin, & Degenstein, 2003). Providing technological support for SBHC providers to identify and assess children's weight-related cardiovascular risk factors is an important step in the prevention of many lifelong chronic illnesses. It also has the potential to close the gaps in the health disparities in these conditions as SBHCs serve a significant number of these at-risk children and adolescents. The purpose of this quality improvement study was to evaluate computer support for improving the identification and assessment of overweight children and adolescents at risk for health disparities among poor, underserved, minority populations who access care in an SBHC.

Background and Significance

The AMA Expert Committee recently redefined overweight in children 2 years and older as a body mass index (BMI) $\geq$ 85th percentile but < 95th percentile for age and sex (Barlow & the Expert Committee, 2007). Children with a BMI $\geq$ 95th percentile are considered obese. In 2003–2004, 33% of children and adolescents met the current criteria for overweight or obese (BMI $\geq$ 85th percentile), up from 30% in 2001–2002, and 28% in 1999–2000. Other studies suggest that 80% of overweight adolescents become obese adults (Guo & Chumlea, 1999; Whitlock, Williams, Gold, Smith, & Shipman, 2005). Direct and indirect medical costs of obesity in the United States were estimated at $92.6 billion in 2002 (Finkelstein, Fiebelkorn, & Wang, 2005). Reversing this trajectory toward treating lifelong, expensive chronic illnesses requires the identification and assessment of those at risk, and early interventions to promote healthier behaviors.

Data from 1999 to 2004 indicated significant differences in the prevalence of overweight among minority racial/ethnic groups of children and adolescents (Ogden et al., 2006). Hispanic, African American, and Native American children and adolescents are more likely to be overweight and have more cardiovascular and diabetes risk factors than non-Hispanic White children. Non-White Hispanic children and adolescents are the most at risk (Tortolero et al., 1997; Troiano & Flegal, 1998; Whitaker & Orzol, 2006). Insulin resistance, elevated fasting glucose, elevated BMI, and other risk factors were more prevalent in Hispanic youth than in non-Hispanic Whites (Tortolero et al., 1997).

Perhaps more troubling than the high prevalence of overweight among children and adolescents are the associated metabolic comorbidities, including hypertension, dyslipidemia, abdominal adiposity, and glucose dysregulation. These comorbidities, collectively known as the metabolic syndrome, tend to cluster around a common pathophysiology related to insulin resistance and confer greater risk for cardiovascular disease morbidity and mortality (Ogden et al., 2002). National estimates suggest that 90% of overweight children and adolescents have at least one risk factor for the metabolic syndrome. Approximately 30% of these overweight children and adolescents exhibit the metabolic syndrome phenotype, putting them at increased risk of developing diabetes (Freedman et al., 2006). The obesity epidemic in children and adolescents is leading to treatment of expensive, lifelong chronic illnesses, including hypertension,

type 2 diabetes, musculoskeletal disorders, respiratory problems, psychopathology, and metabolic syndrome, increasing the likelihood they will suffer from diabetes, cardiovascular disease, or certain cancers in adulthood (Barnard et al., 2006; Buddeberg-Fischer et al., 1999; Harvie et al., 2005; Must et al., 1999; Ramirez et al., 2004; Saltzman et al., 2008; Strauss & Pollack, 2003). Prospectively, the metabolic syndrome in childhood predicts adult cardiovascular disease and thus offers an intermediate target for preventing adiposity-related chronic diseases. Many primary care providers, however, are not identifying the clusters of risk factors and assessing children and adolescents for metabolic syndrome (Jago et al., 2006).

Current Recommendations

Responding to the need for practical guidance for providers in the area of pediatric obesity, several professional organizations brought together experts to review the evidence and develop guidelines and recommendations aimed at the identification, assessment, and treatment of overweight in children. These groups recognized that there had been considerable research conducted since the 1998 Expert Panel recommendations, but the occurrence of obesity was increasing (Barlow & Dietz, 1998; Ogden et al., 2006). In addition, the traditional prescriptive approach was not working to treat this problem, and experts wanted to include a developmental, family-centered approach that encouraged the use of motivational interviewing to guide practitioners in promoting healthy weight in children (Barlow & the Expert Committee, 2007; National Association of Pediatric Nurse Practitioners, 2006).

Both the National Association of Pediatric Nurse Practitioners and the AMA convened groups of experts who conducted a comprehensive literature review of current evidence on the prevention, identification, assessment, and treatment of childhood obesity. Based upon literature reviews and their clinical expertise, the National Association of Pediatric Nurse Practitioners' clinical practice guidelines, Healthy Eating and Activity Together (HEAT^{sm}), were published in the *Journal of Pediatric Health Care*, in spring 2006, and included six areas: early identification of overweight, developmental considerations, parent/child communication, nutrition essentials, feeding and eating behaviors, and physical activity. In a similar undertaking, the AMA and its partners appointed experienced scientists and clinicians to review the literature and recommend approaches to the prevention, assessment, and treatment of child and adolescent overweight and obesity. The "Expert Committee Recommendations Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity Summary Report" were published in a special supplement of *Pediatrics* in December 2007 (Barlow & the Expert Committee, 2007). Both expert panels emphasized the need for early identification and assessment of overweight/obese children and adolescents. The experts recommended the calculation of BMI percentile for age and sex, and plotting the BMI percentile on the CDC growth charts to monitor changes over time. The guidelines also recommend well-child visits include an assessment of cardiovascular risk factors, including family history, dietary behaviors, and activity levels.

In addition, the AMA recommendations offer providers specific guidelines on when to evaluate medical comorbidities in overweight children and adolescents. The recommendations suggest that children and adolescents ≥ 85th percentile should undergo a fasting lipid profile, fasting glucose, and blood pressure (BP) when other risk factors are present (e.g., family history or recent BMI increase). In children and adolescents with BMIs ≥ 95th percentile, fasting laboratory tests should be evaluated every 2 years, regardless of whether other risk factors are present. Recent data suggest that risk-factor clustering may be more important for identifying chronic disease risk than interpreting individual levels of abnormal risk factors (Lee et al., 2006). The National Institute for Child Health and Human Development convened the Pediatric Metabolic Syndrome Working Group in July 2006 to review the evidence regarding this clustering of risk factors in children and adolescents (Shaibi & Goran, 2008). The group adopted age-appropriate cut points for the following risk factors: abdominal obesity (≥ 90th percentile), elevated triglycerides (≥ 150 mg/dl), low high-density lipoprotein cholesterol (< 40 mg/dl), elevated BP (≥ 130 mmHg systolic or 85 mmHg diastolic), and fasting hyperglycemia (> 100 mg/dl). Children and adolescents with three or more of these risk factors are considered to have metabolic syndrome. In order to implement these recommendations, however, providers must obtain the BMI for age and sex, and assess the child for associated cardiovascular risk factors.

Lack of Adherence to Guidelines

Despite consensus guidelines recommending the use of BMI percentile for age and sex for the diagnosis and management of childhood obesity, providers in general pediatric practices document BMI in only 5% of initial visits for children diagnosed with obesity during a routine well-child visit (Mabry et al., 2005). Another study involving chart reviews of well-child visits revealed that providers documented a diagnosis of obesity (BMI ≥ 95%) in less than 1% (0.93%) of visits (Cook, 2005). This number is remarkably low, considering the high prevalence of childhood obesity. It suggests that clinicians may be overlooking overweight/obesity during routine office visits, thus missing an opportunity to intervene. Another chart review of 191 pediatric visits (20% of active charts) conducted at an SBHC revealed that 98% had weight and height documented, but only 20% had BMI docu-

mented, and only 17% had a BMI percentile based upon age. Although 84% of those children older than or equal to 3 years old had BP documented, only 1% had BP percentile for age, height, and sex documented (Kopanos, 2007). This site was subsequently used to evaluate the HeartSmartKids™ (HSK™) decision support system described in this article.

Surveys also suggest that only 25% of pediatricians, pediatric nurse practitioners, and registered dieticians reported including all elements (family history, past medical history, physical examination, and laboratory evaluations) of the assessments for children at risk for overweight or obesity (Barlow, Dietz, Klish, & Trowbridge, 2002). In addition, pediatric providers, including pediatric nurse practitioners, have reported low proficiency in counseling families on behavioral management and eating practices, changing sedentary behaviors, giving guidance in parenting, and addressing the degree of overweight (Story et al., 2002).

Computer Support for Guideline Adherence

Computer technology is a mechanism to support providers in the adoption of and adherence to current guidelines. The 2001 publication *Crossing the Quality Chasm: A New Health System for the 21st Century* (Institute of Medicine) noted that computer systems lead to an improvement in the implementation of clinical guidelines (Bordowitz, Morland, & Reich, 2007; Garg et al., 2005; Goldberg et al., 2000) and better patient outcomes (Institute of Medicine, 2001). Computerized clinical decision support has been developed to promote the use of current practice guidelines by aiding the provider in identifying and assessing overweight/obese children and facilitating clinical decision-making. This type of technology support uses computerized evidence-based algorithms to match individual patient risk factors to patient-specific recommendations. Garg et al. (2005) conducted a systematic review of 100 controlled trials (randomized and nonrandomized) on computer-assisted decision support systems for a variety of clinical problems. Studies included research on computer diagnostic systems (40%), reminder systems (76%), disease management systems (62%), and prescribing systems (66%). Results of the review of computer-assisted quality improvement studies suggested that clinical decision support systems improved the provider performance in 62 (64%) of the 97 studies that evaluated provider performance (Garg et al., 2005). In the studies that included patient-specific advice, recommendations were reviewed by a provider before any clinical action was taken. Fifty-two percent of trials assessed one or more patient outcomes; however, many had limited power to detect clinically significant differences. Therefore, the authors concluded the effects of these systems on patient health look promising but remain understudied and have inconsistent findings.

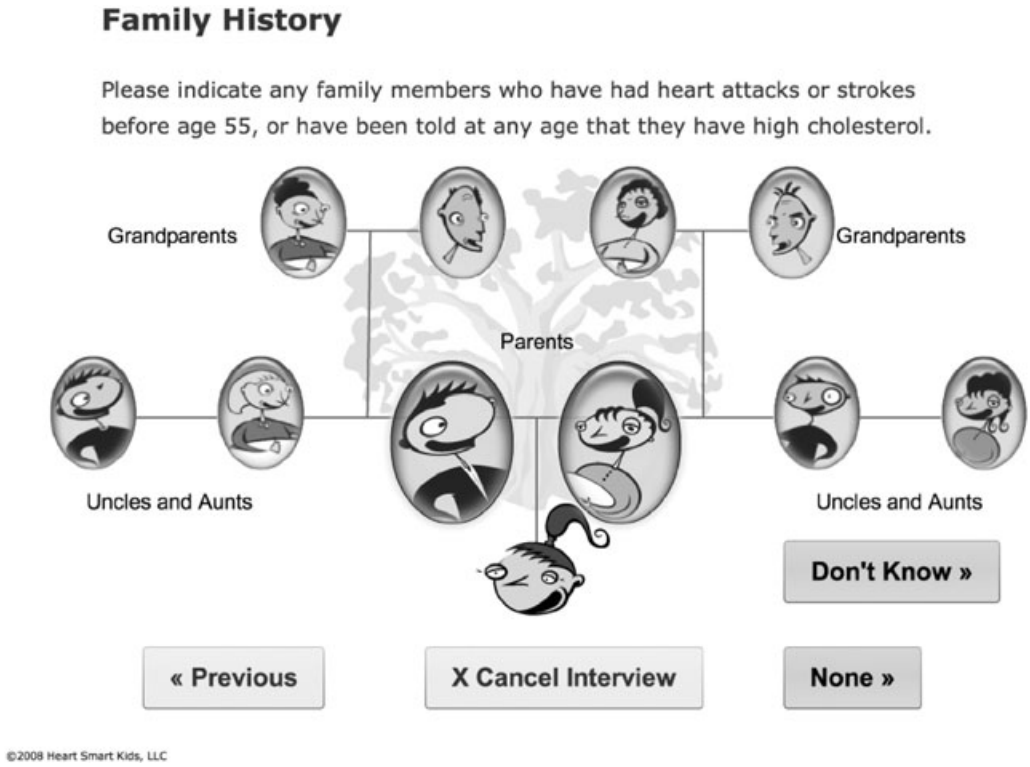
A kiosk is a patient-centered technology that promotes application of evidence-based guidelines to direct care. Kiosks are user-friendly technologies that allow the patient to directly enter information that is applied to decision support algorithms. The technology links patient data with guidelines and generates tailored health recommendations. A formative evaluation of an asthma kiosk in the emergency department reported that the kiosk was able to capture patient-specific data in the emergency department ($\mu = 11$ min), identifying critical history components normally undocumented and successfully linking patient care to guideline recommendations (Porter, Cai, Gribbons, Goldmann, & Kohane, 2004).

HeartSmartKids™

HSK™ is a bilingual kiosk and decision support system that assists providers in the care of children. The HSK™ system compares lifestyle information gathered prior to the encounter with clinical practice guidelines. Standard growth charts, including BMI percentile, are automatically generated and plotted, promoting greater understanding of the child's growth pattern by parents and providers. Relevant health risks are highlighted in the HeartPrint™, a summary of the child's cardiovascular risk factors. The system can be used to increase perception of risks and provide suggestions regarding evidence-based behavior change strategies. In addition, this cardiovascular risk-assessment clusters risk factors for provider convenience in identifying the risk of metabolic syndrome. Tailored recommendations give the provider and the family a starting point for discussions of behavior change. The cardiovascular risk assessment goes home with the family and allows communication of status to other care providers. The HSK™ system consists of two Web-based applications: a bilingual lifestyle questionnaire and a Web page for entry of measurements and generation of HeartPrint™ summaries. Both applications are accessed through standard Web browsers on Internet-connected computers. The patient or parent completes the questionnaire using a touch screen monitor, which allows for intuitive use by those who lack basic computer skills. The standard questionnaire covers family history of cardiovascular disease, eating habits, smoke exposure, activity levels, and sedentary time (see Figure 1).

The measurement entry application is accessed by staff on any office computer where the height, weight, and BP measurement are entered into the decision support system through the Web browser. A cardiovascular risk summary (Figure 2) and tailored recommendations (Figure 3) are generated for use in the patient encounter so they can be used to increase the patient's/family's understanding of risks and provide the patient-specific recommendations for collaborative goal setting and care planning. Patients who complete the questionnaire in Spanish receive their HeartPrint™ summaries and lifestyle recommendations in Spanish.

Figure 1. Family History Screen From HeartSmartKids™ Interview



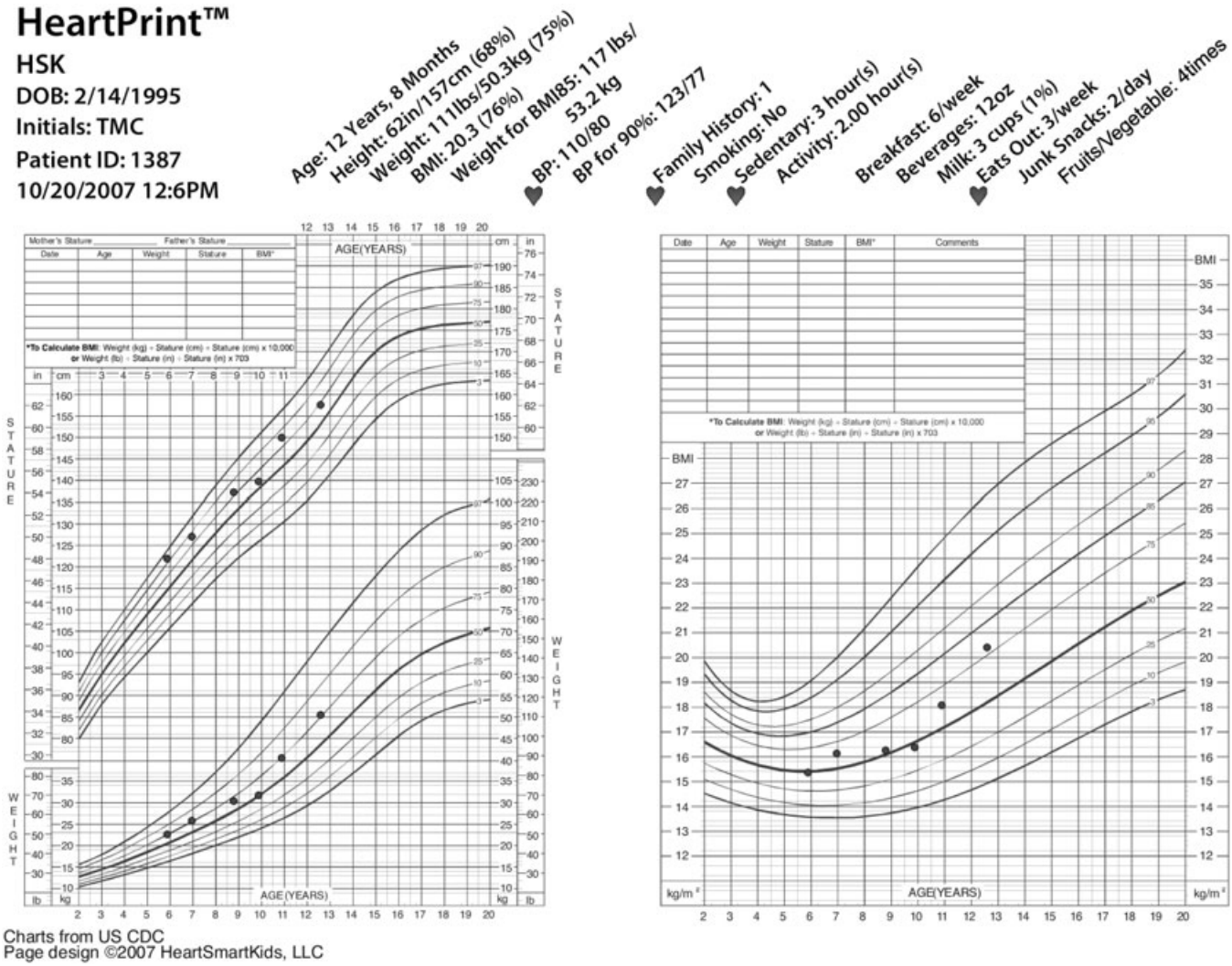
Note. In addition to gathering information on family history, this screen also increases awareness of the importance of health events outside the immediate family.
Permission has been granted by HeartSmartKids LLC to publish this figure in "Evaluation of Technology to Identify and Assess Overweight Children and Adolescents" in the January 2010 issue of the *Journal for Specialists in Pediatric Nursing*.

Two of the major barriers to implementation of the current recommendations are time and ease of use. HSK™ was designed to overcome these barriers. The questionnaire can be completed in 5–7 min in the waiting room or while the anthropometric measures are obtained, depending on language, literacy, and comfort with the touch screen. The time required for staff to enter the measurements and generate the HeartPrint™ is usually less than 20 s, less than that required to plot the height, weight, BMI, and BP on standardized charts.

Conceptual Framework: Chronic Care Model for Childhood Obesity

Prevention of obesity-related chronic diseases in children is an ongoing process requiring lifestyle changes that will not occur with a simple prescription given at one healthcare visit. The chronic care model, originally described by Wagner (1998), is a synthesis of evidence-based system changes that organizations might use to guide quality improvement and disease management activities. Glasgow, Orleans, Wagner, Curry, and Solberg (2001) suggested that the changes needed to improve the delivery of effective preventive care were fundamentally the same as those recommended in the chronic care model of effective chronic disease management. The National Initiative on Child Health Quality agreed that adapting the model to guide acute, chronic, and preventive care for children and their families would be effective (National Initiative on Child Health Quality, 2006). The model provides a functional blueprint or template and a set of organizing principles for practice changes to support preventive care that is evidence based, population based, and patient centered. The model provides a framework in which improvement strategies can be tailored to local conditions. The model used in this study was adapted from the more general chronic care model to specifically address the use of

Figure 2. HeartPrint™ Cardiovascular Risk Summary Including Growth Charts

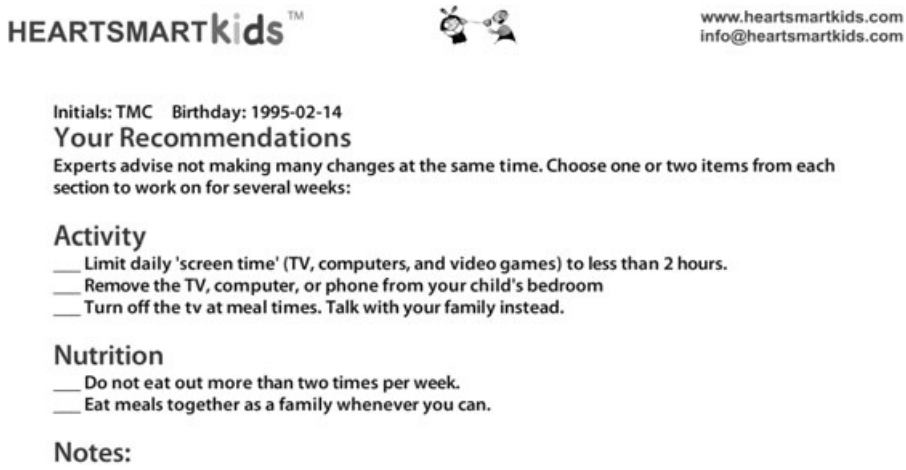


Note. Standard pediatric growth charts and percentiles are accompanied by prehypertensive blood pressure (BP) levels and a summary of the lifestyle interview. The lifestyle summary has small hearts that draw attention to areas of concern. Permission has been granted by HeartSmartKids LLC to publish this figure in "Evaluation of Technology to Identify and Assess Overweight Children and Adolescents" in the January 2010 issue of the *Journal for Specialists in Pediatric Nursing*.

technology in obesity prevention in children (Figure 4). The model acknowledges that SBHCs exist within a broader health system in a community with resources and policies that influence the health and health care of children. The healthcare system changes to promote care for the prevention of obesity-related chronic conditions, including delivery system redesign, decision support, self-management support, and computer information systems.

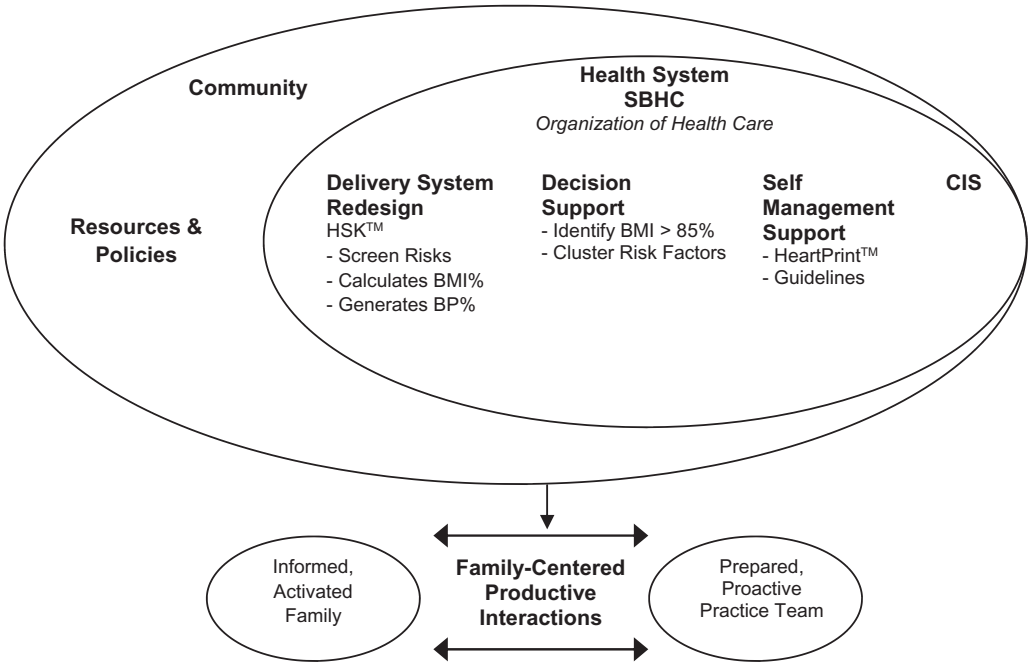
Delivery system redesign. Delivery system redesign includes the use of the HSK™ system to screen children for cardiovascular risk factors, and calculation of BMI and BP percentiles for sex and age. The system embeds the collection of relevant history and growth parameters into routine practice and automatically calculates the percentiles for use in identifying those at risk. The system provides decision support by linking the patient history and risk factors to

Figure 3. Example of Tailored Small-Step Recommendations on the HeartPrint™



Note. If the patient completes the interview in Spanish, this recommendation sheet is generated in Spanish.
Permission has been granted by HeartSmartKids LLC to publish this figure in "Evaluation of Technology to Identify and Assess Overweight Children and Adolescents" in the January 2010 issue of the *Journal for Specialists in Pediatric Nursing*.

Figure 4. Chronic Care Model for Childhood Obesity



Note. BMI, body mass index; BP, blood pressure; HSK™, HeartSmartKids™; SBHC, school-based health center.

current evidence-based obesity guidelines. Research indicates the use of computer-assisted decision support shows promise for improving decision support (Garg et al., 2005). BMI, BMI percentiles, and cutoffs for the evaluation of BP appropriate for age, height, and sex are calculated. Results are summarized as well as plotted on standard CDC growth charts. The individualized growth charts are assembled with the lifestyle questionnaire results and tailored recommendations into a summary called the HeartPrint™. Small flags (hearts) are placed under potentially risky information, identifying those points that exceed the definitions and established cut points in the clinical practice guidelines. The HSK™ system generates tailored recommendations based upon the patient's history and measurements. The HeartPrint™ with the graphic depiction of cardiovascular risk factors, growth charts, and individualized recommendations is a tool for patients for self-management support. This information prepares patients to actively engage in the management of their own health care. It involves collaborative goal setting between the patient/family and provider, developing an individualized plan of care and providing education that gives the patient the necessary tools to address lifestyle and monitor changes needed to maintain a healthy weight. The model proposes the use of computer information systems to facilitate the identification, assessment, decision support, and patient education, as described above. The recommended practice-level changes include obtaining and documenting BMI percentile based upon age and sex at every well-child visit; BP percentile based upon age, sex, and height at every well-child visit; documenting and monitoring cardiovascular risk factors; counseling families on appropriate interventions; and developing quality improvement processes to evaluate the translation of current recommendations into practice.

The chronic care model (Wagner, 1998) adapted for childhood obesity guided this study by providing a framework for viewing the multiple systems and processes involved with obesity prevention, including the use of a continuous quality improvement process to evaluate the impact of HSK™ technology on the identification and assessment of overweight and obese children seen for well-child care at an SBHC. Gathering these data was an essential first step to determining the effectiveness of technology support in assisting providers to adhere to obesity prevention guidelines. Identification and assessment precede the collaborative goal setting and treatment planning that can follow with the tailored recommendations.

Methods

Setting

The setting for this study was an SBHC, faculty-practice site in a Rocky Mountain state. The SBHC is a nurse-managed primary care clinic operated by a college of nursing. In 2008, there were 3,683 visits, of which 897 (24%) were well-child visits. Seventy percent of the children seen were Hispanic, and 87% had Medicaid or State Child Health Insurance Program insurance. Approval was obtained from the Institutional Review Board for retrospective evaluation of these quality improvement data. A retrospective chart audit was conducted to evaluate for the documentation of BMI, BMI percentile, BP, and BP percentile in 2006, and the process was repeated again in 2008 after implementation of the computer decision support system.

Procedure

Following a quality improvement chart audit in mid-2006, HSK™ was introduced into the SBHC in mid-2007 to facilitate (a) collection of appropriate history related to cardiovascular risk factors, (b) the calculation of BMI, (c) plotting of BMI on CDC growth charts, (d) documentation of BP, and (e) plotting of BMI and BP for age, sex, and height (BMI and BP percentiles). The touch screen computers were placed in the clinic check-in area. Patients and parents were asked to complete the computer-generated questionnaire, including family history, diet history, and activity and inactivity history. Office staff obtained height, weight, and BP, and entered these data into the system. See Figure 1 for family history screen.

Patient cardiovascular risk summaries and tailored recommendations were generated and given to the provider, prior to the patient encounter, to be used to increase the patient's/family's understanding of risks and provide the patient specific recommendations for collaborative goal setting and care planning. See Figures 2 and 3 for HeartPrint™ and recommendations.

Data Collection

Two chart audits were conducted in this faculty-practice site to assess the presence of documentation of components necessary for determining weight status and identification of obesity. A random sample of approximately 15% of the charts (every eighth chart) of active patients was accessed to evaluate documentation of key cardiovascular risk factors. For the purpose of this study, a subsample of only the well-child visits for children 3–20 years ($n = 101$ in 2006, $n = 100$ in 2008) was included for analysis. Inclusion criteria for this analysis included a child age 3 years or older who was seen for a well-child visit at the SBHC. Exclusion criteria included children seen only for sick visits, immunization visits, and well-child visits for children younger than 3 years. Charts were evaluated for documentation of six components of the visit: (a) weight, (b) height, (c) BMI, (d) BMI percentile, (e) BP, and (f) BP percentile. A quality improvement tally sheet was used to record if the relevant components of the well-child visit

Table 1. Impact of Technology: Percentage of Charts with Documentation of BMI, BMI %, BP, and BP %

	2006			2008				
	No	Yes	Total	No	Yes	Total		
	n (%)	*n* (%)	*N* (%)	*n* (%)	*n* (%)	*N* (%)	Pearson's *df*	*p*
BMI	36 (35.6)	65 (64.4)	101 (100)	14 (14)	86 (86)	100 (100)	12.596 (1)	< .001
BMI %	69 (68.3)	31 (30.7)	100 (99)	24 (24)	76 (76)	100 (100)	40.699 (1)	< .001
BP	18 (17.8)	83 (82.2)	101 (100)	3 (3)	97 (97)	100 (100)	11.798 (1)	.001
BP %	100 (99)	1 (1)	101 (100)	65 (65)	35 (35)	100 (100)	39.531 (1)	< .001

BMI, body mass index; BP, blood pressure.

were documented in the chart. The tally sheet data were recorded in a Microsoft Excel spreadsheet that was then uploaded to SPSS version 16.0 (SPSS Inc., Chicago, IL) for statistical analysis. Analysis of the data included descriptive statistics for demographics and a weighted chi-square analysis to detect differences in documentation rates before and after the introduction of the computer assistance program.

Results

Demographics

The 2006 chart review consisted of 101 charts. Patients ranged in age from 3 years to 19.5 years, with a mean age of 8.25 years and a median age of 6.4 years. The sample was comprised of 45% females and 45% males, and 10% had sex missing on the chart audit record. Although sex was used to generate the BMI and BP percentiles by the computerized decision support system, the sex of participants was not recorded on the chart audit record during the quality improvement study, resulting in some missing data on the demographics values. The 2008 chart review consisted of 100 charts. Patients ranged in age from 3 years to 18 years, with a mean of 9.8 years and a median of 10 years. The sample was comprised of 44% males, 44% females, and 12% missing values for sex.

Chi-Square Analysis of Differences

There were significant differences ($p < .001$) in the documentation of BMI in 2008 after the introduction of the computerized support for the calculation of BMI. The dramatic increase from 64% documentation rate in 2006 to 86% in 2008 indicates clinical significance, not just statistical significance, indicating a dramatic increase in the number of children and adolescents who had BMI calculated at the time of the visit. Documentation of BMI percentile, which requires calculation and graphing the value for age and sex, was also significantly improved ($p < .001$) after the introduction of technology assistance, increasing from 31% documentation in 2006 to 76% in 2008. Documentation of BP also significantly improved ($p < .001$), from 83% in 2006 to 97% in 2008. Documentation of BP percentile, which requires comparing the BP for age, sex, and height with established cut points, showed significant improvement ($p < .001$), from 1% in 2006 to 35% in 2008 (see Table 1).

Discussion

The current obesity epidemic makes it likely that this generation of children will be the first to have a life expectancy shorter than their parents (Ludwig, 2007). To reverse the epidemic, we must implement the current guidelines for obesity prevention and treatment into practice settings such as SBHCs that serve our most at-risk populations. To implement the current guidelines, the provider must identify and assess those children and adolescents who are overweight or obese. Current research, however, suggests providers assess these children and adolescents for overweight/obesity 1–5% of the time in routine pediatric practice. Providers in SBHCs are in an ideal position to implement the recommendations to address the epidemic in their populations if they identify those in need of intervention.

Before the introduction of computers, providers seeking to adhere to guidelines needed to undertake a time-consuming and laborious computation and comparison of children's measures with standardized charts to assess their health status and make recommendations. The HSK™ computerized support system facilitates collection of appropriate history, calculates BMI and BP percentiles, compares data with recommendations, and generates patient-specific recommendations based upon identified risk factors. With this technology support, the providers are prepared for the visit and can spend their time interacting with the patients and parents to collaboratively develop a plan of care. This study demonstrates the feasibility of implementing the technology in an SBHC practice, resulting in dramatic improvements in the identification and assessment of cardiovascular risk factors in these at-risk children and adolescents.

The improvements in documentation of BMI, BMI percentile, BP, and BP percentile were achieved after introduction of the technology support, increasing the potential for accurate diagnosis of obesity-related conditions. Although the providers were obtaining the BMI 65% of the time prior to the introduction of HSK™, BMI percentile was only recorded in half of those patients with BMI documented (31% of the charts audited), limiting the providers' ability to identify the children with a diagnosis of overweight or obesity and counsel families on appropriate action. Likewise, the documentation of BP not only improved with the introduction of the HSK™, but the BP percentile increased from 1% to 35% so that providers were more likely to identify a child who needed further evaluation regarding potential hypertension. Without accurate diagnosis of overweight, obesity, and hypertension, effective counseling to prevent obesity-related chronic conditions is not likely to occur. Thus, this study demonstrates an important first step to moving providers in SBHCs to more effective care for children and adolescents at risk for obesity-related chronic conditions.

Patient and Provider Satisfaction

Because of the retrospective nature of this quality improvement study, a formal evaluation of the patient and provider satisfaction was not included. Anecdotal evidence from conversations with patients and providers revealed satisfaction with the HSK™ and the HeartPrint™ summaries. Providers and staff were pleased with the ease of use of the system and the time saved with the computer's automatic generation of the BMI, height, and weight percentiles, and identification of elevated BP. In addition, the providers mentioned the value of the bilingual system for the lifestyle screening and tailored recommendations for their Spanish-speaking clients. Providers reported parents requested the HeartPrint™ on subsequent visits. Providers also reported that despite the fact that families frequently leave behind the health information handouts given during a well-child visit, HeartPrints™ were never left behind in the examination room. One of the obese patients (BMI > 97th percentile), a teenage girl who received a HeartPrint™, demonstrated her understanding of the BMI percentile discussion with her provider. She pointed to her BMI percentile at the top of the chart and said, "This is where I am." She then pointed to the 85th percentile and said, "This is where I want to be."

Limitations

The limitations of the study included the retrospective, pre/postchart audit methodology comparison of documentation with the introduction of computer-assisted decision-making. Although the quasi-experimental design has weaknesses, the methodology is a real-world quality improvement evaluation of practice change in a population of children and adolescents at risk for obesity-related chronic illnesses. Another limitation was that the 2008 chart audit included some well-child visits that were conducted prior to the introduction of the computer support system; therefore, the findings of the changes in documentation are conservative estimates of improvement after the introduction of the system. The chart audit tally sheet did not include the visit date, preventing the elimination of visits that took place prior to the implementation of the HSK™. Providers reported that in some cases just one HeartPrint™ was printed, and it was sent home with the parents. In these cases, the chart audit did not reflect the documentation of risk factors even though they were discussed in the well-child visit. Finally, the quality improvement study was limited to one SBHC; however, the population served by the SBHC was a predominantly Hispanic population, at greater risk for obesity and related illnesses.

Future Work

Future research is needed to evaluate the impact of technology, such as HSK™, on implementation of current obesity recommendations in pediatric primary care, including (a) the impact of technology on providers' adoption and implementation of guidelines, (b) impact of technology on patient outcomes, (c) impact of technology on providers' implementation of motivational interviewing recommended in the guidelines, (d) role of bilingual technology in improving health disparities in obesity-related conditions, and (e) examination of the chronic care model for childhood obesity in improving the quality of related care. The authors are currently planning evaluation of the HSK™ on providers' behavior and patient outcomes with the implementation of the obesity guidelines, including collaborative goal setting and self-management support utilizing motivational interviewing in the context of the chronic care model.

How Do I Apply This Evidence to Nursing Practice?

Pediatric nurses are in a unique position to help families understand and reduce childhood obesity and other cardiovascular risks. As nurses, we all have opportunities to assess and identify risks and positively affect child health status, not only when weighing and taking BPs in clinics, schools, or hospitals, but also when advising parents prenatally and through childhood, or when voting and encouraging others to support child-friendly, health-enhancing policies in their communities. Those who work in pediatric primary care, including school-based clinics, are particularly well positioned to assess, prevent, and intervene early in

cardiovascular risks to help families prepare better foundations for lifespan health. Many of these opportunities are being missed. The nurse–family interaction is often limited by poor assessment and communication tools, resulting in many families not being counseled effectively.

The quality improvement project presented uses technology support to aid in the assessment and communication of a child's cardiovascular risks. The findings from this study suggest the use of bilingual decision support technology greatly improves the identification and assessment of at-risk children. By gathering and processing information, and providing tailored, evidence-based recommendations for lifestyle changes, the technology helps providers to promote behavior change. The simple Web-based tool enables the nurse to spend time where it counts most, building rapport with the family and facilitating behavior change to improve health. By focusing on one issue, cardiovascular risk assessment, and tasks suited to technology (i.e., collecting and assessing data), the tool provides a helpful way to begin an important and often difficult discussion. We introduced the tool into a clinic that had limited technology and served a predominantly Hispanic, low-income demographic. We achieved substantial improvement in risk documentation rates and positive feedback about patient counseling with minimal training. The tool facilitates a small first step to reverse the current trends of the obesity epidemic. It will take all of us working with children and families to raise awareness and reduce risks so that this generation of children will not have shorter life expectancies than their parents.

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References

Barlow, S.E., & Dietz, W.H. (1998). Obesity evaluation and treatment: Expert committee recommendations. The Maternal and Child Health Bureau, Health Resources and Services Administration and the Department of Health and Human Services. *Pediatrics*, *102*(3), E29. Retrieved from http://pediatrics.aappublications.org/cgi/content/full/102/3/e29

Barlow, S.E., & the Expert Committee. (2007). Expert committee recommendations on the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*, *120S*, S164–S192. doi:10.1542/peds.2007-2329C.

Barlow, S.E., Dietz, W.K., Klish, W.J., & Trowbridge, F.L. (2002). Medical evaluation of overweight children and adolescents: Reports from pediatricians, pediatric nurse practitioners, and registered dieticians. *Pediatrics*, *110*(1), 222–228. Retrieved from http://pediatrics.aappublications.org/cgi/content/full/110/1/S1/222#T5

Barnard, R.J., Gonzales, J.H., Liva, M.E., & Ngo, T.H. (2006). The effects of a low-fat, high-fiber diet and exercise program on breast cancer risk factors in vivo and tumor cell growth and apoptosis in vitro. *Nutrition and Cancer*, *55*(1), 28–34.

Bauer, M.S. (2002). A review of quantitative studies of adherence to mental health clinical practice guidelines. *Harvard Review of Psychiatry*, *10*(3), 138–153. doi: 10.1080/10673220216217

Bordowitz, R., Morland, K., & Reich, D. (2007). The use of an electronic medical record to improve documentation and treatment of obesity. *Family Medicine*, *39*(4), 274–279.

Buddeberg-Fischer, B., Klaghofer, R., & Reed, V. (1999). Associations between body weight, psychiatric disorders and body image in female adolescents. *Psychotherapy and Psychosomatics*, *68*(6), 325–332. doi: 10.1159/000012351

Cabana, M.D., Rand, C.S., Powe, N.R., Wu, A.W., Wilson, M.H., Abboud, P.A., et al. (1999). Why don't physicians follow clinical practice guidelines? A framework for improvement. *Journal of the American Medical Association*, *282*(15), 1458–1465.

Center for Health and Health Care in Schools. (2002). *2002 state survey of school-based health center initiatives*. Retrieved from http://www.healthinschools.org/sbhcs/survey02.htm

Colorado Association of School-Based Health Centers. (2007). *What are SBHCs?* Retrieved from http://www.casbhc.org/SBHC/index.asp

Cook, S. (2005). Screening and counseling associated with obesity diagnosis in a national survey of ambulatory pediatric visits. *Pediatrics*, *116*, 112–116. doi:10.1542/peds.2004-1517

Finkelstein, E., Fiebelkorn, C., & Wang, G. (2005). The costs of obesity among full-time employees. *American Journal of Health Promotion*, *20*(1), 45–51.

Freedman, D.S., Khan, L.K., Serdula, M.K., Ogden, C.L., & Dietz, W.H. (2006). Racial and ethnic differences in secular trends for childhood BMI, weight, and height. *Obesity*, *14*(2), 301–308.

Gance-Cleveland, B., & Yousey, Y. (2005). Benefits of a school-based health center in a preschool. *Clinical Nursing Research*, *14*(4), 327–342. doi: 10.1177/1054773805278188

Gance-Cleveland, B., Costin, D.K., & Degenstein, J.A. (2003). School-based health centers. Statewide quality improvement program. *Journal of Nursing Care Quality*, *18*(4), 288–294.

Garg, A.X., Adhikari, N.K., McDonald, H., Rosas-Arellano, M.P., Devereaux, P.J., Beyene, J., et al. (2005). Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: A systematic review. [See comment]. *Journal of the American Medical Association*, *293*(10), 1223–1238.

Glasgow, R.E., Orleans, C.T., Wagner, E.H., Curry, S.J., & Solberg, L.I. (2001). Does the chronic care model serve also as a template for improving prevention? *Milbank Quarterly*, *79*, 579–612. doi: 10.1111/1468-0009.00222

Goldberg, H.I., Neighbor, W.E., Cheadle, A.D., Ramsey, S.D., Diehr, P., & Gore, E. (2000). A controlled time-series trial of clinical reminders: Using computerized firm systems to make quality improvement research a routine part of mainstream practice. *Health Services Research*, *34*(7), 1519–1534.

Guo, S.S., & Chumlea, W.C. (1999). Tracking of body mass index in children in relation to overweight in adulthood. *American Journal of Clinical Nutrition*, *70*(1), 145S–148S.

Harvie, M., Howell, A., Vierkant, R.A., Kumar, N., Cerhan, J.R., Kelemen, L.E., et al. (2005). Association of gain and loss of weight before and after menopause with risk of postmenopausal breast cancer in the Iowa women's health study. *Cancer Epidemiology, Biomarkers & Prevention*, *14*(3), 656–661. doi: 10.1158/1055-9965.EPI-04-0001

Heuer, S. (2007). Integrated medical and dental health in primary care. *Journal for Specialists in Pediatric Nursing*, *12*(1), 61–65.

Institute of Medicine. (2001). *Crossing the quality chasm: A new health system for the 21st century*. New York: National Academy of Sciences.

Jago, R., Harrell, J.S., McMurray, R.G., Edelstein, S., El Ghormli, L., & Bassin, S. (2006). Prevalence of abnormal lipid and blood pressure values among an ethnically diverse population of eighth-grade adolescents and screening implications. *Pediatrics*, *117*(6), 2065–2073. doi:10.1542/peds.2005-1716

Kopanos, T. (2007). *Cardiovascular disease risk chart evaluation*. Unpublished manuscript, University of Colorado at Denver.

Lee, J.M., Okumura, M.J., Davis, M.M., Herman, W.H., & Gurney, J.G. (2006). Prevalence and determinants of insulin resistance among U.S. adolescents. *Diabetes Care*, *29*, 2427–2432. doi: 10.2337/dc06-0709

Lomas, J., Anderson, G.M., Donmick-Pierre, K., Vayda, E., Enkin, M.W., & Hannah, W.J. (1989). Do practice guidelines guide practice? The effect of a consensus statement on the practice of providers. *New England Journal of Medicine*, *321*, 1306–1311.

Ludwig, D.S. (2007). Childhood obesity—The shape of things to come. *New England Journal of Medicine*, *357*(23), 2325–2327.

Mabry, I.R., Clark, S.J., Kemper, A., Fraser, K., Kileny, S., & Cabana, M.D. (2005). Variation in establishing a diagnosis of obesity in children. *Clinical Pediatrics*, *44*(3), 221–227. doi: 10.1177/000992280504400305

Must, A., Spadano, J., Coakley, E.H., Field, A.E., Colditz, G., & Dietz, W.H. (1999). The disease burden associated with overweight and obesity. *Journal of the American Medical Association*, *282*, 1523–1529.

National Assembly on School-based Health Centers. (2006). *School-based health centers: A national definition*. Retrieved from http://www.nasbhc.org/APP/definition.htm

National Assembly on School-based Health Centers. (2008). *National assembly on school-based health centers*. Retrieved from http://www.nasbhc.org/site/c.jsJPKWPFJrH/b.2554077/

National Association of Pediatric Nurse Practitioners. (2006). Healthy eating and activity together clinical practice guidelines: Identifying and preventing overweight in childhood. *Journal of Pediatric Health Care*, *20*(2), S1–S63.

National Collaborating Centre for Primary Care. (2006). *Obesity: The prevention, identification, assessment and management of overweight and obesity in adults and children* (No. NGC:005396). London: National Institute for Health and Clinical Excellence.

National Initiative on Child Health Quality. (2006). *Child care model*. Retrieved from http://www.nichq.org

Ogden, C.L., Carroll, M.D., Curtin, L.R., McDowell, M.A., Tabak, C.J., & Flegal, K.M. (2006). Prevalence of overweight and obesity in the United States, 1999–2004. *Journal of the American Medical Association*, *295*(13), 1549–1555.

Ogden, C.L., Flegal, K.M., Carroll, M.D., & Johnson, C.L. (2002). Prevalence and trends in overweight among US children and adolescents, 1999–2000. *Journal of the American Medical Association*, *288*(14), 1728–1732.

Ogden, C.L., Troiano, R.P., Briefel, R.R., Kuczmarski, R.J., Flegal, K.M., & Johnson, C.L. (1997). Prevalence of overweight among preschool children in the United States, 1971 through 1994. *Pediatrics*, *99*(4), E1. doi:10.1542/peds.99.4.e1

Porter, S.C., Cai, Z., Gribbons, W., Goldmann, D.A., & Kohane, I.S. (2004). The asthma kiosk: A patient-centered technology for collaborative decision support in the emergency department. *Journal of the American Medical Informatics Association*, *11*(6), 458–467. doi:10.1197/jamia.M1569

Ramirez, A.G., Suarez, L., Chalela, P., Talavera, G.A., Marti, J., Trapido, E.J., et al. (2004). Cancer risk factors among men of diverse Hispanic or Latino origins. *Preventive Medicine*, *39*(2), 263–269. doi:10.1016/j.ypmed.2004.03.034

Registered Nurses Association of Ontario. (2005). *Primary prevention of childhood obesity* (No. NGC:004265). Toronto, ON: Registered Nurses Association of Ontario (RNAO).

Saltzman, B.S., Doherty, J.A., Hill, D.A., Beresford, S.A., Voigt, L.F., Chen, C., et al. (2008). Diabetes and endometrial cancer: An evaluation of the modifying effects of other known risk factors. *American Journal of Epidemiology*, *167*(5), 607–614. doi:10.1093/aje/kwm333

Scott, J.G., Cohen, D., DiCicco-Bloom, B., Orzano, A.J., Gregory, P., Flocke, S.A., et al. (2004). Speaking of weight: How many patients and primary care clinicians initiate weight loss counseling. *Preventive Medicine*, *38*, 819–827. doi:10.1016/j.ypmed.2004.01.001

Scottish Intercollegiate Guidelines Network. (2003). *Management of obesity in children and young people. A national clinical guideline.* (No. NGC:002961). Edinburgh, Scotland: Scottish Intercollegiate Guidelines Network (SIGN).

Shaibi, G.Q., & Goran, M.I. (2008). Examining metabolic syndrome definitions in overweight Hispanic youth: A focus on insulin resistance. *Journal of Pediatrics*, *152*(2), 171–176. doi:10.1016/j.jpeds.2007.08.010

Story, M.T., Neumark-Stzainer, D.R., Sherwood, N.E., Holt, K., Sofka, D., Trowbridge, F.L., et al. (2002). Management of child and adolescent obesity: Attitudes, barriers, skills, and training needs among health care professionals. *Pediatrics*, *110*(1), 210–214.

Strauss, R.S., & Pollack, H.A. (2003). Social marginalization of overweight children. *Archives of Pediatrics & Adolescent Medicine*, *157*(8), 746–752.

The Arizona School-Based Health Care Council. (2005). *School-based health centers*. Retrieved from http://www.azschoolhealthcouncil.org/sbhc.html

Tortolero, S.R., Goff, D.C. Jr., Nichaman, M.Z., Labarthe, D.R., Grunbaum, J.A., & Hanis, C.L. (1997). Cardiovascular risk factors in Mexican-American and non-Hispanic white children: The Corpus Christi Child Heart Study. *Circulation*, *96*(2), 418–423.

Troiano, R.P., & Flegal, K.M. (1998). Overweight children and adolescents: Description, epidemiology, and demographics. *Pediatrics*, *101*(3), 497–504.

Wagner, E.H. (1998). Chronic disease management: What will it take to improve care for chronic illness? *Effective Clinical Practice*, *1*(1), 2–4.

Wang, Y., & Lobstein, T. (2006). Worldwide trends in childhood overweight and obesity. [See comment]. *International Journal of Pediatric Obesity*, *1*(1), 11–25. doi: 10.1080/17477160600586747

Whitaker, R.C., & Orzol, S.M. (2006). Obesity among U.S. urban preschool children: Relationship to race, ethnicity, and socioeconomic status. *Archives of Pediatrics & Adolescent Medicine*, *160*, 578–584.

Whitlock, E.P., Williams, S.B., Gold, R., Smith, P.R., & Shipman, S.A. (2005). Screening and interventions for childhood overweight: A summary of evidence for the US preventive services task force. *Pediatrics*, *116*(1), e125–e144. doi:10.1542/peds.2005-0242

Young, T.L., D'angelo, S.L., & Davis, J. (2001). Impact of a school-based health center on emergency department use by elementary school students. *Journal of School Health*, *71*(5), 196–198.