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ABSTRACT

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Cases of Type 2 diabetes mellitus (T2DM) have been increasing at alarming rates in Texas. Identifying underlying factors, such as acanthosis nigricans (AN), elevated body mass index and hypertension, which might contribute to the development for type 2 diabetes, is critical. This study analyzed the relationship of AN with these risk factors of T2DM. Richardson Independent School District screening results for 2003-2004 were analyzed. This study concluded that calculated BMI values yielded the highest association with grades of AN. BMI-for-age percentiles greater than or equal to the 95th percentile and elevated diastolic and/or systolic blood pressures were strongly associated with AN grades.

AN EVALUATION OF ACANTHOSIS NIGRICANS SCHOOL SCREENING RESULTS IN RICHARDSON INDEPENDENT SCHOOL DISTRICT TO DETERMINE THE ASSOCIATION OF ACANTHOSIS NIGRICANS AND OTHER FACTORS FOR TYPE 2 DIABETES MELLITUS

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CHAPTER I

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is increasing at alarming rates in Texas and throughout the United States. Type 2 diabetes traditionally presents in overweight adults over the age of 45, but the age of type 2 diabetes onset is occurring in younger ages (Texas Diabetes Council, 2001). According to the Texas Department of Health, the number of youth under 18 years of age with type 2 diabetes tripled from 1993 to 1998 (Texas Diabetes Council, 2001). Overweight children with signs of insulin resistance or positive family history of diabetes are considered to be at substantial risk for type 2 diabetes development. Acanthosis nigricans (AN) and polycystic ovarian syndrome (POS) are two disorders that are associated with insulin resistance (American Diabetic Association [ADA], 2000). Considering the trends in diabetes, it is important to identify markers, such as AN, that might assist with the identification of individuals at risk. This study examined the relationship of AN, body mass index, and elevated diastolic and /or systolic blood pressure levels as precursors of T2DM. Once precursors of T2DM are identified in a population health interventions can be introduced and implemented. With effective interventions and life style changes, the development of T2DM can be diverted.

Because of increasing numbers of T2DM cases in children and because AN is an identified risk factor, the 76th Texas Legislature signed House Bill 1860 into effect in 1999. This bill authorized acanthosis nigricans screening in school children from nine border counties coordinated by The University of Texas System Texas-Mexico Border Health Coordinating Office (Appendix A). The program, entitled Acanthosis Nigricans: The Education and Screening Project (ANTES), was initiated on September 1, 1999. The purpose of this program was to target children at risk of developing T2DM and intervene before the diseases occurred (University of Texas System, Texas-Mexico Border Health Coordination [UTS, TMBHC], 1999). This program was expanded in 2001 with implementation of House Bill 2989, during the 77th Texas Legislature session. The new law extended the ANTES program to include eight Texas Education Service Centers (Appendix B). In 2003, the 78th Legislature passed House Bill 2721, further expanding the ANTES program to include an additional three Education Service Centers (University of Texas-Pan American Border Health Office [UTPABHO], 2002). Reported results of AN screenings from the eleven mandated Education Service Centers within Texas, obtained from the Acanthosis Nigricans: The Education and Screening Project (ANTES) website were utilized to create maps. These maps provide a visual graphic displaying the increasing cases of AN within these eleven Education Service Centers (Appendix C).

Statement of Purpose

This research project examined acanthosis nigricans screening results reported from the Richardson Independent School District for the academic school year 2003-2004 to determine a possible association of AN with diastolic and/or systolic blood pressure levels and body mass index (BMI). Currently, Texas law mandates medical referrals be made for all students identified with AN. A calculated BMI value and two blood pressure readings are included in the medical referral to the parent/guardian, and reported to the ANTES website. The American Diabetes Association recommends diabetic screening for children and youth who are at increased risk for the presence or development of T2DM (ADA, 2005). Determination of overweight status and the presence of two additional risk factors are the accepted criteria recommended for diabetic screening by the ADA in adolescents and youth (ADA, 2005). Current literature recommends the calculation and use of BMI percentiles when working with children and issues of weight (Sorof, Lai, Turner, Poffenbarger, & Portman, 2004). This study analyzed calculated BMI values, BMI percentiles, diastolic and systolic blood pressure measurements to determine possible associations with grades of AN.

Importance of Study

With increasing prevalence of type 2 diabetes in Texas, it becomes critical to determine measurable indicators that are precursors of this disease. Diabetes has been associated with the development of serious health complications, such as cardiovascular disease, blindness, kidney disease and diabetic ketoacidosis (ADA, 2002). Significant morbidity and premature death are often associated with diabetes. Knowing that severity of diabetic complications is linked to duration of disease; early age onset often results in increasing health problems among affected adults (Drobac, Brinkman, Smith, & Binss, 2004). A significant number of children diagnosed with type 2 diabetes in the United States are found to have hypertension and hypertriglyceridaemia at the time of diagnosis (Drake, Smith, Betts, Crowne, & Shield, 2002). Often with the subtle onset of type 2 diabetes the signs and symptoms of hyperglycemia remain undetected allowing the risk for developing many of the long-term complications, such as blindness, end-stage renal failure, myocardial infarctions and strokes, associated with this disease to increase (Quarry-Horn, Evans, & Kerrigan, 2003). For example, there is epidemiological evidence reporting retinopathy begins to develop at least seven years prior to the diagnosis of diabetes (Quarry-Horn, Evans, & Kerrigan, 2003). Diabetics have a two-fold to four-fold increased risk of myocardial infarction and stroke when compared to individuals without diabetes. A large portion of this increased risk is due to the common underlying problem of insulin resistance and clustering of cardiovascular risk factors in diabetes (Rizvi, 2004). Implementation of healthy lifestyle changes through a low fat diet, exercise, and prescribing pharmacological therapy when needed can prevent costly and morbid complications of diabetes. Early diagnosis and appropriate treatment to achieve metabolic control in youth with type 2 diabetes can curtail many of these life-threatening consequences associated with diabetes (Quarry-Horn, Evans, & Kerrigan, 2003). Recognizing that disease prevention is preferred to treatment and minimizing complications, it is important to identify measurable signs that indicate risk of development of type 2 diabetes.

The following questions were addressed in this study:

Research Question #1

Are BMI-for-age percentiles values more strongly associated with grades of AN than calculated BMI values?

Research Question #2

Are diastolic and/or systolic blood pressure categories using gender specific stature-for-age percentiles more strongly associated with grades of AN than calculated BMI values?

Research Question #3

Are BMI-for-age percentiles and diastolic and/or systolic blood pressure categories together more strongly associated with grades of AN than when used individually?

CHAPTER II

LITERATURE REVIEW

Diabetes has become a serious public health problem in the United States. In 2002, there were 18.3 million people with diabetes in the US. This represented 6.3% of the general population. Over five million of these individuals are undiagnosed (American Diabetes Association [ADA], 2002). The Centers for Disease Control and Prevention estimate that as many as forty one million Americans have prediabetes (Centers for Disease Control and Prevention, 2005). Prediabetes is present when an individual has elevated blood glucose, but their level is not high enough to be classified as diabetes (Texas Department of Health, 2003). Fasting plasma glucose (FPG) is the recommended test for diagnosing diabetes. Normal FPG is defined as <100 mg/dl. The FPG cutting point separating diabetes from nondiabetes was lowered from ≥ 140 mg/dl to ≥ 126 mg/dl by the 2003 International Expert Committee (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus [ECDCDM], 2004). The range of FPG levels between normal and diagnostic for diabetes was named impaired fasting glucose (IFG). Impaired fasting glucose (IFG) identifies individuals whose FPG is between 100 mg/dl and 126 mg/dl. These individuals are considered to have prediabetes. The diagnostic category of impaired glucose tolerance (IGT) captures individuals whose FPG was <126 mg/dl but their two-hour plasma glucose (2-h PG), after a 75 gram oral glucose challenge, was 140-199 mg/dl (ECDCDM, 2004).

Within the state of Texas, an estimated 1.3 million adults were diagnosed with diabetes in 2003. This represents approximately 8.1% of adults in Texas (TDSHS, 2004). An additional 343,000 adults in Texas are believed to be undiagnosed for diabetes (TDSHS, 2004). The population of Texas is projected to reach 22.8 million by 2006, according to Texas Department of State Health Services (Texas Department of State Health Services, Center for Health Statistics, 2005). Looking at current trends in Texas, the number of non-Hispanic white children will remain fairly constant, compared to the number of African American and Hispanic children. The CDC predicts that within twenty-five years the number of African American children will increase by 32%, and Hispanic children will increase by 60% (Texas Pediatric Diabetes Research Advisory Committee [TPDRAC], 2002). In Texas, children and adolescents with type 2 diabetes are disproportionately of Hispanic, American-Indian, and African-American heritage. Children in these ethnic groups with type 2 diabetes are usually overweight, and their immediate families are overweight and have a high incidence of type 2 diabetes (Texas Diabetes Council, 2004).

Diabetes is commonly described as type 1 or type 2. Historically, type 1 diabetes has been the most common form of diabetes in children. Previously known as insulin-dependent diabetes mellitus (IDDM) or juvenile-onset diabetes, type 1 diabetes develops when the body immune system destroys pancreatic beta cells. These beta cells are the only cells within the body that make the hormone insulin, which is necessary to regulate blood glucose levels. Type 2 diabetes, historically called non-insulin-dependent diabetes mellitus (NIDDM) or adult-onset diabetes, generally begins with insulin resistance, when the cells do not use insulin properly. As the need for insulin increases, the pancreas loses its ability to produce insulin (DHHS, CDC, 2004).

As Bloomgarden (2004) explains, many factors influence the risk of the evolving type 2 diabetes in adolescents. The development of type 2 diabetes involves a loss of balance between insulin secretion and insulin sensitivity. According to Bloomgarden, insulin sensitivity decreases approximately thirty percent during puberty, resulting in an increase of insulin secretion (Bloomgarden, 2004). Obese children are prone to glucose intolerance, which is strongly associated with both insulin resistance and impaired insulin secretion (Bloomgarden, 2004). Type 2 diabetes among children and adolescents may be a result of increasing obesity, particularly increasing central obesity. Bloomgarden (2004) identified gender as an important factor in diabetes as girls are 1.7 times more likely than boys to develop type 2 diabetes. Family history plays a crucial role with diabetes. More than two-thirds of children with type 2 diabetes have at least one parent with type 2 diabetes (Bloomgarden, 2004).

According to the CDC, type 2 diabetes accounts for ninety to ninety five percent of all diabetes in the United States (DHHS, CDC, 2004). Type 2 diabetes has been increasing at alarming rates in Texas and throughout the United States. While the exact number of children in Texas with type 2 diabetes is unknown, recent studies have indicated that eight to forty five percent of newly diagnosed cases in children are type 2 (Texas Diabetes Program/Council, Summer 2004). Endocrinologists are diagnosing type 2 in almost fifty percent of their newly diagnosed cases of diabetes. The numbers of adolescents with type 2 diabetes in Texas is predicted to triple by 2025, resulting in

30,000 Texas youth diagnosed with diabetes, if no change in the current trend occurs (Texas Diabetes Council, 2004). Race and ethnicity play key roles in diabetes prevalence. Type 2 diabetes exists predominantly in children of Hispanic, African American, American Indian and Asian descent (TPDRAC, 2002). Overall, African Americans have the highest prevalence of diabetes and are twice as likely to suffer from diabetes compared to Non-Hispanic Whites. Hispanics also have a higher prevalence of diabetes when compared to Non-Hispanic Whites (TDH, 2003). It is estimated by the CDC that one million children will be born in Texas, or move to Texas, over the next 25 years (TPDRAC, 2002). Taking into account the current trends, the number of non-Hispanic white children will remain somewhat constant. Due to the rapid population growth in Texas, and our great ethnic diversity, Texas will be greatly impacted by these trends (TPDRAC, 2002).

Increasing prevalence of diabetes in Texas has directly impacted economic and personal demands. The direct and indirect cost of diabetes in Texas is estimated at $9 billion annually (Texas Diabetes Council, 2001).

Early detection and prompt treatment may reduce the complications associated with diabetes. The greater the numbers of risk factors that are present with an individual, the greater the chance of developing diabetes. The risks associated with development of type 2 diabetes increase with age, obesity, and a lack of physical activity. The American Diabetic Association recommends that children and youth with substantial risk for the presence or development of type 2 diabetes should be tested (ADA, 2005). Individuals belonging to certain ethnic groups and having a positive family history of diabetes are both factors that increase the risk of developing type 2 diabetes (ADA, 2004). Testing is recommended to be done every two years, starting at age ten or at the onset of puberty (ADA, 2004).

The American Diabetes Association recommends children who are overweight with two additional risk factors be screened (ADA, 2004). Additional risk factors include a family history of type 2 diabetes in first-degree and second-degree relatives, Native American, African American, Hispanic American, Asian, and South Pacific Islander heritage, and the presence of insulin resistance or conditions associated with insulin resistance, such as acanthosis nigricans and polycystic ovarian syndrome. As the ADA (2004) explains, diabetic screening is very different from diabetic testing. The purpose of diabetic screening is to identify asymptomatic individuals who are at risk of developing diabetes. The settings in which screenings are performed may have an impact on the screening effectiveness (ADA, 2004). According to the ADA (2004) community screenings, outside a health care setting, may be less effective due to the failure of individuals with positive screening results to seek and obtain appropriate testing. Community screenings are at risk of being ineffective as the screening is poorly targeted. Screenings outside of health care settings are at risk of failing to reach at risk group and at risk of screening inappropriate individuals, such as those at low risk, or previously diagnosed (ADA, 2004).

The presence of acanthosis nigricans is considered a marker of hyperinsulinemia, and thus, a marker for risk of developing T2DM (Stuart, Smith, Gilkison, Shaheb, & Stahn, 1994). In individuals between the ages of twelve and thirty, obesity is the most common abnormality associated with acanthosis nigricans. The extent of AN in adolescent with obesity correlates positively with the degree of excess weight and the presence of diabetes (Hermanns-Lé, Scheen, & Piérard, 2004).

Acanthosis nigricans is characterized by symmetrical, light brown to black, velvety skin markings. This skin marking usually develops in the flexures, especially the axillae, the nape and sides of the neck and the groin. Joints on the feet and hands and palms and soles of the feet often display the AN marker (Hermanns-Lé et al., 2004). Visual examination of the neck, observing for a thickened, darker skin area on the neck, is recommended for school screenings. The visual screening of the neck for AN is preferred in mass screening situations given the ease of access to the posterior neck and the fact that the neck is always involved when AN is present (Kobaissi, Weigensberg, Ball, Cruz, Shaibi, & Goran, 2004).

AN is documented as grades of one, two, three or four. Grade I is typically visualized as a line. Grade II AN is determined by a visible marker measuring between one and two centimeters in width. Grade III AN measures between two and three centimeters in width, with Grade IV AN being all visible markers greater than three centimeters. Higher AN grades are associated with higher blood insulin concentrations (UTS, TMBHC, 1999).

The prevalence of AN differs within the four major ethnic groups in the United States, but within any ethnic group, individuals with AN have shown to have hyperinsulinemia, indicating the highest risk for T2DM (Stuart, Gilkison, Smith, Bosma, Keenan, & Nagamani, 1998). Early detection of acanthosis nigricans is an important, cost-effective, noninvasive screening tool useful for identifying adolescents at risk for development of T2DM (Mukhtar, Cleverley, Voorhees, & McGrath, 2001). A recent study has shown that screening for acanthosis nigricans, according to the ADA recommendations, was also beneficial in identifying young school children, and their siblings, that should be screened for cardiovascular risk factors, as well as T2DM (Urrutia-Rojas, Menchaca, Wadley, Ahmad, Lacko, Bae, Spellman, Kudchodkar, Kudolo, & McConathy, 2004). Reductions in body mass index have shown to improve insulin sensitivity (Reinehr, Kiess, Kapellen, & Andler, 2004). Comprehensive treatment strategies for childhood obesity are effective in reducing risk factors for cardiovascular disease such as insulin resistance (Reinehr et al., 2004).

CHAPTER III

METHODOLOGY

Secondary data from AN screening results in Texas for 2001 and 2003, publicly available on the ANTES website, was utilized to create maps (ANTES, 2004). These maps show the increased number of cases of Grades I, II, III, and IV of AN, for 2001 and 2003, within each of the eleven reporting Education Service Centers in Texas. Richardson ISD was one of the eleven reporting Education Service Centers in 2003. No personal identifiers were used. No AN results were available for 2002 screenings on the ANTES website. These maps are shown in Appendix D, E, F, and G.

This research project analyzed acanthosis nigricans screening results from Richardson ISD. Subjects enrolled in Richardson ISD for the academic year of 2003-2004 with reported positive acanthosis nigricans were analyzed. Data from Richardson ISD subjects included academic grade level, gender, AN grades, height, weight, calculated BMI, and systolic and diastolic blood pressure measurements.

Population and Sample

State guidelines specifically required all students in third, fifth and eighth grades be screened for the presence of acanthosis nigricans. Acanthosis Nigricans screening results for Richardson Independent School District (RISD) for the school year 2003-2004, were analyzed for this research. All students, enrolled in Richardson ISD for this academic school year were potential candidates for AN screening and were therefore potential subjects in this study. Richardson ISD results were student specific, with no personal identifiers reported. All students enrolled in Richardson Independent School District for the 2003-2004 academic school year between pre-kindergarten and ninth grade with positive acanthosis nigricans screening results were included in this data set.

Additional students outside of these mandated grade levels that were screened by each school nurse were included in this study. Students with positive AN markers (*n*=684) were reported by academic grade level.

Protection of Human Participants

Written authorization allowing the use of AN data results for 2003-2004 without identifiers was received from Richardson ISD. After the completion of data analysis, the master list of AN screening results was returned to the director of Health Services for Richardson ISD. Approval from the Institutional Review Board with the University of North Texas Health Science Center for this project was requested and obtained.

Data Collection Procedures

Every student with a positive AN screening result (*n*=684) during the 2003-2004 school year was included in this study. Richardson ISD data was compiled in an Excel file throughout the 2003-2004 academic school year. The data were grouped by school name, academic grade level, AN grade, height (reported in inches), weight (reported in pounds), calculated BMI and two blood pressure readings. Acanthosis nigricans grades were determined by manual measurement, using a ruler with centimeter increments. Categories included Grade I through Grade IV.

The data obtained from Richardson ISD were reported by each campus school nurse to the director of Health Services. Student screening results were reported by academic grade.

Definition of Variables

Body Mass Index: BMI is a commonly accepted measurement for adiposity among adults (Drobac et al., 2004). BMI values are categorized as healthy weight, overweight and obese in the adult population (National Health and Nutrition Examination Survey [NHANES], 2003). According NHANES (2003) adults with BMI values less than 25.0 are considered to be of healthy weight. Adults with BMI values between 25.0 and 29.9 are considered to be overweight (NHANES, 2003). Adults with BMI values greater than or equal to 30.0 are considered obese (NHANES, 2003). Adults with BMI values of 40.0 and greater are considered to be extremely obese (Hedley, Ogden, Johnson, Carroll, Curtin and Flegal, 2004).

In contrast to adults, as children grow their body fatness changes over the years. The rate of growth and development for children is different from adults and different between boys and girls (National Center for Health Statistics, 2000). To account for these specific differences with children and teens, BMI is often reported as BMI-for-age in children and teens. BMI-for-age is gender specific and reported as a percentile. Advisory groups and expert committees have recommended BMI-for-age percentiles as the accepted measurement for assessing overweight in children and adolescents (Drobac et al., 2004). Continuous tracking of overweight individuals from adolescence through adulthood is possible when utilizing BMI-for-age percentiles, since these percentiles are consistent in children, adolescents and adults (Drobac et al., 2004).

Each subject's measured height and weight were utilized to calculate a body mass index (BMI). The reported weight of each subject, reported in pounds, was converted to kilograms. The reported height in inches of each subject was converted to meters. Weight (in kilograms) divided by the measured height (in meters) squared yielded BMI for each subject in this database.

Every reported subject in RISD was plotted on a gender-specific BMI-for-age percentile chart, to determine their BMI-for-age percentile (National Center for Health Statistics [NCHS], 2005). These growth charts are used for children and teens from ages two through twenty and are gender-specific to accommodate for the different amounts of body fat for boys and girls as they mature. These charts contain a series of curved lines, each indicating specific percentile groups. BMI-for-age has been shown to be significantly correlated with subcutaneous and total body fatness in adolescents (Barlow & Dietz, 1998). BMI-for-age values correlate with cardiovascular risk factors, such as hyperlipidemia and high blood pressure (NCHS, 2005). Students with a BMI-for-age less than the eighty fifth percentile were considered to have normal weight. Students with reported BMI-for-age percentiles ranging from eight five percent to less than ninety five percent were considered to be at risk of overweight. Students with BMI-for-age percentiles reported at the 95th percentile range and higher, were categorized as overweight.

Blood Pressure: Normal blood pressure categories for children are defined as systolic blood pressure (SBP) and diastolic blood pressure (DBP) readings that are less than the 90th percentile for gender, age, and height, measured on three different occasions. Prehypertension in children and adolescents is defined as averaged SBP and DBP readings that are equal or greater than the 90th percentile, but less than the 95th percentile, for gender, age, and height, measured on three different occasions. Hypertension is defined as averaged SBP and DBP readings that are equal or greater than the 95th percentile for gender, age and height, measured on three separate occasions. These blood pressure readings must be taken on a minimum of three different occasions to be considered definitive (National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents [NHBPEPWGHCCA], 2004). Additionally, any child with blood pressure readings greater than or equal to 120/80, taken on three separate occasions, is considered hypertensive, regardless of their height percentile (NHBPEPWGHCCA, 2004).

Each subject in Richardson ISD received two blood pressure measurements, taken over a minimum five minute interval. According to the mandates of House Bill 1860, Texas schools are required to obtain two blood pressure readings on all students who are screened positive for AN (UTS, TMBHC, 1999). These two measurements are specified to be taken with a minimum of five minutes between readings. These instructions, although in contrast to the recommended guidelines of the National High Blood Pressure Education Program, were utilized in the Richardson ISD AN screening procedure (NHBPEPWGHBPCA, 2004). As reported by the National High Blood Pressure

Education Program Working Group the normal range of blood pressure for adolescents is determined by age and body size (NHBPEPWGHBPCA, 2004). Standards of blood pressure that are based on age, gender and height yield a more precise classification of blood pressure according to body size. By utilizing these new standards, children who are very short or very tall avoid misclassification (NHBPEPWGHBPCA, 2004).

National Center for Health Statistics gender specific growth charts used for children and teens from ages two through twenty years of age were used to determine each subject's stature percentile. Plotting the subject's age and height on the gender-specific stature-for-age percentile graph resulted in a height percentile determination. Blood pressure results that are within the prehypertension and hypertension categories are recommended to be repeated on three or more visits (NHBPEPWGHBPCA, 2004). The RISD blood pressure measurements were taken during one clinic visit, with a minimum time period of five minutes between readings. To accommodate for the absence of blood pressure readings from three separate occasions, the higher of the two systolic and diastolic blood pressure measurements on each subject were utilized for analysis. The highest measured SBP and highest measured DBP of each subject in this study were compared with blood pressure readings from a gender-specific table, according to the subject's age and height percentile (NCHS, 2005). Subjects were considered normotensive if their blood pressure was less than the 90th percentile. When the blood pressure measurement was between the 90th and 95th percentiles, the subject was categorized as prehypertensive. Blood pressure measurements that were equal or greater than the 95th percentile were categorized as hypertensive. Additionally, all subjects with systolic blood pressures of 120 or higher and diastolic blood pressures of 80 or higher were categorized as prehypertensive, regardless of their height percentile (NHBPEPWGHBPCA, 2004).

Acanthosis Nigricans: A skin disorder characterized by abnormally coloration (hyperpigmentation) and "velvety" thickening (hyperkeratosis) of the skin. AN is most often found in skin fold regions, such as of the neck and groin and under the arms (Hermanns-Lé et al, 2004). AN usually appears slowly and does not cause other symptoms or skin changes. AN was originally described in 1889 by a German dermatologist (Texas Department of Health [TDH], 2003). In 1976, acanthosis nigricans was linked to hyperinsulinemia, a result of insulin resistance (TDH, 2003).

Grades of AN are reported as I, II, III or IV, dependent on the measured width of the marker. Grade I is typically visualized as a line. Grade II AN is determined by a visible marker measuring between one and two centimeters in width. Grade III AN measures between two and three centimeters in width, with Grade IV AN being all visible markers greater than three centimeters (UTS, TMBHC, 1999). All individuals screening for AN must complete a required course and be certified by the University of Texas-Pan American Border Health Office.

Richardson ISD policy for AN screenings instructed each student to stand with his/her back to the examiner. Each student was instructed to hold their head in an upright position. Students were then instructed to flex their neck forward (chin to chest) exposing more of the posterior neck for visual examination. Nurses were instructed to observe for darkened skin marker to the back of the neck of light brown-black coloring.

If no marker was visualized, these negative findings of AN were noted on the permanent health record for the student. If a marker was visualized the nurse was instructed to palpate the marker for skin thickness, ridges and/or uneven texture. For all visualized and/or palpated markers, measurement of the marker was required. Upon successful completion of the AN Screening Program certification course, each nurse was provided an Acanthosis Nigricans Grade Severity Indicator (ANGSI), a ruler with specified AN grade increments. Each nurse placed the ANGSI perpendicular to the marker, at the nape of the neck. Measurement of the total height of the marker was performed, and the AN grade corresponding with the height of the marker was documented.

Limitations

This study assessed only three risk factors associated with type 2 diabetes. The absence of additional risk factors was an identified limitation. Schools assessing children for these three risk factors cannot determine, with certainty, if a child is at risk for developing type 2 diabetes. Risk factors such as a family history of diabetes, race/ethnicity, and lifestyle were not examined in this study.

The lack of an effective system to provide the recommended medical evaluations on referred students was an additional limitation. The purpose of AN screenings is to identify individuals who are likely to be at risk to develop type 2 diabetes (UTS, TMBHC, 1999). Texas law specifies AN screenings in stated education service centers for specific grade levels. Parents of all students identified with acanthosis nigricans are to be notified of the results. No follow up information, repeat screening, counseling or health intervention plans are suggested or required. No suggested guidelines or medical recommendations for additional testing are specified (UTS, TMBHC, 1999).

The effectiveness of all screenings may be dependent on the setting in which the screening is performed (ADA, 2005). According to the American Diabetes Association (2005) screenings outside of the health care setting may be less effective because of the failure of individuals with positive screening results to seek and obtain appropriate follow up testing and care. When screenings are performed outside the health care setting, abnormal findings may never be discussed with a primary care provider (ADA, 2004).

Specific data for height, weight, calculated BMI, systolic and diastolic blood pressure measurements were only available from Richardson ISD. Richardson ISD population may not be representative of the overall adolescent population for the state of Texas. Analyzing data from only one of the eleven reporting Education Service Centers was an additional limitation of this study.

The non inclusions of students negative for AN presented an important limitation in this study. All available data from RISD screening results was limited to students with positive AN screening results. With the absence of all students with negative AN screenings, it was not possible to determine if students with AN were more likely to present additional risk factors, as compared with students without AN.

The accuracy of blood pressure measurements to determine possible hypertension was another limitation in this study. For accuracy of hypertension in children and adolescents, repeated measurements of blood pressure from at least three different occasions are recommended (NHBPEPWGHCCA, 2004). The data results from

Richardson ISD reported two blood pressure readings, taken five minutes apart, on the same day.

Data Analysis

The analyzed data included 684 students between four and fifteen years of age, from a total school population of 34,441, for the 2003-2004 year. Subjects were categorized by academic grade level and gender. BMI-for-age and stature percentiles for all students were determined by age, weight and height. To allow for data analysis by age, a value of six was added to each reported academic grade. This resulted in an age in years for each subject in the study. Richardson ISD data were analyzed for possible significant correlations between calculated BMI values, BMI-for-age percentiles, diastolic/systolic blood pressure measurements and grades of AN.

Research Question #1

Are BMI-for-age percentiles more strongly associated with grades of AN than calculated BMI values from height and weight measurements?

Each calculated BMI was plotted on a gender-specific BMI-for-age percentile chart, resulting in a BMI-for-age percentile for each subject. Students with a BMI-for-age percentile less than the 85^{th} percentile were considered to have normal weight. Students with reported BMI-for-age percentiles ranging from 85% to less than 95% were considered to be at risk of overweight. Students with BMI-for-age percentiles reported at the 95^{th} percentile range and higher were categorized as overweight.

BMI values reported on Richardson ISD subjects ranged from 15.47 to 51.85, with 481 different values. Analysis of variance was performed to compare the variance among groups with the variance within groups. In order to perform analysis of variance on the reported BMI values, it was necessary to create groups with similar BMI calculations. BMI calculations were grouped into five categories to allow for statistical analysis of variance. The groups were created by dividing the total number of subjects into five groups, of approximately equal size, by increasing BMI values.

Analysis of variance was performed with weight categories (determined from BMI-for-age percentiles) as the independent variable and grades of AN as the dependent variable to determine if there was a significant difference on grades of AN by weight categories. Analysis of variance was performed with calculated BMI groups as the independent variable and grades of AN as the dependent variable to determine if there was a significant difference in grades of AN from calculated BMI groups. When a significant F value was obtained from analysis of variance, post-hoc tests were performed to determine which particular groups differ from other groups. The Tukey method is preferred when the number of groups is large, since it is a very conservative comparison test, and researchers prefer to be conservative when the large number of groups threatens to inflate Type I errors (WebStat, 2005). Tukey honestly significant difference (HSD) test was used to determine significance between the different calculated BMI groups.

Regression analysis was performed with grades of AN as the dependent variable and BMI-for-age category as the predictor to determine predictive distribution of BMI-for-age categories on grades of AN. Regression analysis was performed with grades of

AN as the dependent variable and calculated BMI values as the predictor to determine the predictive distribution of calculated BMI values on grades of AN.

Research Question #2

Are blood pressure categories, determined by diastolic and systolic blood pressure values and gender specific stature-for-age percentiles more strongly associated with grades of AN than calculated BMI values?

Analysis of variance was performed with calculated BMI groups as the independent variable and grades of AN as the dependent variable to determine if there was a significant different in grades of AN by calculated BMI values. Analysis of variance was performed with blood pressure categories (determined from stature for age percentiles) as the independent variable and grades of AN as the dependent variable to determine if there was a significant difference in grades of AN by blood pressure categories. Regression analysis was performed with grades of AN as the dependent variable and blood pressure categories as the predictor to determine the predictive distribution of blood pressure categories on grades of AN. Regression analysis was performed with grades of AN as the dependent variable and calculated BMI values as the predictor to determine the predictive distribution of calculated BMI values on grades of AN.

Research Question #3

Are BMI-for-age percentiles and blood pressure categories together more strongly associated with grades of AN than when used individually?

The calculated BMI for each subject was plotted on gender-specific BMI-for-age percentile charts to determine the BMI-for-age categories. Regression analysis was performed with grades of AN as the dependent variable and BMI-for-age categories as the predictor. Regression analysis was performed with grades of AN as the dependent variable and blood pressure categories as the predictor. Finally, multiple regression analysis with grades of AN as the dependent variable and both BMI-for-age categories and blood pressure categories as the predictors was performed.

CHAPTER IV

RESULTS

This study of Richardson Independent School District students analyzed reported results for 683 students who were positively screened for the presence of acanthosis nigricans. Richardson ISD reported an enrollment of 34,441 students for the 2003-2004 year. The ethnic distribution of students in the 2003-2004 school year for RISD was comprised of 40.1% white, 25.7% Hispanic, 25.1% African-American, 8.6% Asian/Pacific Islander and 0.5% Native American. Approximately 2% of the student population for Richardson ISD in 2003-2004 was determined to be positive for acanthosis nigricans. Females (*n*=345) accounted for 50.5% of the total reported population and males (*n*=338) accounted for 49.5% of the total reported population (Table 1).

Table 1

Age and Gender of Subjects in Study

Age in Years	Female	Male	Total Number of Subjects	% of Total Subjects
4	1	1	2	0.3%
7	0	1	1	0.1%
8	0	1	1	0.1%
9	97	90	187	27.4%
10	1	2	3	0.4%
11	133	147	280	41.0%
12	2	0	2	0.3%
13	0	1	1	0.1%
14	108	84	202	29.6%
15	3	1	4	0.6%
Total	345	338	683	100%

An analysis by student age (*n*=683), shown in Table 2, resulted in a mean age of 11.3 years, with a range from 4 to 15 years of age.

Table 2

Descriptive Statistics for Years of Age

Years of age range	N	Mean	SD
4-15	683	11.33	1.99

Table 3 shows the measurement and distribution of grades of AN by gender. There are similar findings by age groups, comparing boys and girls.

Table 3

Measurement and Grades of Acanthosis Nigricans by Gender

AN Grade	Measurement	Female	Male	Total	Percentage of Total Population
I	Line<1cm	175	214	389	57%
II	1-2cm	128	89	217	31.8%
III	2-3cm	35	31	66	9.7%
IV	>3cm	7	4	11	1.6%
Total		345	338	683	100%

Calculated BMI measurements ranged from 15.47 to 51.85, with a mean value of 28.66. To allow for analysis of variance, BMI calculations were grouped into five categories, of similar values. These groups were created by dividing the total subjects into five groups of approximately equal size (Table 4).

Table 4

Descriptive Statistics for Calculated BMI Groups

Group	Calculated BMI range	N	Mean	SD	% of Total
1	15.47-23.96	136	21.69	1.87	19.90
2	23.99-26.48	129	25.23	0.78	18.89
3	26.50-29.08	137	27.79	0.71	20.06
4	29.10-32.96	139	30.78	1.19	20.35
5	33.00-51.85	142	37.23	3.69	20.80

As shown in Table 5, BMI-for-age percentiles were grouped into three separate categories using the guidelines established by the Centers for Disease Control and Prevention. BMI values that were less than the 85th percentile were categorized as not at risk of overweight. All subjects with BMI-for-age percentiles in the 85th to 94th percentiles were categorized as being at risk for overweight. BMI values that were equal to or greater than the 85th percentile up to the 94th percentile were determined to be at risk of overweight. All BMI values equal to or greater than the 95th percentile were categorized as overweight.

Table 5

Descriptive Statistics for BMI-for-age Percentile Categories

BMI-for-age %	Weight Category	Number of Subjects	Mean	SD	% of Total Subjects
<85%	Not at risk	30	1.17	0.379	4.4%
85% - 94%	At risk of overweight	84	1.26	0.518	12.3%
≥ 95%	Overweight	569	1.62	0.757	83.3%

Stature-for-age percentiles were determined and reported, for each subject. The percentile breakdown of stature-for-age of the subjects is shown in Table 6.

Table 6

Stature for Age Percentile Categories

Percentile	Number of Students	% of Total Students
5^{th}	17	2.5%
10^{th}	24	3.5%
25^{th}	87	12.7%
50^{th}	142	20.8%
75^{th}	149	21.8%
90^{th}	86	12.6%
95^{th}	178	26.1%

To accommodate for the lack of three separate blood pressure measurements, the highest of the systolic and diastolic blood pressure measurements were used for the analysis. The highest systolic and highest diastolic blood pressure measurements from two readings were plotted on gender-specific blood pressure levels by age and height percentile graphs to determine the resulting blood pressure category. Diastolic and systolic blood pressure values were categorized as normotensive (34.3%), prehypertensive (10.2%), or hypertensive (55.5). As shown in Table 7, the greatest numbers of subjects were identified as hypertensive.

Table 7

Descriptive Statistics for Diastolic and Systolic Blood Pressure Categories

Blood Pressure % Category	Mean	SD	N	% of Total Subjects
<90%	1.46	0.700	234	34.3%
90% - <95%	1.50	0.654	70	10.2%
≥95%	1.63	0.760	379	55.5%

Research Question #1:

Are BMI-for-age percentiles more strongly associated with grades of AN than calculated BMI values? The data analysis indicated that BMI-for-age percentiles were not more strongly associated with grades of AN than calculated BMI values.

Each calculated BMI was plotted on a gender-specific BMI-for-age percentile chart to determine the BMI-for-age percentile for each subject. Using Pearson correlation analysis, BMI-for-age percentiles were positively correlated with AN ($r=.20$, $p<.01$). Using Pearson correlation analysis, calculated BMI values were positively correlated with grades of AN ($r=.34$, $p<.01$). Calculated BMI values were shown to have a stronger association with grades of AN than BMI-for-age percentiles.

Analysis of variance performed with weight categories (determined from BMI-for-age percentiles) as the independent variable and grades of AN as the dependent variable revealed a significant effect, $F(2,680) =13.94$, $p<.05$. Post-hoc comparisons using the Tukey HSD comparison test indicated that the overweight group had significantly higher grades of AN ($\bar{x}=1.62$) than both the group of not at risk of overweight subjects ($\bar{x}$=1.17) and the group of at risk subjects ($\bar{x}$=1.26). There was no significant difference in grades of AN between the not at risk of overweight group and the at risk of overweight group.

BMI calculations were grouped into five categories (Table 5) to allow for statistical analysis of variance. These groups were created by dividing the total subjects into five groups of approximately equal size. Analysis of variance performed with calculated BMI groups as the independent variable and grades of AN as the dependent variable revealed a significant effect, $F(4,678)=24.069$, $p<.05$. Post-hoc comparisons of the five calculated BMI groups (Table 5) using the Tukey HSD comparison test indicated that the fifth group, having calculated BMI values between 33.0 and 51.85, had significantly higher grades of AN ($\bar{x}$=37.23) than all other groups of calculated BMI values. The fourth group, having calculated BMI values between 29.10 and 32.96, was shown to have significantly higher grades of AN ($\bar{x}$=30.78) than the first group ($\bar{x}$=21.69) and the second group ($\bar{x}$=25.23). There was no significant difference in grades of AN between the fourth group and the third group of calculated BMI values ($\bar{x}$=27.79). The third group, having calculated BMI values between 26.50 and 29.08 was shown to have significantly higher grades of AN than the first group. There was no significant difference in grades of AN between the first and second groups or between the second and third groups.

Regression analysis was performed with grades of AN as the dependent variable and calculated BMI values as the predictor (Table 8). This analysis revealed that calculated BMI values accounted for approximately 11% of the variance of grades of AN.

Table 8

Model Summary for Calculated BMI (groups) on Grades of AN

Model	R	R Square	Adjusted R Square	SE of the Estimate
Calculated BMI (groups)	0.335	0.112	0.111	0.691

Predictors: (Constant), Calculated BMI (groups)

Regression analysis was preformed with grades of AN as the dependent variable and BMI-for-age percentile as the predictor (Table 9). This analysis revealed that BMI-for-age percentiles accounted for approximately 3.7 % of the variance of grades of AN.

Table 9

Model Summary for BMI-for-age% on Grades of AN

Model	R	R Square	Adjusted R Square	SE of the Estimate
BMI-for-age %	0.19	0.037	0.036	0.720

Predictors: (Constant), BMI-for-age%

Research Question #2:

Are blood pressure categories, created from diastolic and systolic blood pressure values with gender specific stature-for-age percentiles, more strongly associated with grades of AN than calculated BMI values? The data analysis indicated that diastolic and systolic blood pressure categories using gender specific stature-for-age percentiles were not more strongly associated with grades of AN than calculated BMI values.

Calculated BMI values were determined to be positively correlated with AN ($r=.34$, $p<.01$). Diastolic and systolic blood pressure categories were positively correlated to AN ($r=.12$, $p<.01$). Analysis of variance performed with diastolic and systolic blood pressure categories (determined from stature for age percentiles) as the independent variable and grades of AN as the dependent variable revealed a significant effect, $F(2,680)=4.142$, $p<.05$. Post-hoc comparisons using the Tukey HSD comparison test indicated that the hypertensive group had significantly higher grades of AN ($\bar{x}=1.63$) than the normal- tensive group ($\bar{x}=1.46$). There were no significant differences in grades of AN between the prehypertensive group ($\bar{x}=1.50$) than both the normal-tensive group and the hypertensive group.

As discussed in question one, regression analysis was performed with grades of AN as the dependent variable and calculated BMI values as the predictor. This analysis revealed that calculated BMI values accounted for approximately 11% of the variance of grades of AN.

Regression analysis was preformed with grades of AN as the dependent variable and blood pressure categories as the predictor (Table 10). This analysis revealed that blood pressure categories accounted for approximately 1% of the variance of grades of AN.

Table 10

Summary for Blood Pressure Categories on Grades of AN

Model	R	R Square	Adjusted R Square	SE of the Estimate
Blood Pressure Categories	0.108	0.012	0.010	.0729

Predictors: (Constant), Blood Pressure Categories

Research Question #3

Are BMI-for-age percentiles and blood pressure categories, created from diastolic and systolic blood pressure values with gender specific stature-for-age percentiles, together more strongly associated with grades of AN than when used individually? The data analyses indicated that BMI-for-age percentiles and diastolic and systolic blood pressure categories combined were more strongly associated with grades of AN than when used individually.

Every calculated BMI was plotted on a gender-specific BMI-for-age percentile chart to determine the BMI-for-age percentile. BMI-for-age categories were positively correlated with AN ($r=.20$, $p<.01$). Diastolic and systolic blood pressure categories were positively correlated to AN ($r=.12$, $p<.01$).

Analysis of variance was with grades of AN as the dependent variable and BMI-for-age category as the predictor revealed that BMI-for-age was significantly associated with grades of AN, $F(1,681) = 26.19$, $p<.05$. As previously shown in Table 9, regression analysis was performed with grades of AN as the dependent variable and BMI-for-age %

as the predictor. BMI-for-age accounted for approximately 3.7 % of the variance of grades of AN.

As previously shown in Table 10 , regression analysis with grades of AN as the dependent variable and blood pressure categories, created from diastolic and systolic blood pressure values with gender specific stature-for-age percentiles, as the predictor revealed that diastolic and systolic blood pressure categories were significantly related to grades of AN, $F(1,681)=8.045$, $p<.05$. Diastolic and systolic blood pressure categories accounted for approximately one percent of the variance of grades of AN.

As shown in Table 11, multiple regression analysis with grades of AN as the dependent variable and both BMI-for-age categories and diastolic and systolic blood pressure categories as the predictors revealed a significant relationship between grades of AN and both predictor groups, $F(2,680)=14.965$, $p<.05$. Combining BMI-for-age percentiles with diastolic and systolic blood pressure categories accounted for approximately 4 % of the variance of grades of AN.

Table 11

Summary for Combined BMI-for-age and Blood Pressure Categories on Grades of AN

Model	R	R Square	Adjusted R Square	SE of the Estimate
BMI-for-age and Blood Pressure Categories	0.21	0.04	0.04	0.178

Predictors: (Constant), BMI-for-age Categories and Blood Pressure Categories

When the predictive model included the addition of diastolic and systolic blood pressure categories to BMI-for-age percentiles, the variance explained in AN grades increased to 4%, which was a significant increase ($F(1,681)=26.192$, $p<.05$).

In summary, approximately 3.7 % of the variance in grades of AN can be associated with BMI-for-age categories. Approximately one percent of the variance in grades of AN can be associated with diastolic and systolic blood pressure categories. Approximately 4 % of the variance in grades of AN can be associated to the combined effect of BMI-for-age categories and diastolic and systolic blood pressure categories. There is an increased association on grades of AN from the combined effect of BMI-for-age and diastolic and systolic blood pressure categories.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Summary

This study of AN screening results for Richardson ISD in 2003-2004 determined that calculated BMI values provided the strongest association with grades of AN. These findings show that BMI calculated values are still important with evaluating risk factors associated with the development of T2DM. Diastolic and systolic blood pressure measurements combined with stature-for-age percentiles are useful in determining association of risk factors with T2DM. These resulting diastolic and systolic blood pressure categories were positively associated with grades of AN, with the hypertensive category having the strongest correlation of all three blood pressure categories. Therefore, diastolic and systolic blood pressure measurements are useful when evaluating risk factor for T2DM. Combining BMI-for-age percentiles with diastolic/systolic blood pressure categories resulted in stronger associations with grades of AN, when compared to being used individually.

Richardson ISD data analysis indicated that among children with AN, 83.3% of the AN subjects were determined to be overweight, having a BMI-for-age percentile that is greater than or equal to the 95th percentile. Additionally, the data analysis indicated that 55.5% of these subjects in the study were categorized in the hypertensive group, having a diastolic and/or systolic blood pressure value, adjusted with stature percentiles, greater than or equal to the 95th percentile. All subjects in this study were identified to be positive for AN. The non inclusions of students negative for AN resulted in AN screening results being misrepresentative of the overall RISD population. Lacking the inclusion of all RISD students screened, both positive and negative for AN, the actual percentage of students grouped in the overweight or hypertensive category was not determined.

These same concerns can be extrapolated to the entire adolescent population in Texas. Data analysis on positive AN screening results may not be representative of the overall population, however it may provide information regarding children with AN.

Conclusion

The purpose of this study was to determine possible associations of acanthosis nigricans with other indicators of type 2 diabetes mellitus. Calculated BMI values were shown to have the strongest association with grades of AN. Additionally, BMI-for-age percentiles, determined by using an individual's age and calculated BMI value, were shown to be strongly associated with AN grades. Combining diastolic and systolic blood pressure measurements with stature percentiles resulted in classifying blood pressures into three categories. These blood pressure categories were shown to be strongly associated with AN grades.

Currently in Texas, parents of students with positive AN screening results are notified of the screening results. The results of this study suggest that possible changes with the screening and notification process should be considered. The American Diabetes Association (2005) recommends testing for T2DM in children who are overweight with two additional risk factors. Elevated BMI calculations or BMI-for-age percentiles with elevated systolic and/or diastolic blood pressures and positive AN results may be sufficient to justify medical referrals for additional testing. Utilizing calculated BMI values, BMI-for-age percentiles, and diastolic/systolic blood pressure categories in association with positive AN screening results would strengthen the medical referral process.

Recommendations

Isolated positive acanthosis nigricans screening results should not be a requirement for parent notification. The presence of elevated BMI-for-age percentiles or hypertensive blood pressure should be additional requirements to justify parent notification and recommended medical evaluations. Considering the results of this study, current referral criteria with AN screenings should be reviewed. All students with a BMI-for-age greater than or equal to the 95^{th} percentile, or with a calculated BMI greater than 26.5, that show the presence of AN should be referred for further medical evaluation. Additionally, all students with AN and a systolic and/or diastolic blood pressure value greater than or equal to the 95^{th} percentile should be referred for additional medical evaluation. All students determined to have a BMI-for-age greater than or equal to the 95^{th} percentile or a systolic or diastolic blood pressure reading greater than or equal to the 95^{th} percentile and show for the presence of acanthosis nigricans should be further evaluated for the risk of type 2 diabetes.

Public health concerns on the adolescent population with acanthosis nigricans, elevated BMI values and elevated diastolic and/or systolic blood pressure are important factors to consider when identifying individuals at risk. Type 2 diabetes is one of many important health conditions currently effecting our youth (National Mental Health Association, 2005). Screening for acanthosis nigricans, BMI, and diastolic/systolic blood pressure levels should be continued with health screenings in the school setting. The presence of AN without an elevated calculated BMI value, and elevated BMI-for-age percentile or elevated diastolic/systolic blood pressure category should be a situation for continued observation and monitoring. Adding additional risk factors, such as a family history of diabetes, poor dietary habits and inactive life style, will greatly strengthen the medical referral process from school health screenings.

An important element of all public health programs is the evaluation process. Currently, an evaluation of the AN screenings programs in school settings is lacking. An ongoing evaluation of nurses performing the AN school screenings is also missing from the current program. Screenings are effective in identifying individuals at risk of development of disease (ADA, 2005). Texas law mandates that all third, fifth and eighth grade students be screened for acanthosis nigricans, in specified Education Service Centers (House Bill 2721). Lacking an evaluation component with current AN protocol, screening for AN potentially becomes ineffective.

Currently, two bills are pending in the Texas Senate that may potentially change the current AN screening program in Texas. Senate Bill 467 was presented to the Texas Senate on February 11, 2005, during the 79^{th} session of Texas Legislature by Lucio and Hinojosa (SB 467). The bill allows for the continuation and expansion of the current AN screening program in Texas schools. The proposed name of the updated screening program is Risk Assessment for Type 2 Diabetes. The University of Texas at Pan America will have the authorization to include private schools, in addition to including all Education Service Centers, in Texas for screening. The proposed protocol is amended. The initial step of screening will be the calculation of BMI for every student (SB467). BMI-for-age percentiles will be determined for each student. All students with a BMI-for-age percentile greater than or equal to the 95^{th} percentile with two additional risk factors will have a risk assessment for T2DM performed (SB467). Under the proposed plan, the University of Texas at Pan America will be required to notify physicians in Texas about the new program. SB 467 proposes a student's type 2 diabetes risk assessment be transferred to any new school the student may attend, without parent approval. Under the proposed SB 467, certified screeners are instructed to help the individual or family receive evaluation and intervention by the school district or by a physician or health care provider. There are no funds attached with SB 467, to cover the financial costs of implementation of the program.

Senate Bill 545 was presented to the Texas Senate on February 28, 2005, during the 79^{th} session of Texas Legislature by Madla (SB 545). This legislation creates a Type 2 Diabetes Screening Program Advisory Council and establishes a T2DM screening program for school children. This proposed bill moves the management of the program from the University of Texas Pan America to the Department of Health Services in Texas. As with SB 467, the screening of students will begin with the calculation of BMI and the BMI-for-age percentile. School districts will have the opportunity to consult with University of Texas Pan America or they may opt to utilize additional higher authorities, such as the Texas Diabetes Council or Texas Tech Diabetes Research Center. A significant addition to SB 545 is the requirement of tracking of screening results. SB 545 suggests the use of EpiInfo, available through the CDC, as an epidemiological mapping program. Both of these proposed bills are currently in the Education committee of the Texas Senate, 79th session.

With the current AN screening program, parents are required to be notified when their student is screened positively for AN. In Richardson ISD, AN screeners attempt to contact families of every student that screened positively for AN by phone. Following the phone contact, a letter is mailed to the parent/guardian of every student with AN, explaining the screening results and encouraging the family to obtain additional medical evaluation by their health care provider. Families that are unable to be contacted by phone receive the mailed letter, explaining the screening results and encouraging additional medical evaluation by their health care provider. Families are encouraged to contact their school nurse for additional information. There are no required mandates to follow up or track students with positive AN screenings in the current program. Students are not tracked or identified to enable repeat screenings.

Adding calculated BMI values, BMI-for-age percentiles and diastolic/systolic blood pressure categories to the current AN screening program, the screening and recommended evaluation process becomes potentially more effective. Expanding the limited requirement of parent notification on every positive AN screening to include elevated BMI values, elevated BMI-for-age percentiles and diastolic/systolic blood pressure categories > 95th percentile allows families to be informed of potential health risks before the development of acanthosis nigricans.

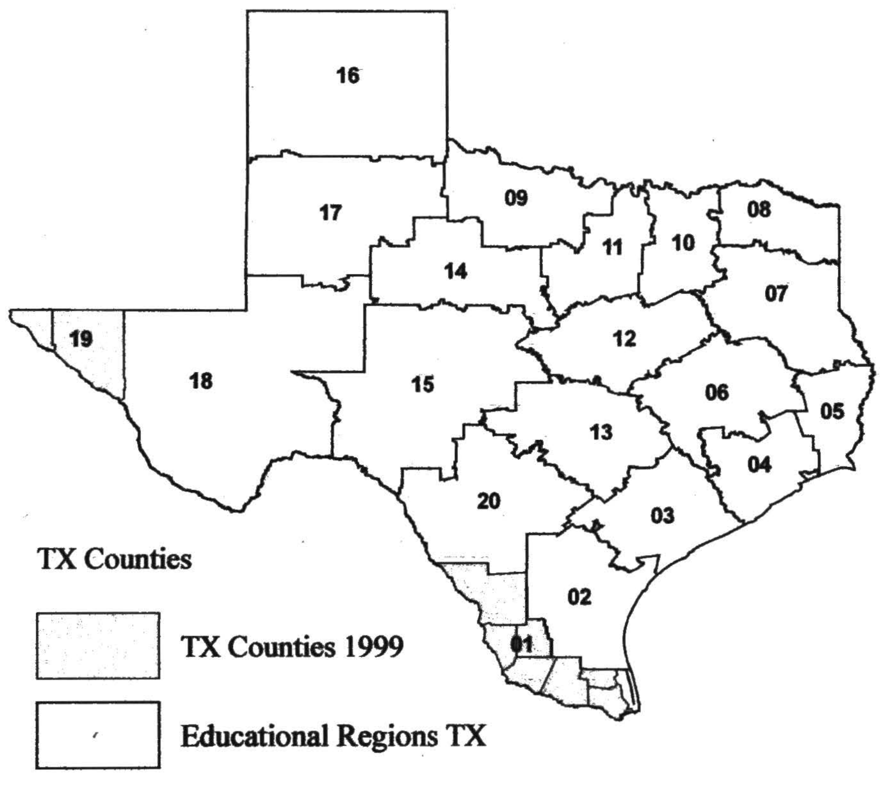
With the absence of T2DM from the reportable diseases in Texas, it continues to be difficult to obtain sufficient data to determine actual prevalence of T2DM in our adolescent population. The fact that T2DM can go undetected for years in many cases it becomes ever more concerning to develop adequate screening programs to identify adolescents at risk of development of disease. Expanding the current AN screening program in Texas to include BMI-for-age percentiles and diastolic/systolic blood pressure categories would identify additional students at risk of development of T2DM and other health conditions, especially those related to overweight.

In an ideal situation, parent notification is only the first step. Information on suggested dietary changes and physical activity changes should be included. Developing a combined effort with family and school towards achieving optimal health status for all students is an optimal goal. Current modification of food choices in school lunch programs and limiting the availability of candy and soft drinks is a great start. Incorporating health-smart choices in all educational programs of our schools would provide a much needed extension to the current health education for students (United States Department of Agriculture [USDA], 2005). When health-smart concepts are integrated into all areas in the lives of our students, such as dietary choices, physical activity programs, academic education, family involvement, and community activities and programs, our students are the beneficiaries and become winners (USDA, 2005). Acknowledging the many serious and long-term health complications associated with unhealthy life choices early in life, it is critical to improve, strengthen, and expand the screening and medical referral/evaluations of our children.

APPENDIX A

MANDATED ACANTHOSIS NIGRICANS SCREENING AREAS IN TEXAS

FOR 1999 BY EDUCATION SERVCICE CENTERS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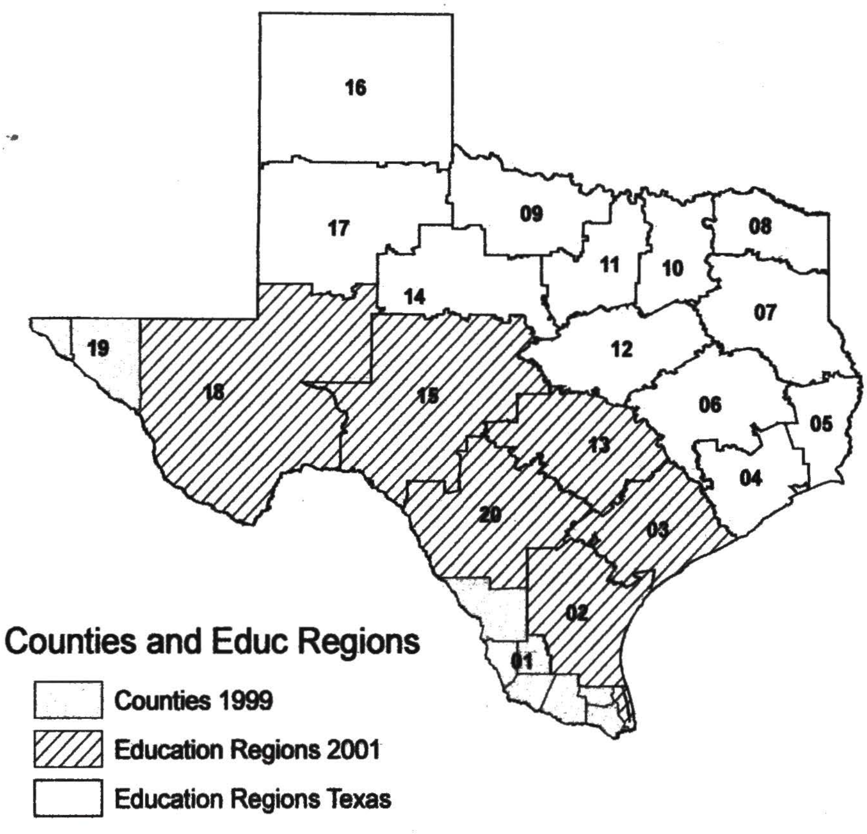
TX Counties
TX Counties 1999
Educational Regions TX

APPENDIX B

MANDATED ACANTHOSIS NIGRICANS SCREENING AREAS IN TEXAS FOR 2001 BY EDUCATION SERVICE CENTERS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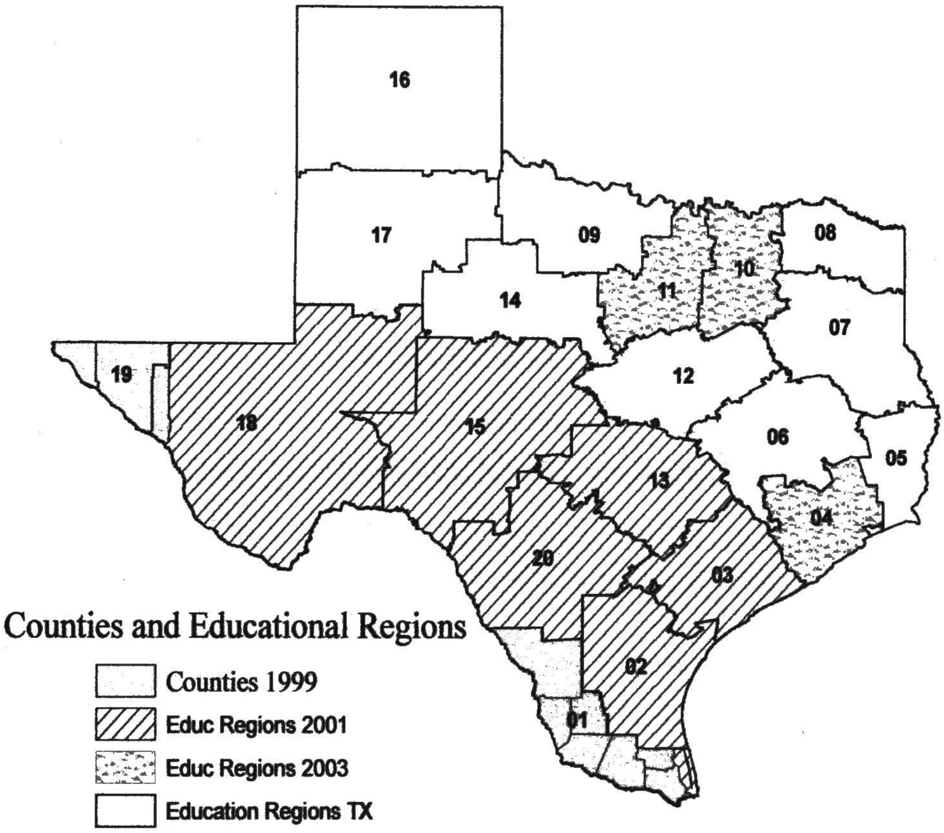
Counties and Educ Regions
Counties 1999
Education Regions 2001
Education Regions Texas

APPENDIX C

MANDATED ACANTHOSIS NIGRICANS SCREENING AREAS IN TEXAS FOR 2003 BY EDUCATION SERVICES CENTERS


Counties and Educational Regions
Counties 1999
Educ Regions 2001
Educ Regions 2003
Education Regions TX
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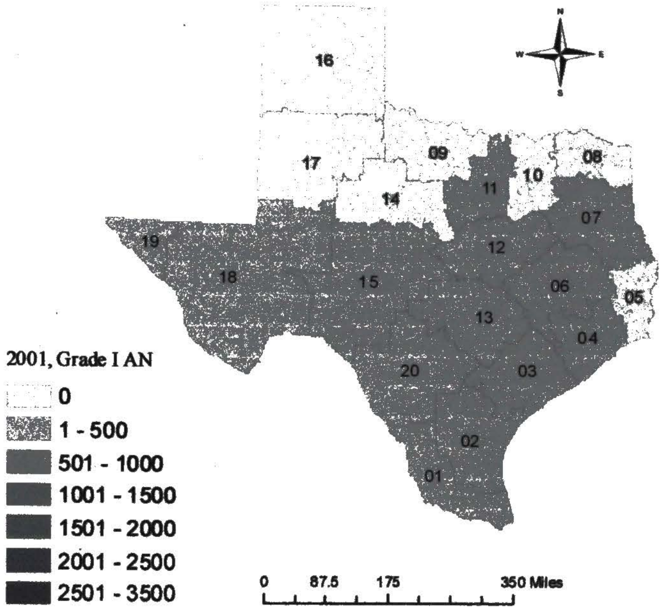
APPENDIX D

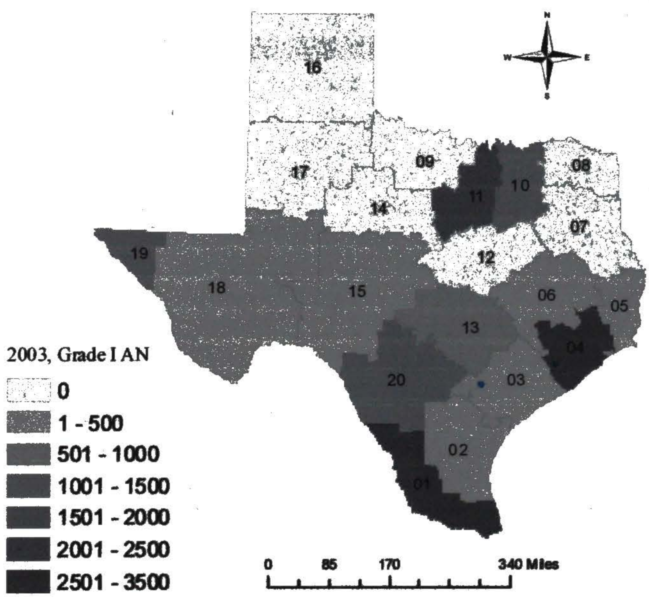
CASES OF ACANTHOSIS NIGRICANS GRADE 1,

BY TEXAS EDUCATION SERVICE CENTERS FOR 2001 AND 2003

Grade I AN Cases, 2001



Grade I AN Cases, 2003

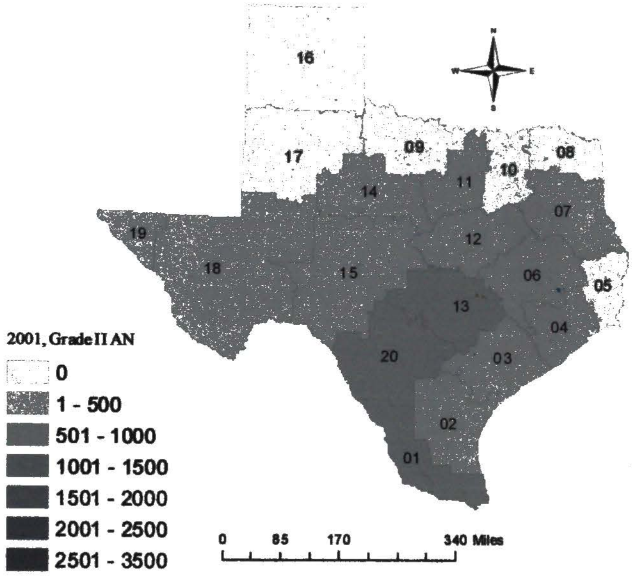


APPENDIX E

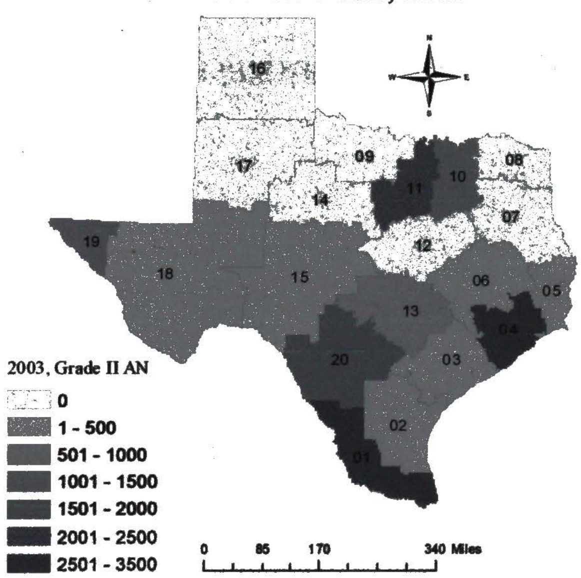
CASES OF ACANTHOSIS NIGRICANS GRADE II,

BY TEXAS EDUCATION SERVICE CENTERS FOR 2001 AND 2003

Grade II AN Cases, 2001



Grade II AN Cases, 2003

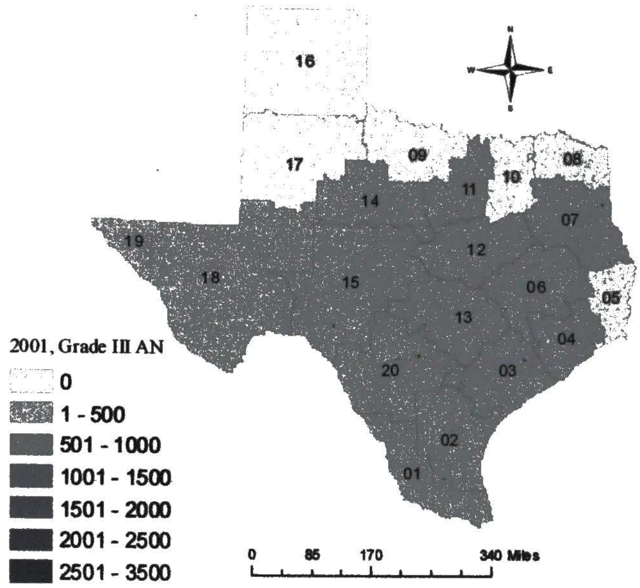


APPENDIX F

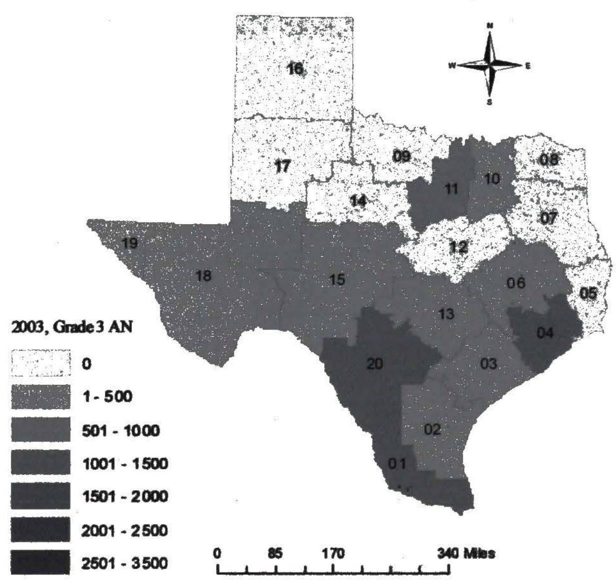
CASES OF ACANTHOSIS NIGRICANS GRADE III

BY TEXAS EDUCATION SERVICE CENTERS FOR 2001 AND 2003

Grade III AN Cases, 2001



Grade III AN Cases, 2003

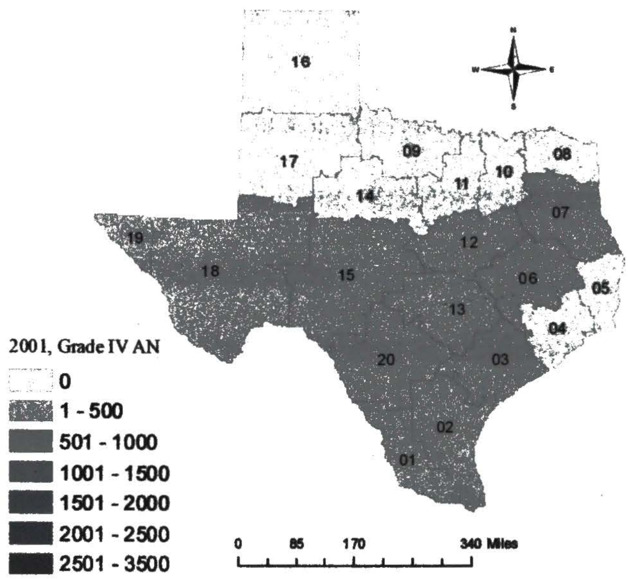


APPENDIX G

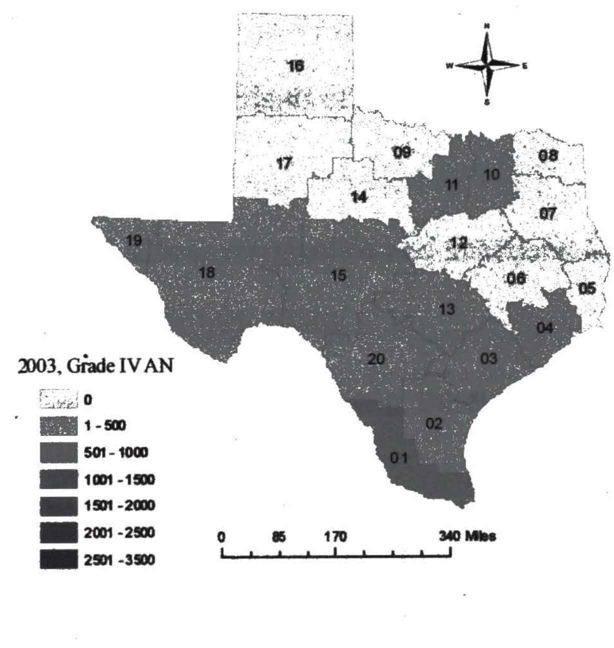
CASES OF ACANTHOSIS NIGRICANS GRADE IV

BY TEXAS EDUCATION SERVICE CENTERS FOR 2001 AND 2003

Grade IV AN Cases, 2001



Grade IV AN Cases, 2003



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