THESIS

EVALUATION OF A SCHOOL-BASED DIABETES EDUCATION INTERVENTION, AN EXTENSION OF PROGRAM ENERGY

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ABSTRACT

EVALUATION OF A SCHOOL-BASED DIABETES EDUCATION INTERVENTION, AN EXTENSION OF PROGRAM ENERGY

Background: The prevalence of both obesity and type 2 diabetes in the United States has increased over the past two decades and rates remain high. The latest data from the National Center for Health Statistics estimates that 36% of adults and 17% of children and adolescents in the US are obese (CDC Adult Obesity, CDC Childhood Obesity). Being overweight or obese greatly increases one's risk of developing several chronic diseases, such as type 2 diabetes. Approximately 8% of adults in the US have diabetes, type 2 diabetes accounts for 90-95% of these cases. Type 2 diabetes in children and adolescents is still rare, however clinical reports suggest an increase in the frequency of diagnosis (CDC Diabetes Fact Sheet, 2011). Results from the Diabetes Prevention Program show that the incidence of type 2 diabetes can be reduced through the adoption of a healthier lifestyle among high-risk individuals (DPP, 2002).

Objectives**:** This classroom-based intervention included scientific coverage of energy balance, diabetes, diabetes prevention strategies, and diabetes management. Coverage of diabetes management topics were included in lesson content to further the students' understanding of the disease. Measurable short-term goals of the intervention included increases in: general diabetes knowledge, diabetes management knowledge, and awareness of type 2 diabetes prevention strategies.

Methods: A total of 66 sixth grade students at Tavelli Elementary School in Fort Collins, CO completed the intervention. The program consisted of nine classroom-based lessons; students participated in one lesson every two weeks. The lessons were delivered from November of 2005

to May of 2006. Each bi-weekly lesson included a presentation and interactive group activities. Participants completed two diabetes knowledge questionnaires at baseline and post intervention. A diabetes survey developed by Program ENERGY measured general diabetes knowledge and awareness of type 2 diabetes prevention strategies. The second questionnaire, adapted from a survey developed for the Starr County Diabetes Education Study (Garcia et al, 2001), measured general diabetes and diabetes management knowledge. A comparison group, a total of 19 students, also completed both surveys during the study period.

Results: Significant increases ($p<0.05$) were seen in the post-intervention study group in general diabetes knowledge, diabetes management knowledge, and awareness of diabetes prevention strategies, when compared to the baseline study group and comparison group.

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LITERATURE REVIEW

Prevalence of Obesity

The prevalence of overweight and obesity in the United States has increased dramatically over the past few decades. In fact, in 2001, the US Surgeon General used the term "epidemic" to describe the rapid rise seen in US obesity rates. Overweight and obesity were referred to as one of the most important new health challenges facing the nation in the *Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity* (2001). Since 2001, obesity rates among US adults have continued to climb upward. Prior to listing statistics, the terms overweight and obesity need to be defined. Overweight is operationally defined as a body mass index (BMI), a measure of body weight relative to height, of greater than or equal to 25 kg/m^2 and less than 30 kg/m^2. Obesity is operationally defined as a BMI of 30 kg/m^2 or above (CDC Adult Obesity). Estimates from the National Health and Nutrition Examination Survey (NHANES) III data, 1988-1994, indicated that 56% of adults in the US were overweight or obese. Approximately a decade later, NHANES data from 2003-2004 estimated that the percentage of overweight or obese adults in the US had risen to 66%. During this same time period the prevalence of obesity among US adults rose from 23% to 32% (CDC Health E-Stat). The latest data from the National Center for Health Statistics estimates that 36% of adults in the US are obese (CDC Adult Obesity). This means that currently, more than one out of every three adults in the US is classified as obese.

Obesity prevalence rates among US children and adolescents have reached a plateau recently, however rates remain high. Obesity among children and adolescents is currently defined as a BMI at or above the 95^{th} percentile of the sex-specific CDC BMI-for-age growth

charts (CDC Childhood Obesity). Between NHANES 1988-1994 data and 2003-2004 data, the obesity rate among US youth increased from 7 to 14% among 2-5 year olds, 11 to 19% among 6 to 11 year olds, and 11 to 17% among adolescents. Overall, results from the 2003-2004 NHANES estimated that 17% of youth ages 2-19 were obese, youth obesity rates have remained stable since that time (CDC Health E-Stat, CDC Childhood Obesity). The high rates of obesity among youth is a serious issue because of the strong relationship between childhood and adult obesity. It is estimated that one-third of obese preschoolers and greater than one-half of obese grade school children will become obese adults (Whitaker et al, 1997).

Prevalence of Diabetes

Being overweight or obese at any age increases the risk of developing several chronic conditions. These conditions include cardiovascular disease, several types of cancer, osteoarthritis, sleep apnea, stroke, and type 2 diabetes (Friedman and Fanning, 2004: Must et al, 1999). Not surprisingly then, paralleling the increase in obesity rates seen in the US is an increase in the prevalence of diabetes. Prevalence of diabetes in US adults aged 18 to 79 remained fairly constant from 1980 to 1990. Since 1990 however, the prevalence of diabetes has risen steadily (CDC Diabetes Report Card, 2012). NHANES 2005-2008 data estimated that 11.3%, or 25.6 million Americans 20 years and older have diabetes. Additionally, data from 2005-2008 estimated that 35% of US adults, or 79 million Americans had prediabetes, or impaired glucose homeostasis. Prediabetes increases an individual's risk of developing type 2 diabetes in the future. An individual is identified as having prediabetes if their blood glucose or hemoglobin A1c concentration are elevated above normal, but not high enough to be diagnosed as diabetes. (CDC Diabetes Fact Sheet, 2011). Diabetes is diagnosed when an individual has a fasting plasma glucose of greater than or equal to 126mg/dL, a plasma glucose of greater than or

equal to 200 mg/dL two hours after a 75 gram oral glucose tolerance test, or a random plasma glucose of greater than or equal to 200 mg/dL in an individual experiencing symptoms of hyperglycemia. Additionally, a hemoglobin A1c concentration of 6.5% or higher can be used to diagnose diabetes. A classification of prediabetes is made when an individual has a fasting plasma glucose of 100 mg/dL to 125 mg/dL, a plasma glucose level of 140 mg/dL to 199 mg/dL two hours after a 75 gram oral glucose tolerance test, or a hemoglobin A1c concentration of 5.7% to 6.4% (ADA Standards of Medical Care, 2014). If current trends continue, it is predicted that one out of every three adults in the US could have diabetes by 2050 (Boyle et al, 2010).

Diabetes is a group of diseases characterized by elevated blood glucose levels due to defects in insulin production, insulin action, or both. Type 1 diabetes is an autoimmune disease that develops when an individual's immune system destroys pancreatic beta cells. Beta cells are responsible for the production of the hormone insulin, this hormone regulates blood glucose levels. Disease onset can occur at any age, however type 1 diabetes is typically diagnosed in youth or young adulthood. People with type 1 diabetes must have insulin delivered by injection or insulin pump to survive. Currently, there is no known way to prevent this form of diabetes. Type 1 diabetes accounts for approximately 5% of all diabetes cases in the US. Type 2 diabetes accounts for 90 to 95% of all diabetes cases in the US (CDC Diabetes Fact Sheet, 2011). Type 2 diabetes develops due to insulin resistance, a condition in which the body's cells do not use insulin properly. Initially, as insulin resistance develops, due to compensatory increased production of insulin by the pancreatic beta cells, blood glucose concentrations are maintained within a normal range. However, as the need for insulin rises, the beta cells can gradually lose the ability to produce insulin and consequently the blood glucose concentrations rise. People with type 2 diabetes can often manage their disease by eating a healthy diet, increasing physical

activity, and by taking oral medications. Insulin injections are needed to manage type 2 diabetes in some individuals.

The prevalence rate of diabetes rises with age. The prevalence of diabetes is about seven times higher for adults aged 65 years and older, when compared to those aged 20 to 44 years (CDC Diabetes Report Card, 2012). The prevalence of diabetes is also higher among most minority populations. After adjusting for population age differences 7.1% of whites, 8.4% of Asian Americans, 11.8% of Hispanics, and 12.6% of blacks aged 20 and older were diagnosed with diabetes, based on estimates from 2007 to 2009 national survey data. Indian Health Service (HIS) data from 2009 estimates that 16.1% of Native Americans and Native Alaskans aged 20 and older who received care from IHS had diagnosed diabetes. Prevalence rates among Native Americans ranged from 5.5% among Alaska Native adults to 33.5% among American Indian adults in southern Arizona (CDC Diabetes Fact Sheet, 2011).

Diabetes in Youth

Type 2 diabetes was formerly known as adult-onset diabetes. During the last few decades however, limited epidemiologic evidence and clinical reports suggests that type 2 diabetes in youth is increasing in frequency (CDC SEARCH; Fagot-Campagna et al, 2001; Neufeld et al, 1998; Rosenbloom et al, 1999). Type 2 diabetes is rare among children less than 10 years of age. Among youth aged 10 to 19, type 2 diabetes is still rare, however higher rates are seen in many minority populations. From 2002 to 2005, 15,600 youth were newly diagnosed with type 1 diabetes annually and 3,600 new cases of type 2 diabetes in youth were diagnosed annually. Type 1 diabetes incidence was greater than the incidence of type 2 diabetes in white youth aged 10-19. Newly diagnosed cases of type 2 diabetes outnumbered new cases of type 1 diabetes in Asian/ Pacific Islander and Native American youth aged 10-19. In Black and

Hispanic youth, aged 10-19, incidence rates of type 1 and 2 diabetes were similar. Data from 2010 estimated that 215,000 people younger than 20 in the US had type 1 or 2 diabetes. (CDC Diabetes Fact Sheet, 2011).

Complications of Diabetes

Diabetes increases risk of cardiovascular disease, stroke, blindness, kidney disease, neuropathy, and lower limb amputations. If a person with diabetes can effectively manage their blood glucose by keeping their hemoglobin A1c to near normal levels and manage their blood pressure, many diabetes-related complications can be prevented of delayed. Unfortunately though, diabetes was still the seventh leading cause of death based on U.S. death certificates in 2007. Adults with diabetes have death rates due to cardiovascular disease that are 2 to 4 times higher than adults without diabetes. Diabetes is the leading cause of new cases of blindness among adults less than 75 years of age. Diabetes is also the leading cause of kidney failure among US adults (CDC Diabetes Fact Sheet, 2011). Type 2 diabetes diagnosed in childhood or adolescence places the individual at great risk of diabetes-related complications at a young age, likely during the most economically productive years of life (Bloomgarden, 2004; Botero and Wolfsdorf, 2005).

Economic Burden of Diabetes

Diabetes places an economic burden on each diagnosed individual. Additionally, the increasing prevalence of diabetes in the US is placing an enormous economic burden on our nation's healthcare system. Medical expenditures among people with diabetes were 2.3 times higher than they would have been in the absence of diabetes. In 2007, direct medical costs due to diabetes were estimated to be $116 billion. Indirect costs such as disability, work loss, and premature mortality were estimated at $58 billion in the US (CDC Diabetes Fact Sheet, 2011).

Type 2 Diabetes Risk Factors

The aging of the US population, shifts in racial demographics, and the fact that people with diabetes are living longer due to improvements in diabetes management can account for a small portion of the increases seen in diabetes prevalence rates. As discussed previously, risk factors for the development of type 2 diabetes include obesity, prediabetes, older age, and can include race/ethnicity. Family history of type 2 diabetes and history of gestational diabetes, or glucose intolerance during pregnancy, are additional risk factor for type 2 diabetes (CDC Basics About Diabetes; CDC Diabetes Fact Sheet, 2011). Genetic susceptibility does play an important role in the occurrence of type 2 diabetes. The same gene abnormalities are likely involved in type 2 diabetes in both youth and adults (Bloomgarden, 2004; Rosenbloom et al, 1999). Changes in the human gene pool occur slowly however. The rapid and substantial increases currently seen in type 2 diabetes prevalence rates are likely due to changes in lifestyle. Physical inactivity and obesity are strong risk factors for the development of type 2 diabetes (ADA, 2002; Klein et al, 2004; Must et al, 1999). The risk of developing type 2 diabetes increases with increasing levels of BMI above 25.0 kg/m^2. An individual's risk of developing type 2 diabetes also increases with the duration of overweight and obesity (Wannamethee and Shaper, 1999). Obesity and physical inactivity are modifiable risk factors, an individual through lifestyle change can influence them. Obesity and physical inactivity should therefore be the target of public health type 2 diabetes prevention strategies. One study determined that preventing a population of middle-aged Mexican Americans and whites from increasing one BMI unit, would result in a 12.4% and 13.0% decrease in the incidence of type 2 diabetes among Mexican Americans and whites, respectively (Burke et al, 2003). Obesity is a complex problem likely caused by many factors, including genetics, behavior, and environment. For example, it has been hypothesized

that some people have a "thrifty genotype," that they have been preprogrammed to store calories in times of plenty. It is thought that these thrifty genes may have assisted our ancestors survive times of famine, and therefore multiplied (Neel, 1999). It is believed that these genes may make some individuals more susceptible to our modern obesity-conducive environment (CDC Genomics and Health). Regardless of the factors involved, obesity is due to a chronic energy imbalance that occurs when an individual's caloric intake is greater than their caloric expenditure (CDC Adult Obesity, CDC Childhood Obesity).

Prevention of Type 2 Diabetes

Type 2 diabetes can be prevented or at least delayed, therefore reducing the risk of diabetes-related complications, in the majority of cases. The Diabetes Prevention Program Research Group conducted a clinical trial that showed the incidence of type 2 diabetes can be reduced, even among individuals with prediabetes, by a reduction in body weight and increasing physical activity. Subjects in the trial were not diagnosed with diabetes, however all had elevated fasting blood glucose and impaired glucose tolerance. Subjects were assigned to one of three groups: placebo, metformin, or lifestyle-modification group. Metformin is an oral medication used in the treatment of type 2 diabetes. Subjects in the metformin group were instructed to take metformin (850mg) twice daily and to follow "standard" lifestyle recommendations. Lifestyle recommendations were given in written materials and 20-30 minute annual education sessions. Subjects in this group were encouraged to follow the Food Guide Pyramid, to reduce their weight, and to increase their physical activity. Subjects in the lifestyle-modification group were given the goal of at least a 7% initial body weight reduction and maintenance and to participate in 150 minutes or more of moderate physical activity per week. Subjects in this group received a 16-lesson curriculum covering a healthful diet and physical

activity to help them achieve these goals. Fifty percent of the lifestyle group were able to obtain a 7% reduction in body weight, 38% were able to maintain that weight loss. The goal of 150 min of weekly physical activity was obtained by 74% of the lifestyle group, 58% of the group was able to maintain this level of activity throughout the study period. At the end of the study the lifestyle-modification intervention reduced the incidence of type 2 diabetes by 58%, and the metformin intervention decreased the incidence by 31% relative to the placebo group (DPP, 2002).

What are the behavioral and environmental factors contributing to the increasing rates of obesity and type 2 diabetes in the US? More specifically, what are the behavioral and environmental factors that are contributing to the high rates of obesity and increasing cases of type 2 diabetes in youth? Increasing portion sizes, the availability and intake of energy-dense foods and sugary drinks, the easy access and convenience of fast-food restaurants, limited access to healthy affordable foods in some communities, and advertising of less healthy foods targeted at youth have all been identified as contributors to increasing energy intake. Lack of safe places to play and exercise in some communities, decreased levels of active forms of transportation, lack of daily physical activity in all schools, and increasing use of television and media have been identified as factors contributing to decreases in energy expenditure among youth (CDC Childhood Obesity; Dehghan, Akhtar-Danesh, and Merchant, 2005).

School-Based Type 2 Diabetes Prevention Programs

Weight loss in adulthood, after overweight or obesity have become established, is difficult. Therefore, the prevention or treatment of overweight or obesity in youth is crucial. Schools provide a natural setting for obesity prevention programs (Dehghan, Akhtar-Danesh, Merchant, 2005). School-based obesity prevention programs that target children, versus

adolescents, appear to be more successful in the prevention and reduction of obesity (Story, 1999) In The *Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity 2001*, schools were identified as a key setting for public health strategies targeted at decreasing obesity rates among youth, for a number of reasons. Most children spend a large amount of each weekday in school. Students are taught about health topics in science and health classes, the importance of physical activity can be reinforced in physical education classes, and school lunch programs can be used to modify the food environment of youth and reinforce healthy eating patterns. Therefore, schools provide an ideal setting to directly address the increasing rates of obesity and type 2 diabetes in youth (Surgeon General's Call To Action, 2001).

Prior to the development and delivery of this school-based diabetes education intervention (developed in 2005, delivered in 2005 - 2006), previous interventions that were targeted at type 2 diabetes prevention were reviewed. A review article by Satterfield et al in 2003, identified 16 published (from 1990 – 2001) community-based interventions that were specifically designed to prevent or delay type 2 diabetes. Three out of the 16 interventions were targeted at youth, were completely or partially school-based, and had published results. Following is a brief review of these three interventions. Two additional school-based interventions that published results after the review article are also discussed. In general, all targeted high-risk populations, Native American or Hispanic, and none of the studies included a control group.

The Zuni Diabetes Prevention Program was a community-based intervention targeted at high-school aged adolescents. The intervention took place in two high schools, over a four year period on the Zuni Pueblo Reservation, New Mexico. The primary goal of the program was to

reduce the prevalence of diabetes risk factors. Secondary goals of the program were to increase diabetes knowledge, increase physical activity, increase fruit and vegetable intake, and reduce soft drink consumption. Measures reported were taken at baseline and mid-project (2 years after baseline), 119 subjects were evaluated at baseline and 173 subjects were evaluated at the midpoint. Measures included BMI, glucose tolerance test, 24 hour dietary recalls, and a questionnaire. The intervention included integration of diabetes education into the school curriculum, development of a school-based wellness center, and modification of the school food supply. At the midpoint, significant results were seen in soft drink consumption (80% to <50% of total beverage intake) and glucose-insulin ratios, fasting and 30-minute postprandial (Teufel and Ritenbaugh, 1998).

The Bienestar Health Program was developed for 4th grade Mexican-American children in San Antonio, Texas. The goal of the program was to decrease risk factors for type 2 diabetes, primarily overweight and intake of dietary fats. Secondary goals included increases in fruit and vegetable intake, health knowledge, self-efficacy, self-esteem, and activity levels. Results from this 2 year study were reported from baseline and 9 months post baseline for 102 students from two elementary schools. Measures included BMI, 24 hour dietary recalls, and a questionnaire. The intervention consisted of classroom-based curriculum designed to supplement existing health curriculum, a school cafeteria component, an after-school physical activity component, and parent health education. Significant increases in diabetes health knowledge were seen (44.6 to 62.5, scale 0-100). Significant changes to behavior were also observed: decreased intake of dietary fat (7.40 to 5.53 daily servings) and increased intake of fruits and vegetables (2.5 to 3.1 daily servings) (Trevino et al, 1998).

Jump Into Action, was a school-based non-insulin dependent diabetes mellitus (type 2 diabetes) prevention program developed for 5th graders. The intervention took place in 14 elementary schools in Webb County, Texas. Webb County lies on the US and Mexican border and has a primarily, 94%, Hispanic population. The goal of the program was to increase students' knowledge, self-efficacy, and behaviors regarding type 2 diabetes prevention. Increasing intake of low-fat foods, increasing physical activity levels, and decreasing obesity were targeted as type 2 diabetes prevention strategies. Pre and post tests that measured knowledge of diabetes, foods, exercise, exercise self-efficacy, and related behaviors were completed by 835 students. The intervention integrated program objectives into existing reading, writing, math, science, and physical education curriculum. Significant increases were seen in knowledge and self-efficacy concerning type 2 diabetes prevention. Significant diet and exercise related behaviors were also observed (Holcomb et al, 1998).

A small pilot diabetes education program developed by Frencher et al, was targeted at 6th grade students in an inner-city school in Bronx, New York. The school population was primarily Hispanic (57%) and black (27%). The intervention integrated nutrition, physical activity, and obesity topics into standardized mathematics curriculum. Two mathematic modules were developed, a food label module and burning calories module. A total of 32 students completed and evaluated the food label module. Ninety-seven percent of the students reported that the module was helpful in seeing the applicability of math in daily life, 50% reported that they would likely read food labels when picking foods, and 50% indicated that the module motivated them for dietary change. A total of 11 students completed and evaluated the burning calories module. Seventy-three percent of the students reported that the module was more enjoyable than their traditional math class, 91% indicated a better understanding of energy expenditure, and

64% reported that they were motivated to increase their physical activity levels (Frencher et al, 2003).

The Sandy Lake school-based diabetes prevention program was developed for 3rd, 4th, and 5th grade elementary school students and their parents. Sandy Lake is a Native North American reserve in northern Canada that has exceptionally high rates of both obesity and type 2 diabetes. The goal of the program was to increase the students' knowledge, skills, and self-efficacy, and to have a positive impact on behavior towards diet and physical activity. The study had a single-sample design with pre and post tests that included anthropometric measures, 24 hour dietary recalls, and two questionnaires. The intervention occurred over the course of one school year and included four culturally appropriate components: curriculum, family, peer, and environmental components were all included in the intervention. The curriculum component focused on knowledge and skill development concerning healthy eating, physical activity, and diabetes education. The curriculum was delivered in 16, weekly, 45-minute lessons. Significant increases were seen in dietary fat knowledge (5.3 to 7.1, range 0-10), dietary intent (3.5 to 4.2, range 0-6), dietary preference (2.5 to 3.2, range 0-6), dietary self-efficacy (17.9 to 19.6, range 0-27), and curriculum knowledge (2.9 to 4.5, range 0-8), all $p<0.001$ (Saksvig et al, 2005).

Another school-based program targeting obesity and diabetes in elementary school children was Program ENERGY (Education, Nutrition, Exercise, and Recreation for Growing Youth). This program was a science and health enrichment program designed for kindergarten through sixth grade students. The objective of Program ENERGY was to reduce the rate of obesity and type 2 diabetes in elementary school students by teaching and reinforcing healthful behavior choices through science education enrichment. Program ENERGY, which was funded by the National Institutes of Health and Science Education Partnership Award, began during the

2001-2002 school year at Putnam Elementary School of Science in Fort Collins, Colorado. Dr. Arthur Campfield, Professor at Colorado State University, was the principal investigator for Program ENERGY. Putnam Elementary school was selected due to its high percentage of Hispanic-American students, the large number of its students eligible for free or reduced school meals, and its need for additional science and math curriculum. Harris Bilingual Immersion School in Fort Collins, Colorado served as a matched control. Beginning with the 2005-2006 school year, Program ENERGY relocated to Tavelli Elementary School in Fort Collins, Colorado. Wellness is a major focus of Tavelli Elementary School; goals of the school include increasing the fitness level and healthy food choices of their students.

Program ENERGY was developed using components of the Theory of Reasoned Action and the Social Cognitive Theory. The Theory of Reasoned Action provides a framework for understanding an individual's behavioral intent. Behavioral intent is a function of an individual's attitude toward a behavior and the individual's perception of the social norm regarding that behavior. While the Social Cognitive Theory states that an individual's actions are determined by their knowledge, perceived self-efficacy, outcome expectations, and goals regarding that behavior (Bandura, 2004). In line with these behavior change theories, Program ENERGY was designed with the goal of increasing students' knowledge regarding obesity and type 2 diabetes. The intervention also sought to increase the students' self-efficacy through hands-on activities, providing the students' with confidence that their actions could successfully result in a desired behavior change.

An inquiry-based learning approach was utilized during Program ENERGY lessons. Four main areas of biological science were emphasized in Program ENERGY, including: health/biomedical science, human nutrition, physical activity, and science museum/outreach.

Program ENERGY included weekly classroom (60 minutes) lessons and weekly physical activity (30-40 minutes) lessons lead by Colorado State University graduate and undergraduate students, as well as a bi-monthly cooking component. The cooking component was led by a chef and Registered Dietitian from Johnson's and Wales University in Denver, Colorado, who provide snack preparation lessons to the students.

Program ENERGY was successful in significantly increasing health and science knowledge, attitudes, and healthful behaviors of the elementary school students enrolled in the intervention when compared to the control students. The program received positive evaluations from the children and educators, and increased interest in science and health-related careers by the students involved in the intervention.

Project Goal and Hypothesis

The goal of this thesis project was to develop a stand-alone, classroom-based type 2 diabetes education intervention, targeted at sixth grade elementary school students. Diabetes content from existing Program ENERGY curriculum was included and expanded upon. We hypothesized that the short-term measurable outcomes of this classroom-based diabetes education intervention would be an increase in: general diabetes knowledge, diabetes management knowledge, and awareness of type 2 diabetes prevention strategies.

METHODS

Intervention Development

This diabetes education intervention included scientific coverage of energy balance, diabetes, diabetes prevention strategies, and diabetes management. Experiences from a Program ENERGY lesson titled, Medical Doctor and Diabetes, led to the inclusion of disease management coverage in an intervention to promote diabetes prevention. Medical Doctor and Diabetes was delivered to the fourth and fifth grade classes at Putnam Elementary School of Science on January 12, 2005. During the lesson a medical doctor visited the classroom and assisted Program ENERGY staff and volunteers in educating the students about diabetes and its management. Over the course of the lesson the students actively explored the various tools (blood glucose monitors, insulin vials, syringes, insulin pumps) and techniques (including the injection of an orange) that someone with diabetes must use to self-manage their disease. Additionally, the students actively explored tools and techniques commonly used by doctors during a visit to the doctor's office. Student evaluations of the lesson were high.

The inclusion of diabetes management topics brought diabetes out of the abstract and into something real that helped the students understand what the disease is. The hands-on activities were well liked and the student feedback provides evidence of a memorable experience that may help the students remember what diabetes is into the future. Topics covered during the Medical Doctor and Diabetes lesson were expanded upon in this intervention. The role of medication, nutrition, and exercise in the management of diabetes were all included in the intervention lesson content. Due to the advanced scientific concepts covered, sixth grade classes were chosen for the study population.

The study protocol and all of its procedures, inclusion and exclusion criteria, consent forms, assent forms, and surveys were reviewed and approved by the Human Research Committee of Colorado State University. In accordance with protocol, informed consent was obtained from all parents/legal guardians and informed assent was obtained from all sixth grade students involved in the study. A letter of explanation and an advertisement flyer were sent home in conjunction with the consent/assent forms in order to provide the participants with a thorough explanation of the study's design, goal, and methods (Appendix A).

Study and Comparison Populations

The subjects of this intervention were sixth grade students between the ages of 11 and 13, from Tavelli Elementary School, in Fort Collins, Colorado. In the fall of 2005, 75% of the students enrolled in sixth grade at Tavelli Elementary School were Caucasian, 23% were Hispanic, and 2% were from other ethnic backgrounds (Colorado Department of Education, 2005). A total of 88 students in four sixth grade classes received the intervention lessons. Approved consent forms and cover letters regarding the details of the study were sent home with the students and were to be given to their parents. A total of 66 students obtained parental consent and also personally agreed to be included in the study population.

A comparison group was included in the design of this study. Sixth grade students from one classroom at Bennett Elementary School in Fort Collins, Colorado were utilized as a comparison group. In the fall of 2005, the sixth grade students at Bennett Elementary School were: 88% Caucasian, 8% Hispanic, and 4% were from other ethnic backgrounds (Colorado Department of Education, 2005). A total of 19 students obtained parental consent and also agreed to be included in the comparison population.

Intervention

The intervention consisted of a nine lesson series. The lessons were titled, Energy Balance, Introduction to Diabetes, Discovery of Insulin, Tools of Diabetes Management, Nutrition and Diabetes, Exercise and Diabetes, Body Image, Diabetes Prevention, and a review lesson (Table 1). An outline of each lesson can be reviewed in Appendix B. Two classrooms were taught per week, therefore the students received lessons bi-weekly. Lessons were presented during the last two hours of the school day. The intervention took place over a six month period of time, from November 2005 to May 2006.

Lessons were 55 minutes in length. Lessons content was primarily delivered by myself, however a few intervention lessons were delivered with the assistance of other Program ENERGY staff and graduate students. Lessons typically consisted of a short presentation, approximately ten minutes in length, followed by interactive group activities. Students worked in groups of four to five students, under the guidance of a Program ENERGY staff member or volunteer. Student groups were matched with the same Program ENERGY staff member or volunteer each week, whenever possible. Lessons typically ended with a short lesson summary presentation, approximately five minutes in length. Classroom teachers were present in the classroom during lessons to assist with discipline, if needed, but did not play an active role in lesson delivery.

Table 1. Intervention Lesson Titles and Corresponding Lesson Objectives

Lesson Title	Objective
Energy Balance	Energy balance equation
Introduction to Diabetes	Diabetes: types, terms, basic concepts
Discovery of Insulin	Insulin: what it is, discovery process
Tools of Diabetes Management	Glucose monitors, oral medications, insulin delivery
Nutrition and Diabetes	Nutrients, label reading, Plate Method
Exercise and Diabetes	The role of exercise in diabetes management and prevention
Body Image	Healthy at any body shape
Diabetes Prevention	3 "keys" to diabetes prevention
Review	Diabetes Jeopardy, snack

Measures

Two diabetes knowledge questionnaires were completed by the study group at baseline and post intervention. The baseline questionnaires were completed by two classes on November 3rd and by the second two classes on November 10th, 2005. Each class received their first intervention lesson two weeks later. Post intervention questionnaires were completed by each class two weeks after the final intervention lesson, on May 11th and 18th, 2006. Both diabetes knowledge questionnaires were also completed by a comparison group, at a single point in time during the intervention period, in January of 2006.

The short diabetes knowledge questionnaire included five "true" or "false" questions. Question #5 stated, "Diabetes can be prevented," if the student answered true it also asked them to fill in three lines with the ways diabetes can be prevented (Appendix C). This questionnaire was developed by Program ENERGY for use in previous Program ENERGY interventions. The questionnaire included one demographic question, "Do you have some member in your family that has diabetes (high blood sugar) OR tests the amount of sugar in their blood?" However, the

questionnaire was primarily designed to measure diabetes knowledge and awareness of diabetes prevention strategies.

The long diabetes knowledge questionnaire included 19 "yes," "no," or "I don't know" questions (Appendix C). The questionnaire was adapted from a 24 item questionnaire developed for the Starr County Diabetes Education Study. The 24 item questionnaire had a reliability coefficient of 0.78, indicating reliability. The questionnaire was also sensitive to the Starr County intervention, indicating validity (Garcia et. al., 2001). All 24 questions did not correspond to this intervention, five questions concerning the management of diabetes complications were removed. Use of this questionnaire was intended to measure general diabetes and diabetes management knowledge.

Lessons were evaluated by all students receiving the intervention lessons. Lesson evaluations were anonymous. The evaluations used a six category Likert scale. The evaluations listed the title of individual lessons and students were asked to circle their response beside each lesson title. Possible responses included: awesome, I liked a lot, I liked a little, OK, I didn't like much, I didn't like at all (Appendix D). The first evaluation, which covered the first four lessons, was given to students at the beginning of the fifth lesson in February of 2006. A second evaluation, covering lessons from the second half of the intervention, was given to the students in May of 2006. The second evaluation was completed by the students during the same time period as post intervention questionnaires.

Statistical Analysis

To insure confidentiality, the students were assigned a numerical code by an undergraduate nutrition student not directly involved in this research project. For all questionnaires given, student names were removed and replaced with their numerical code.

Scores for both diabetes knowledge questionnaires were computed by assigning one point for each correct response, zero was assigned for each incorrect, or blank, response and points were summed.

Data was analyzed using 2003 Microsoft Excel Analysis ToolPak. The study groups' pre and post questionnaires were analyzed for increases in diabetes knowledge. To assess this, one-tailed paired t-tests were used to compare mean pre and post questionnaire scores. Secondly, study group results were compared to the comparison group results. For this comparison, two-tailed, independent t-tests were used to compare mean comparison group scores to mean intervention group pre and post scores. Statistical significance was determined using $p < 0.05$.

RESULTS

A total of 60 students in the intervention group completed both pre and post intervention questionnaires. In each of the four classes there were 18, 14, 11, and 17 students, respectively that completed both pre and post intervention questionnaires. Students who were absent on one of the days that questionnaires were administered, therefore only completing the pre or post questionnaires, were not included for statistical analysis.

Demographics

A total of 54% of the intervention group used in statistical analysis were female and 46% of the students were male. The short diabetes questionnaire contained one demographic question. Question number four asked, "Do you have some member in your family that has diabetes (high blood sugar) OR tests the amount of sugar in their blood?" At baseline, 26 students (43%) reported yes and 24 students (40%) reported yes after the intervention.

Knowledge

The mean score for the short diabetes questionnaire at baseline was 3.2 (+/- 0.2), the mean score at post-intervention was 5.6 (+/- 0.2). Mean scores for the long diabetes questionnaire increased from 6.0 (+/- 0.4) at baseline to 10.8 (+/- 0.4) at post-intervention. Both the short and long diabetes knowledge questionnaires showed significant increases in mean scores ($t = 12.06$, $p < 0.001$ and $t = 11.78$, $p < 0.001$, respectively). Therefore, the null hypothesis was rejected.

The number of correct responses increased for every question on the short diabetes knowledge questionnaire, except for the first question (Table 2). Question number one asked, "Diabetes is a serious disease in which there is too much sugar in your blood," true or false?

Ninety percent of the students answered this question correctly at baseline. Only 85% answered this question correctly at post intervention.

Table 2. Intervention Group Results from Short Diabetes Knowledge Questionnaire
Table 2 shows percentage of correct responses per question and total from the short diabetes questionnaire. Intervention group results are shown from the pre and post intervention questionnaires. Difference column shows difference in percentage points between pre and post intervention questionnaires.

	Pre	Post	Difference
1. Diabetes is a serious disease in which there is too much sugar in the blood.	90%	85%	-0.5%
2. Eating too much sugar can cause diabetes.	26%	80%	54%
3. Children cannot get type 2 diabetes.	74%	79%	5%
4. Diabetes can be prevented.	56%	95%	39%
5. Healthy eating	36%	82%	46%
6. Exercise	38%	87%	49%
7. Maintaining a healthy weight	0%	56%	56%
Total	46%	80%	34%

The number of correct responses increased for every question on the long diabetes knowledge questionnaire, except for two questions which showed no change (Table 3). Question number 13, "Diabetes often causes poor circulation," yes, no, or I don't know? A total of 35% of students answered this question correctly at pre and post intervention. Question number one, "Frequent urination and thirst are signs of low blood sugar," yes, no, or I don't know? A total of 21% of students answered this question correctly at pre and post intervention.

Table 3. Intervention Group Results from Long Diabetes Knowledge Questionnaire
Table 3 shows percentage of correct responses per question and total from the long diabetes questionnaire. Intervention group results are shown from the pre and post intervention questionnaires. Difference column shows difference in percentage points between pre and post intervention questionnaires.

	Pre	Post	Difference
1. Eating too much sugar and other sweet foods is a cause of diabetes.	10%	69%	59%
2. The usual cause of diabetes is lack of effective insulin in the body.	39%	94%	55%
3. Kidneys produce insulin.	18%	50%	32%
4. In untreated diabetes, the amount of sugar in the blood usually increases.	56%	71%	15%
5. If I am diabetic, my children have a higher chance of being diabetic.	42%	60%	18%
6. Diabetes can be cured.	24%	69%	45%
7. A fasting blood sugar of 210 is too high.	44%	71%	27%
8. The best way to check diabetes is by testing urine.	31%	61%	30%
9. Regular exercise will increase the need for insulin or other diabetic medication.	32%	48%	16%
10. There are two main types of diabetes: Type 1 and Type 2.	40%	97%	57%
11. An insulin reaction is caused by too much food.	16%	42%	26%
12. Medication is more important than diet and exercise to control diabetes.	48%	77%	29%
13. Diabetes often causes poor circulation.	35%	35%	0%
14. The ways I prepare my food is as important as the foods I eat.	58%	69%	11%
15. Diabetes can damage the kidneys.	31%	35%	4%
16. Diabetes can cause loss of feeling in hands, fingers, and feet.	21%	31%	10%
17. Shaking and sweating are signs of high blood sugar.	13%	23%	10%
18. Frequent urination and thirst are signs of low blood sugar.	21%	21%	0%
19. A diabetic diet consists mostly of special foods.	21%	60%	39%

Comparison Group

Nineteen students in the comparison classroom completed both the short and long diabetes knowledge questionnaires. The comparison group completed both diabetes knowledge

questionnaires at a single point in time during the intervention time period, in January of 2006, but received no diabetes education lessons.. A total of 40% of the comparison group were female and 60% of the students were male. When asked, "Do you have some member in your family that has diabetes (high blood sugar) OR tests the amount of sugar in their blood?" Six students, or 32%, reported yes.

Mean scores for the short and long diabetes knowledge questionnaires were 3.0 (+/- 0.5) and 7.2 (+/- 0.6), respectively. No significance was found between comparison and pre intervention group mean scores for the short ($t = 0.47$, $p = 0.64$) or long questionnaire ($t = 1.50$, $p = 0.14$). Post intervention group mean scores were significantly higher, when compared to comparison group mean scores, for both the short ($t = 5.27$, $p < 0.001$) and long questionnaire ($t = 4.82$, $p < 0.001$). (Figures 1 and 2).

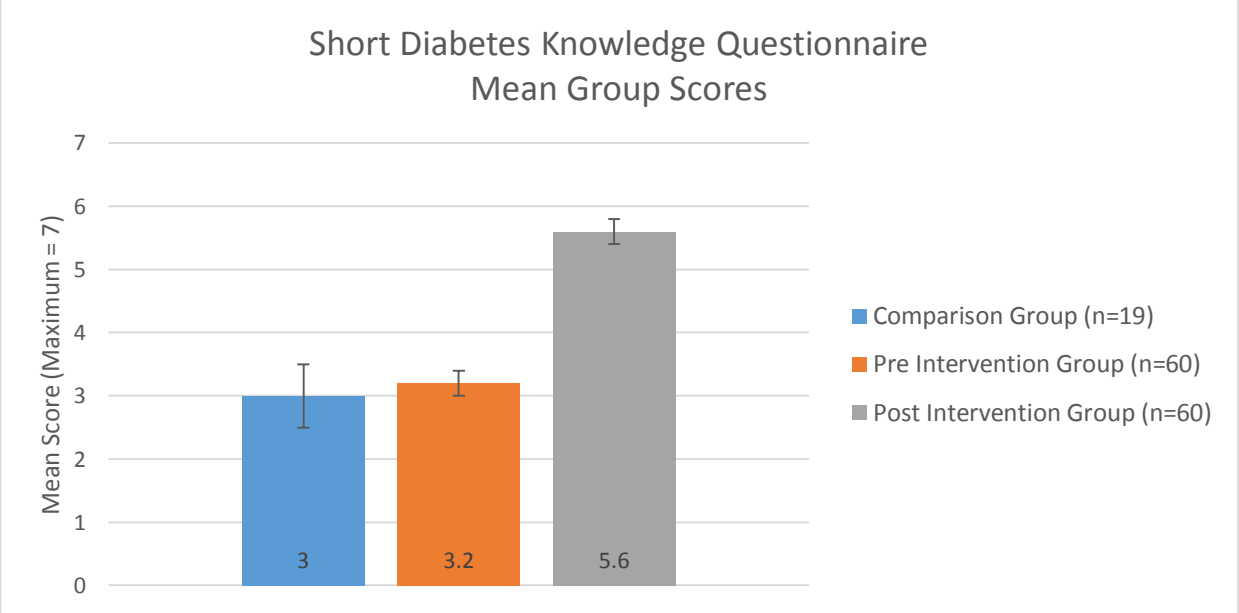

Figure 1. Short Diabetes Knowledge Questionnaire Mean Group Scores
Figure 1 shows comparison, pre intervention, and post intervention mean group scores from the short diabetes knowledge questionnaire. The maximum score is 7.

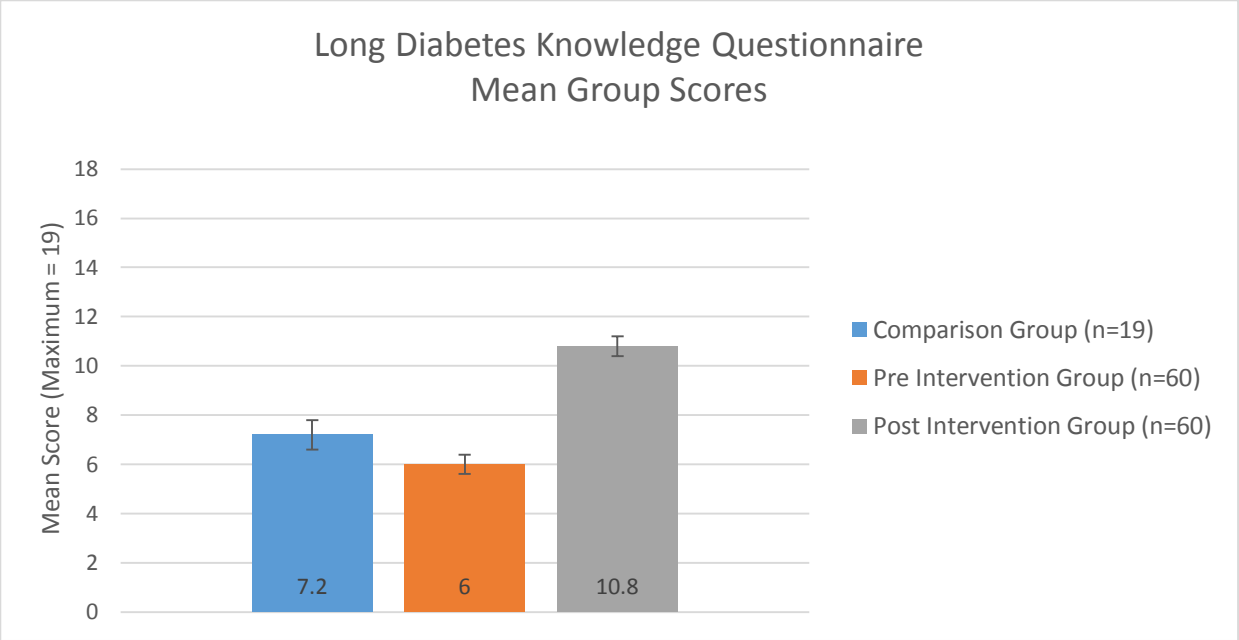

Figure 2. Long Diabetes Knowledge Questionnaire Mean Group Scores
Figure 2 shows comparison, pre intervention, and post intervention mean group scores from the long diabetes knowledge questionnaire. The maximum score is 19.

Lesson Evaluations

Anonymous lesson evaluations were done by all students receiving the intervention lessons. The first evaluation, which covered the first four lessons, was completed by 74 students. The second evaluation, which covered the last five lessons, was completed by 87 students. The results are expressed as a total percentage with all four classrooms combined. To simplify the evaluation results, the first two responses "Awesome" and "I liked a lot" can be combined into a positive category. The next two responses "I liked a little" and "OK" can be combined into a neutral category. The last two responses "I didn't like much" and "I didn't like at all" can be combined into a negative category. When evaluating the student lesson reviews in this manner, the Discovery of Insulin, Tools of Diabetes Management, Exercise and Diabetes, Body Image, and Jeopardy Review lessons all received the highest number of responses in the positive category. The other four lessons received the highest number of responses in the neutral category. The two most liked lessons were the Tools of Diabetes Management (72% positive,

23% neutral, and 6% negative) and Jeopardy Review (60% positive, 30% neutral, and 10% negative). The two lessons with the highest number of negative reviews were the Introduction to Diabetes (33% positive, 51% neutral, and 16% negative) and Body Image (53% positive, 28% neutral, and 19% negative). Interestingly, the Body Image lesson received the most negative reviews and was also one of the top three lessons in the positive category. See Table 4 for complete lesson evaluation data.

Table 4. Intervention Lesson Evaluation Results

Table 4 shows the percentage of responses received for each lesson, per category.

Lesson	Awesome	I Liked A Lot	I Liked A Little	OK	I Didn't Like Much	I Didn't Like At All
Energy Balance	20%	14%	40%	17%	3%	6%
Introduction to Diabetes	11%	22%	27%	24%	11%	5%
Discovery of Insulin	24%	26%	29%	18%	3%	0%
Tools of DM Management	58%	14%	17%	6%	3%	3%
Nutrition and Diabetes	6%	22%	36%	30%	6%	1%
Exercise and Diabetes	25%	23%	29%	15%	6%	1%
Body Image	33%	20%	15%	13%	12%	7%
Prevention	11%	22%	25%	34%	4%	4%
Review	34%	26%	17%	13%	4%	6%

DISCUSSION

Interventions targeted at the primary prevention of type 2 diabetes in the US are needed. As discussed in the Introduction, the prevalence of obesity among US adults and youth has increased dramatically over the past few decades. Obesity is a well-established risk factor for type 2 diabetes. The prevalence of type 2 diabetes in US adults has increased alongside increasing obesity rates. Type 2 diabetes, a disease once referred to as adult-onset diabetes, has made an appearance in US adolescents. Rates of type 2 diabetes in youth are rising, most notably among minority populations. Interventions that target children and adolescents, hopefully before overweight, obesity, and unhealthy lifestyles have become established are likely to be the most effective. Schools provide an ideal environment to reach this target population and address these public health issues directly.

Program ENERGY had the primary objective of reducing the rates of obesity and type 2 diabetes. Program ENERGY utilized three components: weekly science and health enrichment lessons in the classroom, weekly physical activity, and bi-monthly healthy snack preparation in the classroom. This thesis project was designed to add science and health enrichment content to the existing educational component of Program ENERGY. In addition, this thesis project was used as a pilot-test for a 6th grade target audience. Prior to this project, 5th grade students had been the oldest target audience for Program ENERGY interventions.

The measurable goals of this project were to increase general diabetes knowledge, diabetes management knowledge, and awareness of type 2 diabetes prevention strategies. These goals were met, significant knowledge increases were seen among the 60 subject study group. The study group was not without risk for the development of type 2 diabetes. Forty percent of

the study group had a family member with diabetes, a risk factor for the development of type 2 diabetes. In addition, 23% of the sixth grade students enrolled at Tavelli Elementary School in the fall of 2005 were Hispanic, another established risk factor for the development of type 2 diabetes.

Comparing the results of this intervention to the results of similar studies is difficult due to the different measures used and study periods, as well as variations in intervention content. However, the results of this project do seem to be consistent with the findings from several previous interventions. Elementary school students, when exposed to interventions that attempt to increase knowledge about diabetes and diabetes prevention are able to comprehend and retain this information for the length of the study. Of the five school-based interventions targeted at type 2 diabetes prevention reviewed prior to the development of this intervention, four had published knowledge results. Of these four, three saw significant improvements in diabetes-related knowledge. One study was unable to significantly impact diabetes-related knowledge due to barriers in intervention implementation, such as faculty turnover and lack of administrative support (Teufel and Ritenbaugh, 1998). The length of the three studies with significant knowledge increases was one academic school year, or nine months. One of these studies, Jump Into Action, integrated diabetes-related content into existing reading, writing, math, science, and physical education curriculum (Holcomb et al, 1998). While the Bienestar Health Program and the Sandy Lake Diabetes Prevention Program, similar to this thesis project, supplemented school curriculum with diabetes-specific lessons (Trevino et al, 1998; Saksvig et al, 2005).

The sixth grade students were receptive to the lessons and were able to understand and remember many of the scientific concepts covered. For example, during the Introduction to

Diabetes lesson, class content covered the hormone insulin, insulin's role in the body, causes of type 1 and type 2 diabetes, and prevalence of type 1 and type 2 diabetes. During the post test, five months after this lesson, 94% of the study group knew that the usual cause of diabetes is a lack of effective insulin in the body. Only one question from the two questionnaires had a decrease in the number of correct responses. The short diabetes questionnaire asked, "Diabetes is a serious disease in which there is too much sugar in your blood," true or false? Ninety percent of the students answered this question correctly at baseline, compared to 85% at post intervention. Given the high number of correct responses at baseline, the slight decrease in correct responses maybe due to a ceiling effect.

One novel aspect of this study was the inclusion of diabetes management topics. Diabetes management was primarily covered in the Tools of Diabetes Management lesson. During this lesson students pretended to measure the blood glucose level of three blood samples, by measuring the glucose level of three glucose and water solutions with color-coded test stripes. Students also pretended to give someone an injection of insulin, by using a syringe to inject an orange with saline. The same technique that is used to teach someone newly prescribed with insulin to give themselves an insulin injection. The Nutrition and Diabetes lesson, along with the Exercise and Diabetes lesson also covered some diabetes management topics, along with diabetes prevention methods. The students seemed to enjoy the coverage of these topics. The Tools of Diabetes Management was the highest evaluated lesson in the intervention, 72% of the respondents evaluated it positively, 58% of the respondents placed the lesson in the "awesome" category. The hands-on coverage of diabetes management may help the students remember what diabetes is in the future.

The long-term goal of this project and Program ENERGY is to reduce the rate of type 2 diabetes. Given the study length, this was not measurable. However, awareness of type 2 diabetes prevention and prevention strategies increased significantly among the study group. At the end of the intervention, 95% of the students knew that diabetes is largely preventable. Eighty-seven percent of the study group knew that physical activity was key to preventing diabetes, 82% knew that a healthy eating pattern was key to preventing diabetes, and 56% knew that maintaining a healthy weight was key in the prevention of type 2 diabetes. At baseline, no students were able to list maintaining a healthy weight as a strategy for preventing type 2 diabetes.

The inclusion of a comparison group does add support to the findings of this study. The study group mean scores for the two questionnaires were not significantly different at baseline when compared to the comparison group. Significant differences were seen between the study group post intervention scores when compared to the comparison group. However, this is not an experimental design, the lack of a true control group is one limitation of this study.

This study has several other limitations. Wellness was a major focus for Tavelli Elementary School. Goals of the school included increasing the fitness level and healthy food choices of their students. The school lunch environment of the school was modified, most notably a fresh salad bar was available to the students at each meal. Physical education classes encouraged increased levels of physical activity. To my knowledge, the study group was not exposed to any other diabetes education. The increased awareness of healthy eating and the importance of physical activity in the school may have had an impact on student questionnaire scores, most likely on the "keys" to diabetes prevention section.

Another potential limitation is the lack of formal questionnaire reliability testing on the target 6th grade audience of the study. The evaluation tools used in this study were adopted from other studies. The short diabetes knowledge questionnaire was developed by Program ENERGY and was used in previous Program ENERGY interventions. The long diabetes knowledge questionnaire was adapted from a questionnaire developed for the Starr County Diabetes Education Study. The 24-item questionnaire did undergo formal reliability testing, however this testing was conducted in an adult Mexican-American population (Garcia et al, 2001).

The short diabetes knowledge questionnaire contained a question asking, "Eating too much sugar can cause diabetes," true or false? The long diabetes knowledge questionnaire asked a similar question, "Eating too much sugar and other sweet foods is a cause of diabetes," true or false? The correct answer for both of these questions was false. On the American Diabetes Association's website (www.diabetes.org), common diabetes myths are discussed in the Diabetes Basics section of the website, an educational portion of the website. The educational content of this website is targeted at the general public. In 2006, shortly after this thesis project, the ADA had this to say concerning high sugar intake and the development of diabetes.

> "Myth #3: Eating too much sugar causes diabetes.
>
> No. Diabetes is caused by a combination of genetic and lifestyle factors. However, being overweight does increase your risk for developing type 2 diabetes. If you have a history of diabetes in your family, eating a healthy meal plan and regular exercise are recommended to manage your weight." (ADA, 2006)

The concepts of healthy eating and regular physical activity to maintain a healthy weight were emphasized throughout the intervention. The concept that high sugar intake had a direct causal role in the development of type 2 diabetes, was considered a common myth about diabetes.

Recent research is questioning the role of high sugar intake, mostly in the form of high-fructose corn syrup in sugar-sweetened beverages, and the development of type 2 diabetes. A meta-analysis conducted by Malik et al (2010a), examined the relationship between the intake of sugar-sweetened beverages (SSB's) and risk of type 2 diabetes. Eight prospective cohort studies, which published results between 2004 and 2010 were included in the analysis. Risk of developing type 2 diabetes was 26% greater among individuals in the highest quartile of SSB intake (1-2 servings a day or greater) when compared to the lowest quartile of SSB intake (none to less than one serving per month). Adjustments for BMI were not made in this analysis. The increased risk of developing type 2 diabetes seen in this analysis is likely mediated in part, by an increase in overweight and obesity among habitual SSB drinkers. However, some research does suggest high SSB intake directly increases the risk of type 2 diabetes, independent of obesity. The exact mechanism is unknown, however some researchers believe that the high and persistent glycemic load and increased fructose metabolism that an individual with high SSB intake experiences may lead to inflammation, insulin resistance and beta cell dysfunction (Malik et al, 2010b; Schulze et al, 2004). A review article by Malik et al (2010b) reviewed four published epidemiologic studies on SSB intake and type 2 diabetes risk. The results of the studies were mixed. Half of the reviewed studies showed an increased risk of developing type 2 diabetes with high SSB intake, independent of BMI. The other half did not show a direct relationship between SSB intake and type 2 diabetes risk.

The American Diabetes Association has changed their response slightly in light of the emerging evidence that high SSB intake may play a role in the development of type 2 diabetes. Currently this is the response posted on the American Diabetes Association's website:

> "Myth: Eating too much sugar causes diabetes.
>
> Fact: The answer is not so simple. Type 1 diabetes is caused by genetics and unknown factors that trigger the onset of the disease; type 2 diabetes is caused by genetics and lifestyle factors. Being overweight does increase your risk for developing type 2 diabetes, and a diet high in calories from any source contributes to weight gain. Research has shown that drinking sugary drinks is linked to type 2 diabetes. The American Diabetes Association recommends that people should limit their intake of sugar-sweetened beverages to help prevent diabetes." (ADA, 2014)

The Starr County Diabetes Education Study published the 24-item questionnaire in 2001 in Diabetes Care, a scientific journal of the American Diabetes Association. The long diabetes knowledge questionnaire used in this study was adapted from this questionnaire. Given the current debate on SSB intake and risk of type 2 diabetes, I would likely be cautious and not include questions concerning high sugar intake causing type 2 diabetes in a survey designed to measure diabetes knowledge today, in 2014.

In conclusion, despite the limitations previously discussed, this intervention was successful. This school-based diabetes education intervention significantly increased diabetes-related knowledge among a study group of 6th grade students. It was a successful 6th grade pilot for Program ENERGY. The underlining goal of teaching youth about diabetes at a young age is to guide their lifestyle choices in the future. Knowing the intervention was successful at increasing diabetes-related knowledge among 6th grade students, the next step would be to test behavioral changes. It would be a benefit in future interventions and research to evaluate the impact, if any, of higher levels of diabetes-related knowledge and impacts on health-related behavior.

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APPENDIX A:

LETTER OF EXPLANATION AND CONSENT FORM

"Intervention"

Department of Food Science
and Human Nutrition
Fort Collins, Colorado 80523-1571
Fax: (970) 491-3875
www.fshn.colostate.edu

August 2005

Dear Parents or Guardians,

Your child's second, fourth or sixth grade class has been selected to participate in a research project titled "*Obesity & Diabetes Prevention Through Science Enrichment"* Program ENERGY sponsored by Colorado State University, National Institutes of Health, and the American Honda Foundation. Your child will be participating, with your permission, in this research project. The goal of this project is to improve the health, nutrition, and physical activity of children grades 2-6. This is being done through enrichment opportunities in the classroom, special guests, field trips, and physical activities.

The research part of this program will involve **confidential** recording of your child's height, weight and waist size, and questionnaires about activity, eating habits, their opinion of the culture of their family, and how they feel about themselves. This information will help us be certain that our program is appropriate for your child. Some of these questionnaires may be completed in the computer lab at school. We see this as an exciting opportunity to enrich our classrooms and contribute to the health of all children.

We would also like to ask if you would like to participate in the research project. We want to collect information on your knowledge and attitudes toward the prevention of Type 2 diabetes and obesity through adoption of a healthier lifestyle (good nutrition and physical activity). We will ask you to complete **confidential** questionnaires or telephone surveys. It will take approximately 15 minutes of your time. We will ask you to complete these questionnaires now and the end of this school year. We will provide educational information every other week for you to read. We see this as an exciting opportunity to contribute to the health of children and their families.

Attached you will find the consent form necessary for you and your child to participate in this study. Please read it carefully and discuss it with your child. If you have any questions at all please call Ms. Francoise J. Smith, Program Director, Program ENERGY in Fort Collins at 970-491-7889.

If you and your child choose to participate, please sign the consent form and complete the questionnaire. If you do not, write "No". In either case, have your child return the form and questionnaire to their teacher.

Thank you,

Francoise Smith

E-mail: smith@cahs.colostate.edu
Tel: 970-491 7889

www.ProgramENERGY.org

child's Name

"Intervention – Mini-Program ENERGY"

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

TITLE OF PROJECT: **Obesity & Diabetes Prevention Through Science Enrichment**

NAME OF PRINCIPAL INVESTIGATOR: **L. Arthur Campfield**

NAME OF CO-INVESTIGATOR**: Françoise Smith**

CONTACT NAME AND PHONE NUMBER FOR QUESTIONS/PROBLEMS: **Ms. Francoise J. Smith 970-491-7889 in Fort Collins**

SPONSOR OF PROJECT: **National Institutes of Health, American Honda Foundation**

PURPOSE OF THE RESEARCH:
The purpose of this study is to determine the effectiveness of science and health educational enrichment in children in kindergarten through 6thgrade designed to prevent obesity and type 2 diabetes. We will collect information including height, weight, waist circumference, number of steps/day, body image, eating and physical activity behavior, and self-esteem of these children. This information includes the major factors that predict obesity and type 2 diabetes and can be used to prevent these diseases in children. This information will be collected at the beginning and end of each school year, and possibly up to two times during each school year, for up to three additional years. This information is very important because the number of children who are overweight and at high risk for type 2 diabetes is rising very quickly and there are data that shows that overweight and obesity in children can lead to future health problems, including type 2 diabetes and heart disease. This is especially true, if being overweight is common in your family. We will also ask about the culture your family. We also want your help to determine what your child eats by asking them, and you, to remember ("dietary recall').

In this study, your child will receive information on how to make healthy eating choices and increase their physical activity since these are two things that may affect a child's health.

PROCEDURES/METHODS TO BE USED:
If you agree to have your child in this research study,

1. We will measure your child's height, weight, and waist circumference at school during the science/math or wellness class or lunch under the supervision of a health professional using privacy screens. These procedures will take approximately 5 minutes to do.
2. We will ask your child what food he/she eats, how much physical activity he/she does every day, how he/she feels about body image, the culture (Anglo or Hispanic) of their family, and how he/she feels about themselves.
3. We will collect measurements (1.) and ask your child to complete the questionnaires (2.): once at the beginning of the fall or the winter semester, at the end of the spring semester, and possibly up to two times during each school year, for up to 3 years.
4. We will ask your child to wear a pedometer during 4 to 7 days at the beginning, the end of the school year, and possibly at other times during the school year. This is a small device, similar to a watch, which automatically records the number of steps your child will take.
5. We will occasionally observe your child's food selection during school lunch, ask your child to record food eaten and physical activity at school and at home, and recall what foods he/she has eaten and what physical activities he/she has done recently.
6. All or part of some of the science enrichment lessons may be provided through interactive computer

activities (games, stories, experiments). During these activities, your child will be asked to respond to questions to indicate understanding, knowledge and attitudes toward nutrition, science and health.

7. We plan to offer quarterly free family activity nights/days and field trips after school or on weekends that will involve physical activity for the entire family as well as provide fun, interactive education on the prevention of type 2 diabetes and obesity through healthy lifestyle to your child and your family. These family activities will be described in an occasional newsletter.

Assent will be obtained from each child and measurements performed in private to maintain confidentiality.

There is no cost to your child for participating in this study. Your child will not be paid for his/her participation in the study.

If you also agree to participate in this research project:

1. We will ask you to complete **confidential** questionnaires or telephone surveys (each will take approximately 10-15 minutes) designed to measure your current attitudes and knowledge regarding nutrition, physical activity, Type 2 diabetes, obesity and their prevention by adopting healthy lifestyle. We will ask you to complete these questionnaires now and at the end of this school year, and possibly up to two times during each school year.
2. On these questionnaires, we will ask you about what foods your family eats, how they are prepared, family activities, how much physical activity you do each week, the cultural identity of your family, what you know about Type 2 diabetes and obesity and the role of healthy lifestyle in maintaining the health of your family.
3. We will ask you to indicate **your preference** for providing the information to us by:
    a. completing paper questionnaires and returning them to us.
    b. participating in telephone surveys - These will be scheduled in advance at times that are convenient for you.
    c. having a member of the research team visit you in your home to complete the questionnaires These visits will be scheduled in advance at times that are convenient for you.
4. We will ask you to read the educational information that your child will bring home to you:
    Biweekly educational take home flyers (newsletters and physical activity and nutrition challenge assignment and report form) highlighting physical activities and nutrition information/activities in which the entire family can participate over the weekend and providing information designed to increase your knowledge about Type 2 diabetes, obesity and its prevention
5. We will also ask that you help us verify your child's "recall" of what she/he ate yesterday and today. This will require comparing her/his responses with your memory.

There is no cost to you for participating in this study. You will not be paid for your participation in the study.

RISKS INHERENT IN THE PROCEDURES:
There are no risks or discomfort for your child. Each child will be made to feel comfortable with the study assistants who will take the measurements. There are no risks or discomfort for you, other than in completing the questionnaires or telephone surveys. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

BENEFITS:
Children will receive free measurements of their height, weight, and waist circumference and will be exposed to science enrichment program. You and your child will also have the opportunity to participate in the planned, free quarterly family activity nights/days and field trips. You will receive free educational information.

CONFIDENTIALITY:
Assent will be obtained from each child and measurements performed in private to maintain confidentiality. The investigator will treat your child's identity and yours by using professional standards of confidentiality. Your child's name will be removed from all work completed as part of this research project and replaced by a numerical code to protect your child's privacy. The same process will be used for questionnaires or surveys that you complete. The information obtained in this study may be published in medical journals, but your identity and your child's

identity will not be revealed.
Since all of the members of the classroom will participate in all activities, including being videotaped/photographed, use of pictures of your child (named or unnamed) will not identify either your child as participants in this study. You will be asked to identify the ethnicity of your child using standard US Census categories, with the option "decline to state".

LIABILITY:
The Colorado Governmental Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury.
Questions about participants' rights may be directed to Janell A. Meldrem at (970) 491-1655.

PARTICIPATION:
Your **child's participation** in this research is completely voluntary and she/he may choose to withdraw at any point in time during the study. You may withdraw your consent and stop your child's participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Your **child's participation** in this research is voluntary. If you decide to let your child participate in the study, your signature acknowledges that you have read the information stated and willingly sign this consent form.

Your participation in this research is completely voluntary and you may choose to withdraw at any point in time during the study. You may withdraw your consent and stop your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

If you decide to participate in the study, your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing __4__ pages and 2 additional pages for you to indicate the ethnicity of you child and to indicate your preferences to complete the questionnaires.

PARENTAL SIGNATURE FOR MINOR

As parent or guardian you authorize _____ (print child's name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to you by Ms. Francoise J, Smith, Program Director or a staff member and you are satisfied that proper precautions will be observed.

_____
Minor's date of birth

_____
Parent/Guardian name (printed)

_____ _____
Parent/Guardian signature Date

PARENTAL CONSENT TO PARTICIPATE

_____
Parent/Guardian name (printed)

_____ _____
Parent/Guardian signature Date

_____ _____
CSU Staff Investigator Date

Permission for Child to be Photographed

As parent or guardian you authorize_____ _____ (print child's name) being of legal age, hereby grants full and perpetual rights to Colorado State University, its successors, assigns and permittees, to use video tape, still and motion photographs or other likenesses of the undersigned and the undersigned's premises, facilities, and equipment, photographed on the date below or later, and any reproductions thereof, in whole or in part, and either in conjunction without his/her name, in connection with any programs, advertisements, promotions, or other uses.

_____
Minor's date of birth

_____
Parent/Guardian name (printed)

_____ _____
Parent/Guardian signature Date

Permission to be Photographed

The undersigned_____, (print your name) being of legal age, hereby grants full and perpetual rights to Colorado State University, its successors, assigns and permittees, to use video tape, still and motion photographs or other likenesses of the undersigned and the undersigned's premises, facilities, and equipment, photographed on the date below, and any reproductions thereof, in whole or in part, and either in conjunction without my name, in connection with any programs, advertisements, promotions, or other uses.

_____
Parent/Guardian name (printed)

_____ _____
Parent/Guardian signature Date

APPENDIX B:

INTERVENTION LESSON OUTLINES

Energy Balance

Grade level: Sixth

Lesson Overview: During this lesson students will learn about ENERGY, one of the laws governing ENERGY and how to balance the ENERGY IN to their bodies through the food that they eat with the ENERGY OUT of their bodies with the physical activities that they do. Calories will be reviewed as a unit energy that we use to measure ENERGY IN and ENERGY OUT. Students will try to guess the amount of ENEGY IN in four foods and the ENERGY OUT from four physical activities. Students will discover the more ENERGY OUT (physical activity), the more ENERGY IN (food) your body can and needs to have. As a final activity, students will put their ENERGY BALANCE knowledge to test when they help one of four skateboarders get into ENERGY BALANCE by analyzing their current ENERGY IN and OUT and offering advice to help them get into balance. This analysis will continue as a homework assignment.

Objectives:

1. Define and explore ENERGY and ENERGY BALANCE.
2. Define and explore calories as a unit of energy.
3. Identify what happens to weight and health when ENERGY BALANCE is not maintained.

Standards:

Colorado Science Standards:

- Standard 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
- Standard 3.3: Students know and understand how the human body functions, factors that influence its structures and functions, and how these structures and functions compare with those of other organisms.

National Science Education Standards:

- Content Standard A: Science as Inquiry
- Content Standard F: Science in Personal and Social Perspectives

1. **Vocabulary**: balance, energy, energy balance, energy in, energy out, calorie, physical activity, nutrient, carbohydrate, fat, protein, physical activity , resting metabolic rate

Materials:

Background:

- Display board with food plates totaling 1700 calories, 2000 calories and 2300 calories
- Light bulb

Activity 1:

- Energy IN/OUT Estimation Visual aids: Big Mac, Pizza with multiple toppings; Salad with ranch dressing, apple, 1 running shoe, jump rope, bowling ball.
- Energy Estimation Data Sheet (1 per student)

Activity 2:

- Energy Balance Case Studies (total of 4: Anya, Charlie, Crystal, Pablo) (1 per student -2 students given the same case study)
- ENERGY IN = ENERGY OUT game

Background: (12 min)

0-12 min Intro and engagement through Q & A – Energy Balance [Art]

ENERGY:
Storage and Circulating forms
Food
Calorie
Compartments
Stored energy
Thermodynamics 1st law-work
Steady state
ENERGY BALANCE
THREE STATES
ENERGY BALANCE AT ANY WEIGHT
GOLDILOCKS AND THE THREE BEARS
Estimating caloric content

WORDS THAT WERE assigned two weeks ago-define

When I say ENERGY, what image pops into your head……more here

When I say *balance*, what image pops into your head? Maybe you see a gymnast walking across a balance beam or someone standing on one foot. Both of these images are of balance and that is exactly what we will be talking about today, but we will be talking about a different kind of balance. Today we are going to explore ENERGY BALANCE. Energy balance means balancing the energy you put into your body with the energy out of your body. Where do you think ENERGY IN comes from? Our ENERGY IN comes from the food that we eat. How about ENERGY OUT? ENERGY OUT actually comes from 2 things—the physical activity that you do during the day and from your Basal Metabolic Rate. Basal Metabolic Rate is all the energy it takes your body just to live. Sometimes we call Basal Metabolic Rate BMR. BMR includes the energy it takes to blink your eyes, your heart to beat, your lungs to breathe, and your digestive system to digest your food. So when we say ENERGY BALANCE, that means balancing the ENERGY IN from food with the ENERGY OUT from physical activity and the energy your body requires to live or your BMR.

We can measure energy in many different units. For example, we measure the energy in this light bulb in watts. Does anyone know the unit we use to measure the energy in food and uses in physical activity? CALORIE. A calorie is a unit to measure the energy <u>in</u> food and <u>used</u> in physical activity. For example, if I say this slice of cheese has 150 calories that means it has 150 units of energy. Or if I say rollerblading for 30 minutes uses 100 calories—that means it uses 100 units of energy

Now that you know how we measure the energy in food and energy used in physical activity, let's see if you can estimate the number of calories, or units of energy, in some food items and physical activities. **See Activity 1 below**

Now the question is: How do you know how much ENERGY IN your body needs? The answer to this depends on the how much ENERGY OUT you have from physical activity. Let's say you are not very active that means you do not have much ENERGY OUT. With only a little bit of energy out from physical activity, you do not need as much energy in. If we look at this board, here is the ENERGY IN someone your age would need if they were not very active—it adds up to be about 1700 calories of ENERGY IN. If someone is physically active a medium amount, they can add more ENERGY IN because they have more ENERGY OUT. On our food board you could add these three snacks (for a total of 2000 calories with breakfast, lunch, dinner and snacks) to ENERGY IN and still be in ENERGY BALANCE. If you were very physical active you could add even three more snacks and still be in ENERY BALANCE. The bottom line, the more physically active you are (a lot of ENERGY OUT), the more food or ENERGY IN you can and need to have!

Engagement: What is ENERGY BALANCE? Where do we get ENERGY IN? How do we get ENERGY OUT? What would happen if someone was out of ENERGY BALANCE and ENERGY IN < ENERGY OUT? (lose weight) What if ENERGY IN > ENERGY OUT? (gain weight)

Exploration: Now that you are ENERGY BALANCE experts your skateboarding friends from the DNA Detective lesson need your help to get into ENERGY BALANCE. You will have to help them make food choices and physical activity choices so they can achieve ENERGY BALANCE.

12-27 min Activity # 1 (15-20 min) Energy Density Estimation [Elizabeth]

[relative food 5-7 min; PA 5-7 min; calories 5-6 min]
NOTE: This activity should be completed midway through the Background/Introduction to the lesson after the concept of calorie is introduced.

1. Each student will receive an Energy Estimation Data sheet.
2. Prior to estimating the amount of energy in calories, the food items [add Big Mac, Pizza with multiple toppings, salad] and physical activities [Morgan's cards] will be introduced to the students.
3. Students will be instructed to estimate the: 1) Relative ENERGY content (IN) of the 4 food items and the ENERGY value (OUT) of the 4 physical activities; and 2) the absolute calories of the 4 food items and the ENERGY value (OUT) of the 4 physical activities. First, each student estimates the relative order of the foods and records their answer on their data sheet, then the group discusses the food results and comes to a consensus or near-consensus and "writer" records the group result on black board and the "reporter" hold it up. Each student then corrects data sheet if necessary. This is then repeated with the physical activity. "writers" and "reporters" rotate around the group.
4. Once the estimating is completed, as a group, students will be asked share some caloric estimates then the class will converge on the correct answer. Students should record the correct amount of energy or calories in each food and physical activity on their data sheet in the space provided.
5. If time allows, explore caloric density Need weight of the food items

27-42 min **Activity # 2 (15-20 min) Skateboarder Case study [Matt or Art]**

During this activity, students will put their energy balance knowledge to test to help one of four skateboarders get into ENERGY BALANCE! (10 min)

1. Each group of students will receive one of four energy balance case studies: Anya, Charlie, Crystal or Pablo. Each pairs will have the same case study.
2. Each case study starts out with an ENERGY IN and ENERGY OUT total. The students must evaluate whether or not the person is in balance. Please see case study data sheets.
3. Next, students are asked to take a closer look at where the person's ENERGY IN and OUT came from. During this section, students must use their addition and subtractions skills.
4. The last section of the case study data sheet, has the case study experiencing an unexpected event like breaking a leg or getting sick that affects energy balance. Students will have to reevaluate ENERGY IN and OUT to determine if the person is still in balance and then offer the person some advice to help them get back into balance (i.e. because less physically active now, may need to decrease number of snacks from 4 to 2 a day.)

ENERGY IN = ENERGY OUT Game (Francoise)

BMI (during game and/or snack)

42-52 min Snack (10 min)

52-60 min Summary and Home work (8 min)

Timeline:

0-12 min	Intro and engagement through Q & A – Energy Balance (12 min)
12-27 min	Activity # 1 (15-20 min) Energy Density Estimation
27-42 min	Activity # 2 (15-20 min) Skateboarder Case study
42-52 min	Snack (10 min)
52-60 min	Summary and Home work (8 min)

Tavelli 6th Grade: Introduction to Diabetes Lesson
December 8, 2005 and January 12, 2006

1. 10 minutes: Introduction to blood glucose regulation
   Dr, Campfield
2. 5 minutes: Play parts one and two of Educator Lou video (American Diabetes Association)
   a. Play part two of the video twice, point out highlights of mechanism:
      i. Glucose and insulin in bloodstream
      ii. Insulin (key) binds to insulin receptor (keyhole)
      iii. Glucose transport opens
      iv. Glucose from bloodstream enters cell
   Matt Conner
3. 20 minutes: Intoduction to scientific method and activity #1: insulin resistance mechanism
   a. Scientists: observe, develop hypothesis, and test their hypothesis
   b. Have groups of students develop hypothesis for insulin resistance with guidance from ENERGY team leaders
   Matt Conner
4. 5 minutes: Discuss activity #1 results
   a. Have one member of each group explain their hypothesis
   b. Take home message: scientists still trying to figure out the mechanism for insulin resistance, all of the group's hypothesis may be possible
   Matt Conner
5. 5 minutes: Finish Educator Lou video (American Diabetes Association)
   a. Pause after part three (type 1 diabetes), point out that all three management blocks (meal plan, exercise, and medication) are necessary for blood glucose regulation
   b. Pause after part four (type 2 diabetes), ask which management block is the most important for blood glucose regulation (Answer: they are all equally important)
   c. Point out that we will be covering each of the three blocks: meal plan, exercise, and medication in following lessons
   d. Play part five (insulin resistance) twice, point out that insulin or the "key" doesn't work and glucose can't enter the cell
   Matt Conner
6. 10 minutes: Activity #2: blood glucose regulation matching worksheet
   a. Have groups of students complete worksheet with guidance from ENERGY team leaders
   Matt Conner

Total Time: 55 minutes

Needed Materials:

Media cart
Activity #1 worksheets
` Activity #2 worksheets
Baskets, pencils

Reference: American Diabetes Association. Youth Zone: Educator Lou video. Accessed online January 2006 at http://www.diabetes.org/youthzone/lou.jsp

Tavelli 6th Grade: Discovery of Insulin Lesson
January 19th and 26th, 2006

1. 5 minutes: Brief diabetes history introduction
    a. Earliest known record of diabetes was in 1552 BC on Egyptian papyrus by physician Hesy-Ra.
    b. Prior to the discovery of insulin, diabetes was treated with severe calorie-restriction. This resulted in a very poor quality of life for patients with diabetes and only worked for a limited amount of time (patients died fairly soon after diagnosis).
    c. In 1921, Dr. Banting and Mr. Best discovered insulin, our topic today…
    d. In 1959, in Washington DC two major types of diabetes were recognized.
    e. 1997-2002, the results of four studies in England, China, Sweden, and US showed that type 2 diabetes can be prevented through changes in lifestyle, we will talk about the US study, the Diabetes Prevention Program, in a future lesson.

2. 10 minutes: Show first scene of Discovery of Insulin video
    a. Start: Dr. Banting at home at night
    b. Pause to restate background: Dr. Banting read about previous studies, severe and fatal diabetes in dogs occurred when tying off pancreatic ducts and when pancreas is tied off and withers, islets may remain intact.
    c. Pause after chalkboard scene to restate hypothesis

3. 10 minutes: Explanation of "The Discovery of Insulin" worksheet
    a. Have students complete hypothesis and background sections with guidance from ENERGY team leaders

4. 5 minutes: Show second scene of Discovery of Insulin video (scene at very end of tape #1)
    a. Start: as soon as lab scene begins
    b. Stop: Best saying "0.09"
        i. Emphasize: dog "Alpha" starts at 0.38, injection and wait an hour, 0.26, another injection, then blood glucose at 0.09 and feeling well
        ii. At conclusion, state that Banting and Best basically had the juice that was squeezed out of a withered pancreas, before human testing could begin, they had to isolate the active chemical and create a pure solution that could be injected

5. 15 minutes: Complete "The Discovery of Insulin" worksheet
    a. Have students fill out methods, results, summary, and conclusion sections with guidance from ENERGY team leaders

Tavelli 6th Grade: Discovery of Insulin Lesson

6. 5 minutes: Show third and fourth scenes of Discovery of Insulin video (both scenes are on tape #2)
    a. Third scene: 1.5 minutes, Elizabeth getting injection on deathbed
    b. Allow 1.5 minutes to fast-forward to fourth scene
    c. Fourth scene: 2 minutes, Dr. Banting and Elizabeth visit with other doctors and medical researchers

7. 5 minutes: Brief summary of video and worksheet (scientific method)

Total Time: 55 minutes

Needed Materials

Media Cart
Discovery of Insulin Videos (Part 1 and 2)
The Discovery of Insulin Worksheets
Baskets, pencils

Reference: Till, E (Director). Glory Enough For All: The Discovery of Insulin, a videotape. Gemstone Productions Ltd., Toronto, Canada. 1988.

Tavelli 6th Grade: Tools of Diabetes Management Lesson
February 2 and 9th, 2006

1. 5 minutes: Brief introduction to diabetes management
    a. Goals of management: avoid hyper- and hypoglycemia
        i. Hyperglycemia: signs and symptoms include lack of energy (alpha the dog in movie), frequent urination and thirst
        ii. Hyperglycemia/ diabetes can be controlled by diet and exercise or diet, exercise, and medication (our topic today…)
        iii. Hypoglycemia: signs and symptoms include shaking and sweating (only need to worry about if on certain pills or insulin)
        iv. Hypoglycemia treated with carbohydrate intake
    b. Complications of poor diabetes management
        i. Use mannequin during intro talk

2. 15 minutes at each of three stations:

    a. Station #1: Insulin delivery, **Matt**
        i. Showing of insulin vial (protein, yet clear liquid)
        ii. Injection of an orange with "insulin"

    b. Station #2: Blood Glucose Monitoring, **Francoise**
        i. Each pair of students will test three different solutions
        ii. Completion of medical detectives activity

    c. Station #3: **"**Diabetes supply Price-is Right" and snack, **Elizabeth and Kristen**
        i. Each pair of students will guess cost of commonly used diabetes management supplies (blood glucose monitor, blood glucose test strips, glucophage, insulin, alcohol swabs)
        ii. Use whiteboards, pair of students with closest guess (without going over) gets a "point," whoever collects most points gets first choice of Larabar flavor

    d. Mannequin exploration if group finishes early at a station

3. 5 minutes: Allow time for groups to move between stations

Total time: 55 minutes

Tavelli 6th Grade: Tools of Diabetes Management Lesson

Needed materials:

Intro talk:	mannequin	
	Oral medication visual	
Station #1:	insulin vial	
	Syringes (10)	
	Vials of saline	
	Oranges (10)	
Station #2:	blood glucose monitors (5)	
	Test strips (bring at least 100 ea. lesson)	
	3 glucose solutions	
	Pipettes (to transfer solution to strip)	
	Medical detective worksheets (100)	
	Pencils	
Station #3:	Visuals:	blood glucose monitor box
		blood glucose test strip box
		Glucophage image
		Insulin vial image
		Alcohol swab box
	Price sheet for Elizabeth and Kristen	
	White boards (6)	
	Larabars	
	Hand sanitizer	

Tavelli 6th Grade: Nutrition and Diabetes Lesson
February 16 and 23, 2006

1. 5 minutes: Lesson Evaluations
2. 5 minutes: Power Point presentation
    a. Define: nutrient, macronutrients, and micronutrients. Provide examples and a few functions of each.
    b. **"**Do people with diabetes have to eat special foods or special diets? No, in fact the diet that is recommended for someone with diabetes is also the diet that is recommended for you to remain healthy."
    c. "However, people with diabetes do have to closely monitor their intake of one of the macronutrients, the one that breaks down into glucose…..can anybody name it? Diabetics must monitor their intake of carbohydrates to make sure that their dosage of medication and amount of physical activity is appropriate. If their carbohydrate intake, medication, and physical activity are all in balance then their blood glucose levels will be at the proper level."
3. 15 minutes at each station:
    a. Station #1: Insulin Secretion/ Dosage **Matt**
        i. Coverage of insulin secretion in response to meals with different amounts of carbohydrate, using graphs
        ii. Identification of foods containing carbohydrate from food recalls
    b. Station #2: Nutrition Label Reading/ Comparison. **Gael**
        i. Comparison of whole, 1%, chocolate milk, and coke
        ii. Discussion of serving sizes
        iii. Which item(s) would be the best for:
            - Someone trying to loss weight?
            - Protein content?
            - Micronutrient content?
            - Individual with diabetes who is using diet and exercise alone to control blood glucose levels? (must monitor carbohydrate intake)
        iv. Students complete worksheet (in pairs)
    c. Station #3: Idaho Plate Method/ Review Game **Elizabeth**
        i. Explanation of Idaho Plate Method
        ii. Students construct meals following Idaho Plate Method using food cut-outs
        iii. Fact or fiction review game

Total Time: 55 minutes

Tavelli 6th Grade: Nutrition and Diabetes Lesson

Needed Materials:

Evaluations (100)
Baskets, pencils

Power Point presentation
Media cart

Station #1: Graph of insulin secretion responses
Meal recall sheets (100)
Carbohydrate content tables (15)

Station #2: Nutrition labels (4 ea): Whole milk, 2% milk, 1% milk, chocolate milk, and coke
Nutrition label worksheets (50)

Station #3: Idaho Plate Method displays
Plates
Food cutouts

Tavelli 6th Grade: Exercise and Diabetes Lesson
March 9th and 23rd, 2006

1. 5 minutes: Introduction
    a. Educator Lou had to balance "3 boxes" to manage diabetes. We have discussed medication and diet; can anyone remember what the "third box" was? Our topic today…
    b. People with type 2 diabetes are recommended to do some form of physical activity every day to help maintain proper blood glucose levels, to maintain or loss weight (increase energy out), and to help avoid complications.
    c. Physical activity is also very important for people without diabetes. It helps maintain a healthy body weight and assists in the prevention of a number of diseases (such as diabetes).
    d. In fact, the same amount of physical activity is recommended for someone without diabetes as someone with diabetes. Does anyone know how much physical activity a day is recommended for someone your age? (Answer: 60 minutes daily)
    e. Discussion of physical activity: doesn't have to mean sports or gym, ask for and provide examples.

2. 5 minutes: Travel to computer lab

3. 15 minutes**:** Microsoft Excel introduction and demonstration of sample graph construction
    a. Enter data into columns A,B, C (expand cell width)
    b. Chart wizard, steps:
        i. Line graph
        ii. Click series tab
            1. enter person #1 name and insulin values, repeat for person #2
            2. x-axis: enter values
        iii. Title and axis labels
        iv. Object in sheet

4. 15 minutes: Students construct graph
    a. Students use provided data tables, with the insulin requirements for two people with diabetes : one who is sedentary and one who is active for 60 minutes daily
    b. Demonstrate how to adjust scale and allow students to adjust graphics

5. 5 minutes: Discussion of graph
    a. What is the graph illustrating? (Answer: Less insulin is needed when physically active)

6. 5 minutes (optional, if time allows)**:** "Food Fight" and "Healthy Plate" computer games in the American Diabetes Association's youth zone

7. 5 minutes: Travel back to classroom

Total Time: 55 minutes
Needed Materials: Data tables (100)

Tavelli 6th Grade: Body Image Lesson
March 30th and April 6th, 2006

1. 5 minutes: Introduction power point, **presented by Kristin**
    a. Discussion topics include:
        i. Ask students what they think body image means. Can you have healthy and unhealthy body image?
        ii. The media: we are bombarded with images every day, how do these images make us feel? What are they trying to tell us or sell us? Why do they use these types of images?
        iii. How has the "perfect image" changed over time? What did it used to be like? What is it like now? (provide examples of changing female/male images)
        iv. The differences between what we see in movies and magazines versus real world: provide facts to back it up.
        v. What are ideals in other cultures? Examples of neck elongation and foot binding. Consequences of these ideals (deformities, etc). What are consequences of our ideals?

2. 10 minutes: First part of Mirror, Mirror video

3. 10 minutes: First side of "Body Image" worksheet
    a. Have students complete first page of "Body Image" worksheet in groups with guidance from ENERGY team leaders

4. 5 minutes: Discussion of worksheet, **by Kristin**
    a. Write female and male stereotypes on board

5. 5 minutes: Conclusion of Mirror, Mirror video

6. 15 minutes: Image retouching demonstration and "Magazine Activity," **by Matt**
    a. Have students complete second page of worksheet in groups with guidance from ENERGY team leaders

7. 5 minutes: Conclusion, **by Kristin**
    a. Last few slides of power point, cover ways to build a healthy body image

Total Time: 55 minutes

Needed Materials:

Media cart
Power Point presentation
Mirror, Mirror video
Worksheets (100)
Baskets, pencils, "sticky" pads
Magazines (10)

Tavelli 6th Grade: Type 2 Diabetes Prevention Lesson
April 13th and 20th, 2006

1. 5 minutes: Review of three diabetes management lessons
    a. Students, working in their groups, will try to answer the following question:
        i. What must someone with diabetes do to manage their disease?

2. 10 minutes: Power Point presentation
    a. Discussion of review question
    b. Consequences of poor management, complications
        i. Acute: hyper- and hypoglycemia
        ii. Long-term: retinopathy, kidney disease, heart disease, nerve damage, amputation (emphasize reduced risk with proper management)
    c. Is diabetes a serious disease? Do you feel that it is worth the effort to try and prevent type 2 diabetes?
    d. Can anyone name the main cause of type 2 diabetes?
    e. Brief coverage of overweight, obesity, and type 2 diabetes prevalence statistics
    f. Introduction to Diabetes Prevention Program study
        i. Importance, provided scientific evidence that type 2 diabetes can be prevented
        ii. 3 groups: placebo (define), metformin (define), and lifestyle
        iii. Measured incidence (define) of type 2 diabetes over the following 4 years

3. 15 minutes: Diabetes Prevention Program graph reading
    a. Students, working in groups with guidance from ENERGY team leaders, interpret (put into words) 6 graphs from the Diabetes Prevention Program study, each group will be assigned 1 graph that they will have to explain to the rest of the class.

4. 5 minutes: Discussion of Diabetes Prevention Program graphs
    a. Have a member of each group explain the meaning of their assigned graph to the rest of the class
    b. Can anyone name the 3 keys to type 2 diabetes prevention?

5. 10 minutes: "Three keys of diabetes prevention" worksheet
    a. Healthy Eating
        i. What does healthy eating mean? (Answer: proper intake of all macro and micronutrients)

b. Physical Activity
    i. How much physical activity is recommended for someone my age everyday? (Answer: 60 minutes)
    ii. Am I getting 60 minutes or more of physical activity most days of the week?
    iii. If yes, what activities do I do? (list), If no, what are some possible ways that I can try to increase the amount of my daily physical activity? (list)
c. Maintain a Healthy Weight
    i. Write the energy balance equation. (Answer: Energy In = Energy Out)
    ii. If I want to maintain my weight, does 'Energy In' need to be less than, equal to, or greater than 'Energy Out'? (Answer: equal to)
    iii. If I want to loss weight, does 'Energy In' need to be less than, equal to, or greater than 'Energy Out'? (Answer: less than)
    iv. How can I decrease the amount of 'Energy In'? (Answer: decrease intake of calories)
    v. How can I increase the amount of 'Energy Out'? (Answer: increase physical activity)

6. 5 minutes: Discussion of worksheet
    a. Write major concepts on board

7. 5 minutes (if time allows): Revisit body image concepts

Total Time: 55 minutes

Needed Materials

Media Cart
Power Point
Diabetes Prevention Program graph handouts (2 per group = 12 total)
Graph reading worksheets (100)
Diabetes prevention worksheets (100)
Baskets, pencils

Tavelli 6th Grade: Review Lesson
April 27th and May 4th, 2006

1. 5 minutes**:** Review of Diabetes Prevention Lesson
    a. Ask students if they can remember the three ways that type 2 diabetes can be prevented. (Answer: healthy eating, physical activity, and maintaining a healthy weight)
    b. Write three "keys" to preventing type 2 diabetes on board.

2. 40 minutes**:** Diabetes Jeopardy (game template adapted from Wellness IN the Rockies Jeopardy)
    a. Winning group wins first choice of snack after the questionnaire time period in two weeks.

3. 10 minutes**:** Snack

Total Time: 55 minutes

Needed Materials:

Media Cart
Diabetes Jeopardy Power Point
White Boards (6)
Dry erase markers
Snacks (50)
Napkins

Reference:

WIN the Rockies Jeopardy, Wellness IN the Rockies, www.uwyo.edu/wintherockies Accessed online April 2006.

APPENDIX C:

DIABETES KNOWLEDGE QUESTIONNAIRES

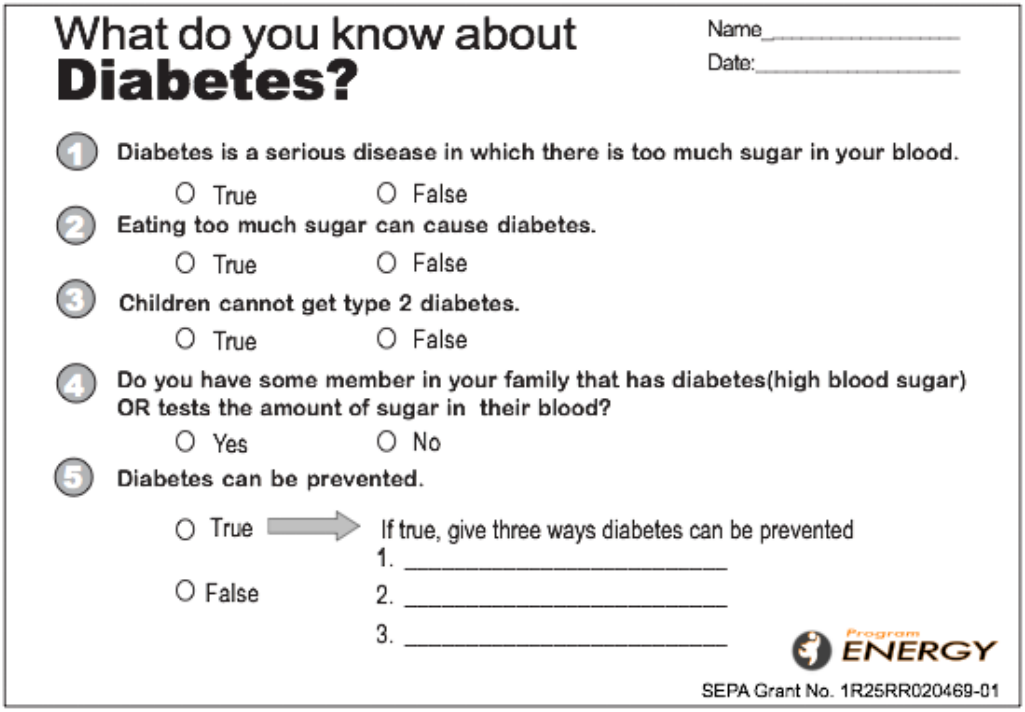

Figure 3. Short Diabetes Knowledge Questionnaire
Figure 3 shows the short diabetes knowledge questionnaire developed by Program ENERGY.

Name_____
Date_____

Diabetes Knowledge Questionnaire

(Adapted from: Diabetes Care, volume 24, number 1, January 2001)

Please place an X in either the yes, no, or I don't know column next to each question.

Item #	Question	Yes	No	I don't know
1.	Eating too much sugar and other sweet foods is a cause of diabetes.			
2.	The usual cause of diabetes is lack of effective insulin in the body.			
3.	Kidneys produce insulin.			
4.	In untreated diabetes, the amount of sugar in the blood usually increases.			
5.	If I am diabetic, my children have a higher chance of being diabetic.			
6.	Diabetes can be cured.			
7.	A fasting blood sugar of 210 is too high.			
8.	The best way to check diabetes is by testing urine.			
9.	Regular exercise will increase the need for insulin or other diabetic medication.			
10.	There are two main types of diabetes: Type1 and Type 2.			
11.	An insulin reaction is caused by too much food.			
12.	Medication is more important than diet and exercise to control diabetes.			
13.	Diabetes often causes poor circulation.			
14.	The way I prepare my food is as important as the foods I eat.			
15.	Diabetes can damage the kidneys.			
16.	Diabetes can cause loss of feeling in hands, fingers, and feet.			
17.	Shaking and sweating are signs of high blood sugar.			
18.	Frequent urination and thirst are signs of low blood sugar.			
19.	A diabetic diet consists mostly of special foods.			

Figure 4. Long Diabetes Knowledge Questionnaire

Figure 4 shows the long diabetes knowledge questionnaire, adapted from the Starr County Diabetes Education Study.

APPENDIX D:

LESSON EVALUATIONS

	Awesome	I Liked A lot	I Liked A Little	OK	I Didn't Like Much	I Didn't Like At All
Energy Balance	1	2	3	4	5	6
Introduction to Diabetes	1	2	3	4	5	6
Discovery of Insulin	1	2	3	4	5	6
Tools of Diabetes Management	1	2	3	4	5	6

List at least one activity that you really liked:

List at least one activity that you didn't like:

Figure 5. First Lesson Evaluation

Figure 5 shows the first lesson evaluation, covering the first four intervention lessons.

	Awesome	I Liked A lot	I Liked A Little	OK	I Didn't Like Much	I Didn't Like At All
Nutrition and Diabetes	1	2	3	4	5	6
Exercise and Diabetes	1	2	3	4	5	6
Body Image	1	2	3	4	5	6
Diabetes Prevention	1	2	3	4	5	6
Diabetes Jeopardy Review	1	2	3	4	5	6

List at least one activity that you really liked:

List at least one activity that you didn't like:

Figure 6. Second Lesson Evaluation

Figure 6 shows the second lesson evaluation, covering the fifth through ninth intervention lessons.