

Effects of Nutrition Education and Exercise in Obese Children: The Ho-Chunk Youth Fitness Program

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ABSTRACT

Background: Type 2 diabetes is increasingly common, primarily because of increases in the prevalence of a sedentary lifestyle and obesity. This is even more apparent in certain minority populations, such as Native Americans. Whether the risk of type 2 diabetes can be decreased by interventions that affect the lifestyles of children at high risk is not known.

Methods: The Ho-Chunk Youth Fitness Project, aimed at dietary and exercise instruction and intervention, consists of 38 native (Ho-Chunk Tribe, Wisconsin) and non-native children (ages 6-18 years). Children underwent evaluation including medical exam, nutrition, exercise assessment, metabolic testing of fasting plasma insulin, plasma glucose, plasma cholesterol, and percent body fat before and after a 24-week intervention. Intervention consisted of twice weekly classes with supervision for both nutrition and exercise.

Results: Mean fasting plasma insulin decreased from $22 \pm 7.7 \mu\text{IU/ml}$ to $11 \pm 6 \mu\text{IU/ml}$ (normal $< 15 \mu\text{IU/ml}$) after 24 weeks of training ($P < 0.05$). Percent body fat ($30.2 \pm 6.4\%$), glucose ($91 \pm 9 \text{ mg/dL}$), and total cholesterol ($182 \pm 22 \text{ mg/dL}$) remained unchanged during this time.

Conclusions: Risks for insulin resistance and type 2 diabetes, as measured by fasting insulin (an indirect mea-

surement of insulin sensitivity in obese children), can be decreased by supervised nutrition and exercise intervention. Furthermore, hyperinsulinemia in overweight children can be reduced without decreasing body fat.

INTRODUCTION

The incidence of type 2 diabetes mellitus (T2DM) is increasing worldwide. T2DM results from a combination of genetic predisposition with behavioral and environmental risk factors.¹ While the genetic basis of this risk has yet to be identified, there is strong evidence that physical activity and obesity remain key modifiable risk factors.²⁻⁴

According to NHANES III (Centers for Disease Control and Prevention), approximately 14% of US children are overweight and more than 25% of US children are at risk for being overweight; therefore childhood obesity has become a public health concern. The degree of obesity in childhood correlates with progressive impairment of insulin sensitivity and compensatory hyperinsulinemia.^{5,6} Insulin resistance has become recognized as an independent predictor of the development of stroke, cancer, coronary artery disease, hypertension, and T2DM in adulthood.⁷ These findings suggest that maintaining insulin sensitivity and preventing the development of hyperinsulinemia during childhood is an important public health goal.⁸ Whether structured exercise for high-risk children can reduce the fasting hyperinsulinemia often seen in obese children is an important question.

METHODS

Thirty-eight children participated in this study. As part of the annual school year health evaluation, height on a wall-mounted stadiometer and weight were obtained from all students by trained nurses. School nurses referred children from the local school districts with a body mass index (BMI) above the 85th percentile to the Ho-Chunk Youth Fitness Program (HYFP), which is associated with the Ho-Chunk tribe in Wisconsin. Letters were sent to

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the parents of these children notifying them of an opportunity for structured exercise and after-school nutrition classes. The first 38 children who were interested and met the elevated BMI criteria were enrolled in this program. The Human Subjects Committee at the University of Wisconsin approved the study, and consent was obtained from all children.

Upon evaluation for the program, all participants had fasting blood work completed for insulin and glucose. Total cholesterol was obtained in 20 children. Next, after an overnight fast, participants' body composition was measured by bioelectrical impedance analysis (BIA). Then the children underwent a history and physical exam by a pediatric endocrinologist, evaluation by a pediatric nutritionist (with at least 1 parent) using a 24-hour dietary recall method, and assessment by an exercise physiologist, which included aerobic capacity and muscular endurance (YMCA sub-maximal protocol, Canadian crunch test). These baseline values were compared to re-evaluation results taken after 24 weeks of twice-weekly supervised nutrition and exercise classes.

The children were divided by age into 2 groups: ages 6-10 and 11-18. Class time was divided between fitness and nutrition education, physical activity (45 minutes) and making a healthy snack (30 minutes). The participants learned about a variety of fitness and nutrition topics. Fitness education included: body composition; benefits of exercise; muscular, cardiovascular and skeletal systems; components of a workout; ratings of perceived exertion; and diseases related to inactivity. Participants also performed an array of physical activities. The younger class focused on learning fundamental skills: running, jumping, skipping, balance, throwing, and catching, as well as swimming, soccer, kickball, parachute games, and obstacle courses. The older class focused on more organized activities such as weight training, racquetball, team games, and using various cardiovascular machines.

Nutrition education included: the food guide pyramid, reading food labels, 5-a-day fruit and vegetables, the importance of eating breakfast, soda consumption, eating at holidays, and fast food eating behaviors. Using additional behavioral modification techniques, participants could fill out fitness and nutrition log sheets. Children that completed the log sheets received points for their efforts. Participants also received points for attending classes, special events, and completing home activities. These points were then redeemed at a later time for incentive prizes (jump ropes, baseballs, shoes, heart rate monitors, cookbooks, juicers, etc.).

RESULTS

Baseline and 24-week data are presented in Table 1. Mean age of the study group was 9 ± 3 years. Subjects had blood testing and body composition assessed fasting in a consistent protocol for hydration status. Average blood glucose was normal 91.3 ± 9.2 mg/dL, total cholesterol was also normal at 182 ± 26 mg/dL. While no change was seen in percent body fat after 24 weeks of structured activity, a significant decrease in fasting insulin was seen (Figures 1 and 2).

DISCUSSION

The health benefits associated with a physically active lifestyle in children include weight control, lower blood pressure, and improved psychological well being, and a predisposition to increased physical activity in adulthood.⁹ In adults, increased physical activity has also been associated with decreased risks of cardiovascular disease, increased life expectancy, and improved glucose tolerance.⁴ In adults with known impaired glucose tolerance, changes in lifestyle (30 minutes of moderate exercise per day) have demonstrated a decrease in the risk of developing T2DM.¹⁰ Clinical data has also shown that lifestyle intervention can delay or prevent T2DM in high-risk adults by 58%, or by 31% with metformin.¹¹ These effects were similar for men and women, and in all racial and ethnic groups.

Impaired glucose tolerance is highly prevalent among children and adolescents with obesity, and is highly correlated with insulin resistance.¹² It has also been demonstrated that insulin resistance and obesity in childhood have an increased risk for continuing into adulthood.¹³ Health care professionals play a vital role in promoting healthy lifestyle as part of preventive childhood health care. Pediatricians can effectively increase fitness participation and improve insulin sensitivity.¹⁴

It has been demonstrated in adults that level of fitness is a more accurate predictor of cardiovascular and all-cause mortality than weight status.¹⁵ Physical activity alters insulin sensitivity, independent of changes in weight and fatness in adults.¹⁴ This effect may be due to reductions in skeletal muscle triglyceride, which increases insulin sensitivity independently of central adiposity.¹⁶ Physical activity and fitness training without weight loss also have been shown to decrease early modulators of insulin activity. Further, aerobic fitness primarily correlates with fat free mass rather than (inversely) with fat mass.¹⁷ Consequently, the beneficial effect of fitness training on insulin sensitivity may reflect combined effects of increased lean mass and reduced fat mass, whereas both lean and fat mass are reduced dur-

Table 1. Baseline and Post-Testing Results (Mean ± Standard Deviation)

	Baseline (n=38)	24 Weeks Post (n=38)
Insulin (mIU/ml)	22±7.7	11±6*
Glucose (mg/dL)	91.3±9.2	90.2±7.4
Cholesterol (mg/dL)	182±26	180±24
Body fat (%)	30.4±6.4%	29.0±6.3%

* $P < 0.01$ compared to baseline.

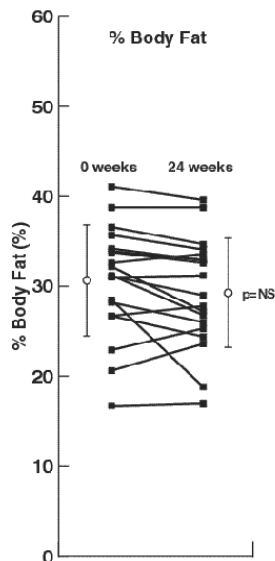


Figure 1. Change in percent body fat (mean ± standard deviation).

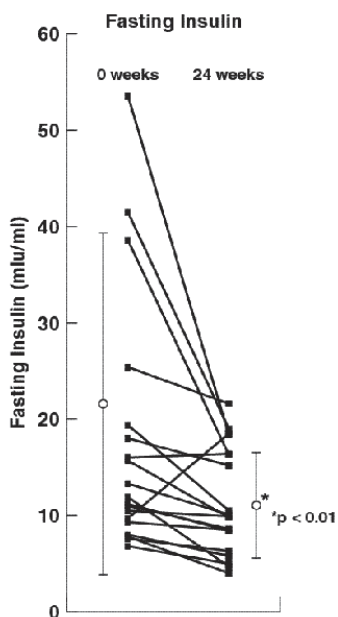


Figure 2. Change in fasting insulin (mean ± standard deviation).

ing caloric restriction alone in children. Efforts to improve insulin sensitivity in children, therefore, may be best focused on increasing physical activity rather than simply restricting calories to achieve weight control.

While many pediatric practitioners view child and adolescent obesity with concern and feel that intervention is important, data is limited for outcomes of childhood intervention.¹⁸ Although intensive, behavior-based weight loss programs for children have proven successful in clinical studies,¹⁹ these approaches have not translated into effective office-based care.²⁰ Further, many practitioners emphasize weight loss, rather than increasing fitness, and report frustration or “failure” if weight loss does not occur. These data demonstrate that in these high-risk children, increased activity without any change in body fat still improves fasting hyperinsulinemia, a main risk factor associated with obesity. This important distinction should be highlighted from our data: the benefits of structured exercise for overweight children can be seen without evidence of weight loss or loss of body fat.

While these data are encouraging, the results should be viewed cautiously. First, the type of assessment performed for body composition, BIA, has less specificity than other technologies such as dual energy x-ray absorptiometry (DEXA), although BIA measurements in our study followed a strict protocol for hydration and time of day determination, which improve its specificity. Secondly, our assessment of insulin sensitivity, namely fasting insulin levels, is admittedly less sensitive than oral glucose tolerance testing, frequently sampled intravenous glucose tolerance testing, or glucose clamp studies. Studies have shown that hyperinsulinemia per se is a significant predictor of future morbidity.²¹ Further, other investigators have developed a prediction equation for insulin sensitivity from anthropometry and fasting insulin in prepubertal children²² that is reported widely in interventions. Finally, when conducting studies in children, a primary concern is willingness to undergo repeated noxious testing, which is why we chose not to perform repeated measures of insulin sensitivity in addition to maximal exercise testing.

CONCLUSIONS

Children represent an important part of the growing trend of obesity, and increased risk for insulin resistance and T2DM. The HYFP has established a unique partnership between a University, a Native American community, and local school districts collaborating toward treating our public health concerns of childhood obesity. Intervention with structured exercise and nutrition education can play an important role in improving insulin

sensitivity, and thus decreasing the risk of glucose intolerance or T2DM. This program utilizes an innovative approach with both a fitness and nutrition emphasis. By combining these separate disciplines within 1 setting, this program highlights the importance of integrating both activity and nutrition education to achieve improved health for overweight children. This study demonstrates that insulin sensitivity can improve in obese children, even without weight loss or significant change in body composition (percent body fat). Increased awareness of the benefits of structured activity should be highlighted in preventive health care for children.

The recent "obesity epidemic" among children and adolescents is a major public health concern. T2DM in childhood is increasingly common, largely because of increasing childhood obesity. This is especially evident in minority populations including Native Americans. Associated with obesity are physiologic changes that increase insulin resistance, including hyperinsulinemia.²³ The absence of a clear mechanism makes treating the obese child a difficult task, and standardized therapeutic approaches do not exist. This report demonstrates that structured exercise and nutrition education can be done with high-risk children and be fun, successful, and improve insulin sensitivity, even without weight loss or loss of body fat. Larger controlled studies need to be applied to this population for improved recommendations for public health prevention.

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