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EFFECT OF AGING AND EXERCISE TRAINING ON PLASMA INSULIN CONCENTRATION

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Abstract

Background and Aims. *Previous studies have shown that aging is an important risk factor for insulin resistance and type 2 diabetes. The beneficial effects of exercise on glucose metabolism are well known. Our goal was to examine whether physical activity improves insulin levels in older individuals.* ***Material and Methods****. Plasma glucose and insulin were measured in fasting state and 2 h after a 75-g oral glucose tolerance test in young lean, sedentary, non-diabetic subjects (n=34, age 25±2 years, body mass index-BMI 24.4±0.7 kg/m2) and older, lean, sedentary, non-diabetic subjects (n=36, age 75±3 years, BMI 24.8±0.4 kg/m2), before and after 8 weeks of aerobic exercise. Training consisted of exercise (such as cycling or fast walking) 5 days/week for approximately 30 min/day.* ***Results****. Fasting plasma insulin and 2-h serum insulin levels at baseline were significantly higher in older than young subjects (11.6 µU/ml vs 10.0 µU/ml, p=0.0001, 46.3 µU/ml vs 34.0 µU/ml, p=0.0001). Fasting and 2h plasma insulin levels were reduced after 8 weeks of aerobic exercise in older subjects, with no change in body weight.* ***Conclusion.*** *In our study the hyperinsulinemia associated with aging can be blunted significantly by aerobic exercise in older individuals independent of any changes in body composition.*

key words: *aging, type 2 diabetes, aerobic exercise*

Background and aims

Previous studies have shown that aging is a important risk factor for insulin resistance and type 2 diabetes [1]. Aging is associated with alterations in skeletal muscle energy metabolism, insulin resistance and a higher prevalence of type 2 diabetes mellitus (T2DM). The causes of insulin resistance in aging are not known but previous studies suggested a postreceptor defect in target tissue insulin action [2]. Insulin resistance increases with aging. In a recent issue of Diabetes, Evans JL and Goldfine ID published a review article entitled: "Aging and Insulin Resistance: Just Say iNOS" in which they report that "*Impaired insulin signaling can result from mutations or posttranslational modifications of the insulin receptor tyrosine kinase or its downstream effector proteins. Additional*

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candidate molecules that have been implicated in insulin resistance in humans include plasma cell membrane glycoprotein-1 and protein tyrosine phosphatase-1B" [3]. Aerobic exercise was reported to have small or moderate effects on glucose control (fasting glucose, postprandial glucose, insulin sensitivity, and fasting insulin) in diabetic patients [4,5]. Our goal was to examine whether physical activity improves insulin levels in older individuals.

Materials and Methods

We evaluated fasting plasma glucose and insulin levels in 34 young lean, sedentary, non-diabetic subjects and 36 older, lean, sedentary, non-diabetic subjects, before and after 8 weeks of aerobic exercise. A 75-g oral glucose tolerance test (OGTT) was performed at baseline and after 8 weeks exercise. Plasma glucose levels were measured by glucose oxidase assay both before and 2 h after the glucose load. Fasting and 2-h postchallenge plasma insulin levels were measured with a radioimmunoassay specific for insulin, based on an antiserum with less than 1% cross-reactivity for proinsulin. Training consisted of exercise (such as cycling or fast walking) 5days/week for approximately 30 min/day. The study protocol and informed consent were approved by the Institutional Ethics Committee. All subjects provided written informed consent before participating in this study.

Statistical analysis

Data are presented as mean±SD. Clinical characteristics were compared using the t Student Test. Pearson's moment-product correlation coefficients were calculated to evaluate correlations between variables. Significance was defined at the 0.05 level of confidence. All calculations were performed using the Statistical Package for Social Sciences Software (SPSS) version 15.

Results

The median age was 25±2 years in young lean, sedentary non-diabetic subjects and 75±3 years in older, lean sedentary, non-diabetic subjects. Body mass index (BMI) computed as a ratio of weight to the square of height (kg/m2) before and after 8 weeks of aerobic exercise is shown in Figure 1. Aerobic exercise generated no changes in BMI (24.4±0.7 kg/m2 *vs* 24.4±0.6 kg/m2 in young lean, sedentary non-diabetic subjects and 24.8±0.4 kg/m2 *vs* 24.8±0.2 kg/m2 in lean, sedentary non-diabetic subjects).

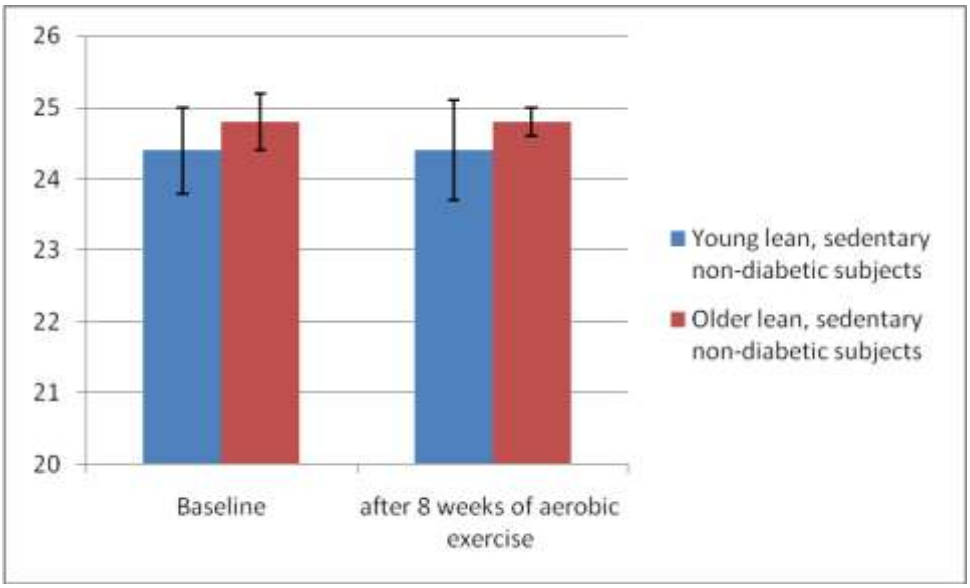

Figure 1. Changes in BMI before and after 8 weeks of aerobic exercise.

Fasting blood glucose levels, glucose levels during OGTT, insulin levels before and after 8 weeks of aerobic exercise in young and older lean, non-diabetic subjects are shown in Tables 1 and 2.

Fasting plasma insulin and 2-h plasma insulin levels at baseline had significantly higher values in older than young subjects (11.6 µU/ml *vs* 10.0 µU/ml, p<0.05, respectively 46.3 µU/ml *vs* 34.0 µU/ml, p<0.05) (Figure 2).

Fasting and 2-h plasma insulin levels were reduced after 8 weeks of aerobic exercise in older but not in young subjects. As shown, aerobic exercise generated not significant changes in fasting blood glucose levels and glucose levels during OGTT.

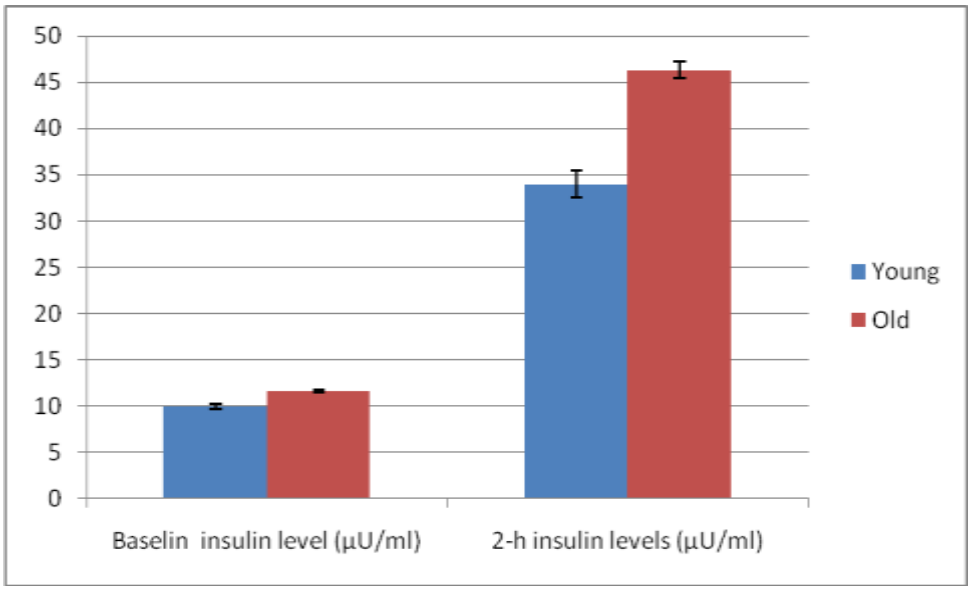

Figure 2. Fasting and 2h plasma insulin levels in young and older subjects at baseline.

Table 1. Insulin, fasting blood glucose levels and glucose levels during OGTT before and after 8 weeks of aerobic exercise in young subjects

	Baseline	After aerobic exercise	p *vs* baseline
Fasting plasma insulin (µU/ml)	10. 0±0.27	9.87±0.12	P=NS
2-h plasma-insulin levels (µU/ml)	34.0±1.44	33.16±0.64	P=NS
Fasting plasma glucose (mg/dl)	82.12±4.44	81.92±3.22	P=NS
2h OGTT plasma glucose (mg/dl)	123.54±4.13	122.62±3.76	P=NS

Table 2. Insulin, fasting blood glucose levels and glucose levels during OGTT before and after 8 weeks of aerobic exercise in older subjects.

	Baseline	After aerobic exercise	p *vs* baseline
Fasting plasma insulin (µU/ml)	11. 6±0.11	9.57±0.32	P<0.05
2-h plasma insulin levels (µU/ml)	46.3±0.88	40.22±0.56	P<0.05
Fasting plasma glucose (mg/dl)	90.26±3.56	89.86±4.01	P=NS
2h OGTT plasma glucose (mg/dl)	133.77±3.78	132.44±4.01	P=NS

Discussion

Official statements of the American College of Sport Medicine state the fact that "Most risk factors associated with disease increase with age, so the benefits of regular exercise are significant from a health perspective. As insulin resistance increases with age, the positive effects of regular aerobic exercise in older individuals on improving insulin sensitivity and increasing glucose transporters in muscle are of clinical importance for the treatment and prevention of adult-onset diabetes" [6].

In our study, aerobic exercise generated nonsignificant changes in BMI. In a meta-analysis published in 2001 in *JAMA,* Boulé NG *et al*, reported that "*In the present meta-analysis, the exercise interventions produced no statistically significant reduction in body weight. There are several possible explanations for this. First, the exercise interventions were of relatively short duration and involved only moderate amounts of exercise. Second, exercise participants might have reduced their daily physical activities, partially counterbalancing the increased energy expenditure from the exercise intervention. Third, exercise group subjects might have increased their food intake, or decreased it less than control subjects*" [4].

In our study, fasting plasma insulin and 2-h plasma insulin levels were reduced after 8 weeks of aerobic exercise in older but not in young subjects. In contrast, a study performed by Short KR *et al.* analyzed the impact of aerobic exercise training on age-related changes in insulin sensitivity and muscle oxidative capacity and found that insulin sensitivity improved in younger people but not in middle-aged or older groups [7]

Conclusion

In our study the hyperinsulinemia associated with aging can be blunted significantly by aerobic exercise in older individuals, independent of any changes in body weight. Physical activity provides health benefits and should be promoted to increase insulin sensitivity and prevent glucose intolerance and T2DM in older subjects.

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