Brief Report

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The Impact of Resistance and Aerobic Training on the Insulin Synthesis Genes Expression in Diabetic Rats

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Abstract

Objective: In the last two decades, genetic studies have strongly supported the effective role of genetic factors on the synthesis of insulin from the pancreas. The purpose of this research is to determine the effect of aerobic and resistance exercises on the expression of NeruoD1 and PDX1 in pancreatic tissue, as well as serum insulin and glucose levels in type 2 diabetic rats.

Materials and Methods: 21 male wistar rats (220±10 g) were included. Then diabetic rats were randomly assigned into 3 groups: 1) control (no-training), 2) resistance training and 3) aerobic training. Exercise training lasted 10 weeks and 5 times weekly for training groups. After intervention, NeruoD1 and PDX1 expression in pancreas, insulin and glucose were compared between groups. Data compared by one way ANOVA and Tukey's post hoc test between groups ($P < 0.05$).

Results: Compared to control rats, resistance and aerobic training led to significant increase in serum insulin (P= 0.001, P= 0.013 respectively), PDX1 expression (P= 0.001, P= 0.001 respectively) and decrease glucose (P: 0.001, P: 0.001 respectively). Significant difference was not observed between control and aerobic groups with regard to NeruoD1 expression (P= 0.077). In addition, NeruoD1 expression in resistance group was significantly higher than aerobic and control groups (P= 0.018, P= 0.001, respectively).

Conclusion: Despite the improvement of insulin and glucose in response to both aerobic and resistance training, it seems that resistance training affects genes affecting insulin synthesis and transcription more than aerobic training.

Keywords: Insulin synthesis, Aerobic and resistance training, Type 2 diabetes, Gene's expression

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Introduction

Regarding the influence of exercise on the transcription factors effective on insulin synthesis (1-7), in the study of Eizadi et al (2016) reported a decrease in pancreatic TCF7L2 expression in response to resistance training (8) and Ramazany et al (2017) found an increase in pancreatic GLP-1R expression following 3 months of aerobic training in type 2 diabetic rats (9).

However, studies evaluating the impact of exercise training on the expression of PDX1 and NeuroD1 in diabetic rats are not available (8-12). Therefore, the present research aimed to evaluate the effect of resistance and aerobic training on the expression of PDX1 and NeuroD1 in pancreatic tissue, as well as fasting glucose and insulin in Type 2 Diabetic (T2D) rats.

Materials and Methods

Twenty one 10 weeks old rats were prepare from the animal house of Pasteur Institute of Tehran, Iran. Then, after induction of T2D, they were randomly divided into 3 groups: 1) control, 2) aerobic training and 3) resistance training.

T2D induced by an intraperitoneal (i.p.) injection of 60 mg/ kg streptozotocin, 15 min after injection of 95 mg/kg of nicotinamide (13).

The aerobic group participated in aerobic training in the form of running on the treadmill (6 weeks, 5 sessions/ weekly) according to Table 1 (14).

The resistance group participates in a resistance training program in the form of 3 set with 6 repetitions in each set (10 weeks, 5 sessions/ weekly). The rest time between sets is 3 minutes and the rest time between repetitions in each period are 45 seconds (15) (Table 2).

All rats were anesthetized and dissected 48 hours after the last training session (overnight fast) intraperitoneal injection of 10% ketamine along with 2% xylosine (50 mg/kg and 10 mg/kg respectively), then they were dissected (13). Blood samples were derived through cardiac puncture. Then, pancreas tissue was removed, and immersed in RNA later to determine PDX1 and NeruoD1 expression. Insulin and glucose were assessed by ELISA (Demeditec, Germany) and glucose oxidase method (Pars Azmoonf kit, Tehran).

For purify RNA, 20 milli-grams of tissue were ground using a mortar and pestle, and extraction was then performed employing the RNeasy Protect Mini Kit (Qiagen, Germany) according to protocol (16). RNA Polymerase I I was used as a control gene (Table 3)

Table 1. Training protocol based on time and speed in the aerobic group

Exercise session (Week)	1	2	3	4	5	6	7	8	9	10
Running time (min)	16	18	20	20	22	22	24	24	26	26
Running speed (m/min)	15	20	30	30	40	40	45	45	50	50

Table 2. Resistance training protocol based on body weight percentage

Exercise session (Week)	1	2	3	4	5
Resistance (Body weight %)	20	40	60	80	100

Table 3. Primer sequence

Genes	Primer sequence
PDX1	**For**: ATACGCAGCAGAACCGGAG **Rev**: ACTTCATGCGACGGTTTTGGA
NeruoD1	**For**: AAGATAGAGACACTGCGCTTGG **Rev**: ATTGGTAGTGGGCTGGGACA
RNA Polymerase I I	**For**: ACTTTGATGACGTGGAGGAGGAC **Rev**: GTTGGCCTGCGGTCGTTC

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Statistical analysis

Data analyzed were performaed by the Statistical Package for Social Sciences (SPSS, version 22.0). One way ANOVA and Tukey's post hoc test used to compare the variables between groups.

Ethical considerations

This study approved by Ethics in Research of Islamic Azad University of Karaj Branch, Alborz, Iran (Ethic Code: IR.IAU.K.REC. 1401.111) and carried out in accordance with CPCSEA guidelines.

Results

Biochemical markers of 3 groups are showed in Table 4. There are a significant difference in serum insulin (*P*= 0.001) as well as glucose (*P*= 0.001) between the study groups. Based on the findings of Tukey's test, both aerobic and resistance training led to a significant increase in insulin (*P*= 0.013, *P*= 0.001 respectively) and significant decrease in fasting glucose (*P*= 0.001respectively) compared to the control group. However, there was no significant difference in serum insulin (*P*= 0.480) and glucose (*P*= 0.552) between aerobic and resistance groups.

Determining the effect of aerobic and resistance training on NeruoD1 and PDX1 expression in pancreas tissue is main aims of this research. There is a significant difference (*P*= 0.001) in PDX1 expression in pancreatic tissue between the study groups. On the other hand, based on the findings of Tukey's post hoc test, both aerobic and resistance training led to significant increase in PDX1 expression compared to the control group (*P*= 0.001). However, there was no significant difference in PDX1 expression between aerobic and resistance groups (*P*= 0.585).

There is a significant difference (*P*= 0.001) in NeruoD1 expression in pancreatic tissue between the study groups. Based on the findings of Tukey test, resistance training leads to a significant increase in NeruoD1 expression compared to the control group (*P*= 0.001), but aerobic training does not change NeruoD1 expression compared to control group (*P*= 0.077). Also, resistance training leads to a significant increase in NeuroD1 expression compared to the aerobic group (*P*= 0.018) (Table 5).

Conclusions

Aerobic and resistance exercises are associated with improvement of serum insulin and fasting glucose in T2D rats. Considering the impact role of transcription factors NeruoD1 and PDX1 in the insulin transcription and synthesis, this improvement may be attributed to the changes in the relative expression of these transcription factors in response to the mentioned training methods. However, more researches are needed to understand the main mechanisms responsible for these changes.

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Table 4. Mean and standard deviation of diabetes determinants of studied groups

Group	Control Mean (±SD)	Aerobic Mean (±SD)	Resistance Mean (±SD)	*p**
Glucose (mg/dL)	293 (± 11)	218 (± 14)	210 (± 11)	0.001
Insulin (µIU/ml)	4.52 (± 0.64)	5.72 (± 0.31)	6.15 (± 0.84)	0.001

Analysis of variance (ANOVA)

Table 5. Pattern of changes in gene expression in response to aerobic and resistance training

Group	Control	Aerobic Mean (±SD)	Resistance Mean (±SD)	*p**
PDX1 relative expression	1	1.55 (± 0.11)	1.50(± 0.10)	0.001
NeruoD1 relative expression	1	1.17 (± 0.13)	1.38 (± 0.16)	0.001

Analysis of variance (ANOVA)

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Conflict of Interest

The authors declared no conflict of interest.

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