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Effect of Resistive and Aerobic Exercise on Reducing Insulin Sensitivity during Pregnancy

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Authors' contributions

This work was carried out in collaboration between all authors. Author HME designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author EME managed the literature searches, analyses of the study performed the spectroscopy analysis and Author HMK managed the experimental process and MD identified the species of plant. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The purpose of this study was to evaluate whether a combined resistive and aerobic training program would improve insulin sensitivity compared with aerobic training alone in pregnant women.
Place and Duration of Study: Department of Obstetrics and Gynecology, Out Patient Clinic at El Mataria Teaching Hospital, between January and July 2014.
Methodology: This study was carried out upon forty primipara pregnant women, who had insulin resistance, their age ranged from 25 to 35 years and their gestational age ranged from 20 to 24 weeks. They were divided into two groups equal in number, group (A) who performed resistance exercise and aerobic exercise (RE and AE) and group (B) who performed who aerobic exercise only(AE only).

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Assessment of all subjects in both groups (A&B) was carried out at the beginning of the study and at 37 weeks of gestation using HOMA test.
Results: There was a highly statistically significance decrease in insulin resistance in both groups where the p value was (0.0001) favoring group (A).
Conclusion: Adding resistance exercise to aerobic exercise had a greater effect on improving insulin sensitivity than aerobic exercise only.

Keywords: Pregnancy; resistive and aerobic exercise; insulin sensitivity.

1. INTRODUCTION

Insulin resistance (IR) is defined as a subnormal response to both endogenous and exogenous insulin. It is characterized by decreasing sensitivity of target tissues to the action of insulin, by elevated blood glucose concentration and increased hepatic production of atherogenic lipids. IR contributes to the pathology of diabetes, obesity, metabolic syndrome and many cardiovascular diseases [1].

Pregnancy is a complex metabolic state involving dramatic alterations in the hormonal or cytokine environments (increases in estrogen, progesterone, prolactin, cortisol, human chorionic gonadotropin, placental growth hormone and human placental lactogen, TNF-alpha, resistin, leptin, and a decrease in adiponectin) as well as an increasing burden of fuel utilization by the conceptus. Metabolically, the first trimester is characterized by increased insulin sensitivity and lipogenesis. The second and third trimesters, in contrast, are characterized by insulin resistance and increased lipolysis [2].

Exercise training has been known to be effective in type 2 diabetes mellitus by increasing insulin sensitivity and strengthening antioxidant defenses and may reduce oxidative stress [3].

Exercise is an effective treatment and management of insulin resistance through enhanced insulin sensitivity, increased skeletal muscle glucose uptake and improved B-cell function. Additionally, exercise may positively modify co-morbidities often associated with IR [4].

Aerobic exercise training is an effective intervention for the prevention and treatment of insulin resistance and type 2 diabetes. Also, resistance training may induce beneficial changes in insulin sensitivity via muscle mass development, effectively increasing glucose storage, facilitating glucose clearance from the circulation, and reducing the amount of insulin required to maintain a normal glucose tolerance [5].

2. MATERIALS AND METHODS

A randomized controlled trial design was used for the purposes of the current study. Patients were randomized to either group A (RE and AE) or group B (AE only) by simple randomization using the envelope method. Accordingly, a pack of sealed envelopes including a card with either the word ‘RE and AE’ or ‘AE only' written on it, was given to a staff physical therapist unrelated to the study; she picked one envelope after patients agreed to take part in the study. Depending on which card was selected patients were allocated to their respective group.

This study was carried out upon forty primipara pregnant women between 20-24 weeks gestation diagnosed as having insulin resistance calculated by HOMA test (fasting blood glucose× fasting insulin) ÷ 22.5. Fasting blood glucose was assayed by the method adopted from [6]. The test materials for this method were supplied as kits by “Diamond Diagnostics,” while Insulin concentrations were measured in previously frozen and thawed serum samples by enzyme immunoassay using the human Insulin ELISA kits. The pregnant women were referred from Obstetrics Out Patient Clinic at El Mataria Teaching Hospital. Their ages were ranged from 25-35 years and their BMI not exceed 35 Kg/m^2.

All participants were free from cardiovascular diseases, chest diseases, pre – eclampsia, gestational diabetes, history of ante -partum hemorrhage or history of pre term labor. Pregnant of twins and who have fetal congenital anomalies were excluded from the study.

All participants in both groups (A& B) were evaluated before the study and at end of 37 weeks gestations for fasting blood glucose level, fasting insulin level and HOMA test of insulin resistance.

HOMA-IR is the product of fasting insulin (microunits/ml) and fasting glucose (mmol/L) divided by 22.5. Lower index indicates greater insulin sensitivity.

Insulin resistance ≥ *4* [7]

$$\text{HOMA- IR} = \frac{\text{Fasting insulin (µIU/ml)} \times \text{fasting glucose (mmol/L)}}{22.5}$$

Group (A) consisted of twenty primipara pregnant women with insulin resistance, their age ranged from 25-34 yrs, their gestational age ranged between 20-24 weeks, their BMI ranged from 27.34 to 32.46 Kg/m^2. They performed aerobic exercise in the form of walking on treadmill for 35 minutes, intensity between 60-75% of maximum heart rate, 3 times weekly until the end of 37 weeks gestations in addition to resistive exercise of the following muscles (chest, back, biceps, triceps, deltoid, quadriceps, thigh, and calf muscles) using an elastic band, 3 times weekly until the end of 37 weeks gestations. Exercise training was performed at Out Patient Clinic at El Mataria Teaching Hospital under the supervision of same physiotherapists.

Group (B) consisted of twenty primipara pregnant women with insulin resistance, their age ranged from 25-34 yrs, their gestational age ranged between 20-24 weeks. Their BMI ranged from 27 to 30.8 Kg/m^2. They performed only aerobic exercise in the form of walking on treadmill for 35 minutes, intensity between 60-75% of maximum heart rate, 3 times weekly until the end of 37 weeks gestations.

2.1 Statistical Analysis

The Data were analyzed using SPSS statistical package and presented using descriptive statistics including the mean, percent and the standard deviation in addition to dependent samples t-test was used for the comparison between the variables. p-value of less than 0.05 was considered as statistically significant.

2.2 Physical characteristics of the subjects

The mean values of the age of the patients in group (A) and group (B) were (29.35±2.5) and (29.2±3.2) respectively. The mean values of the body mass index of the patients in group (A) and (B) were (29.35±1.4) and (28.89±1.1) respectively as shown in Table 1.

Table 1. Physical characteristics of patients in both groups (A&B)

	Group (A)	Group (B)
Age	29.35±2.5	29.2±3.2
BMI	29.35±1.4	28.89±1.1

2.3 Fasting Blood Glucose Level

Group (A): The mean value of the fasting blood glucose level of patients in group (A) was (7.54±0.70), and after the treatment was (4.87±0.43), which reveled a highly statistically significant decrease. The percent of improvement in group (A) was 35.4%.

Group (B): The mean value of the fasting blood glucose level of patients in group (B) was (7.66±0.60), and after the treatment was (5.84±0.52), which revealed a highly statistically significant decrease. The percent of improvement in group (B) was 23.7%.

There was a non statistical significant difference (P>0.05) in fasting glucose level between both groups (A&B) before the treatment, while there was a highly statistical significant difference (P<0.001) after the treatment in favor of group (A) as shown in Table 2.

2.4 Regarding to Fasting Insulin Level

Group (A): The mean value of the fasting insulin level of patients in group (A) was (18.60±1.70), and after the treatment was (11.19±1.50), which revealed a highly statistically significant decrease. The percent of improvement in group (A) was 39.8%.

Group (B): The mean value of the fasting insulin level of patients in group (B) was (18.27 ±0.60), and after the treatment was (12.40 ±0.52), which revealed a highly statistically significant decrease. The percent of improvement in group (B) was 32.12 %.

There was a non statistically significant difference (P>0.05) in fasting insulin level between both groups (A&B) before the treatment, while there was a highly statistical significant difference (P<0.001) after the treatment in favor of group (A) as shown in Table 3.

2.5 Regarding to HOMA Test (Insulin Resistance)

Group (A): The mean value of the insulin resistance (HOMA test) of patients in group (A) was (6.17±0.60), and after the treatment was (2.39±0.31), which revealed a highly statistically significant decrease. The percent of improvement in group (A) was 61.2%.

Group (B): The mean value of the insulin resistance (HOMA test) of patients in group (B) was (6.14±0.76), and after the treatment was (3.19±0.46), which revealed a highly statistically significant decrease. The percent of improvement in group (B) was 48%.

There was a non statistical significant difference (P>0.05) in insulin resistance (HOMA test) between both groups (A&B) before the treatment, while there was a highly statistical significant difference (P<0.001) after the treatment in favor of group (A) as shown in Table 4.

Table 2. The mean values of fasting blood glucose level (mmol/L) before treatment versus after treatment in both groups (A & B)

		Mean	SD	% of improvement	t-value	P-value
Group (A)	Before	7.54	±0.70	35.4%	15.11	0.0001
	After	4.87	±0.43			
Group (B)	Before	7.66	±0.60	23.7%	11.15	0.0001
	After	5.84	±0.52			
Before treatment	Group (A)	7.54	±0.70		0.58	0.56
	Group (B)	7.66	±0.60			
After Treatment	Group (A)	4.87	±0.43		6.4	0.0001
	Group (B)	5.84	±0.52			

Table 3. The mean values of fasting insulin level (µIU/ml) before treatment versus after treatment in both groups (A & B)

		Mean	SD	% of improvement	t-value	P-value
Group (A)	Before	18.60	±1.70	39.8 %	12.02	0.0001
	After	11.19	±1.50			
Group (B)	Before	18.27	±0.60	32.12%	14.24	0.0001
	After	12.40	±0.52			
Before treatment	Group (A)	18.60	±1.70		0.62	0.53
	Group (B)	18.27	±0.60			
After Treatment	Group (A)	11.19	±1.50		3.89	0.0004
	Group (B)	12.4	±0.52			

Table 4. The mean values of insulin resistance (HOMA test) before t treatment versus after treatment in both groups (A & B)

		Mean	SD	% of improvement	t-value	P-value
Group (A)	Before	6.17	±0.60	61.2 %	22.25	0.0001
	After	2.39	±0.31			
Group (B)	Before	6.14	±0.76	48%	17.11	0.0001
	After	3.19	±0.46			
Before treatment	Group (A)	6.17	±0.60		0.12	0.9
	Group (B)	6.14	±0.76			
After Treatment	Group (A)	2.39	±0.31		6.42	0.0001
	Group (B)	3.19	±0.46			

3. DISCUSSION

Normal pregnancy is characterized by facilitated insulin action in the first half of pregnancy whereas the second half is consistent with a state of insulin resistance which can be potentially diabetogenic. During the 1st trimester and early 2nd trimester, an increase in insulin sensitivity occurs mainly because of increased serum estrogen concentration. However, in the late 2nd trimester and early 3rd trimesters, there is reduced sensitivity of insulin action and development of insulin resistance [8].

This insulin resistance leads to higher levels of glucose and free fatty acids; this effect is counterbalanced, however, by increased secretion of maternal insulin. In 2-4% of women, the pancreatic insulin response is inadequate and gestational diabetes develops [9].

HOMA is no better than fasting insulin concentrations for the estimation of insulin sensitivity in normal individuals. There are several reasons why the use of HOMA in normal subjects is worthwhile. The use of HOMA to quantify insulin sensitivity and β-cell function can be helpful in normal populations as it allows *1*) comparisons of β-cell function and insulin sensitivity to be made with subjects with abnormal glucose tolerance and *2*) the collection of longitudinal data in subjects who go on to develop abnormal glucose tolerance [10].

Several studies have examined exercise programs for women with IR. Moderate-intensity arm ergometry exercise (70% of maximal maternal heart rate) improved IR in ten women compared to controls, in a 6-week laboratory-based aerobic training program. In addition, this study reported a decline in blood glucose of 8.4% during exercise (20 min) on the first day of the training program. A partially home based program of regular low-impact endurance exercise at 70% of estimated maximal heart rate would decrease blood glucose levels in women with insulin resistance. Intensity of aerobic exercise will be described as "moderate" when it is at 40-60% of v02 max (60-75% of maximum heart rate) [11].

This study was carried out on forty pregnant females medically diagnosed as having insulin resistance. The results of this study showed a statistically highly significant decrease ($P<0.001$) in fasting blood glucose level, fasting insulin level and insulin resistance (HOMA test) in both groups (A and B) after the end of the treatment favoring group (A).

These results come in consistent with Misra et al. [12] who stated that moderate-intensity progressive resistance exercise training for 3 months resulted in significant improvement in insulin sensitivity, glycemia, lipids, and truncal and peripheral subcutaneous adipose tissue compartments (SCAT) in patients with type 2 diabetes.

The results of this study agree with Cuff et al. [5] who concluded that adding resistance training to aerobic training enhanced glucose disposal in postmenopausal women with type 2 diabetes. The improved insulin sensitivity is related to loss of abdominal subcutaneous and visceral adipose tissue and to increased muscle density.

The results of this study also supported by Brankston, et al. [13] who found that resistance exercise training may help to avoid insulin therapy for overweight women with gestational diabetes mellitus.

On the contrary, the results of this study disagree with Stafne, et al. [14] who found that there was no evidence that offering women a 12-week standard exercise program during the second half of pregnancy prevents gestational diabetes or improves insulin resistance in healthy pregnant women with normal body mass indexes.

4. CONCLUSION

In conclusion, Adding resistance exercise to aerobic exercise appears to have a greater effect on improving insulin sensitivity during pregnancy than aerobic exercise only.

CONSENT

All authors declare that ‘written informed consent was obtained from the patient before starting the study for publication of this case report.

ETHICAL APPROVAL

This study was approved by ethical committee of faculty of Physical Therapy, Cairo University.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mizrahi M, Lalazar G, Adar T, Raz I, Ilan Y. Assessment of insulin resistance by a 13C glucose breath test: a new tool for early diagnosis and follow-up of high-risk patients. Nutrition Journal. 2010;27(9):25 DOI: 10.1186/1475-2891-9-25.
2. Ahn K. Insulin resistance during pregnancy. Korean Diabetes J. 2009;33(2): 77-82.
3. Ibanez J, Izquierdo M, Arguelles I, Forga L, et al. Twice weekly progressive resistance training decreases abdominal fat and improves insulin sensitivity in older men with type 2 diabetes. Diabetes Care. 2005; 28:662-667.
4. Lance M, Peter M. Exercise and insulin resistance. Strength and Conditioning Journal. 2011;33(5):40-43.
5. Cuff D, Meneily G, Martin A, Ignaszewski A, et al. Effective exercise modality to reduce insulin resistance in women with type 2 diabetes. Diabetes Care. 2003;26 (11):2977-2982.
6. Trender P. Determination of glucose in blood using glucose oxidase with an alternative oxygen receptor, Ann. Clin. Biochem. 1969;6:24-27.
7. Wallace T, Levy J, Matthews D. Use and abuse of HOMA modeling. Diabetes Care. 2004;27(6):1487-1495.
8. Holt R, Misra S. Diabetes and pregnancy: A practical Approach, Kontentworx, New Delhi. 2012;5.
9. Doshani A, Konjem J. Review: Diabetes in pregnancy: insulin resistance, obesity and placental dysfunction, The Journal of Clinical Endocrinology & Metabolism. 2009;83(7):2338-2342.
10. Levy J, Matthews D, Hermans M. Correct homeostasis model assessment (HOMA) evaluation uses the computer program (Letter).Diabetes Care.1998;21:2191-2192.
11. Avery M, Walker A. Acute effect of exercise on blood glucose and insulin levels in women with gestational diabetes. The Journal of Maternal-Fetal Medicine. 2001;10:52-58.
12. Misra A, Alappan N, Vikram N, Goel K, et al. Effect of supervised progressive resistance-exercise training protocol on insulin sensitivity, glycemia, lipids, and body composition in Asian Indians with type 2 diabetes. Diabetes Care. 2008;31(7):1282-1287.
13. Bankston G, Mitchell B, Ryan E, Okun N. Resistance exercise decreases the need for insulin in overweight women with gestational diabetes mellitus. American Journal of Obstetrics and Gynecology. 2004;190:188-193.
14. Stafne N, Salvesen A, Kjell A, Romundstad R, et al. Regular exercise during pregnancy to prevent gestational diabetes: A Randomized Controlled Trial, Obstetrics & Gynecology. 2012;119(1):29.

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