Multi-Disciplinary Journal
ISSN No- 2581-9879 (Online), 0076-2571 (Print)
www.mahratta.org,editor@mahratta.org

Effect of Strength Training on Blood Glucose Level In Prediabetic Patients

Dr. Bhagyashri Sonawadekar (PT)
Assistant Professor, Department of Physiotherapy
Tilak Maharashtra Vidyapeeth Pune-37
bhagyashreedeore16@gmail.com

Abstract

Background:

Prediabetes is a condition defined as having blood glucose situations above normal but below the defined threshold of diabetes. Prediabetic cases are sedentary and along with increased blood glucose position have redundant adipose mass in visceral region within cadaverous muscle and in liver and have increased cardiovascular threat profile like hypertension. Treatment pretensions for cases with prediabetes include achieving and maintaining optimal blood glucose, blood pressure, and lipid situations in order to help or delay the progression of diabetes. Exercise helps treat the glucose, blood pressure, and lipid abnormalities frequently set up in people with diabetes, and assists with weight loss conservation. Strength training increases glucose uptake and posterior muscle glycogen resynthesize. Exercise intensity is known to greatly impact physiologic functions contributing to glucose regulation and insulin perceptivity independent of changes in insulin. therefore, the strength training exercise demanded to evoke the optimal enhancement insulin perceptivity is unknown. Hence the need for study is to determine the effectiveness of strength training on blood glucose position of Prediabetics.

Aim:

To determine the effect of strength training on dieting blood glucose position in Prediabetics.

Methodology:

Ethical concurrence was attained from the Institutional ethical commission. concurrence was attained from the diabetic conventions where study was supposed to be carried out. Pre evaluation of the subjects was done. Subjects who satisfy the criteria of the study were selected. The pre interposed dieting blood glucose position from 100mg/ dL to 125mg/ dL on all the named subject were noted. As the signed subjects satisfied all the study criteria, they were included in the study. Consequently, 30 subjects were signed for the study on the base of addition criteria and briefed about the same. latterly, a written concurrence was attained from the party in the study. later, 30 actors were enrolled. slice of the subjects was done by simple arbitrary slice. The actors were trained with 20- 30 of intensity which was determined according to the target heart rate, calculated by Karvonen's formula. The intervention period for all party was for 6 weeks. All the actors entered 50 of 1RM resistance training. Once the party achieved the target heart rate the training was terminated. Warm- up for 5- min and the protocol given was leg extension, leg press, casket cover, pull- down, biceps coil and triceps coil, and cool- down for 5- min. Actors were trained thrice a week for 6 weeks with 8 reiterations of each resistance exercises with dumbbells and a rest interval was given for 2 twinkles.

Result

There was significant effect of strength training on dieting blood glucose position of Prediabetics

Conclusion

Strength training was effective for advancements of the blood glucose position and in muscle strength.

Keywords: Prediabetes, fasting blood glucose level, strength training, target heart rate, dumbbells

Introduction

Prediabetes is a condition defined as having blood glucose situations above normal but below the defined threshold of diabetes[1]. Type 2 diabetic cases pass through a phase of disabled glucose forbearance or bloodied fasting glucose known as' Prediabetics state'[2]. Prediabetes increases morbidity and mortality due to heart complaint, stroke, blindness, order failure, bottom problems, and periodontal complaint, and has a significant impact on quality of life [3].

World Health Organization(WHO) has projected the maximum increase in diabetes would do in India by 2030[4]. The International Diabetes Federation(IDF) anatomized that the total number of diabetic subjects to be around40.9 million in India and this is further set to rise to69.9 million by the time 2025[4]. According to the National Urban Diabetes Survey, the frequency of diabetes andpre-diabetes were12.1 and 14, independently[4]

Prediabetes encompasses conventional individual orders of disabled fasting glucose and/ or disabled glucose forbearance but is a band of glucose attention and a temporal phase over a continuum extending from conventional normal glucose forbearance to overt type 2 diabetes. Insulin resistance and imperfect glucose seeing at the β- cell are the central pathophysiologic determinants that together beget hyperglycemia [5]

The World Health Organization (WHO) has defined prediabetes as a state of intermediate hyperglycemia using two specific parameters, impaired fasting glucose(IFG) defined as fasting plasma glucose(FPG) of6.1-6.9 mmol/ L(110 to 125 mg/ dL) and impaired glucose tolerance(IGT) defined as 2 h plasma glucose of7.8-11.0 mmol/ L(140- 200 mg/ dL) after ingestion of 75 g of oral glucose load or a combination of the two grounded on a 2 h oral glucose fortolerance test(OGTT)[6].

Treatment pretensions for cases with prediabetes include achieving and maintaining optimal blood glucose, blood pressure, and lipid situations in order to help or delay the progression of diabetes[3].

Exercise, diet and weight control, are together considered essential for the forestallment and operation of diabetes. Exercise helps treat the glucose, blood pressure, and lipid abnormalities frequently set up in people with diabetes, and assists with weight loss conservation[3].

Two major modes of exercise are aerobic exercise and strength training. Aerobic exercise involves exercises performed with large muscle groups over extended ages involving hundreds of reiterations and limited by the delivery of oxygen to the working muscles[7, 8, 9]. Strength training involves the movement of high loads using resistance from either machines or weights for a lower number of reiterations[7,8,9]. Aerobic exercise has been shown to ameliorate insulin action, detention pancreatic prostration, and may decelerate the progression of prediabetes to class 2 diabetes[10].

Therefore, the resistance exercise demanded to evoke the optimal enhancement insulin perceptivity is unknown.

Need of The Study

Prediabetic cases are sedentary and along with increased blood glucose position have redundant adipose mass in visceral region within skeletal muscle and in liver and have increased cardiovascular threat profile like hypertension.

Studies have delved the relationship between physical exertion and insulin situations unequivocally demonstrate that high situations of sedentary time, low situations of diurnal movement, and little moderate to vigorous physical exertion are associated with poor glycemic control. Insulin resistance is an abecedarian trait of both IFG and IGT, and the inverse relationship between physical exertion and insulin resistance is unstintingly proved in both healthy individualities and those withpre-diabetes. therefore, early life intervention in those withpre-diabetes may represent a window of occasion for health enhancement before the unrecoverable goods of diabetes set in.

Hence the need for study is to determine the effective of strength training on blood glucose position of Prediabetics.

Aims And Objectives

- To determine the effect of strength training on fasting blood glucose level in Prediabetics.

Review of Literature

1. **Nils Swindell et al. (2018)** in the study, 'Objectively Measured Physical Activity and Sedentary Time Are Associated With Cardiometabolic Risk Factors in Adults With Prediabetes: The PREVIEW Study' aimed to examine the association among physical activity (PA), sedentary time (ST), and cardiometabolic risk in adults with prediabetes with participants from eight countries, with a BMI >25 kg · m and impaired fasting glucose or impaired glucose tolerance, where seven-day accelerometry objectively was assessed at PA levels and ST and concluded that in adults with prediabetes, objectively measured PA and ST were associated with cardiometabolic risk markers and total PA was at least as strongly associated with cardiometabolic risk markers as MVPA, which may implied that the accumulation of total PA over the day is as important as achieving the intensity of MVPA.
2. 'Exercise reduces body fat and improves insulin sensitivity and pancreatic β-cell function in overweight and obese male Taiwanese adolescents' by **Kuang-Chung Shih et.al(2018)** studied the impact of exercise training on body fat and insulin sensitivity and secretion in overweight and obese adolescents for a 12-week exercise program on the parameters of adiposity and glucose homeostasis were investigated in 47 overweight and obese male adolescents; and resulted that oral glucose tolerance tests showed reduced glucose and insulin levels at all time points following the exercise training and the subgroup analysis of overweight and obese adolescents with abnormal glucose tolerance revealed that there was no difference in plasma glucose levels as compared to the lean group, however it was concluded that a 12-week exercise training was effective in reducing body fat and improving insulin sensitivity and secretion along with the benefits of the exercise intervention were even experienced by those with impaired glucose tolerance.
3. **Joshua D. Eikenberg et.al (2016)** in this study "Prediabetes Phenotype Influences Improvements in Glucose Homeostasis with Resistance Training", was conducted to determine if Prediabetes phenotype influences improvements in glucose homeostasis with resistance training with older, overweight individuals with Prediabetes completed a supervised Resistance Training program twice per week for 12 weeks. Body weight and composition, strength, fasting plasma glucose, 2-hr oral glucose tolerance, and Matsuda-Defronza estimated insulin sensitivity index (ISI) were assessed before and after the intervention resulted that Chest press and leg press strength increased 27% and 18%, respectively, following the 12-week Resistance Training program, Waist circumference and body fat declined, and lean body mass increased following the intervention. Fasting glucose concentrations did not change following the intervention with the conclusions that Resistance Training without dietary intervention improves 2-hr oral glucose tolerance in individuals with Prediabetes however, the improvements in glucose homeostasis with Resistance Training appear limited to those with Impaired Glucose Tolerance or combined Impaired Fasting Glucose and Impaired Glucose Training.
4. 'Effects of Resistance Training and Endurance Training on Insulin Sensitivity in Non-obese, Young Women: A Controlled Randomized Trial' by **Eric T. Poehlman(2016),** was conducted to examine the possible mechanism related to alterations in insulin sensitivity, with measurement of body composition, regional adiposity, and skeletal muscle characteristics with computed tomography and observed that no changes in total body fat, abdominal adipose tissue, or visceral adipose tissue with endurance or resistance training, Insulin sensitivity, however, increased with endurance training and resistance training with the glucose disposal rate expressed per kg fat-free mass, the improved insulin sensitivity persisted in endurance-trained but not in resistance-trained women and resulted that both endurance and resistance training improve glucose disposal, although by different mechanisms, in young women and an

increase in the amount of Fat-Free Mass from resistance training contributes to increased glucose disposal probably from a mass effect, without altering the intrinsic capacity of the muscle to respond to insulin and they conclude that enhanced glucose uptake after physical training in young women occurs with and without changes in Fat-Free Mass and body composition.

5. **Othmar Moser et. al (2015)** investigated blood glucose (BG) and hormone response to aerobic high intensity interval exercise (HIIE) and moderate continuous exercise (CON) matched for mean load and duration in type 1 diabetes mellitus (T1DM) in their study , 'Effects of High-Intensity Interval Exercise versus Moderate Continuous Exercise on Glucose Homeostasis and Hormone Response in Patients with Type 1 Diabetes Mellitus Using Novel Ultra-Long-Acting Insulin' with seven trained male subjects with T1DM performed a maximal incremental exercise test and HIIE and CON at 3 different mean intensities below and above the first lactate turn point and below the second lactate turn point on a cycle ergometer, during exercise, BG, adrenaline, noradrenaline, dopamine, cortisol, glucagon, and insulin like growth factor-1, blood lactate, heart rate, and gas exchange variables were measured and 24 h after exercise, interstitial glucose was measured by continuous glucose monitoring system where they found no differences for post-exercise interstitial glucose, acute hormone response, and carbohydrate utilization between HIIE and CON for first lactate turn point.
6. **Robin M Daly et al. (2014)** in this study "The effects of progressive resistance training combined with a whey protein drink and vitamin D supplementation on glycemic control, body composition and cardio metabolic risk factors in older adults with type 2 diabetes" upon the community-based progressive resistance training program to evaluate whether ingestion of a whey-protein drink combined with vitamin D supplementation can enhance the effects of progressive resistance training on glycemic control, body composition and cardio metabolic health in older adults with type 2 diabetes and found that the increase muscle mass, size and intramuscular fat; fat mass; muscle strength and function; blood pressure; levels of lipids, adipokines and inflammatory markers, serum insulin-like growth factor-1 and 25-hydroxyvitamin D; renal function; diabetes medication; health-related quality of life, and cognitive function.
7. An observational study by **Sheri R. Colberg** et.al, **(2013)** 'Blood Glucose Responses to Type, Intensity, Duration, and Timing of Exercise' examined the physical activity with the Big Blue Test (BBT) which was an annual initiative by the Diabetes Hands Foundation for raising awareness of the importance physical activity of in managing diabetes where individuals with diabetes voluntarily exercise and record self-monitored blood glucose levels, 5,157 diabetic participants anonymously entered exercise type, intensity, duration, time elapsed since last meal, and blood glucose readings before and after one or more bouts of exercise separately through www.BigBlueTest.org or an iPhone app,where the exercise choices given as were walking, running/jogging, cycling, conditioning machines, dancing, with intensity as moderate or vigorous, time of exercise after the last meal was 30 min and 1, 2, or ≥3 h ago and concluded that , varying types, intensities, and durations of exercise generally lower blood glucose levels in most individuals, although exercise of longer duration is likely most effective, and elapsed time since eating should be considered.

Materials And Methods

A) Study Design

- Type of study design: Interventional study
- Setting (location of study): Various clinics
- Duration of the study: 6Months

B) Sample Design

- Sample size: 30

- Sample population: 30-45 years of Prediabetics patient.
- Type of sampling: Simple random sampling (by Alternate Allocation)

C) Inclusion Criteria:

- 30-45 years age [11]
- Male and female
- Diagnosed Prediabetes within 144hours [12]
- Fasting Blood glucose level: 100-125mg/dL [6]

D) Exclusion Criteria:

- Current Insulin therapy
- Hypertensive
- Any Neurological, Musculoskeletal and any other Endocrinological disorder.
- Exercise regularly

E) Materials

- Pen
- Paper
- Dumbbells
- Chair
- Foam mattress

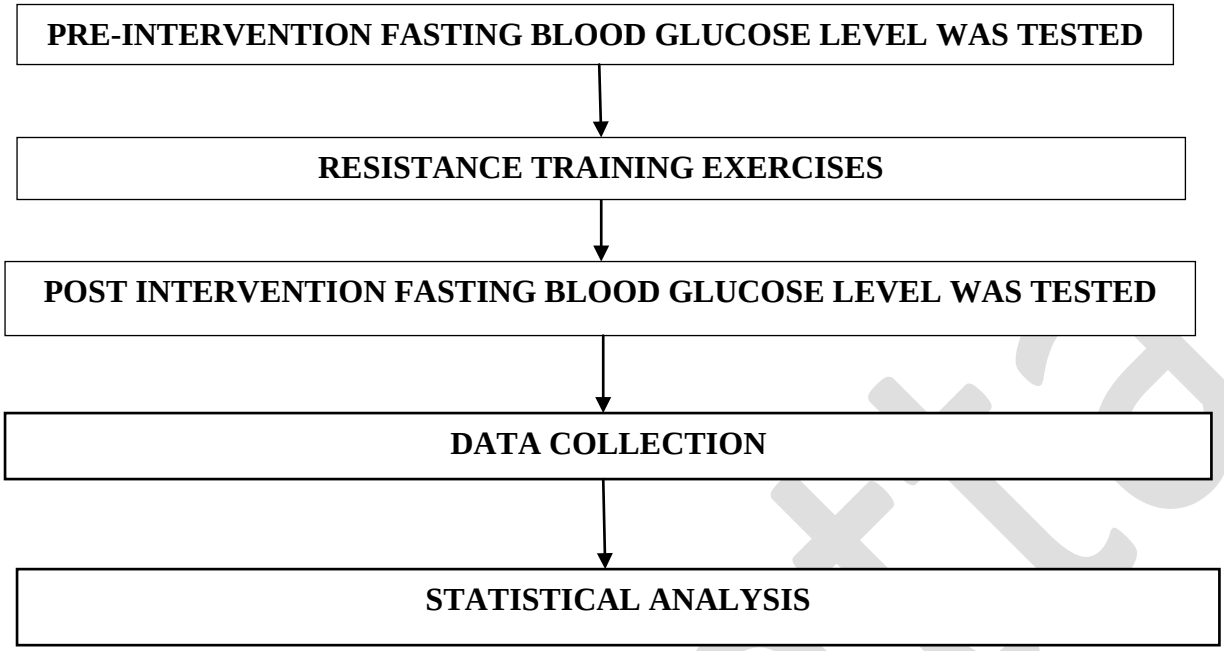
F) Methodology

Ethical clearance was obtained from the Institutional ethical committee. Consent was obtained from the diabetic clinics where study was supposed to be carried out. Pre evaluation of the subjects was done. The pre intervened fasting blood glucose level from 100mg/dL to 125mg/dL on all the selected subject were noted. As the recruited subjects satisfied all the study criteria, they were included in the study. Accordingly, 30 subjects were recruited for the study on the basis of inclusion criteria and briefed about the same. Later, a written consent was obtained from the participant in the study. Sampling of the subjects was done by simple random sampling.
The intervention period for participants was for 6 weeks.

Exercises prescription

- **Warm-up -** 5-min with six chair stands and a 1-min brisk walk around the exercise facility [13]
- **Types of exercises** [14]:
    - Biceps curl,
    - Triceps curl,
    - Leg extension,
    - Leg press,
    - Chest fly,
    - Pull-down,
- **Cool-down** -5-min with flexibility and stretching exercises[13]
  Frequency: thrice a week for 6 weeks [15]
  8 repetitions of each resistance exercises [15]
  Rest interval: 2 minutes [15]
  Dumbbells were used for resistance training [15]

G) PROCEDURE



H) Outcome Measure:

Fasting blood glucose level:
The fasting blood glucose level was checked, pre and post intervention.
The fasting blood test was done, where the patient didn't consume anything except water for at least 8 hours before the test.

Data Analysis And Interpretation

The study included 30 prediabetes participants aged 30-45 years and their pre post blood glucose level was studied. All the participants underwent a pre assessment to assure a safe participation into the training. The training was carried out 3 days/week.
The data collected was statistically analyzed using Microsoft Excel sheet and Primer of Biostatistics Version 7.0
Effect of dose response alteration in resistance training on blood glucose level in Prediabetics was analyzed using appropriate parametric and non- parametric tests.
The various statistical measures such as Mean, Standard Deviation (SD) and test of significance were utilized to analyze the data. The results were concluded to be statistically significant if, $p<0.005$. The data was represented in both tabular and graphical format.

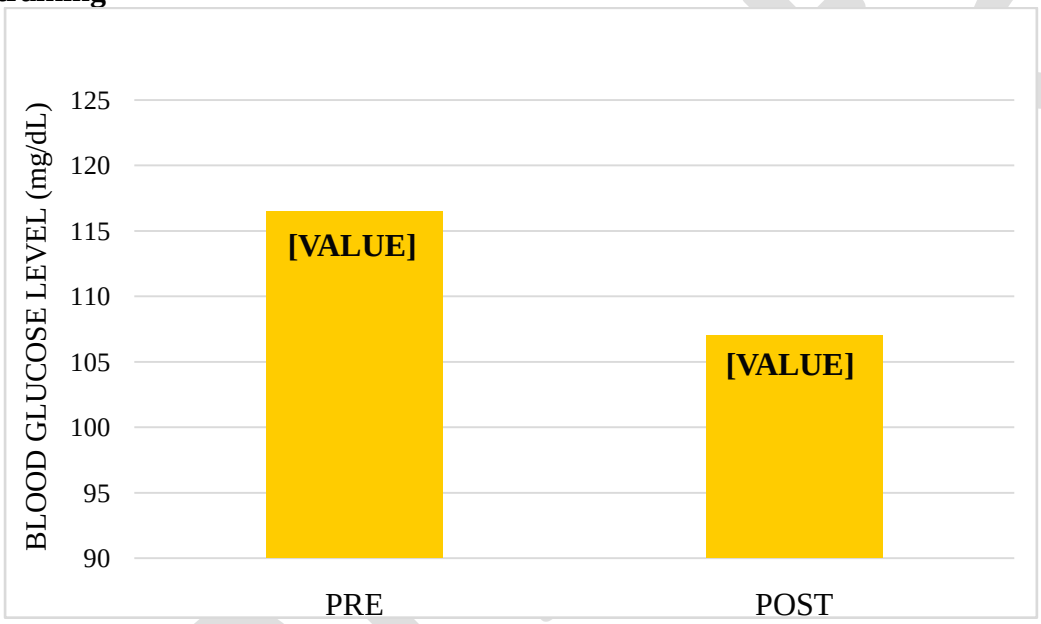
Results

Total 30 participants of age group 30-45 years were included in the study and have completed the 6 weeks of resistance training.

Table 1: Comparison of pre and post blood glucose level in resistance exercises training

Parameter	Pre test		Post test		t Value	p Value	Result
	Mean	SD	Mean	SD			
Blood glucose level (mg/dL)	116.5	5.489	107	8.583	5.129	p = 0.000	Significant

Graph 1- Bar diagram showing comparison of pre and post blood glucose level in resistance exercises training



Inference- the above table and graph shows the comparison of pre and post blood glucose level values in resistance exercises training group. Blood glucose level values significantly reduced from 116.5 mg/dL to 107mg/dL as p value <0.005.

Discussion

The primary findings of this research showed that resistance exercise performed and there was improvement in blood glucose level for age group of 30-45 years amongst Prediabetes participants. All the participants who performed pre intervention fasting blood glucose test showed increased blood glucose level which were improved post intervention. The differences in the blood glucose values were likely due to the specific adaptations that resulted from resistance training. The blood glucose level are comparable with previous findings involving Prediabetics as the training program resulted in significant improvements in the blood glucose levels.

In present study, significantly improved blood glucose level by difference of 8.4 following the resistance training protocol of 6 weeks($p<0.005$). The most possible reason for reduced blood glucose level was that resistance training significantly improved glycemic control, increased fat free mass, reduced the requirement for diabetes medications, reduced abdominal adiposity and systolic blood pressure, and increased muscle strength and spontaneous physical activity [(16)]

Subjects who participated in training program of all the three groups made improvements on blood glucose levels from 118.1mg/dL to 110.2mg/dL in resistance training group($p<0.005$). This also suggests that participants respond to resistance training by improving their ability to perform at strength and endurance events.

During resistance exercises the increased glucose uptake by muscle is balanced by an equal rise in hepatic glucose production, and blood glucose levels remain unchanged. There is a decrease in insulin level, which sensitizes the liver to glucagon, thus increasing glucose production [3, 17] With prediabetes, blood glucose uptake by muscles usually increases more than hepatic production. This is also normally accompanied by a decline in plasma insulin levels, greatly reducing the risk of hypoglycemia in diabetics not using insulin or insulin secretagogues [3, 17].
Studies had demonstrated that exercise/muscle contraction mediated glucose transport is proportionate to the magnitude of G LU T-4 translocation to the plasma membrane. The mechanism by which muscle contraction may activate glucose transport appears to involve the initiation of a contraction signal. Possible reasons for this initiation could include: release of calcium, activation of AMP-activated protein kinase, and nitric oxide activity. An explanation for the improved glucose tolerance and insulin response following the high intensity training could be the magnitude of muscle contraction involved [18].
Therefore, we have demonstrated that a 6- weeks of resistance training program 3 days per week was safe and well tolerated by Prediabetics participants. Whereas, the resistance training was effective for improvements of the blood glucose level and in muscle strength.
In summary, regular participation in a strength training program can make an important contribution in maintaining the normal blood glucose level and the further chances of diabetes can be prevented. The present study provides promising results in improving blood glucose level with the help of resistance training progra

Conclusion

The present study provides results in improving blood glucose level with the help of resistance training program.
Hence on the basis of the results of the present study, we conclude that resistance training program was effective on fasting blood glucose level of Prediabetics.

Future Scope

1. Effect of metabolic responses following resistance exercise when variables such as the duration of exercise, mode of resistance exercise, active muscle mass, and type of subjects on blood glucose level can be done.
2. Effect of dose response alteration in resistance training on blood glucose level and endurance in Prediabetics can be carried out
3. Effect of dose response alteration in resistance training on blood glucose level and BMI in prediabetes.

References

1. Smutok MA, Reece C, Kokkinos PF, Farmer CM, Dawson PK, DeVane J, et al. Effects of exercise training modality on glucose tolerance in men with abnormal glucose regulation. Int J Sports Med. 1994;15(6):283–9. doi: 10.1055/s-2007-1021061 . [PubMed]
2. Bhansali A, Dutta, et.al Pathophysiology of prediabetes. P J Indian Med Assoc. 2005 Nov;103 (11):594-5, 599.
3. O. Peter Adams,et.al The impact of brief high-intensity exercise on blood glucose levels, Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy 2013:6 113–122
4. Gillies CL, Abrams KR, Lambert PC, et al. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. BMJ. 2007 Feb10;334(7588):299
5. Ferrannini E1, Gastaldelli A, IozzoP , et.al Pathophysiology of prediabetes. 2011 Mar;95(2):327-39, vii-viii. doi: 10.1016/j.mcna.2010.11.005.

6. Nidhi Bansal,et.al Prediabetes diagnosis and treatment: A review, World J Diabetes 2015 March 15; 6(2): 296-303 DOI:10.4239/wjd.v6.i2.296
7. Q. Wang and T. Jin, "The role of insulin signaling in the development of β-cell dysfunction and diabetes," Islets, vol. 1, no. 2, pp. 95–101, 2009.
8. W. L. Haskell, I. M. Lee, R. R. Pate et al., "Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association," Medicine and Science in Sports and Exercise, vol. 39, no. 8, pp. 1423–1434, 2007.
9. Richard J.Wood and Elizabeth C. Resistance Training in Type II DiabetesMellitus: Impact on Areas ofMetabolic Dysfunction in SkeletalMuscle and Potential Impact on Bone,Hindawi Publishing Corporation Journal of Nutrition and Metabolism Volume 2012, Article ID 268197, 13 pages doi:10.1155/2012/268197.
10. Laurie e. Black, pamela d. Swan, and brent a. Alvar , et.al effects of intensity and volume on insulin sensitivity during acute bouts of resistance training . Journal of Strength and Conditioning Research 24(4)/1109–1116
11. Ramachandran A, Snehalatha C, Kapur A et al. (2001) High Prevalence of diabetes and impaired glucose tolerance in India. National Urban Diabetes Survey. Diabetologia 44:1094–1101
12. ZhaoweiKong, et.al ComparisonofHigh-IntensityInterval Training and Moderate-to-Vigorous Continuous Training for Cardio metabolic Health and Exercise Enjoyment in Obese Young Women:A Randomized Controlled Trial DOI:10.1371/journal.pone.0158589 July1,2016
13. Ivy, J.L. et.al Role of Exercise Training in the Prevention and Treatment of Insulin Resistance and Non-Insulin-Dependent Diabetes Mellitus November 1997, Volume 24, Issue 5, pp 321–336 Sports Med (1997) 24: 321. doi:10.2165/00007256-199724050-00004
14. Richard A.Winett,et.al Theory-based approach for maintaining resistance training in older adults with prediabetes: adherence, barriers, self-regulation strategies, treatment fidelity, costs doi:10.1007/s13142-015-0304-5
15. Adeyanju, K., T. R. Crews, And W. J. Meadors. Effects of two speeds of isokinetic training on muscular strength, power and endurance. J. Sports Med. 23:352–356, 1983.
16. Castaneda C, Layne JE, Munoz-Orians L, Gordon PL, Walsmith J, Foldvari M, et al. A randomized controlled trial of resistance exercise training to improve glycemic control in older adults with type 2 diabetes. Diabetes Care. 2002;25(12):2335–41. . [PubMed]
17. Errol B. Marliss and MladenVranic,Intense Exercise Has Unique Effects on Both Insulin Release and Its Roles in Glucoregulation,Implications for Diabetes, DIABETES, VOL. 51, SUPPLEMENT 1, FEBRUARY 2002
18. Miller, Andrew Dustin,et.al "Effects of high intensity/low volume and low intensity/high volume isokinetic resistance exercise on postexercise glucose tolerance" ,University of Montana Scholar Works at University of Montana Student Theses, Dissertations, & Professional Papers.(2002) 6614. https://scholarworks.umt.edu/etd/6614