



## Is High Intensity exercise Training Among Type II Diabetic Mellitus a Boon in Diabetic Care?

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### Abstract

**Introduction:** *Diabetes mellitus type II forms major among non communicable diseases worldwide causing greater disability and impact on economy of individual and society physical activities, particularly hi intensity exercises are emerging area where more research are required.*

**Amis & Objectives** *of this monograph presentation was to critically analyse the impact of hi intensity resisted exercises among type II diabetic subjects.*

**Materials & Methodology:** *6 type II diabetic subjects were treated with single session of high intensity resisted exercises. The subjects post parandial blood glucose was analyzed with statistical means*

**Results:** *highly significant statistically  $P < .001$*

**Conclusion:** *with various limitations with high intensity exercises, needs further scientific validation and research for its effect on sustaining of glycemic control among researchers academicians was mainly emphasized as key outcome of this monograph report.*

**Keywords:** *Hba<sub>1c</sub> – Glycated Hemoglobin, GLUT4 - Glucose Transporter Type 4, Quality of life, HIE – High Intensity Exercises, Physical Exercises, RCT – Randomized Control Trial, FG- Fasting Glucose.*

### Introduction

1. Diabetes is a chronic disease nearly all countries with, an estimated 28 billion adults with diabetes in 2010, this number will continue to increase globally due to ageing population, growth of population size, urbanization and high prevalence of obesity and sedentary lifestyle (Shaw et al 2010)
2. Diabetes leads to both premature death and complications such as blindness, amputations, renal diseases and cardiovascular diseases (Zhang et al 2010).
3. 150 minutes of moderate to vigorous intensity exercises each week was recommended for physical activity among type II diabetes (Colberg et al 2010)
4. (Canza et al 2005) have reported a greater reduction in 24 hour in average blood glucose concentration following 4 months of resistance training compared with endurance training in individuals with type II diabetes using continuous glucose monitoring.

**Aims & Objectives** of this original research was a to analyse the impact of hi intensity resisted exercises among type II diabetic mellitus.

### **Role of Physical Exercises in Type II Diabetes**

Exercise training whether resistance (Lee et al 2002) or endurance (Terada et al 2001) leads to increased muscle GLUT4. This increase in GLUT4 probably contributes to the increased capacity for insulin stimulated glucose transport in trained subjects.

- 1) Resistance exercise has greater propensity than aerobic exercise to increase muscle mass and there by glucose storage space (Stratton et al 2006). Hence one of the main factors explaining its effect on glucose disposal (Holten et al 2004) metabolic adaptations to regular physical activity depend on intensity, duration, frequency and mode of exercises and the characteristics of individual like the presence of disease, fitness and genetic determinates.
- 2) Adaptations to endurance exercise enable the muscle to use or and blood borne fuels, where as those for resistance exercises lead to improved force generation (Koranyi et al 1991)
- 3) Boule et al 2001 in a systematic review on the effects of structured exercise intervention in clinical trials of 8 week on hba<sub>1c</sub> and BMI among type II diabetes, twelve studies on aerobic training and two resistance training have shown lowering of hba<sub>1c</sub> with exercises but body weight did not differ.
- 4) Boule et al 2003 have established in a meta analysis on the exercise intensity with 50 – 70% of VOZ max has greater influence on lowering of hba<sub>1c</sub>.
- 5) Wei et al 2000 among 1,263 type II diabetic men between 1970 to 1993 have reported that moderate cardio respiratory fitness was associated with lower mortality.

### **Weight Loss with Exercises**

Diet, exercise behavior modification have produced in a 20 weeks programme with 9-13.6 kg weight loss and 60% o this weight loss was maintained in a 1 year follow up (Wing et al 2002)

- Exercise alone, could produce moderate weight loss of 2 kg, in a RCT, with high volume aerobic exercise of 1 hour / day produced at least as much fat loss as the equivalent degree of caloric restriction and exercise induced weight loss resulted in greater improvements in insulin sensitivity than diet induced weight loss (Ross et al 2000)
- More volume of exercises are needed for sustained major weight loss than to achieve improved glycemic control and cardiovascular health (Klem et al 1997) where in one year follow up 13.6 Kg was lost with 7 hours of weekly moderate intensity exercises (Weinsier et al 2002)
- ACSM recommends resistance training among adults ACSM 1998 and adults with type II diabetic mellitus (Albright et al 2000) as with increased age, there is a progressive decline in muscle mass leading to sarcopenia, decreased functional capacity, increased adiposity and increased insulin resistance where resistance training can have a major positive impact on these (ACSM 1998)
- Type II diabetic mellitus should be encouraged to perform resistance exercise thrice a week, including all major muscle groups progressing to three sets of 8-10 repetitions to maximise health benefits with guidance and supervision by a qualified exercise specialists (Dunstan et al 2002)
- A grade evidence that people with type II diabetic mellitus should be encouraged to perform resistance training twice per week (Colberg et al 2010)
- Progressive resistance exercise improves insulin sensitivity in older men with type II

diabetic mellitus to a greater extent than aerobic exercise

- Stronger evidence for lowering of A1C lowering value of resistance exercise in older adults with type II diabetic mellitus were recorded by (Sigal et al 2004)
- Exercise helps to treat the glucose, blood pressure, and lipid abnormalities often found in people with diabetes and assists with weight loss maintenance (Col Berg et al 2010)
- Treatment goals for patients with diabetes include achieving and maintaining optimal blood glucose, blood glucose and lipid levels in order to prevent or delay the prognosis of chronic complications (ADA 2012)
- HIE requires a high level of motivation, and often sessions are supervised, with significant verbal encouragement to exert maximal effort (Irg 06 2010) and even a very fit person can usually maintain an intensity of >80% VO<sub>2</sub> max for only 10-15 minutes. The exercise load needed depends on the individuals exercise capacity (Gaesser et al 2011)

### **Mechanism of High Intensity Exercises on Glycemic Control**

Mechanisms mediating the improvements in glycemic control following HIT remain undetermined. As short exercise intervention is unlikely to have substantial changes in body composition (Little et al 2011).

Reduced mitochondrial capacity in skeletal muscle has reported in insulin resistance and type II diabetes (Ritov et al 2005 ) and muscle oxidative capacity has been shown to be a significant predictor of insulin sensitivity ( Bruce et al 2003) .

Hence, rapid increase in skeletal muscle mitochondrial content following low volume HIT may a contributing factor related to reduced IR and improved glycemic control.

But, mitochondrial deficiency mediates IR has been questioned (Holloszy2009) indicating that

other adaptations in skeletal muscle may be more independent.

Studies on rodents have proved that exercise induced increased GLUT4 protein is directly related to the increase in muscle glucose uptake at any given insulin concentration (Ren et al 1994 ) and endurance exercises improves hepatic insulin signaling and glycemic control (Wallace et al 2002)

Also the mechanism through which aerobic and resistance exercise increase glucose disposal are similar (Holten et al 2004). In sustained exercises as in aerobic exercises, a decrease in insulin secretion, increases in glucagon, catecholamine's , cortical secretion are observed (Koyama et al 2001), moderate intensity aerobic exercise induced increment in glycogen stimulates glycogenolysis and gluconeogenesis (Waserman et al 1992) which further stimulates hepatic amino acid metabolism and fat oxidation (Kri et al 2011). With every intense aerobic exercises (>80% VO<sub>2</sub> max) important role, where not epinephrine and epinephrine levels rise by 15 fold, glucose production rise by 7 folds (Sigal et al 1996)

### **Salient features in support of HIT**

Majority of individuals does not accumulate significant exercise to achieve help benefits of 150 minutes of weekly physical activities (Colberg 2010) and the most common cited barrier to regular exercise is lack of time (Trost et al 2002) hence low volume HIT may be a viable time – efficient strategy to improve health in patient in type II diabetes (Little et al 2011)

Rubin et al 1999 in a systematic review on quality of life and diabetes have recorded that

- a) Quality of life represents the ultimate goal of all health interventions.
- b) People with diabetes have a worse quality of life than people with non-chronic illness, but a better quality of life than people with most other session's chronic diseases.
- c) Duration and type of diabetes are not constantly associated with quality of life.

- d) Having better glycemic control is associated with quality of life.
- e) Demographic and psychosocial practice influence quality of life of improving health status and perceived ability to control disease improves their quality of life.

### Methodology

6 known type II diabetic subjects of both sex (Male n: 3 Female n: 3) Chennai, where this research was conducted were included in this study. With mean age of 50 years, and mean BMI of 25 kg/m<sup>2</sup> all of the subject has sedentary life style with minimum duration of 5 years as diabetic on medication with metformin.

All the subjects consent was obtained, due ethical committee clearance was processed and the participants were blind folded of the study purpose and outcome.

Participants post prandial blood glucose on a normal day by 4 p.m as their routine lunch was at 2 p.m were evaluated and recorded and to be treated as control group. Same subjects were treated (Experimental Group) next day with high intensity resisted exercises using an air inflated physioball. A set of 15 exercises with 3 repetition and rest interval in between were used. Duration of the session was 20-25 minutes, 2 hours after breakfast.

### Results

All the subjects PPBG was evaluated by 5 p.m tabulated and analysed using due statistical means

Means PPBG mg/100 ml		SD	SE	t	p
Experimental	Pre	197	9.80	4	<.001
	Post	173		6	

Exercises were performed at intensity of 60-65% of VO<sub>2</sub> maximal heart rate and no hypoglycaemic incidents were reported, but all the subjects have reported with exhaustive state the next following two days. While the intensity was based on heart rate, which was recorded manually with population on left radial artery of each subjects.

An interval of 2-3 minutes of rest periods were given and that varied among subjects while 3 out of the 5 study subjects had knee neck and shoulder (Musculoskeletal Ailments) were able to perform HIE without exacerbating their physical ailments.

### Discussion

- 1) In a high intensity exercise study at 75% of VO<sub>2</sub> max thrice a week for 55 minutes, a lowering of hba<sub>1c</sub> by 1.5% and 48% decline of abdominal visceral fat and abdominal subcutaneous fat by 18% among exercise group with magnetic resonance imaging was reported (Maurer et al 1997)
- 2) Eriksson et al 1992 among 8 obese aged 55 +9 years type II diabetic mellitus in a 3 month study with moderate intensity resistance exercise have recorded .6% decreased in hba<sub>1c</sub>
- 3) Ishii et al 1998 among 9 non obese type II diabetic mellitus middle aged type II diabetic mellitus with 6 weeks of high volume moderate intensity weight training where hba<sub>1c</sub> decreased by 2%
- 4) Dunstan et al 1998 among 27 type II diabetic mellitus of 8 weeks moderate resistance training with no effect on hba<sub>1c</sub>, have reported that 3-6 months of training are required for clinically significant muscle hypertrophy
- 5) Dunstan et al 2002 among 36 Australian obese type II diabetic mellitus aged between 60-80 years to 6 months of moderate weight loss plus high intensity resistance training recorded hba<sub>1c</sub> drop by 1.2% and .5 kg weight loss.
- 6) Castenda et al 2002 among 62 sedentary subjects of both sex with mean age of 66 years treated with high intensity resisted exercises recorded 1.1% decreased in hba<sub>1c</sub>.
- 7) With high intensity exercise with 10 minutes of 85% of VO<sub>2</sub> max in the post abortive state is known to cause an

increase in counter regularly hormones and glucose in type II diabetes (Kjaer et al 1990)

- 8) Castenda et al 2002 have shown with high intensity resistance training a reduction of hba<sub>1c</sub> by 1.2% in a 16 week RCT among 62 adults with type II diabetic mellitus have recommended further studies with diet and life style interventions along with resistance exercises.
- 9) Hi intensity interval training which involves repeated bursts of vigorous exercises interspersed with periods of rest may be an attractive option to implement higher intensity exercise training in type II diabetic mellitus (Little et al 2011)
- 10) Two weeks of low volume HIT has been shown to improve glucose tolerance (Babraj et al 2009) improve glucose tolerance and enhance insulin sensitivity in healthy adults (Richards et al 2010)
- 11) Peter Adams 2013 have in a meta analysis of 6 studies on high intensity exercises on blood glucose levels among non diabetes in two weeks have increased insulin sensitivity up to 3 days post intervention. Six single exercise session studies with 13 minutes of HIE among type II diabetic mellitus subjects, an improved PPBG for 24 hours, while 2 week program reduced the average BG by 13% at 48-72 hours after exercise and also increased GLUT4 by 369%
- 12) Richards et al 2010 among young adult subjects with 2 weeks exercise of 6 sessions of HIE, improved insulin sensitivity but not fasting blood glucose.
- 13) Babjaj et al 2009 have estimated 48 to 72 hours after the intervention with NIE with an improved insulin sensitivity among health adults.
- 14) Burgomaster et al 2007 have demonstrated that SIT (Sprint Interval Training) increased muscle GLUT4 by 20% and that

levels remained elevated with 5 weeks of training and 6 weeks of detraining.

- 15) Nybo et al 2010 have found 20 minutes of HIE per week for 12 weeks in improving FBS
- 16) A single session of continuous HIE resulted in 60 minutes of post exercise hyper glycaemic (Kjaer et al 1990) while both a single session of HIT and a 2 week training program have been shown to improve PP control over 924 hour period post exercise (Little et al 2011)
- 17) Kjaer et al 1990 recorded the 5 minutes of NIE on blood glucose control for 3 hours immediately post exercises among type II diabetic mellitus
- 18) Guelfi et al 2005 have recorded that HIT with single session suggest decreased risk of post exercises hypo glycaemia among insulin dependent type II diabetic mellitus. (Cullen et al 2012) have analyzed HIT on 7 adults with 2 D with continuous glucose monitoring for 24 hours on two days on following acute HIT and on a non-exercise control day. They have recorded HIT reduced hyperglycemia and post prandial hyperglycemia was also lower among HIT than non-exercise day among the same subject. (Little et al 2011) have on 8 Type II diabetes with 68 +/- 8 years age and BMI 32 +/- 6 kg / m<sup>2</sup> and HBA<sub>1C</sub> 6.9 +/- 0.7 % analyzed the effect of 6 sessions of HIT at 90% on H.R over 2 week, with continuous glucose monitoring have found an increased muscle mitochondrial capacity thus evidencing that low volume HIT reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type II diabetes mellitus.

#### **Critical Analysis of this research**

- How far hi intensity exercises can be used to improve glycaemic control?

Through HIE were proven to have an impact of (Little et al 2011) PPBG and FBG (Sandvei et al 2012) Further studies of NIE on hba<sub>1c</sub> needs to be evidenced for stronger validation

Is it safe among diabetic subjects with musculoskeletal injuries?

Both the risk of musculoskeletal injury and cardiovascular complications have to be considered (Adams 2013)

- Does any diabetic subject can perform HIE?

Unlike moderate intensity exercise, high intensity exercise decreases the risk of hypoglycaemia during and immediately after exercise in diabetic patients and a cardiac evaluation may be required when presence of coronary artery disease there (Nagi et al 2010)

IS supervision required for HIE to maximise health benefits, minimise the risk of injury, initial supervision and periodic re assessments by a qualified exercise specialist are recommended (Dunstan et al 2002)

Cost effectiveness of HIE, how four economical?

The cost of exercising with HIT and the provision of facilities (Equipment, Supervision and Gyms) if taken care shall have a mass impact (Adams 2013)

- Time saving mode of physical activity?

Gabala et al 2008 recent evidence suggests that among young adults healthy of average fitness intense interval exercise is a time. Efficient strategy to stimulate a number of skeletal muscle adaptations that are compared traditional endurance training. Potency of HIT to induce rapid changes in exercise capacity and skeletal muscle metabolism (Gabala et al 2012) as HIT in two weeks of six sessions indicated with HIT increased capacity for fat oxidation (Talanian et al 2007) 30-60 minutes of moderate intensity exercises on most of the weeks days are recommended for improving health status with physical activity. But HIT, mode of exercise prescription, that yields benefits with minimal time commitments represents a potentially valuable approach to increasing population activity levels and their health

- Is HIE all subjects can do?

As with any exercise prescription, prior medical screening and fitness tests should be due level of physical activity, family history of systemic

illness, drug history musculoskeletal ailments, anthropometric parameters and attitude for doing exercises and improve ones health all of which should be considered prior to HIE training

Is HIE a boon in diabetic care HIE with its high impact nature can have an effect on bone mineral density (Gunczler et al 1998) and increased insulin action in skeletal muscle among type II diabetic. With 30 minutes of thrice a week frequency, hence with increased muscle mass and reduced body fat, lesser time frame is really a boon in preventive as well therapeutic means among type II diabetic mellitus.

Evidenced research available for in favour of HIE Single sessions of HIT, with light studies on diabetics were reviewed by Adams 2013, have reported an improved PPBG and two weeks program in six sessions reduced PPBG by 13%. However further evidenced studies with NIE on glycemic control with an improved hba<sub>1c</sub> is required

- Future HIE?

High intensity exercises on blood glucose were available among diabetic population, but to sustain their effects on hba<sub>1c</sub> needs further longer duration study, with larger sample size diabetic population of various ethnic background, influence of medication, effects on weight loss, needs more RCT for further validation of this research findings and holds the future of HIE on diabetic patients.

Also RCT among non diabetic population on sustaining of insulin sensitivity will hold the key for diabetic prevention, mainly among those with impaired glucose tolerance at pre diabetic subjects will benefit at large.

#### **Need and Scope of This Research Presentation**

- 1) Physical exercises and scientific prescription of physical activity needs more practical approach as for India is concerned.
- 2) As not much diabetic rehabilitation centers, specific researches in physical therapy for diabetic subjects were

available in a country with huge diabetic subject.

- 3) This country with maximum diabetic population, spends 1% of the global diabetic expenditure, so revamping, and more focus on this diabetic health care economy needs revisited.
- 4) Needs a shift in practice from routine advice by diabetologist and physician towards just go for a regular walk to exercise prescription by qualified physiotherapist.
- 5) Preventive means of combating obesity, at school, college levels, behavioral changes in eating habits which requires curriculum planning, cultivate physical activities at adolescent ages.
- 6) Academicians and researches in diabetic health care should take stalk with evidence for various modes of physical activities such as aerobic, resisted exercises, swimming, yoga needs more standardization with Indian life style.
- 7) This emerging area using high intensity exercises in the diabetic care which is time conserving, once mastered can be self manging skill nature, needs more research and acceptance by scientific community, hence various angles of hi intensity with research reports are discussed in this original scholarly presentation and huge scope with need with outcome of this report are expected.

### Executive Summary

Diabetic mellitus, a metabolic disorder and a chronic nature with huge impact an various systems of the body diminishing quality of subject, family and also the economy of the society.

This original research where reports of hi intensity exercises among diabetic subjects on lowering post parandial blood sugar. As an emerging area, where this form of exercises may hold key in diabetic management, physical exercises such as aerobic, resisted exercises on diabetic care are

discussed with research reports. Also the ACSM, ADA guidelines on exercises for diabetic patients were emphasized. Mechanism and salient features of HIT were elaborately discussed with evidence.

As major outcome of this critical questioning on various aspects of hi intensity exercises are discussed for scholarly up graduation of this innovative physical therapy means for diabetic rehabilitation.

### Conclusion

Need of this academic report is with India as diabetic capital, more care towards identification of unknown and undiagnosed diabetic subjects, with due treatment is required. With preventive means of life style modification involving diet, exercises, promote regular walking and eating behavioural changes are to be vehemently implemented at family, among health care professionals and at large by policy planners. These efforts shall save our future citizens health from life style disorders and also country's economy. Presentation of this emerging high intensity exercises conserves time, self managing skills and in subject's control, thereby with good adherence not only control of diabetic, but adds a lot to his quality of life, family and to society.

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