EFFECT OF ONE –TIME PASSIVE STRETCHING IN LOWERING BLOOD GLUCOSE LEVEL IN POPULATION PRONE FOR TYPE II DIABETES MELLITUS

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INTRODUCTION:

It is possible to prevent or delay the onset of Type 2 diabetes by reducing life style risk factors through moderate weight loss and increased physical activity. Several studies have shown that life style changes that included exercise can significantly delay and possibly prevent diabetes.(Tudor – Locke et al 2000, Wei et al 2000). Moreover, in people with Type 2 diabetes using insulin, a single bout of light exercise significantly reduces the prevalence of hyperglycemia during the subsequent day by about 40 % (Manders et al 2010). Also, considerable amounts of data have accumulated showing that muscle contraction triggers glucose uptakes (Dohm 2002,Henriksen 2002). In contrast , if good glucose control is not achieved over time, prolonged hyperglycemia can lead to negative and severe outcomes such as retinopathy, nephropathy, neuropathy, cardio vascular disease, stroke, pressure ulcers, neuropathic wounds, loss of peripheral protective sensation, gangrene, limb amputation, and finally death.

Notwithstanding the benefits derived from regular exercise, there are many people with Type 2 diabetes in **INDIA** who do not exercise. For some individuals, the secondary complications arising from diabetes (e.g., lower limb neuropathies, lower limb amputation, hypertension, kidney diseases, and retinopathies) can either contraindicate exercise or make it more difficult. Also, many elderly people with Type 2 diabetes residing in extended care facilities are either extremely frail, wheel chair bound, or bed bound, and do not have sufficient physical work capacity to exercise aerobically and thus have problems maintaining glycemia (Zarowitz et al 2006).

Passive static stretching of the skeletal muscles may be a modality that could accrue the benefits of exercise without its accompanying physical stress. Passive static stretching occurs when sustained tension develops with in a person’s muscle through actions performed by an outside source. Several studies, using either cell culture or isolated animal muscles, suggest that passive stretching of a person’s muscle could result in increased cellular glucose uptake.

Hatfaludy and colleagues (1989) exposed cultured avian pectoralis muscle cells to repetitive cycles of stretch and relaxation. After four hours, uptake of a marker of tissue glucose use ([3H] deoxy-D-glucose) increased 34%. Similarly, Mitsumoto and colleagues (1992) subjected L6 muscle cells to 24 hours of intermittent stretch and relaxation (25% maximum elongation after 30 cycles per minutes), and saw as much as a 2-fold increase in glucose marker (2-deoxy-D-glucose) uptake. Also, Iwata and colleagues (2007) reported increased glucose marker (2-deoxy-D-gluocose) uptake in mechanically stretched cultured C2C12 myotubes, which they attributed to a Ca++-dependent mechanism.

Correspondingly, using isolated muscle, Ihlemanm and colleagues (1999) stretched soleus muscles in Rats passively for five minutes, and found a 50% increase in uptake of the same glucose marker (2-deoxy-D-gluocose). Lastly, in an *in situ* study, Nie and colleagues (2000) reported an increase in glucose transporters (GLUT 1) in denervated hemidiaphragm. They postulated that the increase in the glucose transporters could have resulted by the passive stretched imposed on the denervated hemidiaphragm by the activity of the contralateral side.

It is therefore possible that an individual could experience a noticeable decrease in blood glucose following a program of successive sustained muscle stretches. Passive stretching requires minimum effort by the person experiencing the stretch, can be performed while sitting or lying down, and can enhance feelings of comfort. Hence, people who are reluctant or unable to exercise may be willing to submit to a stretching protocol.

RESEARCH QUESTION: Can a regimen of passive stretching lower blood glucose levels following glucose challenge in people who are at risk of developing Type 2 diabetes in Indian population **AIM OF THE STUDY:** To find the immediate effect of passive stretching in blood glucose level in risk population. **NEED FOR THE STUDY:** To determine if a program of passive static stretching could significantly lower blood glucose in people who are at risk of developing Type 2 diabetes in Indian population.

METHODOLOGY

STUDY DESIGN	:	Quasi Experimental Design
STUDY TYPE	:	Pre-Post test
STUDY DURATION	:	6weeks
STUDY SETTING	:	SRM University, Kattankulathur

SAMPLING METHOD : Convenient sampling
SAMPLE SIZE : 30

INCLUSION CRITERIA

AGE: > 45 years **SEX:** Male and females Adults were recruited (population approximately 50) to participate in the study. To be eligible to participate, the volunteer has to be "at risk" for Type 2 diabetes by having at least three of the following four risk factors: Sedentary lifestyle with BMI at least 25kg/m^2Family history of Type 2 diabetes

EXCLUSION CRITERIA

Recent fracture, Joint instability, Disease affecting the tissue being stretched, Acute injury, Vascular injury, Infection, Excessive pain when stretched Inflammation or Joint effusion and Patients under hormonal and steroid therapy

MATERIALS USED

- ✓ Glucometer
- ✓ Lancet
- ✓ Sterilium
- ✓ Cotton

FIG-1

OUTCOME MEASURES

Blood glucose levels were analysed from a finger prick drop of blood, using a hand held glucometer.

PROCEDURE

The purpose of the study was explained to the subjects and an informed consent was taken**.** The participants were tested for glucometer reading two hours after eating a meal, and immediately drank a 200 ml can of fruit juice. Thirty minutes after drinking the fruit juice, the participants went through 40 minutes of passive static stretching regimen. The order of intervention was assigned in a random, balanced order.

The experimental group involved a stretching program that consisted of six lower body and four upper body static passive stretches. For each stretch, the muscle was held in the stretched position for 30 seconds, and was repeated four times. A fifteen (15) second relaxation period separated each repeat, and minimum 30 seconds separated the different stretches. For those stretches that stretched a single limb, the right limb was stretched first, and all four stretches were completed before starting on the left limb. In each instance, the experimenter pushes or pulled the specific body part until they received verbal acknowledgment that the stretch was felt by the participant. The experimenters then maintained constant pressure on the participant's body part for 30 seconds. At the end of the stretch, the body parts were returned to a neutral position for 15 seconds. The stretches include: seated knee flexor; seated knee flexor-hip adductor; seated shoulder lateral flexor; supine hip flexor-knee extensor; seated hip external rotator and hip extensor; shoulder extensor, adductor and retractor; supine knee flexor and plantar flexor; prone hip flexor; seated shoulder flexor and depressor; and seated shoulder flexor and elbow extensor. After this protocol the interventions were ended.

PRONE HIP FLEXOR

FIG-2

SUPINE KNEE FLEXOR - PLANTAR FLEXOR

FIG-3

SUPINE HIP FLEXOR AND KNEE EXTENSOR

FIG-4

SEATED HIP EXTERNAL ROTATOR AND EXTENSOR

FIG-5

SEATED SHOULDER AND ELBOW FLEXOR

FIG-6

SEATED SHOULDER FLEXOR AND DEPRESSOR

FIG-7

SEATED SHOULDER ADDUCTOR, EXTENSOR AND RETRACTOR

FIG-8

SEATED SHOULDER LATERAL FLEXOR

FIG-9

DATA ANALYSIS

The collected data were tabulated and analyzed. Paired T-test was adopted to find the effect of 1-time passive static stretching in blood level for people prone for Type II diabetes. Significance was set at $p<0.05$.

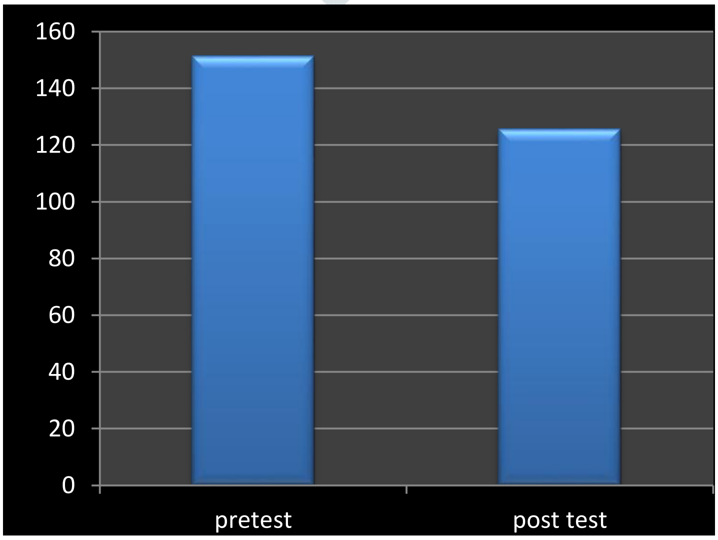
Table 1:

Group	Mean	Standard deviation	T	Degree of freedom	Level of significant
Pre test	151.3000	8.92555	31.632	29	.000
Post test	125.6000	7.45377			

*p<0.05

According to table 1 there is statistical significant reduction in blood glucose level after 20 minutes of passive static stretching.(p<0.05)

GRAPH I



RESULTS

According to table 1 there is statistical significant difference in pre test and post test of Glucometer reading in group trained with passive static stretching.($p<0.05$).

While considering the pre test and post test value of experimental group there is decrease in blood glucose level after a session of passive static stretching.

DISCUSSION

A total of fifty members entered this crossover. From which thirty adults (females 13 and males 17) were participated in this study. The baseline characteristics of the participants are presented in table 2.

Table-2

	All (n=30)	Female (n=13)	Male (n=17)
Age (years)	54.33	50.53	57.23
Height (meters)	1.63	1.54	1.71
Weight (kg)	71.36	64.23	72
BMI	26.63	31.13	26.28

The purpose of the study was to determine if a program of passive stretching could significantly lower blood glucose in people who are at risk of developing Type 2 diabetes. The result suggest that engaging in 20 minutes or more of passive static stretching will lower blood glucose values to great extent than doing nothing. Even light activity can start to lower blood glucose, having the people move around into different position increased lower of blood glucose level. Stretching may possibly cause discomfort and pain during the stretch. Emotional and physical stress can cause the release of cortisol and catecholamine, both of which can raise blood glucose via activation of liver glycogenolysis. However the stretching used in this condition was not eased off to the point of no discomfort. Nevertheless, the stretching regimen still produced significantly lower blood glucose level.

There are several possible mechanisms that could explain why a passively stretched muscle yields a lower blood glucose concentration. First, numerous studies have shown that despite a lack of sarcolemma depolarization or cross bridge cycling, a stretched muscle cell cannot be considered metabolically dormant. In 1932, Feng (1932) showed that a passively stretched in vitro muscle was metabolically active. He found that passively stretched muscles exhibited increased heat production and oxygen consumption. Later research corroborated these findings; Clinch (1968) reported increased heat production while Whalen and colleagues (1962) and Barnes (1987) added reports of increased oxygen consumption. In other related studies, passive stretching increased carbon dioxide production (Eddy and Downs 1921), increased glycogen breakdown (Barnes and Worrell 1985), increased lactic acid production (Barnes 1987), and decreased phosphocreatine concentrations (Barnes 1987). Since increased metabolic activity is related to increased activation of adenosine monophosphate kinase (AMPK) facilitated glucose transporter 4 (GLUT4) activation pathway (Dohm 2002), it is possible that the increased metabolic activity accompanying passive muscle stretching could have activated the incorporation of GLUT4 into the stretched muscles.

`Other research also points to the possibility of stretching increasing GLUT4 incorporation for instance protein kinase B activity partially controls GLUT4 incorporation and activation and Sakamoto and colleagues (2003) found that protein kinase B was stimulated by passively stretching isolated muscles for 10 minutes. Second, mitogen–activated protein kinase activity stimulates muscle cell glucose uptake (Ho et al 2004), and the activity of mitogen –activated protein kinase directly reflects the magnitude of the mechanical stress (ie, actively or passively generated tension) apply to the muscle (Martineau and Gardiner 2001). Third, exercise induced increases in nitric oxide results in increased glucose transport (Roberts et al 1997) and nitric oxide released from excised soleus muscles can be increase 20% by a single 2 minutes passive stretch (Tidball et al 1998). Finally, ischemia can increase GLUT for translocation to sarcolemma as well as increasing glucose uptake (Sun et al 1994, Young et al 1997),and passive stretching has the potential to cause ischemia (Poole et al 1997). Wines and Kirkebo (1976) found an increased resistance to blood flow during passive stretching. 19

Regardless of the responsible mechanisms it is clear that passive stretching had a significant positive effect on blood glucose level. These findings have important clinical application because numerous patient population are sedentary due to chronic illness, no availability of equipment, or a lack of motivation to exercise. Despite encouragement from the medical professions, most people fail to meet the most minimal level of daily exercise that would prevent the deleterious effect of hypomobility (American Diabetes Association 2008, Totor Locke et al 2000, Wei et al 2000). Thus, the finding that static stretching has the potential to be a viable treatment for hyperglycemia provides an alternative treatment modality in the absence of the patient's desire to exercise. In addition stretching skeletal muscle similarly to that demonstrated in this study is a hopeful alternative to exercise for those patients with Type 2 diabetes who are disabled to exercise.

Some patients groups that could benefit from a stretching program for improved glucose control might be patients who have sustained a spinal cord injury, patients who have rheumatoid arthritis, stroke patients and those individuals who are constrained to long term bed rest. As physiotherapists and nurses interact with these hypomobile patient, 20 to 40 minutes of passive stretching could be incorporated into the patients plan of care. Also, many nursing homes do not have a policy to evaluate the effectiveness of a treatment algorithm in their resident population with diabetes to determine if the staff is able to control the glucose peaks in these patients (Feldman et al 2009), a fundamental recommendation by the American Diabetes Association (2008). Failure to control blood glucose levels adequately in diabetes population represents nearly 50% of all deaths in nursing homes (Russell et al 2005). If a stretching program under the supervision of a physio therapist or other trained personnel was established, these patients could realize better blood glucose control and health at a substantial financial saving.

We acknowledge that this study looked only at the immediate effect of stretching and did not ascertain if this effect could carried over successive days of stretching. Nevertheless, Kokkonen and colleagues (2007) have shown that a program of 40 minutes static stretching done 3 times a week can increase muscle strength and endurance. In addition, Nelson and colleagues (2005) have presented data showing that static stretching raises the metabolic rate similar to the rate estimated for walking 40 m/minutes. These findings coupled with the results of the study ,suggest that stretching daily for 20 -40 minutes may help a person to control or lower blood glucose levels .

CONCLUSION

This study shows that static stretching is an additional viable activity that can help regulate blood glucose acutely. Since it requires little effort by the individual, it appears to be an advantageous treatment for those with reduced physical capabilities. Also, it can be done without any additional equipment, facilities, or other expenses. Thus, 1 – time passive stretching reduced the Blood Glucose level in people who are prone for Type II diabetes mellitus.

LIMITATION

It is a onetime observation study.A sample above 45 ages was only taken.These studies were performed in smaller sample size.Researcher and evaluator are same.

RECOMMENDATIONS

Study cannot be done on the larger sample size.This study can be done on longer duration.This study can be done on different age groups.

This study can be done on Type II Diabetes Mellitus patients.

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ANNEXURE I

STRETCHING PROTOCOL

STRETCH	**DESCRIPTION**
Seated knee flexor(bilateral)	Each person sat on the floor with the legs extended and arms above the head. From this position, each person lowered their head toward the knees, while the experimenter pushed down on their back.
Seated knee flexor- hip adductor (bilateral)	The participants sat on the floor in the lotus position. From this position, each person lowered their head toward to the floor, while the experimenter pushes down on their back.
Seated shoulder lateral flexor (bilateral)	The person sat in a chair with fingers interlocked and placed behind the head. Keeping the arms in this position, the experimenter stood behind the person and pulled the elbows back toward the body's midline.
Supine hip flexor-knee extensor (unilateral)	The participants lay on their backs with their leg hanging over the edge of the table with knee flexed at approximately 90 ̊. The hip was then hyperextended by the experimenter pushing down on the thigh.
Seated hip external rotators, extensor (unilateral)	Each person sat on the floor with one leg extended. The opposite leg was flexed at the knee, and the foot placed flat against the extended leg's inner thigh. The person then lowered their head towards the extended knee, while the experimenter pushed down on their back.
Seated shoulder extensors, adductors, retractors (unilateral)	While seated in a chair, each person extended one arm and placed it horizontally across the front of the chest. The experimenter stood behind the person, took hold of the wrist and pulled the arm against the chest as much as possible while the experimenter pushed down on their back.
Supine knee flexor-plantar flexor (unilateral)	Each person lay on their back with the legs extended. The experimenter then raised one leg and simultaneously flexed the hip and dorsiflexed the ankle.
Prone hip flexor (unilateral)	Each person lay on their stomach and flexed one knee at approximately 60 ̊. Keeping the knee at the flexed position, the experimenter lifted the thigh to hyperextended the hip.
Seated shoulder flexors, depressors (bilateral)	Each subject sat on the floor with the legs extended. The experimenter then grabbed the wrist and while keeping the back and elbow straight, hyperextended the shoulder by raising the arm behind the back and up towards the head.
Seated shoulder and elbow flexors (unilateral)	Each subject sat on the floor with the legs extended, with one elbow flexed and brought up near the ear. From this position the shoulder was hyperflexed by the experimenter pushing the upper arm down towards the floor.

ANNEXURE II

MASTER CHART

S.NO	AGE (YEARS)	GENDER	HEIGHT(m)	WEIGHT(Kg)	BMI	PRE-TEST	POST-TEST
1	47	F	1.55	60	25	145	115
2	45	F	1.59	72	28.5	168	137
3	59	M	1.61	70	27	150	124
4	49	M	1.76	80	25.8	140	124
5	50	F	1.56	65	26.7	170	140
6	61	M	1.73	76	25.4	161	130
7	52	M	1.79	82	25.6	155	125
8	46	M	1.60	68	26.6	158	123
9	55	M	1.75	79	25.8	142	126
10	48	F	1.54	65	27.4	157	130
11	51	F	1.52	60	26	144	120
12	54	F	1.50	62	27.6	165	140
13	65	M	1.74	78	25.8	152	131
14	50	F	1.58	69	27.6	145	119
15	66	M	1.78	82	25.9	162	135
16	52	F	1.51	62	27.2	146	122
17	69	M	1.68	74	26.2	142	120
18	50	M	1.82	90	27.2	148	122
19	46	F	1.60	72	28.1	157	125
20	53	F	1.51	63	27.6	153	122
21	58	F	1.52	69	29.9	156	132
22	65	M	1.68	73	25.9	140	116
23	52	M	1.54	70	29.5	158	135
24	60	M	1.67	75	26.9	136	115
25	63	M	1.79	82	25.6	143	120
26	48	F	1.50	56	25.4	152	126
27	55	F	1.55	60	25	155	129
28	62	M	1.75	80	26.1	147	125
29	45	M	1.73	77	25.7	139	110
30	54	M	1.65	70	25.9	153	130