THE EFFECTS OF HIGH INTENSITY OF INTERVAL TRAINING IN HYDROTHERAPY FOR INCREASING INSULIN SECRETION AND MAINTAINING BLOOD GLUCOSE LEVEL IN TYPE 2 DIABETIC MELLITUS PATIENT'S

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ABSTRACT
Background: The goal of this study is to determine the effects of high-intensity interval training in hydrotherapy on insulin secretion and blood glucose control in type 2 diabetes patients. Method: The study focuses on a specific group of 15 people with Type 2 diabetes. This group would perform the exercise with High Intensity of Interval Training in hydrotherapy for 8 weeks. The paired t-test values show that exercise was more effective than normal routine follow-up in Type 2 diabetic Mellitus patients. The mean difference value is 4.92, 47.13, and 1.15 respectively. The standard deviation is 1.48, 16.27, and 0.56 respectively. The paired ‘t’ value is 12.87, 11.2, and 8.04 respectively. The paired test values show that the exercise capacity of type 2 Diabetic Mellitus patients is more effective in hydrotherapy high intensity of interval training exercise. The effects of HIIT show significant improvement between pre and post-test values of BORG RPE, OGTT, HOMA-IR. Comparing the BORG RPE, OGTT, and HOMA-IR SCALeS within the groups shows a statistical difference in it. This can be probably because of the small sample size and immediate measurements of the values. The BORG RPE, OGTT, AND HOMA-IR values of the group may probably source significant differences when measured after long-term treatment and follow-up. This study has proved that hiit in hydrotherapy increase insulin secretion and decrease blood glucose level for type 2 diabetic patients.

Conclusion: The existing study reveals that exercise recipients have boosted insulin secretion and regulated blood glucose levels in Type 2 Diabetic Mellitus patients, improving their quality of life.

Keywords: Type 2 Diabetic Mellitus, Glycemic control, increase insulin secretion, High Intensity of Interval Training in Hydrotherapy.

INTRODUCTION
Diabetes mellitus (DM) is a long-term metabolic condition marked by persistent hyperglycemia. It could be due to a lack of insulin secretion, resistance to insulin's peripheral effects, or a combination of the two. Insulin resistance is a term used to describe a decreased insulin response in T2DM. Insulin is inefficient in this state, thus an increase in insulin production is first used to maintain glucose homeostasis, but this declines with time, leading in T2DM. People over the age of 45 are the most likely to develop T2DM. Nonetheless, increased levels of obesity, physical inactivity, and energy-dense meals are making it more common in children, adolescents, and young adults. (1) The pancreatic -cells produce insulin continuously, regardless of blood glucose levels. When blood glucose levels rise above a particular level, insulin is stored in vacuoles and released. Insulin is the major hormone that controls glucose uptake in most cells, including those in skeletal muscle and adipose tissue. Insulin is also a vital signal for the conversion of glucose to glycogen in the liver and skeletal muscle cells for internal storage. Insulin
release from β-cells decreases when blood glucose levels fall, whereas glucagon release from β-cells increases, boosting glycogen to glucose conversion. The bulk of glucose is produced via glycolysis and gluconeogenesis after an overnight fast. Increased hepatic glucose production, decreased insulin secretion, and impaired insulin action are three significant anomalies at the outset of hyperglycemia in T2DM \(^{(2)}\).

Diabetes mellitus affected approximately 415 million people aged 20 to 79 in 2015, according to the International Diabetes Federation (IDF). Diabetes is becoming a global public health issue, with an additional 200 million people expected to be affected by 2040. Diabetes affects an estimated 150 million people worldwide, and over the next 20 years, that number is likely to climb. 90–95 percent of all diabetes cases are type 2 diabetes mellitus (T2DM). In North America, and T2DM affects approximately 20% of people over the age of 65. T2DM has accounted for 5–10% of total healthcare expenditure in several countries. \(^{(1,3)}\)

High-intensity interval training, or HIIT, is categorized as a burst of vigorous activity followed by a time of rest or low-intensity exercise. The span of an intense exercise can range from 45 seconds to several minutes. Before repeating the process, people must rest or exercise for a similar period of time. A high-intensity interval training (HIIT) session can be accomplished in 15–20 minutes and has several health benefits. Because of its brief duration, it may be a tremendously efficient and important solution for those who find it difficult to commit to longer sessions. HIIT doesn't require any equipment or a gym membership, so people perform it whenever and wherever they wish. \(^{(4)}\)

Ten 1-minute strenuous efforts at 90 percent of maximum aerobic capacity are followed by 1-minute recovery time in a high-intensity interval training (HIIT) regimen that has demonstrated exploratory effects in persons with type 2 diabetes. Two weeks of training three times per week (i.e., six total exercise sessions in 14 days) helped previously sedentary type 2 diabetes participants lower 24-hour mean blood glucose levels \(^{(5)}\). Regular moderate-intensity exercise appears to enhance glycemic control better than HIIT \(^{(12,13,14)}\). Insulin production, rather than insulin sensitivity, seems to be a more reliable assessment of glycemic control training sensitivity \(^{(15)}\).

A-HIIT was found to be safe and to have the potential to improve lower limb strength and aerobic performance. The exercise treatments were properly specified, and exercise intensity could be assessed and reported in the water \(^{(6)}\). Hydrotherapy exercise is a type of physical activity that offers a variety of advantages, including a year-round workout setting. The buoyancy of the water helps you move around in the water and improves your flexibility by supporting a portion of your body weight. Water also provides resistance to motions, which aids in muscular strengthening.

Insulin resistance patients' glucose metabolism and insulin sensitivity were significantly lower before the training began compared to a healthy control group. However, glucose metabolism in the thigh muscles had already reached the beginning level of the healthy control group after two weeks of high-intensity exercise (equivalent to six workout sessions). HIIT training sessions are intense yet short, and they are followed by a recovery period. After both high-intensity training sessions, insulin sensitivity improved \(^{(7)}\).

T2D is linked to a combination of insulin sensitivity and poor pancreatic endocrine function. Exercise is particularly effective in reducing the chance of having T2D \(^{(20)}\). The existing research on the efficacy of regular exercise in insulin sensitivity in T2D patients is a little ambiguous. Regular moderate-intensity exercise and HIIT have both been demonstrated in the following research to enhance insulin sensitivity \(^{(21-27)}\).

Hydrotherapy, popularly known as water therapy, has shown to help people with Type 2 diabetes. Water treatment has been demonstrated to enhance overall well-being by controlling blood sugar levels, optimizing sleep patterns, and boost general well-being. A 30-minute session in a hot tub can help muscles relax, flow improve, and hypertension diminish. It also helps alleviate pain since water therapy promotes buoyancy to the system, which does not or would not arise else. Hydration in water has multiple health benefits and stimulates the release of biochemicals, letting you feel better \(^{(8)}\).

Although research on HIIT in non-healthy groups is growing, it is still limited. The OGTT's widespread use as a clinical technique has resulted in an increase in the number of research studies aimed at understanding the mechanisms underlying T2DM development. Exercise boosts peripheral insulin sensitivity by limiting basal insulin levels and curtailing the insulin spike to glucose load \(^{(16-19)}\).

The RPE (Rating of Perceived Exertion) is a physiological and psychological evaluation that correlates processes into the psychological influence of perceived exertion. It has a standalone executable that provides a sense of effort. Each level on the scale emphasis perhaps a heart rate or a percentage of maximum oxygen consumption (VO2max), both of which are used to quantify the intensity of exercise. In patients with type 2 diabetes, the RPE scale consistently gauges the intensity of physical activity \(^{(9)}\).

The Glucose Tolerance Test (GTT), known colloquially as the Oral Glucose Tolerance Test (OGTT), is a method for analyzing whether or not a subject has diabetes mellitus or insulin resistance. The assay is more accurate than finger prick testing in predicting diabetes \(^{(10)}\). Your body's ability to recognize sugar from food is examined by an oral glucose tolerance test (OGTT). It can notify you if you have diabetes or if you are at likelihood of causing it. An truncated version of the OGTT diabetes tests.
HOMA-IR regulates how much insulin your body craves to keep blood sugar levels consistent. This test was designed to detect insulin resistance, a phase of type 2 diabetes that enhances your chance of gaining a number of chronic illness (11).

METHODS
Participants
This study included 15 subjects aged 40-60 years who were chosen based on inclusion criteria, age group 40-60 years, males and females, random blood sugar level: >140 mg/dl, and exclusion criteria. No intramuscular insulin is secreted, and there is no incidence of terminal liver or kidney disease. Neuropathy and Retinopathy Hypertension is a coronary artery disease that is attributed to type 2 diabetes. All subjects were recruited using such a simple random sequence. Subjects trained for 30 minutes, three times per week, for eight weeks, with a warm-up of 5-7 minutes, a peak workout of 15-20 minutes, and a cool-down of 5-7 minutes.

Study Design
The study was an experimental design study. A convenient sampling method was used to select the subject. The study was conducted for 8 weeks with treatment duration. The study was done outpatient department,Nandha College of physiotherapy, Erode.

OUTCOME MEASURES
Borg rating of perceived exertion scale:
The Borg Rating of Perceived Exertion Scale (RPE) is a psychological and physiological examination that integrates physical stimuli into perceived exertion, a theory explains. Its use is intuitive, and it conveys a sense of labor. Each score on the scale depicts a heart rate or a percentage of maximum oxygen intake (VO2max), which are both used to quantify exercise intensity. The linear relationship between RPE and Oxygen consumption was 0.91. An RPE of Eleven equaled 52 percent of VO2max, an RPE of Thirteen equaled 76 percent of VO2max, an RPE of Fifteen equaled 88 percent of Maximal oxygen uptake, and an RPE of 17 equaled 100 percent of Maximal oxygen uptake. The RPE Scale can be used to measure the intensity of regular exercise in individuals with type 2 diabetes.

Oral glucose tolerance test:
A preliminary or zero-time taking a blood sample first. Before that, the patient will be given a sugar solution to imbibe. Afterwards the, blood tests are taken at regular intervals to check blood sugar levels and, in certain cases, insulin levels. Blood collection can be done at the request of the doctor and can take up to 6 hours.

Homa-ir: homeostatic model assessment - insulin resistance:
From fasting blood serum glucose level ratios, the HOMA formula is used to predict insulin production and -cell function. The glucose-insulin interaction portrays the baseline homeostasis between hepatocellular glucose output and insulin secretion, which is sustained by a virtuous cycle between the liver and -cells.
Fasting plasma insulin (FPI) is multiplied by fasting plasma glucose (FPG) and then divided by 22.5 to even get HOMA-IR=(FPI/FPG)/22.5.

Intervention:
The people were carried out for 3 weeks for each subject. The high intensity of interval training in hydrotherapy was performed 15 to 20 min per session and 6 days in a week for 3 weeks including warm-up and cool down. Based on the principles of type 2 Diabetic Mellitus patients received progression in their protocols.

TRAINING PROGRAM:
High Intensity Of Interval Training
To get started, all you have to do is pick an activity (running, jumping, etc.).
Then you may play about with different activity and recuperation periods, or how long you spend doing intensive exercise and how long you spend recovering.
The following is a 25-minute HIIT workout: Warm up for 5 minutes, 15-minute high-intensity interval training (HIIT) circuit: 15 seconds of intense exercise. Pause for ten seconds 15 seconds of intense exercise. 20 seconds of rest. 15 seconds of intense exercise. 30 seconds of rest. 15 seconds of intense exercise. 40 seconds of rest. 15 seconds of intense exercise. 50 seconds of rest. Rep this circuit three times more. Stretching for 5 minutes to cool down. If you're a newbie, start with 30 seconds of action followed by 90 seconds of rest. If you're used to interval training, 3 minutes of exercise followed by 1 minute of rest can be a good starting point.
Water walk:
You may begin by going for a walk in the water. Walk across the pool with your arms swinging as if you were walking on land in about waist-high water. Keep your back straight and avoid stepping on your tiptoes. To avoid leaning too much forward or to the side, tighten your abdominal muscles.
Wear hand webs or other resistance devices to add resistance when your hands and arms travel through the water. Water shoes might assist you in maintaining traction on the pool's bottom.

Forward and side lunges:
Take an enormous lunge step forward, if necessary, while standing near a pool wall for support. Allowing the forward knee to move past the toes is not a good idea. Rep with the other leg, returning to the beginning position. Encounter the pool's side wall and require long leap to the side for a side lunge. Keep your toes pointed forward. Rep on the opposite side. Three sets of ten lunge steps are recommended. Instead of staying in position, lunge walks forward or sideways for a change of pace.

One Leg Balance
While standing on one leg, lift one knee to hip level. Hold a broom handle underneath the lifted leg and generate a "U" with your foot in the midsection. Switch legs after thirty seconds or as long as you can. Do 1-two set of Five repetitions on each leg.

Side Stepping.
Facing the berm of the pool. Take crosswise steps with your torso and toes towards the wall. After completing 10-20 steps in one manner, come right back. Repeat twice further in each direction.

Pool Wall Hip Kickers.
Retaining your footing by standing with the poolside wall to one side of your body. As if you were leaping, extend one leg forward, locking the knee. Return to the beginning of the storey. Extend the same leg out to the side to begin this process. The similar leg should be placed behind you. Switch your striking leg every three sets of ten.

Planks For The Swimming Pool
There next to you, arrange the noodle. From a plank position, bend forward. Your elbows should be vertically down towards the pool bottom when you immerse the noodle in the water. Put your feet on the edge of the pool at all times. Depending on your core strength, hold for 15 to 60 seconds. Rep this sequence 3-5 times more.

Bicycle on deep water.
Throw 1-2 strands over your back and lean your arms on pinnacle of the strand for comfort in greater depths. As if you were pedalling, flex your legs. Keep going for a further 3 to 5 minutes.

The Arms have been Raised.
Using arm paddles or perforated gloves to confine your arms at your sides for greater resistance. Create a 90 ° angle with your elbows. Start raising and drop elbows and arms towards to the edge of the water while preserving a 90o angle in the elbows. Three ten-piece sets are requested.

Push Uppers
On standing near the water's edge, extend your arms shoulder-width out and on the water edge. Raise your body halfway out of the water by using your hands to press your weight and maintain your elbows portion of the movement. Hold for three seconds before lowering yourself back into the water softly. (For a simpler variation, position your hands shoulder-width out and on the water's edge, flex your elbows, and lay your chest against the pool wall.)

From a standing position, lift your knee.
Of both feet on the ground, balance against the pool wall. Lift one knee to the point where you're marching in place with one leg raised. Straighten your knee to keep it parallel to your hip. After 10 repetitions of bending and straightening your knee, switch legs. Perform three sets of ten reps on each leg. Try to do this workout without having to stand against the water wall for a more daunting task.
RESULTS:

Borg Rating of Perceived Exercise Scale, Oral Glucose Tolerance Test, and Homeostatic Model Assessment - Insulin Resistance Scale in the experimental group were used to examine the pre and post-values. 4.92, 47.13, and 1.15 are the mean difference values, respectively. 1.48, 16.27, and 0.56 are the standard deviations, respectively. 12.87, 11.2, and 8.04 are the paired values. For a 5% level of significance, the paired t-test value exceeds the table value 2.15. The exercise ability of type 2 diabetic Mellitus patients is more effective in hydrotherapy high-intensity interval training exercise, according to the paired t-test results. Between pre-and post-test values of BORG RPE, OGTT, and HOMA-IR, the effects of HIIT indicate a considerable improvement. When the BORG RPE, OGTT, and HOMA-IR SCALES are compared within the group, there is a statistical difference. This is most likely due to the reduced sample size and the fact that the data were measured immediately. This study has proved that HIIT IN HYDROTHERAPY increase insulin secretion and maintain blood glucose level for type 2 diabetic patients.

Data Presentation & Data Analysis

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DISCUSSION:

The research looks at the effects of high-intensity interval training in hydrotherapy for increasing insulin production and maintaining blood glucose levels in type 2 diabetics aged 40 to 60. The data for pre-test and post-test levels of type 2 diabetic Mellitus were calculated using the paired t-test. Different physical therapy approaches may be applied to other ailments such as oxygen consumption, muscle gain, fat loss, increased metabolic rate, reduced heart rate, and blood pressure for further research on type 2 diabetes mellitus. According to the study, Grant Tinsley, Ph.D. Updated on June 2, 2017, HIIT regimens lasting less than 12 weeks can lower blood sugar levels. Not only can HIIT lower blood sugar, but it also lowers insulin resistance more than regular continuous exercise, according to a review of 50 studies. According to these data, high-intensity exercise may be especially useful for people at risk of type 2 diabetes mellitus.
Diabetes. Some research says that, individuals with type 2 diabetes have shown promising results, proven the usefulness of high-intensity interval training (HIIT) in maintaining blood sugar levels. HIIT, on the other hand, appears to be able to improve insulin resistance even more than a regular continuous exercise in healthy people, according to a study.

The kolors Stcolors5th January 2019, HIIT has been found in studies to maintain blood glucose levels as well as muscle mass. The sugar levels of eight patients with type 2 diabetes were compared before and after six sessions of interval training spread out over two weeks in one study. So every practice session consists of ten 1-minute pedaling episodes with 1-minute recovery periods in between. Before the training, the participants’ average blood glucose levels over a 24-hour period were measured between 48 and 72 hours after the last exercise session, and average sugar levels had reduced 6.6 mmol/l. Thomas P. J. Solomon, Kristian Karstoft, Kamilla Winding, Kristian Karstoft, Kristian Karstoft, Kristian Karstoft, Kristian Karstoft, Patients with type 2 diabetes were categorized into 3 groups: control, continuous walking, and interval walking. The training group was obliged to attend five 60-minute sessions per week. The continuous walkers’ glycemic control was stable.

Hot tub therapy is a promising therapy for individuals with type 2 diabetes, as per results released in the New England Journal of Medicine on September 16, 1999. As a consequence, my coworkers and I hypothesized if the benefits of partial exploration in a hot tub might be equated to the perks of exercising. 8 patients (5 men and three female, aged 43 to 68; mean [SD] weight, 104.753.2 kg) were allowed to sit in a sauna with pool water to their shoulders at an athletic facility. From September 1998 to April 1999, they used the hot tub for thirty min, 6 days a week for three weeks.

CONCLUSION
Diabetic mellitus type 2 is by far the most popular. Diabetes is the ninth leading risk factor for death, with nearly one million people who die each year. It’s a condition in which tissues can’t use blood sugar (glucose) as a power source. Production increases too quickly when cells become less sensitive to insulin. In persons with type 2 diabetes, enhancing insulin secretion while maintaining blood glucose levels is crucial. The conducted with a total of 15 type 2 diabetes patients. A single group, got intensive hydrotherapy interval training. Pre- and post-test results were obtained using the borg rating of perceived exertion scale, oral glucose tolerance test, and home-it. The present study findings of the pre- and post-test data demonstrated that HIIT in hydrotherapy was more effective. The efficiency of for boosting insulin secretion and maintaining blood glucose levels in type 2 diabetic Mellitus, as per the findings of this study.

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