THE IMPACT OF THE INTER-SET REST PERIODS OF HIGH-INTENSITY INTERVAL TRAINING IN THE ACUTE GLUCOSE AND INSULIN SENSITYVITY IN TYPE I DIABETIC CHILDREN:A RANDOMIZED CROSSOVER TRIAL

Abstract

Introduction: The impact of the interest rest time of the high-intensity interval training (HIIT) needs to be evaluatedfordiabetics.**Objective:** To investigate the impact of different interest rest on blood glucose levels, and insulin sensitivity (IS) in children with type I diabetes. **Methods:**Twenty subjects were enrolled in three interest rest of HIIT. First, a stimulus of twenty seconds with ten seconds of rest (HIIT20-10), second with twenty seconds of rest (HIIT20-20), and with sixteen seconds of rest (HIIT20-60) using only “burpee” in the maximum effort for 12 minutes totalizing 24 stimulus sets. Finger blood sapling was acquired to the assessment of the blood glucose before, immediately after, 15, 30, 60 and 120 minutes after the exercise session. For IS 4ml of venous blood sampling were acquired before, immediately after, 30, 60 and 120 minutes after the exercise session. The IS was calculated using the Tyg Index. **Results:** No differences were observed within group HIIT20-20 and the HIIT20-60, in regards the glucose, however, the HIIT20-10 display lesser glucose levels from 15 minutes until 120 minutes. For the and improved IS in 60 and 120 minutes after the exercise session. **Conclusion:** The interest rest time have influence in the metabolism of glucose to HIIT.

Key Words: Metabolic Health, metabolism, Diabetes, Metabolic Disease.

1. Introduction

Physical exercise impacts the human systemic responses to many nutrients, like the glucose. However, a progressive decline in the metabolism function caused by aging, sedentarism, and probably nutritional inconsistences may develop diseases like diabetes [1] . Consistent evidences have been displaying that sedentary older adults have a high incidence of metabolic impairments, but physical exercise is associated to prevent or reverse these effects on metabolism [2].

In this context, the type, amount, and intensity alter acute and chronic metabolic responses of the blood glucose [3]. In this context, the Type II Diabetes have an important role in the metabolic response to physical exercise, which will be investigated here [4].

Sometimes, the Diabetes is a silent condition causing pediatric public health problems worldwide. This disease includes a cluster of metabolic disorders such as insulin resistance, often associated with central fat accumulation, constituting a predictive set of cardiovascular risk factors for the development of cardiovascular disease [5].

Nonetheless, exercise has been associated with improvements in all metabolic diseases including Diabetes [4,6,7] However, directly in contrast to this, we have shown that [8] which suggest for us to invest energy to give to the science best parameters of HIIT for different populations. Programs based in HIIT may have adjunctive non-pharmacological effects in the treatment in insulin resistance (IR) and diabetes [9], especially high-intensity exercise which will be here investigated. However, in older adults, data on increasing intensity are limited due to possible contraindications to high-intensity exercise in this population, but several reviews have addressed this issue, indicating the safety, efficacy, and applicability of high-intensity interval training [10].

Here, it is hypothesized that the exercise provokes positive acute adaptations in the glucose metabolism and insulin resistance. Therefore, we aimed to investigate the impact of different interest rest on blood glucose levels, and insulin sensitivity (IS).

2. Methods

2.1 Study type, participants and ethic

The design employed an experimental crossover model conducted in the field, lacking strict control over laboratory parameters. Throughout the study, the identities of the samples remained unknown to both field researchers and laboratory technicians, as determined by a list of computer-generated random numbers.

During the initial week of the experiment, twenty older adults were randomly assigned into groups using a 1:1:1:1 ratio. Subsequently, each week the groups were randomly reassigned to different intervention types, following this pattern until the final week. To mitigate the influence of prior interventions, a 6-day washout period was implemented between each week. Figure 1 illustrates the schematic of the crossover method utilized in this study.

Twenty subjects with 12.8±2.1 years, with 60.4±16.8Kg, 145±22.35cm, and over weight in accordance with the body mass index 28.7±14.8 Kg/m^3 were enrolled in three interest rest of HIIT. This study complied with all mandatory requirements of the Brazilian National Health Council Ethics Law 466/2012 and was approved by the Ethics Committee of the Federal University of Rondônia, under approval report number 2066823. All volunteers signed informed consent and were informed of the risks, benefits and all phases of the study. Since they will not be paid for their participation, they can decline to participate at any time without penalizing the volunteers or any involved researchers. For all subjects the parents signeted the concentiment.

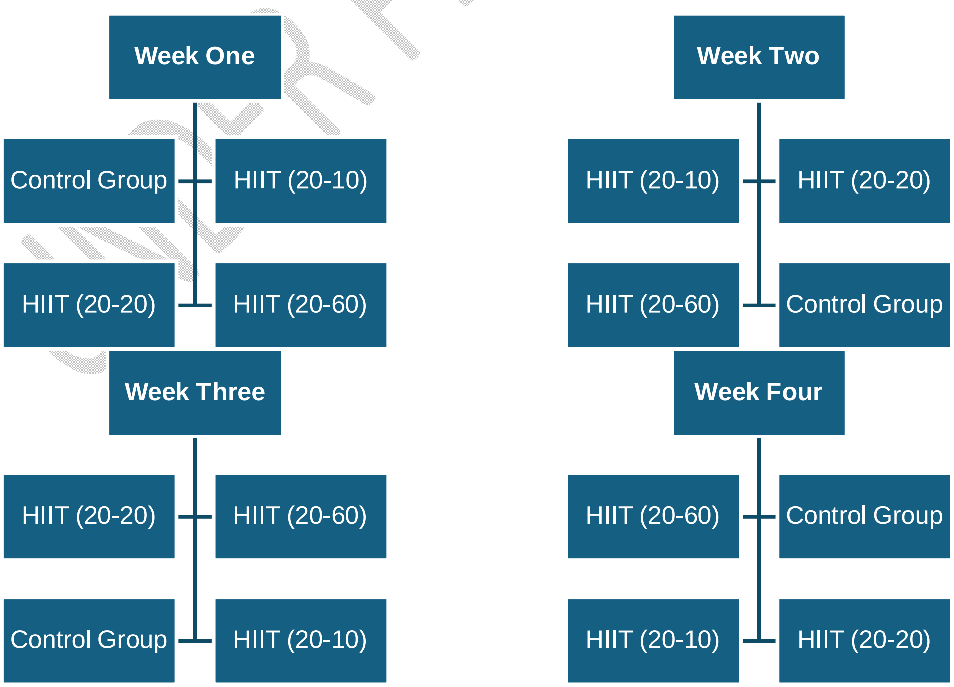

Figure 1: The crossover method used to insert the groups into different intervention each week.

All groups adhered to a protocol requiring exercise at 90% or higher of their maximum heart rate. Participation in all data collections was mandatory for all group members, among other stringent criteria, ensuring rigorous adherence to all parameters. Exclusion criteria included orthopedic disease, ischemic heart disease, previous myocardial infarction, atrial fibrillation, use of rheumatic biological drugs, immunosuppressive therapy, and beta-blockers. Moreover, an equal number of participants were maintained across all study groups throughout the research period.

2.2 Study Design

Blood samples were collected at eight time points: Baseline (before the intervention), 0 (immediately after the intervention), and at 5, 15, 30-, 60-, 90-, and 120-minutes post-training session. Each blood sample was processed twice independently in separate experiments, resulting in four measurements per volunteer. Any discrepancies between these results were excluded, and finally, the average was calculated from the remaining consistent measurements.

2.3 Exercise protocols

Three models of high-intensity interval training (HIIT) programs were evaluated to address our problem. All protocols maintained an intensity level at 90% of maximum heart rate, monitored using a G-Tech (Model ONE) finger oximeter. The first protocol, HIIT20-10, consisted of 20 seconds of exercise followed by 10 seconds of rest. The second protocol, HIIT20-20, involved 20 seconds of exercise followed by 20 seconds of rest. The third protocol, HIIT20-60, comprised 20 seconds of exercise followed by 60 seconds of rest. The exercise performed was the burpee, completed over a total duration of 12 minutes, resulting in 24 sets of stimuli. All exercises were performed without equipment, relying solely on body weight.

To perform a burpee, start by standing with your feet shoulder-width apart and your arms at your sides. Lower your body into a squat position, placing your hands on the floor in front of you, just inside your feet. With your weight on your hands, kick your feet back to land in a plank position, keeping your body in a straight line from head to heels. You can add an optional push-up at this stage by lowering your chest to the ground and then pushing back up to the plank position. Jump your feet forward to return to the squat position, with your hands still on the ground. Finally, explode up from the squat position into a jump, reaching your arms overhead. Land softly and immediately lower back into the squat position to begin the next repetition.

Do a standardized 5-minute gentle warm-up including stretching and gymnastics for 5 minutes each day. This is followed by the main workout, and finally, a 5-minute cool down was performed to promote cool down.

2.4 Blood Sampling Acquisition

For the determination of the glucose curve, 8 drops of blood were collected and analyzed at the time of collection using a glucometer (ROCHE, Accutrend Plus). To determination of serum triglyceride concentration, 4ml of blood were collected before, 60 and 120 minutes after the intervention protocol.

2.5 Insulin Resistance Assessment

TyG index – (the product of serum triglyceride concentration and fasting blood glucose) has been used in studies assessing insulin resistance in adults and adolescents[11,12]. Given the high cost involved in measuring insulin and the lack of a standardized method of measurement, the clinical use of the TyG index is advantageous. A cut point of 4.5 was used as suggested by Guerrero-Romero et al.[11].

$$3 - TyG = \frac{\{Try \text{ x } Glu\}}{2}$$

Equation 1: TyG Index. 3= Tyg Index, Try= Tryglicerides, Glu= Glucose.

2.6 Statistical Procedures

The descriptive data were expressed by the mean, percentage, and standard error. To determine the normality of the data the Shapiro-Wilks test was performed. Then, The ANOVA TWO-WAY with Sídàk posterior test was used to determine the difference in the program "GrafPad Prism 9.5.1" with a significance level of $p<0.05$.

3. Results

Analyzing the intragroup data, no differences were observed between the HIIT20-60 to glucose control and IS ($p>0.05$ both). The HIIT20-20 displayed differences between 30, 60, 90 and 120 minutes to 15 minutes after the exercise session ($p>0.05$, 0.05, 0.01, and 0.01 respectively). However, the HIIT20-10 display lesser glucose levels between 30, 60, 90, and 120 minutes, and improved IS comparing the baseline, time 0, 5 and 15 minutes with 120 minutes ($p>0.05$, 0.05 0.01 and 0.0001 respectively), and 15 with 60 minutes after the exercise session.

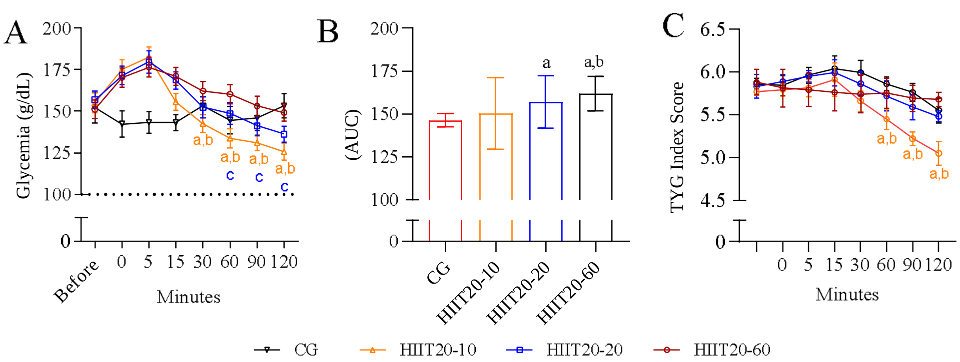

Figure 2: Blood Glucose levels and Insulin Sensitivity. The Figure A represent the blood glucose concentration along the time of investigation; Figure B the Area Under the Curve of the Glucose, and C is the Insulin Sensitivity. The ANOVA TWO WAY with Sídâk Pos-Hoc Test set up at 5% was used to determine the differences between groups. **Legend:** (a,b= difference to baseline, 5 minutes, and 15 minutes, and c= difference to HIIT20-60 and control).

Discussion

This study aimed to investigate the effects of three different rest intervals in high-intensity interval training (HIIT) on acute blood glucose levels and insulin sensitivity. We found that shorter rest intervals significantly impacted the body's acute adaptations to exercise, and this appear to cause more metabolic perturbations due to the glucose response. Specifically, shorter rest periods lead to a peak of glucose in 15 minutes, when, often is the high concentration of insulin in answer to glucose concentration. After, the blood glucose concentration decreases in 30, 60, 90, and 120 minutes exhibiting the classical curve to this metabolic process. Additionally, the HIIT, due to the glucose concentration decreased levels, improve the insulin sensitivity. The area under the curve observed did not has difference between HIIT20-10 and control because, although the decrease is higher, the peak is higher than another three groups.

Initially, blood glucose levels in the HIIT groups decreased 30 minutes after the intervention and continued to decline up to 120 minutes, demonstrating an expected adaptation. Although the HIIT20-20 and HIIT20-60 protocols did not exhibit significant differences, both showed a tendency to lower blood glucose concentration. However, the HIIT20-10 protocol displayed a more pronounced reduction in the blood glucose curve, despite the area under the curve not differing between groups. As a result, the acute insulin sensitivity was better for the HIIT20-10 group due to the lower average glucose concentration compared to the other groups. These findings are supported by several studies showing that HIIT has a significantly greater effect on blood glucose levels [13], and insulin resistance. In fact, short, frequent bouts of exercise may be more effective at suppressing blood glucose spikes in obese individuals than an equivalent amount of continuous exercise [14].

In terms of comparison De Teles et al., (2022) investigated two HIIT protocols: a long HIIT (2 minutes at 100% VO2peak followed by 2 minutes of passive rest) and a short HIIT (30 seconds at 100% VO2peak followed by 30 seconds of passive rest). They reported reductions in blood glucose levels of 32.14 mg/dL and 31.40 mg/dL for the long and short HIIT protocols, respectively. These findings are consistent with our results, which showed reductions of 12.35, 21.35, 23.79, and 29.4 mg/dL at 30, 60, 90, and 120 minutes after the exercise session, respectively.

Despite its clinical importance, there is no consensus on the optimal combination of parameters for designing exercise programs for everyone. However, our study highlighted the importance of carefully planning rest intervals between each stimulus [16,17]. Controlling rest intervals is crucial in an exercise program, as they significantly influence the training outcome. Longer rest periods allow for higher overloads, while shorter rest periods suggest less overload. This is important because when performing exercises with increased overload, the rest period needs to be adjusted to maintain the exercise, focusing the stimulus more on the muscular system. Conversely, shorter rest periods suggest less overload but impact the metabolism, as many myokines are overexpressed in this exercise approach [18,19].

In the context above, interleukin-6 (IL-6) is often present in high-intensity exercise regimes. The effect of this interleukin on metabolism is wide-ranging. For example, IL-6 regulates the expression of glucagon-like peptide 1 (GLP-1) [20]. Ellingsgaard et al., (2011), demonstrated that high-intensity exercise induces the overexpression of IL-6, which upregulates GLP-1 in L cells and alpha cells, leading to improved glucose control in diabetic mice. We suggest that this mechanism underlies the outcomes observed in our study.

What does this article add and practical implications?

This study highlights the potential of high-intensity interval training (HIIT) to acutely improve glycemic control, making it a valuable exercise option for individuals looking to manage their blood glucose levels more effectively. The findings suggest that shorter rest intervals in HIIT protocols may enhance insulin sensitivity and reduce blood glucose concentrations more significantly. This information can help fitness professionals and healthcare providers design more effective exercise programs for individuals with or at risk of metabolic diseases such as diabetes. Additionally, incorporating HIIT into regular exercise routines could provide a time-efficient and effective strategy for improving overall metabolic health. Future research should explore the role of IL-6 and other biomarkers in these adaptations to optimize HIIT protocols further.

Conclusion

Long-term HIIT and MICT are effective in normalizing immune, cardiac, and metabolic responses to exercise in children with type I Diabetes. While this may be true, HIIT is the fastest, most powerful, and most effective than MICT. In this regard, the combination of HIIT methods with drugs needs to be closely monitored, as its effects may be potentially dangerous to the cardiac system and thus need to be exercised with caution.

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