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Implementation of high intensity interval training offers opportunity to enhance glycemic control in patients with type 2 diabetes

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ABSTRACT A clinical decision report using:

Alvarez C, Ramirez-Campillo R, Martinez-Salazar C, et al. Low-Volume High-Intensity Interval Training as a Therapy for Type 2 Diabetes. *Int J Sports Med.* 2016;37(9):723-729. <https://doi.org//10.1055/s-0042-104935>

for a patient with newly diagnosed diabetes mellitus type 2.

Keywords: *type 2 diabetes, HIIT, high intensity interval training, glycemic control*

Clinical-Social Context

Elizabeth Jackson [pseudonym] is a 36-year-old female with a past medical history of essential hypertension, diabetes mellitus type 2 (DM2) not requiring insulin and depression presenting for follow up. Mrs. Jackson was diagnosed with DM2 one year ago. Mrs. Jackson states she has missed several appointments due to work and long commute to the clinic. Mrs. Jackson expresses that her metformin dose was increased and a GLP1 inhibitor was added to her regimen due to persistently high HbA1c levels, the latest being 8.6. Mrs. Jackson expresses concern for progression of her DM2; she does not want to be placed on insulin.

Because of the recent loss of her mom to COVID-19, she is currently experiencing increased depressive symptoms, scoring a 16 on the PHQ-9 (moderately severe depression). Mrs. Jackson brought her blood glucose (BG) logs to the appointment, which show sugars ranging from 150-350. She states no barriers to taking or paying for medication and misses one dose per month.

Mrs. Jackson states that at her recent appointments she has been bombarded with instructions for lifestyle modifications: “No juice, salt or carbs... exercise...DASH diet...more walking” and given little time for questions. She emphasizes her sedentary lifestyle is not for lack of effort; she is too frightened to return to the gym after losing her mom. In addition, the gym is 30 minutes away, complicated by doubled work hours that she acquired to cover for furloughed time. She works as an assembly line technician. BMI is 32. Upon further discussion, she states that she used to go to the gym several days per week and was part of a soccer league that she enjoyed.

Mrs. Jackson states there are few grocery stores near her home or workplace. She fears the risk of infection in public space, especially with her newly diagnosed DM2. She does her best to prepare home cooked meals with vegetables and proteins for herself and two sons, 6 and 8 years old. Sometimes she must settle for fast food after

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work. Her boys now require home schooling due to COVID-19. Her closest family is in Canton, Ohio several hours away, so childcare consumes a significant portion of her income. She is grateful for her safe neighborhood and long-time neighbors that used to offer help but are now reluctant to interact amidst the pandemic.

Mrs. Jackson has made deliberate efforts to adjust her diet and has a positive experience with physical activity. She has limited time and no access to gym equipment. In light of recent research showing the effectiveness of high intensity interval training in lowering BG, this form of physical activity will be discussed as part of her lifestyle modifications to help control her DM2.

Clinical Question

Can patient-centered implementation of home-based high intensity interval training (HIIT) improve glycemic control in newly diagnosed DM2 patients with limited time and income?

Research Article

Alvarez C, Ramirez-Campillo R, Martinez-Salazar C, et al. Low-Volume High-Intensity Interval Training as a Therapy for Type 2 Diabetes. *Int J Sports Med.* 2016;37(9):723-729. <https://doi.org/10.1055/s-0042-104935>¹

Description of Related Literature

The initial literature search was conducted on PubMed: (((diabetes[Title]) AND (high intensity interval training[Title])) NOT (type 1[Title])) NOT (mice). Publications were filtered for clinical trials published within the last 5 years. Google Scholar was used to identify remaining related articles. 12 articles resulted.

Most studies revealed a significant improvement in glycemic control after HIIT when compared to other moderate intensity continuous training (MICT) or no training/control (CON). The impact of HIIT on body weight, visceral fat mass, blood pressure, lipid levels and VO₂ (exercise tolerance) varied.^{2,3,4,5} HIIT was well studied in vulnerable populations.^{6,7}

The Winding study was a randomized control trial (RCT) of DM2 patients assigned to a HIIT, MICT or CON group. Despite a significantly lower time commitment and total energy expenditure, HIIT resulted in greater improvements HbA1c, fasting glucose, postprandial glucose and HOMA-IR (Homeostatic Model Assessment of Insulin Resistance) when compared to the other groups over an 11-week period. VO₂ increased and fat mass decreased in the HIIT group.⁸ The Alvarez study was a single blind RCT of middle-age, obese female patients with DM2 who were assigned to a HIIT or CON group. A significant improvement in fasting glucose, HbA1c, systolic BP, HDL-cholesterol, triglycerides, body weight, waist circumference and fat mass was seen after implementation of low-volume, running based HIIT compared to CON.¹

Mendes et al. demonstrated a greater reduction BG levels during exercise and 50 minutes post-HIIT compared to post-MICT.² Hwang et al. demonstrated that both HIIT and MICT were equally safe and effective in improving aerobic capacity in middle-aged and older DM2 patients.⁴

A few studies addressed the feasibility of clinical implementation of HIIT. Suryangegara et al. demonstrated DM2 patients who engaged in HIIT had a significant reduction in cardiac output and heart rate during exercise compared to CON, suggesting a cardio-protective role of HIIT.⁹ Cassidy et al. further randomized DM2 patients to an unsupervised HIIT or CON group and demonstrated that, even without direct supervision, the HIIT group was found to have significant reduction in HbA1c.¹⁰

Multiple studies demonstrated HIIT requires significantly less time commitment when compared to MICT.^{1,11,12} The Ruffino study concluded that HIIT is superior to MICT even when MICT is performed at a volume five times greater.¹¹ Alvarez et al. found that time required to fulfill guideline-based activity requirements drops 25-56% when engaging in HIIT versus other types of exercise.¹

The Alvarez study was selected for clinical application because the patient population—sedentary, overweight or obese (BMI = 30.5 +/- 0.6 kg/m²) females age 44.5 +/- 1.8 years with the diagnosis of DM2 for 1+ years—was most similar to Mrs. Jackson. Because a



younger patient population was studied, implying a shorter time since diagnosis of DM2, the HIIT methodology can more likely be applied as a preventative measure. Additionally, the authors addressed the HIIT time commitment in accordance with current physical activity guidelines. This information can be considered with Mrs. Jackson's schedule constraints. Furthermore, patients were advised to maintain their current diet and activity level outside of HIIT workouts. Single blinding and utilization of the same researcher for all patient evaluations mitigates confirmation and procedural bias. Only one patient from the HIIT group was excluded due to failure to meet the 70% minimum compliance; it is unlikely that this exclusion had any significant impact on results.

The Alvarez study results align with most other studies with regards to the significant impact of HIIT on glycemic control—lowering HbA1c, fasting and postprandial glucose. The study also demonstrated a significant improvement in systolic BP, HDL-cholesterol, triglycerides, body weight, waist circumference and fat mass in the HIIT group versus CON.

The project was funded by the Family Healthcare Center Tomas Rojas 2014 Annual Grant and 2014 Health Promotion Program of Los Rios Health Service. It is highly unlikely that the funding obscured or incentivized study results.

Based on the SORT criteria, there is grade B recommendation for the use of HIIT in improving glycemic control in DM2 patients (level 2 evidence).¹³

Critical Appraisal

Alvarez et al. addressed a gap in the literature by performing a HIIT trial for 16 weeks in middle-aged, overweight or obese females with DM2.¹

The increased length of study observation has important implications for sustained lifestyle change and effect on HbA1c, a lab that reflects months of physiology. DM2 is a systemic disease, thus, the inclusion of several other body composition and cardiovascular variables with HIIT strengthens the study.

Thorough pre-screening was implemented to ensure no significant differences existed between individuals. The study ensured the participants had good tolerance of the HIIT with no injuries. Astute attention was paid to lowering hyperglycemic medication doses on days of HIIT and monitoring for hypoglycemic symptoms. This is an important component of patient education that I am prepared to share with Mrs. Jackson. HIIT in the form of running, versus ergometers or stationary bikes used in most other studies, is cost-conscious and can be performed anywhere without equipment.

This is a single blinded RCT (Level 2 evidence). It was not possible to blind participants; however, there was a single individual who was blinded and performed all patient assessments. Patients were randomly and equally assigned to mitigate selection bias; however, due to discrepancies in follow up between groups possible attrition bias exists. The study was not registered prospectively to comment on protocol deviation and publication bias.

In further assessment, the exclusion criteria of the study called to question applicability, especially within the Detroit patient population, of the study. Patients with musculoskeletal or cardiovascular conditions, history of stroke, asthma, COPD, or smoker were excluded. Although the exclusion criteria likely mitigates confounding affects, many patients with DM2 were excluded. For the amount of variability that can exist within diet, genetics and other health parameters, 13 HIIT and 10 control study participants seems to be a low sample. However, given the longevity of the study and high patient commitment, the subject enrollment provides foundation for future work. Recruiting participants over the phone may carry participation bias. Additionally, there is a clear benefit to the HIIT program, but no mention of the control group crossing over or being offered HIIT post-study.

Clinical Application

Mrs. Jackson is a 36-year-old female recently diagnosed with DM2, who underwent several medication changes to combat high HbA1c. She is overwhelmed by the information she has been provided. She understands the impact of physical exercise on DM2 and has clear goals but struggles to initiate these changes into her hectic schedule. With the Alvarez study demonstrating the safety, accessibility, and effectiveness of HIIT, I believe that counseling Mrs. Jackson on this measure of physical activity will make significant positive change and delay the need for

medication increases. This form of physical activity is possible with little or no equipment, eliminating Mrs. Jackson's barrier to gym access. In addition, the efficient nature of HIIT is conducive to Mrs. Jackson's work schedule and duties of motherhood while maintaining her own wellness amidst the pandemic. With these points considered, I do not predict that engaging in HIIT will place a burden Mrs. Jackson.

Medicine in Motion is an organization composed of medical students equipped with training in HIIT counseling. Via phone, Mrs. Jackson will be able to follow up weekly with a student to discuss engagement with HIIT, questions and concerns. In addition to phone calls, we will evaluate levels of activity via survey before and after HIIT counseling. In asking patients to make change, barriers are bound to present. Making physical activity changes is physically uncomfortable and requires time, albeit a small amount for HIIT. There is also apprehension with unfamiliarity in addition to physical activity being a privilege in the context of work and family duties. Being voices of support amidst setbacks and reminding our patient of the necessity of her health to take care of others will be key.

The conclusion of this study is reasonable. Previous research shows that HIIT can reduce body fat and increase insulin sensitivity due to upregulation of GLUT4 receptors and mitochondria. This study is highly applicable to Mrs. Jackson's case. It will be important to remind Mrs. Jackson of the signs and symptoms of hypoglycemia and provide information on how to proceed. It is important to explain risks of taking medication near exercise or without food intake. We will use the teach back method to ensure understanding.

New Knowledge Related to Clinical Decision Science

This case highlights the utility of HIIT in DM2 treatment. Medical professionals should be equipped to counsel on HIIT. Patients are overwhelmed with the lifestyle modifications. If physicians show an expertise in HIIT counseling, we have a greater chance of patient adherence. This manuscript provides foundation for implementation of HIIT in the clinical setting. Furthermore, we anticipate that providing a trained group of medical students to follow up with patients, providing further counseling will increase adherence to physical activity and allow for tangible use in treatment, constituting an improvement in clinical practice based on clinical research literature.

Conflict Of Interest Statement

The author declares no conflict of interest.

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