

High-Intensity Interval Training

Subjects: Health Care Sciences & Services | Anthropology

Contributor: Daniel Velázquez-Díaz

High-Intensity Interval Training (HIIT) could have effects on inflammatory biomarkers, based on the investigation conducted of an anti-inflammatory nature, provided that its characteristics are able to trigger the necessary impact to do so.

Keywords: HIIT ; T2D ; inflammatory biomarkers

1. Introduction

A previous study ^[1] showed the relationship between inflammatory biomarkers and obesity, insulin resistance and cardiovascular disease conditions and includes the scientific papers in which these findings are outlined. There we are shown how the IL-6 and the IL-18 keep their pro-inflammatory functions, on the other hand, the TNF- α takes the role of mediator in the inflammatory/immune response and high levels of CRP are found as an inflammatory response ^[1]. Moreover, the study shows the appearance of high levels of inflammatory biomarkers in mice with diabetes, obesity or chronic inflammation, with insulin resistance effects (IL-6, TNF- α) appearing in greater levels in obese individuals and pro-inflammatory effects (IL-1, CRP), which also appear in greater levels in obese subjects ^[2]. Likewise, in mice, some inflammatory biomarkers such as the TNF- α is more relevant in the adipose tissue of persons suffering from obesity ^[3], and in case of being high at the systemic level, it is known as a major inhibitor of insulin signalling, mainly in the liver and muscles causing an insulin resistance ^[4]. Other studies also show the existing relationship between high concentrations of IL-6 and CRP and the risk of suffering from T2D ^{[5][6][7][8]}. In relation to the IL-8, it has been proved how patients with T2D show high circulating values of this biomarker associated with a worse inflammatory condition and metabolic control ^[9]. With regard to the IL-10, low levels of this biomarker are present in patients with T2D compared with healthy patients, which leads to a lesser control or prevention in the production of biomarkers such as the TNF- α and IL-6 ^[10]. Other studies show an increase in sCD163, which is closely linked with the activation of macrophages and the risk of suffering from T2D ^{[11][12]}. Concerning the IL-1Ra, low levels appear in patients with T2D ^{[13][14]}. Furthermore, a 2009 study demonstrated that the treatment with IL-1Ra in patients with T2D reduced inflammatory biomarkers and improved the functioning of β cells ^[15]. As for the IL-15, there are few studies addressing this inflammatory biomarker and T2D, but there are some concerning the presence of high levels of this biomarker in patients with T1D ^{[16][17]}.

HIIT as a modality of exercise and an alternative to the traditional aerobic and resistance training has been booming lately ^{[18][19][20]}. However, the truth is that little information is found in databases on the effects this modality of exercise has on inflammatory biomarkers. Based on this, we have decided to focus this systematic review on looking at the therapeutic effect a modality of physical exercise may have on patients with T2D. Therefore, we have compiled the clinical trials studying T2D patients and the effects this modality of exercise could have on inflammatory biomarkers to draw a conclusion and determine the existing relationship between HIIT, T2D and inflammatory biomarkers.

Given that T2D is a very prevailing pathology and that physical exercise has been proven to have positive effects on the profile of diabetic patients by reducing insulin resistance and improving the inflammatory role of this disease, by doing this systematic review we seek to verify what the effects of HIIT as a modality of physical exercise has on inflammatory biomarkers in patients with T2D and if it is an equally, less or more effective alternative to aerobic or resistance exercise training.

2. HIIT and Inflammatory Biomarkers

First, we should highlight that the sizes of the various samples were quite small. If we observe the participants who only did HIIT, the number of subjects substantially diminishes 13/51 ^[21], 16/36 ^[22], 14/42 ^[13], 39/39 ^[23], 8/14 ^[24], 10/23 ^[25] and 49/80 ^[26] and if we focus on those doing HIIT and suffering from T2D the number is even smaller.

Secondly, we are thoroughly analysing the different components of HIIT and factors impacting on it, and comparing which outcomes were recorded for each of them.

If we consider HIIT intensity, studies did not include an intensity of HRmax lower than 70% or higher than 95%. All the interventions were conducted within this small range, the highest intensities (90%–95%) being attained gradually as the study was conducted. Thus, we could say that because of the heterogeneous outcomes obtained in the different studies, in this case, the exercise intensity was not directly responsible for the results obtained concerning biomarkers and body composition, as we have some studies showing significant results and others with no significant results, and all of them ranged within this small intensity interval, attaining at the end 90%–96% of HRmax or all out.

If we focus on the number of series made during the training days, they are very different when comparing all the studies. Studies not obtaining significant outcomes for inflammatory biomarkers in patients with T2D used a number series of one [21], four [22], or ten [25]. Studies that did obtain significant outcomes used a number of series of four [13], ten [23], five [24] and six to 12 [26]. As described, it is complicated to determine the number of series which may have had a significant impact on biomarkers, as studies using the same number of series show different results—this is probably due to the starting level and the heterogeneous samples. We cannot determine either if there is a direct relationship between the number of series and the significant results. According to the data we are handling in this systematic review, the number of series is not likely to be decisive for the results if examined separately. For this reason, we need to examine this bearing in mind the days and weeks spent in each study for treatment implementation. Taking a closer look to it, we have the advantage that every study implemented exercise for three days a week, the difference lying therefore in the number of weeks. The study with the longest duration for treatment implementation took 52 weeks and it was the one by Magalhães et al. [21] and it did not obtain significant results for any biomarker within the HIIT group. Another study was conducted for 24 weeks [23] and did obtain significant results for several biomarkers. The study with the shortest duration took four weeks [24] and it did find significant changes in one of the biomarkers. The rest of the studies extended from 8 to 12 weeks [13][26][22][25] and 2 of them did not obtain any significant result for the HIIT groups with T2D [22][25]. Based on this, and according to the current studies, we could say that we have not found any direct relationship between the duration and the presence of significant results. It is likely to be more connected with the HIIT working out time and the number of series completed in each session, since the study with the longest duration only conducted one series per session and it did not obtain any results [21]. The rest of the studies, except for two of them [22][25], used intervals between 4 and 12 series and working out times between 30 s and 240 s and they did find significant changes in patients with T2D doing HIIT.

3. HIIT and Values of Body Composition

This search for significant changes could not only depend on HIIT characteristics and variations, but also the characteristics of the patients under study and their type of profile are likely to have something to say. The effects linking HIIT and the values of body composition are discussed below.

For comparison purposes, it would have been interesting to have all the pre- and post-treatment values for all seven studies. HIIT groups with T2D showed significant changes in BMI, weight, LBM and abdominal fat mass [13][25]. The paper by Banitalebi E et al. [13] shows only that there were significant differences between groups; the study by Madsen SM et al. [25] did show a significant reduction in the values already mentioned for the HIIT group with T2D, but the study by Dünwald T et al. [24] interestingly showed a significant increase in the fat free mass value within the CMT group; moreover, the HIIT group with T2D did not record changes in the body composition variables measured in such a study, not like in the CMT group. Except for the study by Madsen SM et al. [25], which did not provide the pre-treatment BMI values, patients had overweight BMI $\geq 25\text{kg/m}^2$ or obesity BMI $\geq 30\text{kg/m}^2$ based on the standard values for overweight and obesity laid down by the World Health Organisation (WHO) [27]. These data on BMI lead to us thinking about the relationship between body composition and biomarkers.

4. HIIT, Biomarkers and Diet

Lifestyle consists of both a regular physical activity and a healthy diet, considering a healthy diet is a diet according with recommendations from authoritative organizations [28]. Although more long-term intervention trials are needed, Papamichou et al. [29] have shown the effect that dietary patterns of a healthy diet should be implemented in public health strategies in order to better control glycaemic markers in patients with T2D. This is why having information on and controlling the diets the subjects were on would help to observe the effects it may have. The low-carbohydrate high-fat diet is a re-emerged dietary approach, which is characterized by a decreased carbohydrate intake and high levels of fat consumption with adequate protein provided [30]. A recent systematic review and meta-analysis has shown that a low-

carbohydrate high-fat diet combined with HIIT reduces body weight and fat mass, while maintaining lean body mass and enhancing aerobic capacity. Moreover, another recent systematic review and meta-analysis has shown that patients who adhere to a low-carbohydrate diet for six months can experience remission of diabetes without adverse consequences [31]; however, these studies did not include inflammatory biomarker analyses [32]. In the papers selected for this systematic review, only one of the studies showed the effects of a HIIT training that four different types of diets have on patients with T2D [23]. In this clinical trial, it was determined that low-fat and low-carbohydrate diets, along with HIIT, had major effects on the reduction of the levels of biomarkers IL-6, TNF- α , leptin and resistin. Based on a single study, we cannot advocate that a type of diet along with HIIT training is the key for the reduction of inflammatory biomarkers. However, it would be interesting to investigate which diets the subjects of available studies were on, so that they could be compared, as there is likely to be a close relationship with the effect they may have on these biomarkers. Furthermore, in relation to the diet implemented in the different groups, the BMI of the participants should be also highlighted as it ranged between 30 and 39 kg/m², these BMI falling into the category of obesity according to the WHO [27]. Thus, we may repeat that the potential effect on the inflammatory biomarkers might be closely linked with fat loss. If the pre- and post-treatment data had been provided for these persons, after the HIIT treatment and a sort of controlled diet, they are likely to have experienced changes in their fat composition.

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