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Artículo de revisión

HIIT in a treadmill for people with overweight or obesity: a systematic review

HIIT en banda sinfín para personas con sobrepeso u obesidad: una revisión sistemática

Claudia I. Herrera-Covarrubias[1], Lidia G. De León[1]*, Ramón Candia-Luján[1], Briseidy Ortiz-Rodríguez[1], Claudia E. Carrasco-Legleu[1]

Universidad Autónoma de Chihuahua. Facultad de Ciencias de la Cultura Física.
Perif. de la Juventud y Circuito Universitario S/N, Fracc Campo Bello C.P. 31124 Chihuahua Chih. México.

*Correspondencia: gdeleon@uach.mx (Lidia G. De León)
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Abstract

A systematic review was carried out with the objective to analyze the workloads of the high intensity interval training (HIIT) protocols in treadmill, in order to identify the most used intensity percentages, administered in people with overweight or obesity; a bibliographic search was performed in SCOPUS, Web of Science, EBSCO, SCIELO and PUBMED databases. Inclusion criteria were: original experimental studies, where one or more HIIT protocols in treadmill were administered on population with overweight or obesity, regardless their age; studies made in athletes or using functional exercises were excluded. Eight articles were considered for this review from a total of 678 articles detected. All of them reported the administration of HIIT protocols at intensities between 80% and 95% of HRmax, HRpeak, calculated HRmax, or HRreserve; with short (30 seconds) to large (4 minutes) high intensity intervals. It is concluded that HIIT on a treadmill can be used on people with overweight or obesity due to its efficacy and safeness at high intensity levels and can provide optimal results in body composition, cardio respiratory fitness and other parameters such as IL-6 and TNFalpha, in addition to reduce systolic blood pressure.

***Keywords*: interval training, treadmill, intensity of exercise, safe exercise, obesity**

Resumen

Se realizó una revisión sistemática con el objetivo de analizar las cargas de trabajo de los protocolos de entrenamiento interválico de alta intensidad (HIIT, por sus siglas en inglés) en banda sinfín, con el fin de identificar los porcentajes de intensidad más utilizados, administrados en personas con sobrepeso u obesidad; se realizó una búsqueda bibliográfica en las bases de datos SCOPUS, Web of Science, EBSCO, SCIELO y PUBMED. Los criterios de inclusión fueron: estudios experimentales originales, donde se administraron uno o más protocolos HIIT en banda sinfín, en población con

sobrepeso u obesidad, sin importar la edad; se excluyeron los estudios realizados en deportistas o con ejercicios funcionales. Se consideraron ocho artículos de un total de 678 artículos detectados; todos reportaron la administración de protocolos HIIT a intensidades entre 80% y 95% de FCmáx, FC pico, FCmáx calculada o FCreserva; con intervalos de alta intensidad cortos (30 segundos), largos (4 minutos) y períodos de descanso activo por debajo del 70% de esos parámetros. Se concluye que el HIIT en banda sinfín se puede utilizar en personas con sobrepeso u obesidad debido a su eficacia y seguridad a niveles de alta intensidad y puede proporcionar resultados óptimos en la composición corporal, la aptitud cardiorrespiratoria y otros parámetros como IL-6 y TNFalpha, además de reducir la presión arterial sistólica.

***Palabras Clave*: entrenamiento intervalado, banda sinfín, ejercicio en obesidad.**

1. Introduction

In recent years, literature has shown that high intensity interval training (HIIT) can induce favorable metabolic adaptations similar to continuous training at a moderate intensity in healthy populations or in people with non-communicable diseases, specifically obesity (Andreato *et al*., 2019). At the beginning of the last century, HIIT emerged as a training methodology used to prepare high performance athletes; at the present, this method represents a new therapeutic strategy that has proven to be effective in improving the physical status associated with health in adult population (Cofré-Bolados *et al*., 2016). HIIT consists of short bouts of intense exercise, alternated with short periods of active or passive rest (Pereira-Rodríguez *et al*., 2020). Current evidence supports that HIIT is a method that has various health benefits; and the short period of time needed to complete the training with a minimum of equipment to obtain physical adaptations, are their main advantages (López, 2018).

HIIT exercise has interesting applications in the control of certain metabolic and cardiovascular pathologies as latest published studies have recognized the benefits in the biological markers that HIIT may provide (Milanović *et al*., 2015). Overweight and obesity are associated with the development of insulin resistance, type 2 diabetes mellitus and cardiovascular disease. It has been shown that regular physical exercise with progressive increases of intensity is one of the most effective solutions to prevent and treat those pathologies (Alarcón *et al*., 2016). HIIT program can be developed as an intervention strategy for people with overweight or obesity and other associated diseases. Increasing the amount of daily physical activity is an essential tool for controlling such problems (Peñailillo *et al*., 2016). However, studies with HIIT method in patients with non-communicable diseases are very limited because its workload intensities can be very high and varied (Gibala *et al*., 2012). Hence, it is necessary to know the appropriate intensity of exercise that can generate safe and effective metabolic changes for the control of these conditions with this method, especially for the treatment of obesity (Alarcón *et al*., 2016). The objective was to analyze the workloads of the high intensity interval training protocols (HIIT) in treadmill, in order to identify the most used intensity percentages, administered in people with overweight or obesity.

2. Article selection

Bibliographic search was carried out in SCOPUS, Web of Science, EBSCO, SCIELO and PUBMED databases, using keywords in English only, such as high intensity interval training, HIIT,

obesity and treadmill, with the Boolean AND operator. Inclusion criteria were: original, experimental studies; where one or more HIIT protocols on treadmill were administered in people with overweight or obesity, regardless their age; studies made in athletes or using functional exercises were excluded. There was no restriction of articles by year of publication. 678 articles were found, of which 666 were eliminated because they did not meet the inclusion criteria. Twelve potential articles were identified, finding four duplicates, so the review was made with the remaining eight documents (see Figure 1). Five studies were randomized clinical trials, one was cuasi-experimental study and the authors did not specify the other two. Two researchers made the search and analyzed the studies.

3. Article analysis

Eight articles meeting inclusion criteria were selected. Detailed review of these documents showed different HIIT protocols used as well as the intensities and duration of each one; workloads of each administered program in the population of interest was analyzed.

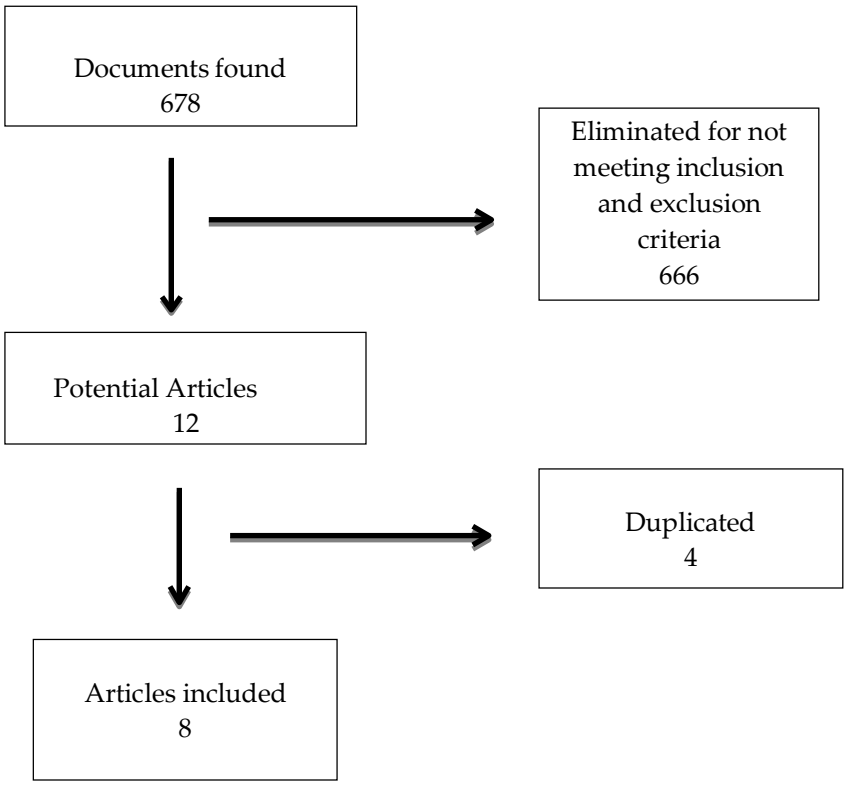

Figure 1. Diagram of the selection process for the review articles
Figura 1. Diagrama del proceso de selección de los artículos de la revisión.

Methodological quality of the selected studies was evaluated in the period of February to June 2019; in order to exclude documents of fair and poor quality, PEDro scale was used. Item one (1) was not taken into account according with PEDro scale instructions (PEDro 2019); items 5, 6 and 7 were not considered due to this kind of studies cannot be blinded, so use so just items 2, 3, 4, 8, 9, 10 and 11 were contemplated. Articles selected in this review had a mean score of 4.87 points, pondered as good cuality (see Table 1). This review was carried out according to PRISMA guidelines (Hutton *et al*., 2017). Four of the selected articles were made in women, two of them recruited a population between 19 and 27 years of age and the other two were realized with women at 23 to 39 years of age. Other study was performed in children (7 to 16y), two more were in adult women and men ages 18 to 55, and only one research was conducted in older adults 50 to 80 years old.

Table 1. Clasification with PEDro of the articles analyzed.
Tabla 1. Escala de clasificación PEDro de los artículos analizados.

	ITEMS											
REFERENCE	1	2	3	4	5	6	7	8	9	10	11	**TOTAL**
Dias *et al*. 2017	-	✔	✔	✔	–	–	–	✔	✖	✔	✔	6
Gerosa-Neto 2016	-	✔	✔	✔	–	–	–	✔	✖	✔	✔	6
Romain *et al*. 2019	-	✖	✖	✔	–	–	–	✔	✖	✔	✔	4
Streese *et al*. 2018	-	✔	✔	✔	–	–	–	✖	✖	✖	✔	4
Zhang *et al*. 2015	-	✖	✖	✔	–	–	–	✔	✔	✔	✔	5
Hornbuckle *et al*. 2018	-	✔	✔	✖	–	–	–	✔	✖	✔	✔	5
Mirgham, Yousefi 2014	-	✖	✖	✔	–	–	–	✔	✖	✔	✔	4
Bonsu, Terblanche 2016	-	✖	✖	✔	–	–	–	✔	✔	✔	✔	5

4. Results

Protocol characteristics

Characteristics of HIIT, number of subjects included in studies, intensity and rest period of intervals, as well as duration of the program, are shown in Table 2. Most of workouts ranged 12 to 16 weeks of activity, with three times a week sessions. Romain *et al*., (2019). implemented a 6-month supervised program, performing trainings twice a week. Two studies used a shorter period applying only four weeks of activity with three sessions per week (Mirghani y Yousefi, (2015). Bonsu y Terblanche, (2016), implemented twice a week only for 6 sessions. Regarding the protocols, four studies had the longest intense and rest intervals with 4 minutes of high intensity workload and 4 and 3 minutes of active rest. On the other hand, shorter intervals between 30 and 60 seconds of work were reported by four articles. All programs handled intensities between 80% and 95% of experimental HRmax and HRpeak, or calculated HRmax and HRreserve; the first two parameters were assessed in treadmill stress test and the other two were calculated. All studies included in this review applied HIIT treadmill protocols on people with obesity or overweight. Most of their objectives were to examine the effects of HIIT on body composition and determine its effectiveness in increasing cardiorespiratory capacity; to identify the effect on inflammatory profile and insulin resistance in addition to the effects on arterial function; cardiometabolic risk factors, liver enzymes and serum lipid levels, as well as blood pressure response, were also studied.

Table 2. Characteristics of the interval and rest intensities of the HIIT sessions.
Tabla 2. Características de las intensidades de intervalos y descansos de las sesiones de HIIT.

Author	Results	n	Protocol used	HI Time	HI intensity	Recovery time	Recovery intensity	Program time
Dias *et al*. 2017	Increased cardiorespiratory capacity	HIIT=33 MICT=32 Nutrition=34	4X3 min 4 series	4 min	85%- 95% HRmax	3 min	50%-70% HRmax	12 weeks
Gerosa-Neto 2016	Decreased IL-6 and Adiponectin	32 (3 Groups)	4X3 min	4 min	90% HRmax	3 min	70% HRmax	16 weeks
Romain *et al*. 2019	Decreased waist-hip index	HIIT=38 Control=28	30 s X 90 s 10 series	30 s	80%-90% HRmax calculated	90 s	50%-60% HRmax calculated	6 months
Streese *et al*. 2018	Reduction of the stiffness of the arterial wall	HIIT= 40 HIIT= 80 Control=40	4X3 min 4 series	4 min	80%-90% HRmax	3 min	65%-70% HRmax	12 weeks
Zhang *et al*. 2015	Decrease in body fat mass	HIIT=14 MICT=15 Control=14	4X3 min 4 series	4 min	85%-95% HRpeak	3 min	50%-60% HRpeak	12 weeks
Hornbuckle *et al*. 2018	Reduced waist circumference	HIIT=16 EE=11	1X3 min	1 min	80%-90% HRmax	3 min	60%-70% HRmax	16 weeks
Mirghani, Yousefi 2015	Decreased waist circumference	HIIT (1)=8 HIIT (2)=8 Control=8	60 s X 60 s 60 s X 30 s 60 s X 30 s	60 s	80% HRreserve	60 s 30 s 30 s	Cool down	4 weeks
Bonsu, Terblanche 2016	Decrease in blood pressure	HIIT=20	1x1 min 10 series	1 min	90%-95% HRmax	1 min	70% HRmax.	6 sessions

HI time=high interval time; HI intensity=high interval intensity; HIIT=high intensity interval training; MICT=moderate intensity continuous training; min=minute; HRmax=maximum heart rate; IL-6=inteleukin-6; s=second; HRmax calculated=calculated maximum heart rate; HRpeak=peak heart rate; SS=Steady State; HRreserve=heart rate reserve.

5. Discussion

HIIT on a treadmill can be considered as a training modality in people with overweight or obesity, due to its high levels of efficacy and safety, as evidenced in the literature reviewed. One of the main findings was the decrease in body fat mass as reported by Zhang *et al*., (2015), who administered a twelve week HIIT program to overweight Chinese women, using 85% and 95% of HRpeak in periods of 4 minutes, and 3 minutes recovery at 50% and 60% of the HR_{peak}; a moderated intensity continuous training (MICT) group performed a continuous run between 60% and 70% of theHR_{peak}, while control group (CG) received no training but maintained their daily physical activity without altering their eating habits. HIIT and MICT groups, reveled an increase in VO_2max and a decrease in body mass, body mass index (BMI), and waist and hip circumferences, after intervention. HIIT group, showed a greater reduction in waist-to-hip ratio compared with the MICT and CG groups.

On the other hand, Hornbuckle *et al*., (2018), concluded that HIIT performed for one minute at 80% and 90% of HRmax with a 3 min-recovery of 60% and 70% of HRmax, was more effective in reducing waist circumference compared to the group that performed a submaximal exercise at steady state (SS) level; however, they did not observe significant changes on the cardiometabolic risk factors, which was the main objective of the study; authors indicated the need for further research with a larger sample to better observe the expected results on these factors. Dias *et al*., (2018), determined the efficacy of a twelve-week HIIT to increase cardiorespiratory capacity and reduce adiposity in obese children; they applied a protocol with a high intensity (HI) of 85% and 95% of HRmax and recovery or low intensity (LI) at 50% and 70% of HRmax; they concluded that this program increased cardiorespiratory capacity compared to a traditional continuous moderate intensity training (CT). Regarding body composition and blood biomarkers, neither of the two training modalities (HIIT/CT) had a significant effect. All the articles included in this review reported the administration of HIIT protocols that worked with intensities above 80% and up to 95% of HRmax, HRpeak, calculated HRmax, or HR reserve. Other authors reported that HIIT should work on anaerobic or ventilatory threshold II (80% to 85% of VO_2max), where central adaptations associated with a sympathetic-adrenal activation and cardio-vagal improvements take place (Cofré-Bolados *et al*., 2016). Therefore, application of this training in sedentary individuals who are also overweight or obese, would have greater advantages in cardiovascular and metabolic health issues (Reljic *et al*., 2016); (Laursen Y Jenkins,2002).

Gerosa-Neto *et al., (*2016) and Streese *et al*., (2018), very similar protocols of four minutes of intense work were performed at 90% of HRmax, for 12 and 16 weeks. First one demonstrated a significantly decrease in Interleukin-6 (IL-6) and adiponectin concentrations; other variables such as BMI, body weight and insulin sensitivity did not have significant changes but a tendency to improve was showed.

Half of the administered HIIT protocols used a longer duration of the intervals, in both exercise and rest periods, between 4 and 3 minutes, except for the protocols used by Mirghani y Yousefi, (2015), Romain *et al*., (2019) and Bonsu y Terblanche, (2016), which had a shorter duration of the intervals or periods, but the same duration in the training sessions. For 4 weeks, overweight women performed a HIIT program, executing a protocol of 60 s of intensity for 60 s of recovery, another of 60 s for 30 s, and a control group. The main purpose of that research was to examine the effect of two HIIT protocols on liver enzymes and serum lipid levels in the participants. Group that performed HIIT protocol 60 s X

30 s had a greater decrease in waist circumference, but there were no changes in the blood lipid profile. Reduction in percentage of fat in the shorter rest interval could be explained because the activity of glycolysis to synthesize energy decreased which increased aerobic metabolism to replace energy expended, since the proportion of energy needed in 30 s of high intensity activity, includes 18% ATP, 2% phosphagens, 25% anaerobic glycolysis and 55% oxidation (Billaut y Bishop 2009). Consequently, performing HIIT protocols with a shorter recovery time results in an increase in aerobic metabolism Mirghani y Yousefi, (2015).

In the study carried out by Bonsu y Terblanche, (2016), a significant reduction in blood pressure was evidenced after 6 sessions of HIIT at 90% and 95% of HRmax in young overweight or obese women, however training effects were lost two weeks after the execution. On the other hand, A3 (Romain *et al*., 2019)., applied a 6 month HIIT program; they investigated the effect of training on body composition, metabolic markers, psychiatric-functional in overweight people with serious illnesses. Intervals were administered for 30 s by 90 s at 90%, 50% and 65% of the theoretical HRmax. Study showed no differences, but waist-hip circumference ratio decreased despite the fact that 50% of the sample abandoned the intervention before the end of the study.

6. Conclusions

HIIT at intensities between 80% and 90% of HRmax, HRpeak, calculated HRmax or HR reserve is practical and comfortable; it can be safely administered to overweight or obese people. HIIT, variable in their duration from 30 seconds to 4 minutes per interval, with a frequency of 2 to 3 sessions per week, it has also been reported with great improvements in cardiorespiratory capacity, fat mass and some biological markers, when performed in a treadmill.

Future perspectives

HIIT on treadmill in people with obesity will be an excellent option to transfer this method to the field, thus the population that does not have an ergometer, can perform this training modality without complications anywhere outdoors.

Strengths of this review

HIIT method reduces the time and volume of weekly practice, becoming a good strategy to capture and maintain the practice of exercise in a population with obesity; therefore, compared to the traditional method of cycling or continuous exercise, it is more convenient for general population. It is also very useful to know the intensities that can be safely administered with this type of persons.

Weaknesses of this review

There is a large number of studies carried out in people with overweight and obesity, however, there are not clinical trials and the vast majority does not report the intensities of workloads, so the number of articles found in this review is not very high.

Conflict of interest

Authors declare that during the period of completion of this investigation, did not exist, nor is there now, any economic, personal, political or academic relationship with groups or institutions that could influence the results of this work or allow bias in the considerations taken into account for discussion or conclusion. Authors have not received any payment or compensation in money, goods or other personal benefits from groups or institutions interested in the results of this research.

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