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Review Article

The Effects of High-Intensity Interval Training with Short Bursts of Work (≤30s) on Body Composition and Exercise Capacity in Overweight or Obese Adults: A Systematic Review

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Abstract

Background: Sprint Interval Training (SIT) has emerged as a very promising exercise approach for improving several health parameters of overweight and obese individuals. However, the effectiveness of SIT with very brief intervals (≤30s) in this population remains unclear. **Objectives:** The objective of this systematic review was to evaluate the application of High Intensity Interval Training (HIIT) and or SIT with short bursts of work (≤30s) on a cycle-ergometer in overweight and obese individuals, in order to assess its effects on body composition parameters and cardiorespiratory fitness. **Methods:** A comprehensive research of electronic databases such as ScienceDirect, MEDLINE and Cumulative Index to Nursing and Allied Health Literature [CINAHL] was conducted in order to identify relevant randomized controlled trials (RCTs) for the period up to May 2023. As the primary outcome, studies were required to include at least one measure of body composition (BW, BMI) and or cardiorespiratory fitness (VO2max, VO2peak). The Cochrane risk of bias (RoB2) tool for RCTs was used to evaluate the risk of bias of each included study. **Results:** This systematic review included 26 RCTs with a sample size of 986 obese and or overweight participants. Overall, HIIT/SIT interventions demonstrated mixed outcomes for body composition parameters and improved cardiorespiratory fitness when compared to a non-exercise control-group. In addition, these high intensity protocols also showed similar significant improvements in cardiorespiratory fitness when compared to continuous training or other exercise interventions. However, some studies noted differences among exercise groups, leading to variations in cardiorespiratory fitness and body composition outcomes. **Conclusion:** Based on the findings, it can be concluded that high intensity exercise with short bursts of work on a cycle-ergometer offer significant improvements in cardiorespiratory fitness which are similar to other exercise interventions such as moderate continuous training. However, the evidence regarding its effectiveness for improving body composition parameters in this clinical population is inconclusive, with mixed outcomes observed across studies.

Keywords: Sprint interval training; High intensity interval training; Obese; Overweight

Introduction

According to the summary report "Obesity: missing the 2025 targets", the worldwide prevalence of obesity is predicted to go up to 18% in men and exceed 21% in women [1]. Overweight and obesity are clinical conditions that are characterized by an abnormal and or excessive accumulation of fat [2]. An obese individual, has body mass index (BMI) greater than or equal to 30 kg/m^2 and an overweight between 25.0-29.9 kg/m^2 [3]. A higher BMI, pre-obesity (overweight) or obesity increases the risk for the development of diabetes, hypertension, cardiovascular and pulmonary diseases, psychiatric diseases and some types of cancer [1,4-8]. Moreover, obesity has been classified as a disease by a range of medical associations as it meets essential criteria of a disease such as: a) signs and symptoms (excessive fat mass), b) dysfunction of an ≥1 organ (inflammation of fat tissue) and c) complications that lead to morbidity and mortality (risk factor for the development of diseases) [9,10].

Exercise training and physical activity, have been suggested as fat-loss strategies along with other interventions for prevention and management of obesity [11]. An enormous amount of research investigated the efficacy of different modes of exercise training in managing obesity and suggested that high intensity interval training (HIIT) and moderate intensity continuous training (MICT) can similarly improve body composition [12-17]. MICT is the most studied training intervention in obesity management, however it requires a very high duration/volume (225–420 min) in order to reach the appropriate energy expenditure which will positively affect body weight [18]. One of the main barriers affecting adherence to exercise training is lack of time [19] and thus, interval training (IT) was introduced as a time-efficient alternative intervention to improve health [20]. There are two models of IT used most frequently: 1) HIIT which uses submaximal efforts (≥90% of VO2max) and 2) spring interval training (SIT) that involves maximal ("all-out") or supramaximal efforts greater than VO2max [21]. SIT is a more intense sub-category of HIIT, where each bout of high-intensity effort (>100% of maximal power) persists for ≤30s and it is interspersed by ~4 min recovery periods between these intervals [22]. The most common protocol is an "all out" 30s sprint on a cycle ergometer mentioned as a Wingate test and normally involves 4 to 6 Wingate tests (4×30s), interspersed with 4 or 4.5 minutes of active recovery period (light exercise) or rest intervals, lasting 20 minutes in total [22,23].

While the majority of the published systematic reviews have reported positive effects of high intensity training programs in to obese and overweight individuals, these reviews combined results from studies using HIIT and SIT and compared it to MICT. Hence, there is a lack of comprehensive research available that directly compares HIIT to MICT and SIT to MICT in terms of their effect on body composition and cardiorespiratory fitness. To our knowledge, there is only one systematic review, which compared SIT to MICT on body composition and cardiorespiratory fitness in obese and overweight individuals [24]. As a result, this systematic review set out to examine if HIIT/SIT performed on a cycling modality and lasting ≤30s is effective for the management of body composition, improvement of cardiorespiratory fitness, physiological and biochemical parameters in obese and overweight individuals.

Methods

Protocol registration and guidelines

This systematic review has been developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [25] and has been registered with the International Prospective Register of Systematic Reviews (PROSPERO – CRD42020137414).

Data sources and search strategies

The following electronic databases were searched by I-C.T and S.H from March 23, 2023 until May 29, 2023: ScienceDirect, MEDLINE and Cumulative Index to Nursing and Allied Health Literature [CINAHL]. All databases were searched using the following keywords: "Obese", "Obesity, "Overweight'' "AND" "High intensity interval training'', "Sprint interval training'', "Supramaximal exercise training", "Repeated sprint exercise" alone or in combination. Each specific phrase was combined with the Boolean operator to limit the search and make it more specific. In this search, both MESH terms and free text words were included. The language of the publications was restricted to English, but no restriction was applied for the date of publications. Additional searches were carried out by scanning the reference lists of the relevant papers in order to maximize the number of investigations included in the current review. There was an extension to the search to include grey literature sources through OpenGrey.eu, in addition to consulting clinical trial registries like the EU Clinical Trials Register, ClinicalTrials.gov, WHO International Clinical Trials Registry Platform. However, a deliberate choice was made to refrain from conducting such a search of grey literature, as the primary emphasis was on selecting high-quality peer-reviewed articles.

Study criteria and selection

In order to define and frame the research question the Population(s), Intervention(s), Comparator(s), Outcome(s) and Study Design (PICOS) were used [26]. The titles and abstracts of all records were screened initially against the basic initial eligibility criteria. A single failed eligibility criterion was sufficient for a study to be excluded from a review [27]. Moreover, the full records that remained after initial eligibility screening, were screened against the full eligibility criteria outlined in (Table 1).

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<table>
<tr><th>PICOS</th><th>Inclusion Criteria</th><th>Exclusion Criteria</th></tr>
<tr><td rowspan="2">Study</td><td>Was the study a randomized control trial (RCT)?</td><td>Other than RCT (non-randomised trials, cohort studies, case control studies, expert opinions, commentaries, etc)</td></tr>
<tr><td>Was the study published in English?</td><td>Other languages, duplicates,
abstracts/commentaries</td></tr>
<tr><td>Population</td><td>Did the study include overweight/obese males or/and females?</td><td>Included non-obese/ non-overweight, under 18 years old, with comorbidities or any other risk factor</td></tr>
<tr><td rowspan="2">Intervention</td><td>Was the intervention a SIT protocol?</td><td rowspan="3">Bursts above 30 seconds, progressed dunging the program, used any other exercise modality</td></tr>
<tr><td>Was the protocol performed on cycle ergometer</td></tr>
<tr><td>Comparison</td><td>Was the intervention compared to another type of exercise/ placebo/ non-therapy?</td></tr>
<tr><td>Outcome</td><td>Did the study assess functional capacity/ body composition/ physiological (heart rate, blood pressure) or biochemical (blood lipid profile) parameters?</td><td>Other outcome measures</td></tr>
<tr><td colspan="3">Abbreviations: RCT: Randomized Control Trial; SIT: Sprint Interval Training: SIT</td></tr>
</table>

Table 1: Eligibility criteria.

Data extraction

For each eligible full-text study, data were extracted using a standardised form including the following fields: first author's name and year of publication, intervention groups and sample size, participant characteristics (mean age and body mass index [BMI], sex), intervention characteristics (time, intensity, modality, frequency) and mean (SD) and/or percentage changes in body composition, and maximal oxygen consumption (VO2max/peak) for both intervention and control groups. Additional physiological or biochemical variables were considered as long as there were sufficient information regarding before and after changes in both groups.

Risk of bias assessment

The quality of the studies was assessed using the Cochrane risk of bias tool (RoB2) in five domains: 1) bias arising from the randomization process, 2) bias due to deviations from intended interventions, 3) bias due to missing outcome data, 4) bias in measurement of the outcome, 5) bias in selection of the reported result [27]. Based on the given answers by the reviewers, domains on the Cochrane Collaboration's tool can be scored in three categories as high risk", if the study displayed methodological flaws that could have influenced the outcomes, "low risk" if it did not exhibit such issues, and "some concerns" if the information provided was insufficient to make a determination [27]. In order to find the overall risk of bias in an RCT, the following criteria were applied: 1) "high-quality" if the analysis indicates that this outcome from the study is considered to have a low risk of bias across all domains, 2) "moderate-quality" if the assessment of the study suggests that there are certain concerns in at least one domain regarding this outcome, but it does not indicate a high risk of bias in any domain and 3) "low-quality" if one or fewer domains received a "low risk" rating [28].

Results

Identification of records and study selection

An initial search of electronic databases revealed 1202 publications (Figure 1) of which 162 were excluded as duplicates. After screening the remaining 1040 records, an additional 678 unrelated articles were removed based on title and abstract review. During full record review 30 records used other exercise modalities, 51 records included participants with diseases, 198 records used longer burst time, 21 records included adolescents and 47 records were not RCT and were excluded. 11 more records were identified from hand-searches in reference lists. 26 records in total met the eligibility criteria and were included in this systematic review.

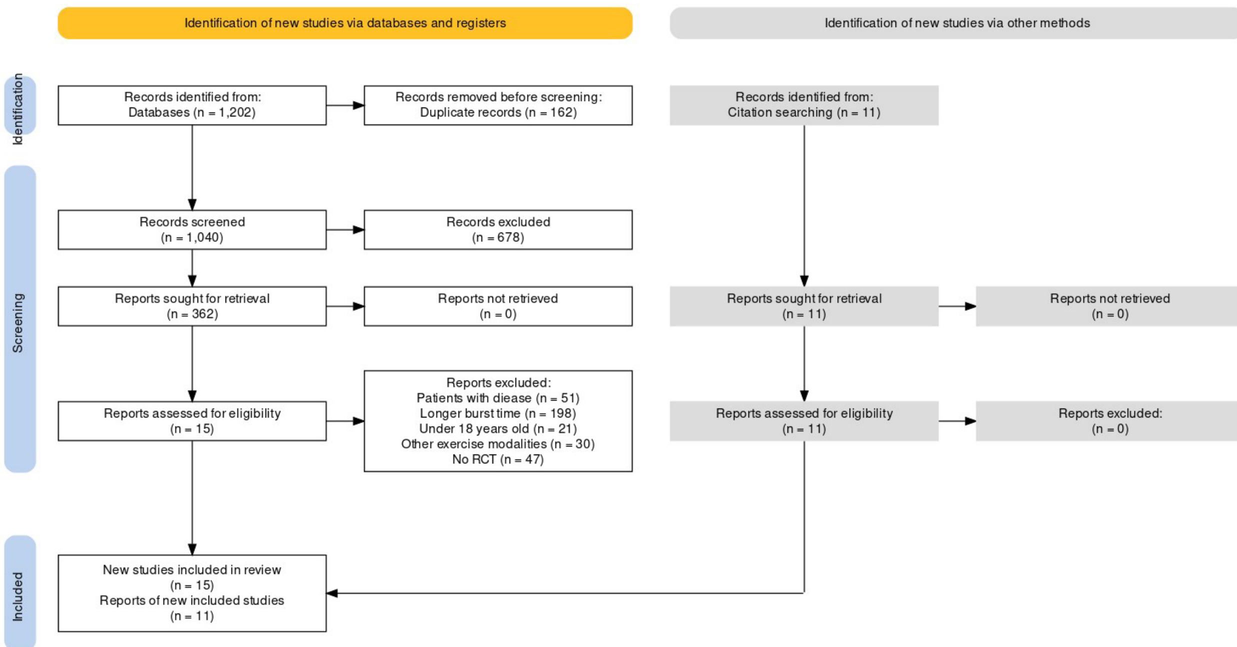

Figure 1: PRISMA flowchart process.

Characteristics of the included studies

Participants characteristics of the 26 studies included in this systematic review are illustrated in (Table 2). A total of 986 individuals was included in the reviewed studies and the age ranged between20 and 62 years. 13 studies included only females [29-41], 9 studies included only males [42-50], 3 studies included both sexes [51-53] and 1 study did not state the sex of the participants [54]. Moreover, 12 studies included both overweight and obese participants [29,31,32,34,35,37,39,40,43,45,50,54], 5 studies included only overweight participants [33,36,42,44,47] and the 9 remaining studies included only obese participants [30,38,41,46,48,49,51-53].

Authors	Sample size/Groups	HIIT/SIT exercise protocol	Results
Trilk et al. (2011) [29]	N=28 (F), Overweight/obese SIT (n=14): Age: 30.1± 6.8 years, BMI: 35.7± 6.3 kg/m^2 (SIT), Control (n=14): Age: 31.4± 5.5 years, BMI: 34.6± 5.9 kg/m^2	SIT: 4-7 X 30s all out sprints, 4min active rest Control: No intervention 4-weeks, 3 days/week	SIT-group improved significantly VO-2peak and some physiological parameters, in contrast to control-group. No significant differences for body composition were observed between the groups.
Heydari et al. (2012) [42]	N=46 (M), Overweight Age: 24.9 ± 4.3 years, BMI: 28.7 ± 0.7 kg/m^2 HIIT (n=25) and Control (n=21)	HIIT: 8s sprints/12s recovery throughout a 20min session, performed at 80-90%HR-peak at a cadence 120-130 rpm/40rpm Control: No intervention 12-Weeks, 3 days/week	HIIT-group improved significantly VO-2peak, physiological and body composition parameters, in contrast to control-group. No significant changes in blood lipid profile.

Skleryk et al. (2013) [43]	N=16 (M), Overweight/obese Age: 38.7±5.5 years, BMI: 33.7±5.7 kg/m^2 SIT (n=8) and TER (n=8)	SIT: 8–12×10s "all out" sprints, performed against a resistance of 0.05 kg/body mass, separated by 80s of rest TER: cycling at ~65% of VO2peak for 30min 2-Weeks, 3 days/week	SIT-group and TER-group did not produce any detectable changes in body composition, VO2peak, blood markers and physiological parameters.
Sim et al. (2015) [44]	N=30 (M), Overweight Age: 31± 8 years, BMI: 27.2 ± 1.3 kg/m^2 HIIT (n=10), MICT (n=10) and Control (n=10)	HIIT: Repeated 15s sprints performed at a power output of ~170% V̇O2Peak, with an active recovery period of 60s at a power output of ~32% V̇O2Peak between efforts MICT: Exercised at 60% of V̇O2Peak continuously, for the duration of each training Control: No intervention 12-Weeks, 3 days/week	Both exercise groups significantly improved VO2peak, with no significant difference between the groups. There were no significant changes in body composition parameters following HIIT or MICT.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Fisher et al. (2015) [45]	N=28 (M), Overweight/Obese Age: 20± 1.5 years, BMI: 29.5 ± 3.3 kg/m^2 HIIT (n=15) and MIT (n=13)	HIIT: 4x 30s sprints, performed at ~85% of peak power, with 4min rest MIT: Cycling at ~55-65% of VO2peak for 45–60 min 6-Weeks, 3 days/week	There was a significant improvement of VO2peak in both exercise groups, but MIT-group increased VO2peak in a significant greater extent than HIIT-group. MIT-group improved significantly DBP, in contrast to HIIT-group. Both exercise groups displayed significant improvement in some body composition and blood lipid profile parameters, with no significant difference between the groups.
Cocks et al. (2016) [46]	N=16 (M), Obese Age: 25± 1 years, BMI: 34.8± 0.9 kg m^2 SIT (n=8) and MICT (n=8)	SIT: 4-7x 30s sprints, performed at 200% Wmax, interspersed with 120s active recovery periods at 30W MICT: Cycling at ~65% of VO2peak for 40–60 min 4-Weeks, 3 days/week	Both exercise groups significantly improved VO2peak, with no significant differences between the groups. No changes were observed in physiological parameters in either group, except HR-resting but with no significant difference among the groups. BF% was only reduced by MICT-group, with no significant difference between the groups.
Martins et al. (2016) [51]	N=46 (M/F), Obese Age: 34.4 ± 8.8 years, BMI: 33.3 ± 2.9 kg/m^2 HIIT (n= 16), 1/2HIIT (n= 16) or MICT (n= 14)	HIIT: 8s performed at 85–90% HRmax, followed by 12s of recovery (250 kcal) 1/2HIIT: 8s performed at 85–90% HRmax, followed by 12s of recovery (125 kcal) MICT: Continuous cycling at 70% of HRmax, to induce a 250kcal energy deficit 12-Weeks, 3 days/week	All exercise groups changed significantly VO2max and body composition parameters; however no significant differences were observed between the groups. No significant change was found in glucose for either group.

Kong et al. (2016a) [30]	N=26 (F) Obese Age: 21.5 ± 4.0 years, BMI 25.8 ± 2.6 kg/m² (HIIT), Age: 20.5 ± 1.9 years, BMI: 25.5 ± 2.1kg/m² (MVCT) HIIT (n=13), MVCT (n=13)	HIIT: 60 x 8s sprints performed at "all out", interspersed with 12s of recovery MVCT: Cycling at 60% of VO2peak for 40min 5-weeks, 4 days/week	Both exercise groups displayed significant enhancements in V̇O2peak; however, there were no significant differences between the groups in terms of these improvements. HIIT-group did not exhibit any significant alterations in body composition parameters, in contrast to MVCT-group. However, there were no significant differences between the groups in terms of the changes observed in body composition.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Kong et al. (2016b) [31]	N=16 (F) Overweight/Obese Age: 19.8 ± 0.8 years, BMI: 25.5 ± 2.1 kg/m² (HIIT), Age: 19.9± 2.1 age, BMI: 26.2± 2.4 kg/m² (MICT) HIIT (n=10), MICT (n=8)	HIIT: 60 x 8s sprints performed at ˜90% VO2peak, interspersed with 12s recovery MICT: Cycling at ~65% of VO2peak for 40min 5-weeks, 4 days/week	Both exercise groups had significantly improved V̇O2peak, but no significant group differences were found. There were no significant alterations in body composition and biochemical parameters for either of the groups.
Gahreman et al. (2016) [47]	N=48 (M) Overweight Age: 26 ± 0.7 years, BMI: 28.5 ± 0.92 kg/m² Control (n=12), Green tea (GT) (n=12), ISE (n=12), GT + ISE (n=12)	ISE: 60 x 8s sprints performed at ˜90% VO-2peak, interspersed with 12s recovery Control: Consume 3 placebo capsules daily, one with each meal GT: Consume 3 green tea extract capsules daily, one with each meal GT+ISE: Supervised ISE session, 3 times/week and ingest one GT capsule 1hour before fasted ISE training and one capsule with lunch and dinner 12-weeks, 3 days/week	ISE-group and GT+ISE group significantly improved several body composition parameters and VOmax, with no significant difference between the groups. ISE-group improved significantly triglycerides and GT+ISE group improved significantly TC.
Higgins et al. (2016) [32]	N=52 (F) Overweight/Obese Age: 20.4± 1.5 years, BMI: 30.3± 4.5 kg/m² SIT (n=23), MICT (n=29)	SIT: 30s "all-out" sprints, followed by 4 min of active recovery MICT: Cycling at ~60% to 70% of HRR at matched energy expenditure of SIT. 6-weeks, 3-days/week	Both exercise groups had significantly improved V̇O2peak, but SIT-group exhibited a twofold rise in VO2peak, in contrast to MICT-group. There were no alterations in body mass in response to either of the exercise interventions, but SIT-group had significant interactions in body fat (kg and %) and fat free mass in contrast to MICT-group.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**

Umama-heswari et al. (2017) [54]	N= 72 (N/A) Overweight/Obese MICT: Age: 24.3±6.2 age, BMI: 29.24±2.59 kg/m^2, HIIT: Age: 23.2±5.6 years, BMI: 29.69±3.2 kg/m^2 HIIT (n=35), MICT (n= 37)	MICT: Steady state cycling at 50%-74%. HRRmax, for a duration of 40 min, 5 days/week, 15-weeks HIIT: 8s sprint cycling at 75%–84% HRRmax, followed by 12s of low intensity cycling for a duration of 20 min, 3 times/week	Both the HIIT-group and MICT-group demonstrated significant enhancements in body composition parameters. However, when comparing the two groups, the improvement was statistically more significant in HIIT-group.
Jabbour et al. (2017a) [52]	N=24 (M/F), Obese Age: 23.3± 2.3 years, BMI: 33.7 ± 3.8 kg/m^2 (SET), Age: 23.1± 3.3 years, BMI: 33.3± 4.8 kg/m^2 (Control) SET (n= 12), Control (n= 12)	SET: 6 X 6s at "all out" sprints Control: No intervention 2-Weeks, 3 days/week	SET-group improved significantly SBP and blood glucose, in contrast to control-group. No significant changes were found in VO2max and blood lipids following SET intervention.
Jabbour et al. (2017) [53]	N=24 (M/F), Obese Age: 23.1± 3.3 years (Control), 22.5± 2.3 years (Trained), BMI: 33.3± 4.8 kg/m^2 (Control), 33.2± 2.8 kg/m^2 (Trained) Control (n=12), Trained (n=12)	HIIT: SET: 6 X 6s at a max velocity, with 2min passive recovery Control: No intervention 6-Weeks, 3 days/week	HIIT-group improved VO2max but was not significant different between the groups. Glucose and insulin improved significantly in HIIT-group but no changes were found in BW.
Shepherd et al. (2017) [48]	N=16 (M), Obese Age: 25 ± 1 years, BMI: 34.8 ± 0.9 8 kg/m^2 SIT (n=8), MICT (n=8)	SIT: 4–7 × 30 s sprints at 200% of Wmax MICT: cycling at ~70% of HRmax for 30–45 min 4-weeks, 3 days/week	SIT-group led to improvements in VO2max, with no difference between groups. No changes were observed in body composition parameters for SIT-group, in contrast to MICT-group.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Tong et al. (2018) [33]	N=54 (F), Overweight Age: 21.3±1.0 years (SIT), 21.3 ± 1.0 years (HIIT), 20.7 ± 1.5 years (Control) BMI: N/A SIT (n=16), HIIT (n=16), Control (n=14)	SIT: 80 X 6s all-out cycle sprints interspersed with 9s passive recovery HIIT: Repeated 4min bouts of cycling at 90% of VO2max, alternated with 3min rest (400KJ) Control: No intervention 12-weeks, 3-4 days/week	Body composition parameters improved significantly in exercise groups, but with no significant difference among them. SIT-group and HIIT-group improved significantly VO2max; however, the improvement in SIT-group was significantly greater than HIIT-group.

Nie et al. (2018) [34]	N=36 (F), Overweight/Obese Age: 20.0± 1.0 years, BMI: 27.0± 2.0 kg/m^2 (HIE), Age: 20.5± 1.6 years, BMI: 27.9± 4.3 kg/m^2 (SIE), Age: 21.2± 2.0 years, BMI: 26.4± 1.9 kg/m^2 (RSE) RSE (n=12), SIE (n=11), HIE (n=11)	RSE: 40 X 6s "all-out" sprints, interspersed with 9s rest SIE: Repeated 1min cycling at 120% ˙ of VO2max, interspersed with 1.5min rest HIE: Repeated 4min cycling at 90% of VO2max interspersed with 3min rest (200 kJ) 12-weeks, 3-4 days/week	All exercise interventions led to a similar significant improvement in body composition parameters and VO2max, without any significant difference among them.
Camacho-Cardenosa et al. (2019) [35]	N=59 (F), Overweight/Obese Age: 40.6 ± 9.5 years, BMI: 28.00 ± 5.32 kg/m^2 AitH (n=13), AitN (n=15), SitH (n=15), SitN (n= 18)	AitH: Exercised for 3min at 90% of Wmax, followed by 3 min of active recovery at 55%-65% Wmax (under hypoxia) AitN: Exercised for 3min at 90% of Wmax, followed by 3 min of active recovery at 55%-65% Wmax (under normoxia) SitH: 5-6 X 30s of all-out (130% Wmax) sprints, followed by 3 min of active recovery at 55%-65% Wmax (under hypoxia) SitN: 5-6 X 30s of all-out (130% Wmax) sprints, followed by 3 min of active recovery at 55%-65% Wmax (under normoxia) 8-weeks, 3days/week	Both hypoxia groups improved significantly some body composition parameters (hip circumference, WHI), in contrast to SitN which improved significantly only hip circumference. SitN-group and AitN-group improved significantly triglycerides, with no significant difference between them.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Sun et al. (2019) [36]	N=42 (F), Overweight Age: 21.2 ± 1.4 years, BMI 26.3 ± 2.5 kg/m^2 SIT (n=14), MICT (n=14), HIIT (n=14)	SIT: 80 X 6s all-out cycle sprints interspersed with 9s passive recovery MICT: Cycling at ~60% of VO2peak for 61min HIIT: 9 × 4 min at ~90% of VO2peak with 3min rest 12-weeks, 3days/week	All three groups produced equivalent significant enhancements in V̇O2peak and exhibited a comparable significant improvement in body composition parameters. Only MICT-group achieved a significant reduction in fasting glucose levels.
Dupuit et al. (2020) [37]	N=27 (F), Overweight/Obese Age: 62.4± 6.7 years, BMI: 31.5± 4.3 kg/m^2 (HIIT), 31.2± 3.0 kg/m^2 (MICT), 31.4± 4.0 kg/m2 (HIIT+RT) HIIT (n=10), MICT (n=10), HIIT+RT (n=10)	HIIT: 60 x 8s at 80-90% of HRpeak, interspersed with 12s active recovery MICT: Exercise at 55-60% of PPO for 40min HIIT+RT: HIIT + 8 whole-body exercises: 1 set of 8-12 repetitions 12-weeks, 3days/week	All groups improved significantly VO2max, with lower values in MICT-group in contrast to HIIT-group and HIIT+RT. All groups improved significantly several body composition parameters (BW, TFM), but these changes were significantly higher in the HIIT-group and HIIT+RT group than in MICT-group. All groups had a significant improvement in triglycerides, but with no significant difference between the groups.

Camacho-Cardenosa et al. (2020) [38]	N=82 (F), Obese Age: 40.6 ± 9.5 years, BMI: 28.00 ± 5.32 kg/m^2 IHT(n=19), INT (n=20), RSH (n=22), RSN (n= 21)	IHT: Exercised for 3min at 90% of Wmax, followed by 3min of active recovery at 55–65%Wmax (under hypoxia) INT: Exercised for 3min at 90% of Wmax, followed by 3min of active recovery at 55–65%Wmax (under normoxia) RSH: 30s of "all-out", followed by 3min of active recovery at 55–65%Wmax (under hypoxia) RSN: 30s of "all-out", followed by 3min of active recovery at 55–65%Wmax (under normoxia) 12-weeks, 3days/week	IHT-group and RSH-group improved significantly VO2max, with no significant difference among the groups.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Hu et al. (2021) [39]	N=66 (F), Overweight/Obese Age:21.2± 1.4 years, BMI: 26.0± 3.0 kg/m^2 SIT (n=15), MICT (n=15), Control (n=15), HIIT (n=15)	SIT: 80 X 6s all-out cycle sprints, interspersed with 9s passive recovery MICT: Exercised continuously at 60% of VO2peak for ~65min Control: No intervention HIIT: Cycling at 90% of VO2peak for 4min, followed with 3min recovery for ~60 min 12-weeks, 3days/week	All exercise groups had a similar significant improvement in VO2peak and body composition parameters (BMI, BW, TFM) with no significant difference between them.
Zhang et al. (2021) [41]	N=59 (F), Obese Age: 20.9± 1.7 years (SIT all-out), 19.7± 1.3 years (SIT120), 19.7± 1.1 years (HIIT90), 21.0± 2.4 years (MICT), 21.2± 2.2 years (Control), BMI: 25.6 ± 2.4 kg/m^2 (SIT all-out), 26.1± 3.2 kg/m^2 (SIT120), 26.0± 2.9 kg/m^2 (HIIT90), 25.1± 3.0 kg/m^2 (MICT), 25.2± 1.8 kg/m^2 (Control) SIT all-out (n=11), SIT120 (n=12), HIIT90 (n=12), MICT (n=11), Control (n=13)	SIT all-out: 40 bouts of 6s all-out sprints, interspersed with 9s passive recovery intervals SIT-120: Repeated 1min exercise bouts at 120% of VO2peak, interspersed with 1.5min passive recovery intervals HIT-90: Exercise at 90% of VO2peak, with 4min exercise bouts and 3 min passive recovery intervals were MICT: Continuous exercise at 60% of VO2peak Control: No intervention 12-weeks, 3-4days/week	All exercise groups had a significant improvement in several body composition parameters, but with no significant differences among the groups. Blood glucose was also improved significantly in SIT-all out, SIT-120 and HIIT-90 but not in MICT-group. Triglycerides and TC were significantly improved only in HIIT-90 and SIT-all out.
Authors	**Sample size/Groups**	**Exercise protocol**	**Results**
Tsirigkakis et al. (2021) [49]	N=16 (M), Obese Age: 38.9± 7.3 years, BMI: 29.8± 2.1 kg/m^2 (HIIT10), 30.1± 2.6 kg/m^2 (HIIT60) HIIT10 (n=8), HIIT60 (n=8)	HIIT10: 48 X 10s repetitions at a steady cadence (70 rpm), performed at 100% of Wpeak, alternating with 15s of active recovery at 15% Wpeak HIIT60: group (8 X 60s bouts at 100% of Wpeak with 90s of recovery 8-weeks, 3days/week	Both exercise groups had significantly improved V̇O2peak, with no significant difference among the two groups. No significant changes were observed in body composition parameters following either intervention.

Petrick et al. (2021) [50]	N=23 (M), Overweight/Obese Age: 37.4± 15.1 years, BMI: 34± 3.4 kg/m^2 SIT (n=12), END (n=11)	SIT: 4–6 X 30s performed at~170%Wpeak, interspersed with 2 min recovery END: Cycling at ~60% of Wpeak for 30-40min 6-weeks, 3days/week	Both exercise groups had significantly improved V̇O2peak and SBP, with no significant difference among the two groups. Only HR-resting and TLM were significantly improved following SIT, in contrast to END-group which improved significantly MAP, DBP, BF%.
Cooke et al. (2022) [40]	N=34 (F), Overweight/Obese Age: 35.4 ± 8.4 years, BMI: 31.3± 3.5 kg/m^2 IF (12), SIT (n=11), IF+SIT (n=11)	IF: 2 non-consecutive days of fasting per week, 5 days on ad libitum eating SIT: 4X 20s sprints at 150% VO2peak, followed by 40s of active rest at 50 watts IF+SIT: A combination of both interventions 16-weeks, 3 days/week	Both IF and IF+SIT resulted in significant reductions in several body composition parameters, compared to SIT-group. However, no significant differences were found between those following a dietary regimen and those combining diet with exercise. There was a significant improvement in VO2peak in SIT-group and IF+SIT-group, with no significant difference among the groups. No significant changes were found in physiological parameters following the interventions. A significant improvement was found only for LDL following IF+SIT.
*Abbreviations: HIIT: High Intensity Interval Exercise; MICE: Moderate Intensity Continuous Exercise; MIIT: Moderate Intensity Interval Training; TER: Traditional Exercise Recommendations; HIIT+RT: High Intensity Interval Training Combined With Resistance Training; MIT: Continuous Moderate Intensity Training; ISE: Interval Sprint Training; GT: Green Tea; GT+ISE: Green Tea Combined with Sprint Training; SET: Supramaximal Exercise Training; MVCT: Moderate to Vigorous Intensity Continuous Training; ½ HIIT: Short Time High Intensity Intermittent Training; HIE: High Intensity Interval Training; SIE: Sprint Interval Exercise; END: Moderate Intensity Endurance Training; F: Female; M: Male; N: Number; IF: Intermittent Fasting; IF+SIT: Intermittent Fasting Combined With Sprint Interval Training; SIT: Sprint Interval Training; AitH: Aerobic Interval Training In Hypoxia; AitN: Aerobic Interval Training In Normoxia; SitN: Sprint Interval Training In Normoxia; SitH: Sprint Interval Training In Hypoxia; RSE: Repeated Sprint Exercise Training; %BF: Percentage Of Body Fat; FFM: Fat Free Mass; BW: Body Weight; HRR: Heart Rate Reserve; WC: Waist Circumference; HDL: High Density Lipoproteins; LDL: Low Density Lipoprotein; VO2peak: Aerobic Capacity; BMI: Body Mass Index; SV: Stroke Volume; HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MAP: Mean Arterial Blood Pressure; TC: Total Cholesterol, TLM: Total Lean Mass.			

Table 2: Summary of the studies included in the review.

Characteristics of the interventions

Interventions lasted between 2 and 12 weeks, with a frequency of 3-4 sessions per week. Exercise protocol varied between the studies as shown at (Table 2). 8 studies [29,32,35,38,45,46,48,50] included sprints with durations of 30s, whereas the remaining studies included sprints with durations ranging from 6-20s. In addition, the work: rest ratio varied from 9s to 4min. Studies reported interval training as: SIT [29,32,33,36,39-41,43,46,48,50], HIIT [30,31,37,42,44,45,49,51,53,54], interval spring training (ISE) [47], supramaximal exercise training (SET) [52], repeated sprint exercise (RSE) [34], sprint interval training in normoxia (SitN) [35] and repeated sprint training in normoxia (RSN) [38]. Four studies compared HIIT/SIT protocols to non-exercise groups [29,42,52,53], whereas the remaining studies compared HIIT/SIT protocols with other exercise interventions reported as: traditional exercise recommendations (TER) [43], continuous moderate intensity (MIT) [45], MICT [31,32,46,48,54], moderate to vigorous intensity continuous training (MVCT) [30] and moderate intensity endurance training (END) [50]. Some other studies included 3 or more groups, most frequently comparing HIIT/SIT to control group and to another exercise/dietetic intervention group [33,35-41,44,47,51]. The included studies present clinical heterogeneity in terms of comparator interventions (Table 2); therefore, the results are presented separately in three categories: (1) SIT/HIIT compared to control-group without exercise, (2) SIT/HIIT compared to another exercise intervention, (3) SIT/HIIT compared to two or more exercise interventions.

Findings from the systematic review

The results of the included studies are summarised in (Table 2). Among the 26 studies, 24 studies assessed body composition changes following SIT/HIIT interventions with 11 reporting significant improvements in several body composition parameters [33,34,36,37,39,41,42,45,47,51,54] compared to the others which did not [27,31,35,40,43,44,46,48,50,52,53]. Moreover, 23 studies assessed cardiorespiratory fitness and 19 studies reported significant improvements post-intervention of HIIT/SIT [29-34,36,37,39,40,42,44-51], whereas 4 studies stated no changes from baseline or any significant changes [38,43,52,53]. While 6 studies reported significant changes in some blood markers following HIIT/SIT [35,37,41,45,47,53], 7 studies reported no significant changes [31,36,40,42,43,51,52]. In addition, 9 studies assessed physiological parameters [29,36,40,42,43,45,46,50,52] and only 5 of them reported significant changes for some variables [29,42,46,50,52].

Studies that compared SIT/HIIT to control-group (no exercise)

The results of the included studies are summarised in (Table 2). Regarding the studies that compared SIT/HIIT to a non-exercise group [29,42,52,53], only one out of four studies did not report body composition outcomes [29]. Among the studies comparing HIIT/SIT to a non-exercise group, significant reductions in body composition parameters were reported in one study by Heydari et al. (2012), including BW, BMI, WC, FM (Kg), BM (%), along with improvements in FFM (Kg) [42]. However, another study by Jabbour et al. (2017a) reported no changes in body composition following 2 weeks [52] and 6 weeks of sprint-training [53]. Moreover, all of these studies reported maximal oxygen consumption (VO2peak) as an outcome [29,42,52,53], with two out of three studies showing significant improvements of VO2peak [29,42]. Regarding cardiovascular parameters, Trilk et al. (2010) and Heydari et al. (2012) [29,42] reported significant reductions in resting HR and stroke volume (SV) post-intervention, while cardiac output (CO) remained unaffected. Changes in glucose levels varied across studies, with Jabbour et al. (2017b) showing significant reductions in glucose but wasn't significantly different between the groups [53]. Systolic blood pressure (SBP) was significantly improved in one study, while diastolic blood pressure (DBP) did not differ between baseline and 2 weeks post-intervention [52].

Studies that compared SIT/HIIT to another intervention

Moreover, studies which compared SIT/HIIT to another exercise-group, reported various findings regarding body composition. In some studies, both HIIT/SIT and other exercise-group demonstrated similar improvements in body composition parameters [45,49,54].

For example, Tsirigkakis et al. (2021) [49] compared 2 different HIIT protocols lasting for 8 weeks and found comparable improvements in body composition, while Fisher et al. (2015) reported similar outcomes between HIIT and MIT-groups over a 6 weeks period [45]. On the other hand, Umamaheswari et al. (2017) reported significant improvements in body composition parameters including [(BF (Kg), FFM (Kg) and BF%], specifically in the SIT/HIIT group compared to MICT [54]. However, conflicting results emerged from other studies, with some of them reporting no significant improvements following HIIT/SIT interventions [27,31,43,46]. Notably, Higgins et al. (2016) found that the improvements of these parameters were greater in SIT-group compared to MICT-group [27], whereas Cocks et al. (2013) found that only MICT-group improved significantly these parameters [46]. Additionally, some specific protocols such as END, MICT and MVCT, were associated with greater improvements in body composition parameters compared to HIIT/SIT in certain studies [30,48,50]. Regarding cardiorespiratory fitness, most studies reported significant improvements following interventions, with some variability in the outcomes. While some studies found no significant differences in VO2peak improvements between HIT/SIT and other exercise-groups [30,31,46,49], others reported significant differences favouring either HIIT/SIT or alternative protocols such as END [45,50]. For instance, Fisher et al. (2015) observed significant greater improvements in MIT-group [45], while Higgins et al. (2016) reported significant improvement in VO2peak in SIT-group [27].

Findings regarding other physiological outcomes such as blood pressure, resting HR and lipid blood profile varied across studies. Some studies reported no significant changes in these parameters following HIIT/SIT interventions [43,45,46], while others observed reductions, more specifically in SBP [50]. Moreover, conflicting results were observed in studies assessing blood lipid profile, with some studies reporting no significant changes [30,31] and others observing reductions in specific blood lipid parameters [45].

Studies that compared SIT/HIIT to two or more groups

In studies with two exercise-groups and one control-group without exercise, significant improvements in cardiorespiratory fitness were observed post-intervention, with variations in outcomes among the exercise groups. More specifically, Tong et al. (2018) reported greater improvement of VO2peak in SIT-group than HIIT-group [33]. Moreover, Sim et al. (2015) reported no significant difference among exercise-groups (HIIT vs MICT) [44]. Similarly, studies with three exercise groups and one control-group reported significant improvements in cardiorespiratory fitness. Hu et al. (2021) reported comparable significant improvements in cardiorespiratory fitness across exercise groups [39], similar to others [34,36], while Gaherman et al. (2016) reported slightly higher improvements in VO2max in the group combining SIT with green tea compared to SIT-group alone [47] and Dupuit et al. (2020) who found lower cardiorespiratory values in MICT-group compared to HIIT-groups [37]. In addition, Carmacho-Cardenosa et al. (2020) reported significant improvements in cardiorespiratory fitness only in HIIT-group under hypoxia [38].

Regarding body composition outcomes, mixed results were found. While some studies reported significant improvements in body composition parameters without significant differences between exercise groups [33,44], others found differences among groups. Among studies with three exercise groups, significant improvements were found in body composition parameters, but with differences between interventions. For instance, Martins et al. (2016) reported significant improvements in several body composition parameters but the improvements did not significantly differ between groups [51]. Moreover, Cooke et al. (2022) stated significant improvements in body composition parameters in the group combining SIT with intermittent fasting diet, with no significant differences between diet and diet-exercise in combination [40]. Similarly, Zhang et al. (2021) stated significant improvements in body composition parameters following 12 weeks of exercise, with no differences among exercise groups [41]. In addition, the effects of HIIT/SIT on lipid profile were inconsistent across studies. While some studies found no significant changes in blood lipid profile parameters such as TC [40,51] and glucose [36], others reported significant reduction in TC or triglyceride levels in SIT and HIIT-groups [41]. For example, Gaherman et al. (2016) demonstrated significant improvements in TC only in SIT-group [47]. Similarly, Zhang et al. (2021) noted reductions in glucose, triglycerides and TC levels in SIT and HIIT-groups compared to the other exercise groups [41]. Carmacho-Cardenosa et al. (2019) also reported significant reductions in triglycerides during detraining period following SIT [35]. Some studies, such as this one of Cooke et al. (2022) found no significant change in blood pressure parameters following HIIT/SIT interventions [40].

Quality and risk of bias assessment

According to Cochrane scores as described previously, 2 out of the 26 studies reviewed were rated as at low risk (high quality), 11 were rated as at high risk (low quality) and the remaining 13 studies were rated as raising some concerns (moderate quality) (Figure 2). 19 studies were rated as raising some concerns in domain 1, due to missing information of randomization process. 16 studies were also rated as raising some concerns in domain 2, due to deviations from the intended intervention because blinding was not possible for those who participated in exercise intervention groups. 21 studies were rated as raising some concerns in domain 4, due to bias in measurement of the outcome because blinding of assessors and participants was not performed. All studies were rated as at low risk in domain 3 and domain 5.

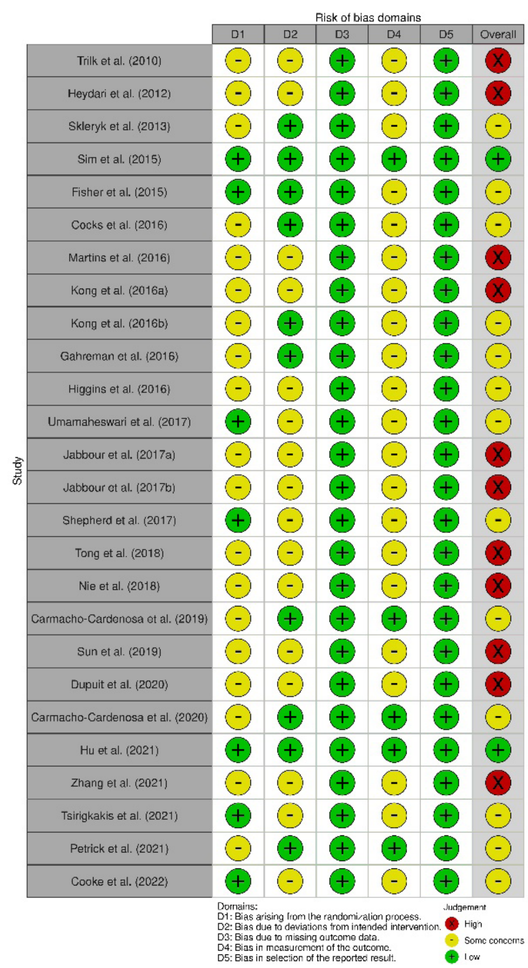

Figure 2: Risk of bias assessment using Cochrane's risk-of-bias 2 (RoB 2) tool.

Discussion

This systematic review examined the effects of HIIT with short work bouts (≤30s) on body composition, cardiorespiratory fitness levels and other physiological parameters in overweight and obese individuals. Due to the rising rates of obesity and its association with well-documented health risks, identifying effective exercise interventions is important.

This review suggests that HIIT with short burst of intense activity, observed notable but mixed improvements in body composition parameters conductive to overall metabolic health and reduced obesity-related complications. More specifically, several studies in this systematic review reported significant improvements in body composition parameters following HIIT/SIT interventions, highlighting the efficacy of these exercise modalities in promoting changes in overall body composition. These findings support previous research demonstrating the effectiveness of HIIT/SIT in inducing alternations in body composition among individuals with excess body weight [14,17,55-57]. It was observed that exercising at least 3 times per week can yield to improvements related to body composition parameters. Research, indicates that a higher frequency (≥3) of exercise can lead to an enchantment of fat loss due to the increased catecholamines response, elevated b-adrenergic receptors and heightened fat oxidation compared to low frequency workouts [58]. SIT involves high intensity activity which can lead to a greater calorie burn both during training and post-training, leading to fat loss and improved body composition. SIT can trigger the release of lipolytic hormones such as catecholamines, cortisol, glucagon, growth hormone and due to the high demand of exercise, ATP resynthesis for sustaining exercise primarily relies on glycolytic metabolism [59]. Moreover, HIIT/SIT is more effective in at activating lipolysis because it leads to a higher excess post-training oxygen consumption (EPOC) [60]. On the other hand, lipolysis in continued training primarily results from elevated concentrations of lipolytic hormones which stimulate fat breakdown in adipose tissue causing triglycerides to be broken down into free fatty acids (FFA) and then transported to active muscle cells and mitochondria where they are undergo b-oxidation [59]. This action is depended upon the duration of exercise as intensity remains moderate and consistent [61]. For this reason, this systematic review along with other research mainly did not observe significant differences in body composition parameters between HIIT/SIT and MICT. The majority of the included studies did not meet the exercise recommendations for physical activity (150 minutes of moderate intensity physical activity per week) for the prevention of weight loss/gain. While it is generally accepted that at least 60 minutes of moderate to vigorous aerobic activity every day is necessary for weight loss, the absence of improvement in some studies may be due to the relatively low total energy expenditure [62]. Notably, this pivotal aspect of SIT is not merely the shorter workout duration, but rather the higher overall energy expenditure achieved through out these exercise intervals involving vigorous intensity. Moreover, due to differences in active and passive recovery periods among these protocols the mechanism of the positive effects on body composition may varies. Nevertheless, it was reported that work bouts lasting ≤60s per repetition were found to improve body composition parameters [63,64], while longer work bouts did not show a significant effect [56]. Another aspect that it should be considered is the exercise modality, as previous research imply that running may activate larger and more muscle groups compared to a stationary cycle ergometer which was used in the protocols of the included studies in this systematic review, thus leading to a more effective increase in metabolic rate in contrast to cycling resulting to a greater BF loss [56].

Continuous training is frequently suggested to enhance VO2max, however HIIT impose more significant physiological demands on the cardiovascular system and seem to elicit a VO2max reaction that is similar to or potentially better than continuous training [65]. In this systematic review, the majority of the findings related to VO2max indicated that HIIT/SIT demonstrated similar or slightly superior improvements over continuous training protocols. The findings of this systematic review, extents the evidence that high intensity exercise with shorter burst time (≤30s) is effective for improving cardiorespiratory fitness. According to Wilsoff et al. (2009), it was reported that the degree of adaptation in VO2max and the function, structure of cardiomyocytes is depended on the intensity of exercise [65]. This improvement is believed to occur from mechanisms that involve cardiac contractility which leads to alternations to stroke volume [66]. Moreover, it involves the transportation of glucose and the enhancement of skeletal muscle oxidative capacity and therefore, increase the generation of ATP through improved mitochondrial function [67]. Considering the health significance associated with VO2max [68], the results of the systematic review underscore the valuable ability of SIT to enhance cardiorespiratory fitness efferently, with just 3 sessions on average per week.

While it's been observed that reductions in BP post-training appear to correlate with exercise intensity [69], previous results from systematic review and meta-analysis examining the effectiveness of HIIT in improving BP have produced conflicting findings [70-73]. Moreover, HIIT shows similarities to MICT in reducing arterial stiffness [72] and studies have demonstrated its superiority in enhancing endothelial function [74,75]. Some studies in this systematic review assessed BP and while the majority of them did not report any changes [43,45,46], one reported that a SIT protocol can improve SBP [52]. This improvement in endothelial function may contribute to decreased peripheral vascular resistance, potentially mitigating the impedance mismatches between central and peripheral vessels. This finding suggests that the protocol with shorter interval (≤6s) and "all out" intensity by Jabbour et al. (2017) [52] probably promoted a higher parasympathetic reactivation, which is characterized by maximum effort exertion. This intensity leads to accelerated blood flow and elevated subsequently nitric oxide (NO) levels in the structures of endothelium. This increased level of NO enhances vasodilation capacity, promoting more effective vascularization and increased peripheral compliance and this process lead in a reduction of BP [76].

HR-resting is a crucial indicator of health and well-being, serving as a significant marker for various health conditions [77]. While it was assessed only by 4 studies [29,42,46,50] in this systematic review, all of these studies reported significant reductions following HIIT/SIT protocols. The mechanisms contributing to the decrease of resting HR may involve the reduction of the activity of sympathetic nervous system (SNS), therefore improving SV and reducing resting-HR [78].

In addition, glucose was examined by some studies in this systematic review and only 3 studies reported significant improvements following HIIT/SIT [41,52,53]. The results of this systematic review are in some way in agreement with previous studies assessing individuals with [79,80] and without diabetes [81]. Nevertheless, the baseline metabolic health of the overweight and obese participants, including their baseline glucose level coupled with the diverse nature of high intensity protocols, in which each exercise parameter is manipulated differently and could lead to varying acute and chronic responses. High intensity exercise allows the increase of fat oxidation during its application and this adjustment seems to be partially linked to an improvement of glycolytic activity within the muscle, leading to increased breakdown of glucose in order to produce energy to perform the exercise [53].

Research suggests that approximately one-third of cardiovascular diseases could be linked to elevated levels of TC, due to its role in the pathogenesis of atherosclerosis [82]. While some of the included studies reported that following high intensity protocols significantly improve blood lipid parameters [35,37,40,41,45,47], others reported no changes at all [31,42,43,52]. The results of this systematic review are mixed regarding the impact of HIIT/SIT in lipid profile of obese and overweight individuals, but they are in line with other systematic reviews reporting no significant changes following HIIT [83,84]. In the systematic review they were included studies with interventions duration ranging between 2-5 weeks, which may be very brief to produce significant changes [31,43]. Another reason for these mixed results of the systematic review can be explained by earlier studies which indicated that the levels of cholesterol and their respective normal ranges can differ depending on age of the individual, gender and ethnicity, consequently affecting the interpretation of TC levels as a disease risk factor [85]. The studies included in the systematic review involved individuals of various age groups. Studies have demonstrated a significant relationship between exercise intensity and the levels of growth hormone, epinephrine and fat oxidation. Both these hormones exhibit lipolytic properties and when combined with fat oxidation could have improvements on blood lipids [86]. Given that HIIT/SIT demands higher exercise intensities compared to MICT, it is possible that the greater levels of growth hormone, epinephrine and fat oxidation associated with the application of high intensity may influence lipid profile in a different way than MICT. Moreover, changes in the autonomic nervous system that occur during the application of intermittent exercise might lead to better cardiovascular and hemodynamic responses. More specifically, these approaches are effective in reducing the blood flow to fat tissues because there is an increase in the activity of a specific type of receptor called a2-adrenergic receptors and when they are activated, they signal the fat cells to release fewer fat acids into the bloodstream [87]. This reduction in fat acid could lead to lower levels of blood lipids, such as TC and triglycerides which are well-known risk factors for developing cardiovascular diseases.

As an overall, HIIT/SIT interventions compared to a non-exercise group showed mixed results in body composition and cardiovascular parameters, with some studies demonstrating significant improvements in cardiorespiratory fitness and certain metabolic markers. Moreover, when HIIT/SIT interventions were compared to another exercise intervention, while demonstrated promises for improving body composition and cardiorespiratory fitness, their efficacy compared to other exercise modalities, remains somehow inconclusive. However, the efficacy of HIIT/SIT in improving these health parameters may vary depending on the duration of intervention, burst work duration of interval and as well as participants characteristics.

The present systematic review has some limitations that are worth nodding. The included studies exhibited variations in the duration of intervention, frequency, total duration of the training program, duration and number of bouts of intervals, the type of recovery periods (active/passive). These differences may bring difficulties in consolidating the results and reaching conclusive conclusions. It was reported earlier that some studies had relatively brief duration of intervention, which has been shown that is probably not sufficient to observe significant changes in various health care parameters of overweight and obese individuals. Another aspect was the participants characteristic, which varied in terms of age and gender and could influence the response of exercise training.

Conclusions

This systematic review has explored the application of HIIT/SIT with very short intervals in overweight and obese population. These findings suggest that while SIT holds promise as an effective approach for improving various health parameters of this clinical population, there remain several gaps in the literature. While some included studies demonstrated positive results, such as improvement in cardiorespiratory fitness and body composition, others reported inconclusive results or negligible effects. Moreover, the heterogeneity of the studies in terms of protocol parameters, participants characteristics, poses challenges related to the synthesis of the findings and conclusions. The methodological limitations observed across the studies they were related to small sample size, inadequate blinding and randomization procedures, underscoring the need for future high quality studies in this clinical population. Despite these limitations, the overall findings of this systematic review suggest that SIT with a shorter duration of intervals can be a valuable exercise intervention for those with obesity.

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