

Acute and subacute psychophysiological responses in body weight HIIT sessions: a systematic review Respostas psicofisiológicas agudas y subagudas em sesiones de HIIT com peso corporal: una revision sistemática

*Paulo Vinicios C. Zovico, *Carine D. F. C. Leite, **Roberta L. Rica, *Bruna Massaroto Barros, *Alexandre F. Machado, **Elis Aguiar Morra, ***Alexandre L. Evangelista, *Richard D. Leite, *Valerio G. Barauna, *Danilo S. Bocalini
*Federal University of Espirito Santo (Brasil), **Estácio de Sá University (Brasil), ***Italo Brasileiro Catholic College (Brazil)

Abstract. Objective: This review synthesized evidence on the use of body weight exercises through high-intensity interval training (HIIT-BW). Methods: The research was performed in the Science Direct, Embase, MEDLINE, PEDro, SciELO, CINAHL, and LILACS databases from 2013 to 2023. Descriptors such as: high-intensity whole-body, high-intensity functional training, whole-body, whole-body training, whole-body calisthenics, high-intensity calisthenic training, and HIIT bodywork were used. In addition, original articles in English and Portuguese that addressed body weight HIIT were included. The final analysis consisted of 12 articles. Results: HIIT-BW protocols presented varied methodological characteristics: number of series ranged from 4 to 20; stimulus time ranged from 5 to 30 seconds with all-out intensity; and the passive interval ranged from 10 to 35 seconds between the series in 11 studies. The acute responses resulted in psychophysiological changes, increased lactate, Rated Perceived Exertion (RPE), heart rate (HR), fatigue, sweating rate, body size perception, training load, maximum oxygen volume (VO₂max), caloric expenditure, perception of recovery, feeling of anger, mood disorder, intention of physical activity and reduction in the perception of pleasure, variability in HR, number of movements in complex exercises, and vigor. When compared with moderate continuous exercise and other high-intensity interval training protocols, HIIT-BW presented similar responses, however the use of preferred songs in the session provided an increase in the number of movements and perception of pleasure when compared with sessions that used non-preferred music and without music. Conclusion: In conclusion, based on data from studies found in the literature, HIIT-BW sessions promote increased feelings of fatigue, anger, mood disorder, RPE, HR, lactate, sweating rate, body size perception, caloric expenditure, and VO₂. The results found helped to project indicators of long-term physical fitness and to plan sessions aimed at improving the lifestyle of its practitioners.

Keywords: high-intensity interval training, body weight, physiological response, physical fitness

Resumen. Objetivo: Esta revisión sintetizó la evidencia sobre el uso de ejercicios con el propio peso corporal a través del entrenamiento en intervalos de alta intensidad (HIIT-BW). Métodos: La investigación se realizó en las bases de datos Science Direct, Embase, MEDLINE, PEDro, SciELO, CINAHL y LILACS desde 2013 hasta 2023. Se utilizaron descriptores como: entrenamiento de alta intensidad para todo el cuerpo, entrenamiento funcional de alta intensidad, entrenamiento de todo el cuerpo, calistenia de todo el cuerpo, entrenamiento calisténico de alta intensidad y trabajo corporal HIIT. Además, se incluyeron artículos originales en inglés y portugués que abordaban HIIT con peso corporal. El análisis final consistió en 12 artículos. Resultados: Los protocolos HIIT-BW presentaron características metodológicas variadas: el número de series osciló entre 4 y 20; el tiempo de estímulo varió entre 5 y 30 segundos con intensidad máxima; y el intervalo pasivo varió entre 10 y 35 segundos entre series en 11 estudios. Las respuestas agudas resultaron en cambios psicofisiológicos, aumento de lactato, Percepción del Esfuerzo (RPE), frecuencia cardíaca (HR), fatiga, tasa de sudoración, percepción del tamaño corporal, carga de entrenamiento, volumen máximo de oxígeno (VO₂max), gasto calórico, percepción de recuperación, sentimiento de ira, trastorno del estado de ánimo, intención de actividad física y reducción en la percepción del placer, variabilidad em HR, número de movimientos en ejercicios complejos y vigor. Al compararse con ejercicios continuos moderados y otros protocolos de entrenamiento en intervalos de alta intensidad, el HIIT-BW presentó respuestas similares; sin embargo, el uso de canciones preferidas en la sesión proporcionó un aumento en el número de movimientos y en la percepción del placer en comparación con sesiones que utilizaron música no preferida o sin música. Conclusión: En conclusión, basado en los datos de estudios encontrados en la literatura, las sesiones de HIIT-BW promueven un aumento en los sentimientos de fatiga, ira, trastorno del estado de ánimo, RPE, HR, lactato, tasa de sudoración, percepción del tamaño corporal, gasto calórico y VO₂. Los resultados encontrados ayudaron a proyectar indicadores de la condición física a largo plazo y a planificar sesiones orientadas a mejorar el estilo de vida de sus practicantes. **Palabras clave:** entrenamiento en intervalos de alta intensidad, peso corporal, respuesta fisiológica, condición física

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Carine Carine

carinecleite@gmail.com

Introduction

Traditionally, body weight exercises were called calisthenics (Alijas & Torre, 2015). Currently, calisthenics is understood as the practice of free exercises with different loads and variations of amplitudes that aim at an integral development of the body, through eccentric, concentric, and isometric exercises of strength, power, and resistance. The fundamental pillar is the weight of one's own body (Alijas & Torre, 2015).

The reintroduction of this concept of training using

body weight associated with the high-intensity interval training (HIIT) method, has been investigated in the literature by several studies (Evangelista et al., 2017; Gist et al., 2014; Machado et al., 2018a; Machado et al., 2018b; Mcrae et al., 2012; Rica et al., 2018; Schaun et al., 2018), however, the psychophysiological information during and after exercise session remains unclear. Recently, both HIIT and body weight training have become trends and gaining popularity, being present in the fitness trends indicated by the American College of Sports Medicine (ACMS), placed in the "top ten" of this list (Thompson, 2022). Although we

understand that bias does not necessarily indicate evidence, data collection on body weight HIIT (HIIT-BW) becomes essential for a better understanding this type of approach used as a form of exercise. The first studies that investigated body weight training associated with high-intensity interval training, used 8 sets of 20 seconds of exercise with 10 seconds of passive recovery (Mcrae et al., 2012) and 4-7 sets of 30 seconds of exercise with 4 minutes of active recovery (Gist et al., 2014, 2015). Basically, HIIT-BW consists of standard warm-up, body weight exercises, and subsequent recovery strategy. In this context, HIIT-BW has advantages as a training method to improve physical fitness, mainly due to low costs, easy access, and short time for its practice. In addition, its applications could be considered possible facilitator by minimizing barriers to the practice of physical activity (Scoubeau et al., 2022; Spiteri et al., 2019).

Machado and collaborators presented a possible strategy for prescribing HIIT using body weight. This proposal allows for the manipulation of training load variables such as 1) stimulus time, 2) recovery time, 3) total training time, and 4) selection of simple or complex exercises according to your movement pattern (Machado et al., 2017). High-intensity interval training based on body weight exercises consists of a standard warm-up followed by a series of body weight exercise stimuli, which can have a single (simple) or combined (complex) movement pattern, with an “all-out” intensity, that is, the maximum intensity possible during the stimulus. The interval between sets can be passive or active (Evangelista et al., 2017; Gist et al., 2014; Machado et al., 2018a; Machado et al., 2018b; Mcrae et al., 2012; Rica et al., 2018). Furthermore, this training methodology has been utilized in diverse populations, including children, adolescents (Bento et al., 2021; Philippot et al., 2022), adults (Filho et al., 2022; Machado et al., 2022; Rica et al., 2018) and elderly individuals (Rivas-Campo et al., 2023).

HIIT with body weight is a training method that requires understanding the methodological characteristics and possible manipulated variables since these changes could result in different responses after the session. The manipulation of variables such as stimulus and recovery time, total session time, and selection and distribution of exercises results in several possibilities for designing a HIIT-BW session. Furthermore, this review may reveal the advantages and limitations of this method relative to other HIIT methods, such as those using ergometers, continuous exercise of moderate intensity, and vigorous intensity. Compiling this data and the main outcomes found can help coaches prepare strategies and include this method in training programs, in addition to allowing the prediction of future adaptations of HIIT-BW. Thus, considering the model as a potential method within training programs, as well as the lack of studies on HIIT-BW performed acutely and its effects on psychophysiological variables, the objective of this study was to describe information from studies that used this training method considering methodological aspects and characteristics of exercises session and acute and subacute psychophysiological repercussions with the practice of HIIT-BW.

Materials and methods

Design

This SR of randomized controlled trials (RCTs) was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (von Elm et al., 2007). The protocol was registered in the PROSPERO database under the number CRD42023387200. The PICOT method was used to formulate the guiding question: P – participants (individuals submitted to HIIT-BW session); I – intervention (pre-intervention findings); C – comparison (post-intervention findings); O – outcome (psychophysiological outcomes); and T – intervention time (volume of session). Thus, the research strategy sought to answer the following problem: what are the methodological characteristics and acute and subacute psychophysiological responses in HIIT-BW sessions?

Eligibility criteria

Inclusion criteria

No restrictions were imposed regarding age, sex, or ethnicity. Acute and subacute psychophysiological responses studies elicited after a HIIT-BW session were included. The methodological characteristics of the studies were also analyzed. To be included in the analysis, the subjects had to be capable of performing the HIIT-BW protocol, and the articles had to be written in English, Spanish, or Portuguese and contain relevant keywords in the title and abstract related to acute intervention protocol (von Elm et al., 2007). The search was conducted from June 2021 to August 2023.

Exclusion criteria

Chronic intervention protocol, studies that used equipment, animal studies, review articles and case reports, letters of opinion, and letters to the editor, were not considered for this SR.

Information sources

Searches were performed on Science Direct, Embase, MEDLINE, PEDro, SciELO, CINAHL, and LILACS databases for potentially eligible studies published in English, Portuguese, and Spanish from June 2003 to August 2023.

Search strategy

The terms “High-Intensity Interval Training” and “calisthenics” were verified as Medical Subject Headings (MeSH) of the National Library of Medicine, and their respective entry terms were added to the search fields to make the search more sensitive and effective. The following search terms were employed: “high-intensity whole-body” OR “high-intensity functional training” OR “whole-body” OR “whole-body training” OR “whole-body calisthenics” OR “high-intensity calisthenic training” OR “HIIT bodywork.”

Selection of studies

Two reviewers (PVCZ and CDFCL) conducted the

searches on the databases. All search results were imported to the Rayyan software (Qatar Computing Research Institute, Qatar Foundation) to ensure a systematic and comprehensive search and to register the selection process (von Elm et al., 2007).

One reviewer (RLR) managed the Rayyan program, identifying and removing duplicate citations and ensuring an independent review of titles and abstracts (blinding the decisions of the other two reviewers). PVCZ and CDFCL reviewed the titles and abstracts of the shortlisted citations in the Rayyan program using a customized inclusion/exclusion checklist. After identifying discrepancies between the two reviewers using the Rayyan software, a third reviewer was consulted to establish a consensus for selecting the studies. Full-text copies of all selected studies were obtained to acquire more details. Both reviewers reviewed the full-text copies of the articles to determine whether diagnostic instruments were used to identify if a single session of HIIT-BW was applied and to evaluate psychophysiological responses. During the selection process, additional studies were identified in the reference lists of the selected articles. Figure 1 presents the flowchart with the stages of the article selection methodology.

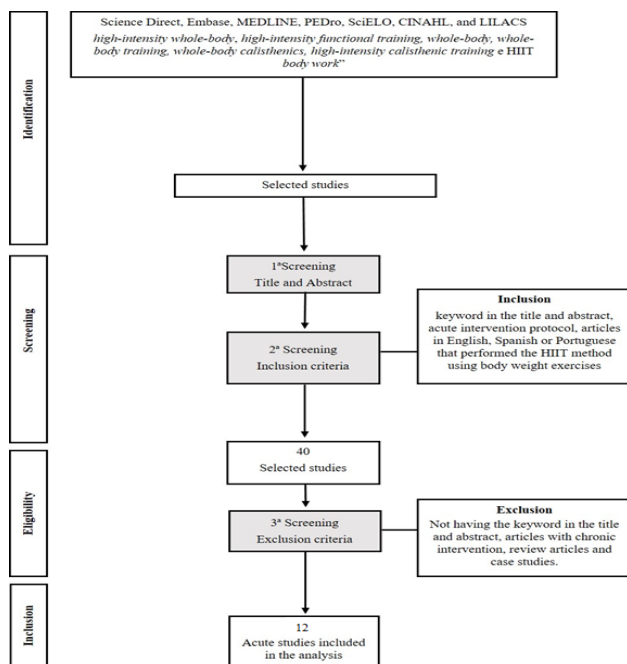


Figure 1. Flowchart with the phases of the methodology for selecting articles included in the reviews.

Table 1. General characteristics of the selected studies.

Author	Language	Journal	IF
Gist et al. 2014	English	Journal of Strength and Conditioning Research	4.415
Evangelista et al. 2017	English	Journal of Exercise Physiology online	-
Machado et al. 2018a	English	Clinics	2.365
Machado et al. 2018b	English	Brazilian Journal of Sport Medicine	0.652
Rica et al. 2018	English	Motricidade	-
Machado et al. 2020	English	Motriz	0.086
Machado et al. 2021	Portuguese	Coleção Pesquisa em Educação Física	-
Rosa et al. 2022	Portuguese	Interdisciplinary Journal of Research and Innovation	-
Ojeda et al. 2022	English	Perceptual and Motor Skills	2.212

Appraisal of methodological quality

Two reviewers (PVCZ and BMB) independently appraised the quality of the RCTs using the JADAD scale (Jadad et al., 1996). In addition, they assessed the risk of bias using the Cochrane RoB-2 tool, as recommended in the Cochrane Collaboration handbook (Whiting et al., 2016).

The Jadad score consisted of three items: randomization (0–2 points), blinding (0–2 points), and dropouts and withdrawals (0–1 points). The response to each item was either “yes” (1 point) or “no” (0 points). The final score ranged from 0 to 5 points, with higher scores indicating better reporting. Studies with a Jadad score of 2 or less were considered low quality, and those with a Jadad score of 3 or more were considered high quality.

The RoB-2 tool comprises six domains: (1) selection bias (e.g., random sequence generation and allocation concealment), (2) performance bias (e.g., blinding of participants), (3) detection bias (e.g., blinding of outcome assessment), (4) attrition bias (e.g., incomplete outcome data), (5) reporting bias (e.g., selective reporting) and (6) other biases. This tool enables researchers to assign a quality score of “high,” “low,” or “unclear” risk based on seven factors that may cause the effect of treatment to be overestimated or underestimated in individual studies.

Divergences of opinion regarding the JADAD and RoB-2 scores were discussed between reviewers until reaching a consensus. If divergence persisted, a third reviewer was consulted to obtain consensus by discussion or arbitration.

Results

Considering the available evidence on HIIT-BW, a literature search resulted in 12 articles. We found one study published in 2014 and another in 2017, three in 2018, two between 2019 and 2021, four in 2022 and one in 2023, reaching an average of 1.2 studies published per year. Table 1 shows the characteristics of the selected studies.

Of the 12 articles, 10 studies were published in English and two in Portuguese. The journal’s impact factor (IF) varied, with the lowest value corresponding to 0.086 and the highest value of 4.775.

Machado et al. 2022	English	Frontiers in Physiology	4.775
Filho et al. 2022	English	Physiology & Behavior	3.742
Machado et al. 2023	English	Journal of Physical Education and Sport	1.544

Table 2 and Figure 2 evaluate the methodological quality and bias risk. The average score on the Jada quality scale (Table 2) was 3.15 ± 0.38 points, with eleven studies with

3 points and two with 4 points, both considered high quality.

Table 2. The methodological quality of the studies according to the Jadad scale.

Study	Was the study described as randomized?	Has randomization been described, and is it adequate?	Were there comparisons and results?	Were the comparisons and results adequately described?	Did the study describe losses and exclusions?	Score
Gist et al.(2014)	0	0	1	1	1	3
Evangelista et al.(2017)	0	0	1	1	1	3
Machado et al.(2018a)	0	0	1	1	1	3
Machado et al.(2018b)	0	0	1	1	1	3
Rica et al.(2018)	0	0	1	1	1	3
Machado et al.(2020)	0	0	1	1	1	3
Machado et al.(2021)	0	0	1	1	1	3
Rosa et al.(2022)	0	0	1	1	1	3
Ojeda et al.(2022)	1	0	1	1	1	4
Machado et al.(2022)	1	0	1	1	1	4
Filho et al.(2022)	0	0	1	1	1	3
Machado et al.(2023)	0	0	1	1	1	3

Jadad scale / Score (0/5)

Regarding the evaluation of Roob-2 (Figure 2), two studies presented a low risk of random sequence generation, whereas seven studies showed adequate allocation concealment. The present study did not evaluate the blinding of participants and personnel. None of the studies were evaluated as having a low risk of bias in blinding outcome assessment, but 10 studies presented a low risk of incomplete outcome data and three studies presented selective reporting. One study was indicated to have a low-risk bias in other areas. The analysis provided by the researchers showed no discrepancies.

The methodological characteristics of acute studies are presented in Table 3 and Table 4. As Table 3 shows, the selected studies totaled 219 participants. Among them, 70.3% were men, 9.6% were women and 20.1% uninformed. Their mean age ranged from

21.9 ± 2.1 to 34 ± 6 years. The number of series ranged from 4 to 20. In 11 studies, the stimulus time ranged from 5 to 30 seconds with all-out intensity and a passive interval of 10 to 35 seconds between sets. Additionally, one study used an active interval of 4 minutes and another used passive and active intervals.

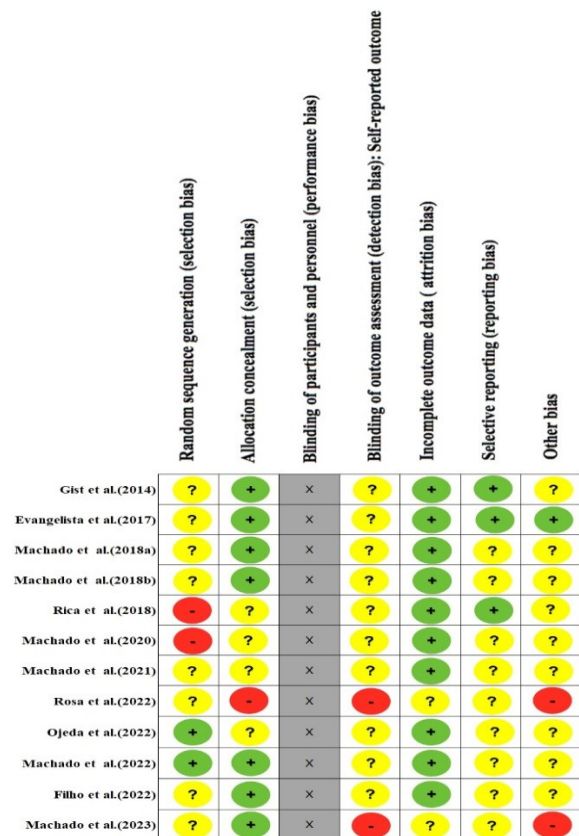


Figure 2. Cochrane risk of bias for individual studies. Included studies classified as low risk (green), unclear risk (yellow), and high risk (red) are shown for each of the seven types of bias. Item blinding of participants and personnel (performance bias) was not evaluated (gray).

Table 3. General characteristics of the subjects.

Author	Subjects/Sample	Age (Years)
Gist et al. 2014	A total of 11 college-age moderately trained members of a university U.S. Army Reserve Officers' Training Corps organization (8 men and 3 women).	Men: 22.1 ± 2.4 Women: 21.3 ± 1.2 Combined: 21.9 ± 2.1
Evangelista et al. 2017	26 healthy adult men physically independent and recreationally active	28.73 ± 5.64
Machado et al. 2018a	A total of 24 individuals of both sexes divided into three different groups: HIIT-WB5 (5 x week), HIIT-WB3 (3 x week) and MR5 (moderate running 5 x week).	HIIT-WB5: 37 ± 4 HIIT-WB3: 35 ± 5

Author	Study Population	MR5
Machado et al. 2018b	20 healthy adult men physically independent	34 ± 6
Rica et al. 2018	A total of 20 healthy adult men physically independent	34 ± 6
Machado et al. 2020	12 physically active men	24 ± 3
Machado et al. 2021	A total of 20 physically active students from Cross Fit box 1270 in São José dos Campos/SP of both sexes	28 ± 5
Rosa et al. 2022	A total of 17 physically independent and practicing cross training for at least 1 year (8 men and 9 women).	33 ± 12
		30.1 ± 5.9
		32 ± 6.14
		Men: 25.2 ± 4.2
Ojeda et al. 2022	18 healthy, young, moderately active adults (9 men and 9 women).	Women: 20.9 ± 1.6
		Combined: 23 ± 3
Machado et al. 2022	20 healthy cross fit practitioner men for at least 2 years	26 ± 5
Filho et al. 2022	A total of 11 healthy male individuals and practitioners of CrossFit modality for at least one year	26.64 ± 2.15
Machado et al. 2023	20 cross fit practitioner men active for at least 2 years	24 ± 2

The main outcomes found for psychophysiological and physiological responses after a HIIT-BW session were: increased sensation of fatigue, anger, mood disorder, Rated Perceived Exertion (RPE), heart rate (HR), increased lactate, sweating rate, body size perception, caloric expenditure, and increased oxygen volume (VO₂). According to the comparative data in the literature, it can be suggested that changes in HIIT-BW structure (block sessions or circuits) demonstrate different acute responses, such as greater perception of recovery and lower lactate concentration for the session structured in circuits. Using ergometers as measuring tools, HIIT-BW presents acute cardiorespiratory responses similar to HIIT. In relation to moderate continuous

exercise, HIIT-BW seems to present more significant responses in the sweating rate and training load regardless of the individual's fitness level. In addition, HIIT-BW leads to a greater sensation of pleasure, preference, and intention for the practice of this modality with a frequency of 5 × per week when compared with Vigorous Intensity Continuous Training (VICT). Only one study evaluated the effect of music during HIIT-BW sessions, and an increase in perception of pleasure and number of movements was found in the group that used music they liked compared to the groups that used music they disliked or no music at all. These results are detailed in Table 4.

Table 4.
Acute HIIT-BW intervention.

Author	Number of series	Time of Stimulus	Interval	Exercises	Responses
Gist et al. 2014	4 (3 exercise sets)	30"	4' active	Burpee	Similar cardiorespiratory responses (VO ₂ peak and HRpeak) compared to the high-intensity sprint protocol
Evangelista et al. 2017	8 (2 sets for each exercise)	20"	10" passive	Burpee, jumping jacks, climber, and squat and thrust	↑ Fatigue ↑ RPE during the session ↓ perception of recovery after the 3rd series ↓ Pleasure after the 4th series
Machado et al. 2018a	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, climber, burpee, and jump squat	↑ Lactate ↑ RPE during the session ↑ absolute and relative HR in the complex exercises (burpee and jump squat) ↑ Internal load after the 5th series ↓ Total amount of movements in the complex exercises (Burpee and jump squat) ↓ Perception of recovery after the 2nd exercise series
Machado et al. 2018b	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, climber, burpee, and jump squat	↑ Sweating rate ↑ Training load Greater responses compared to moderate exercise regardless of the subject's fitness level (active and inactive)
Rica et al. 2018	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, climber, burpee, and jump squat	↑ Lactate ↑ RPE ↑ Perception of body size Positive correlation between Body Image and Lactate
Machado et al. 2020	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, climber, burpee, and jump squat	↑ Relative HR after the 2nd series ↑ VO ₂ after the 3rd series ↑ Caloric expenditure after the 2nd series Greater responses are observed in the burpee exercise
Machado et al. 2021	20 Intervals: 5 sets for each exercise without alternating Circuit: 1 alternating set for each exercise until 5 sets for each exercise	30"	30" passive	Jumping jacks, Burpee, climber, and jump squat	↓ Lactate for circuit vs block sessions ↑ Perception of recovery for circuit vs block sessions Similar responses for HR, RPE, and number of movements for both sessions
Rosa et al. 2022	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, Burpee, climber, and jump squat	↑ Relative HR ↑ RPE ↑ Anger, Fatigue, and mood disorder ↓ Stamina ↓ Perception of pleasure ↑ RPE*
Ojeda et al. 2022	10	5"	35" passive	Burpee	↓ Perception of pleasure* ↑ PACES and preference vs VICT ↑ intention to practice 5 times a week vs SIT and VICT. *Similar results for the 3 groups

					↑ HR* ↑ Lactate* ↓ Perception of pleasure (A<B and C; B<C) ↑ Number of movements of protocol A vs B and C and protocol B vs C. ↑ Perception of recovery of protocol A vs B and C and protocol B vs C. *Similar results for the 3 protocols
Machado et al. 2022	20 (5 sets for each exercise)	30"	30" passive	Protocols A: Jumping jacks, Burpee, climber, and jump squat B: Jumping jacks, climber, burpee, and jump squat C: Burpee, jump squat, jumping jacks, and climber	
					↑ HR* ↑ Lactate* ↓ Tension and stamina* ↑ Fatigue and mental confusion*
Filho et al. 2022	20 (5 sets for each exercise)	30"	30" passive	Jumping jacks, Burpee, climber, and jump squat	↓ Perception of pleasure for the group of MNG and SM. ↑ Perception of pleasure for the group of MG ↑ Number of movements (MG>SM and MNG; SM>MNG) ↑ Mood disorder for the MNG group after session. *Similar results for the 3 groups after the session.
			30" Passive Or Active (stationary march 1 or 2 RPE)	Jumping jacks, Burpee, climber, and jump squat	↑ HR* ↑ Lactate* ↓ Perception of pleasure ↓ Perception of recovery from the 3 exercise series* *Similar results for the 2 types of recovery

All HIIT-BW protocols were developed with all-out intensity.

Discussion

Physical inactivity is the main factor for the development of chronic diseases (Lee et al., 2012; Ojeda et al., 2022). Due to the new habits and behaviors, the lack of time has been considered a determining factor for non-adherence to physical activity, regardless of age, gender, socioeconomic status, and ethnicity (Godin et al., 1994; Gray et al., 2016; Mcrae et al., 2012).

In this perspective, the practice of HIIT-BW is an interesting method due to the reduced time demand compared to other training methods. In addition, it is possible to consider that the non-use of materials can facilitate adherence and performance of physical exercise. However, knowledge about acute and subacute psychophysiological responses in HIIT-BW sessions remains inconclusive. Thus, this review presents a set of evidence found in the literature that indicates the main acute and subacute responses in HIIT-BW sessions.

The maintenance of regular physical activity is related to psychological variables such as the perception of pleasure that the practitioner feels when performing an exercise session (Ojeda et al., 2022; Trost et al., 2002). Our findings indicate that the practice of HIIT-BW may present a strategic potential for healthy adult women (Mcrae et al., 2012), as well as provide a pleasant response similar to traditional HIIT (Schaun & Alberton, 2022) and greater compared to Vigorous Intensity Continuous Training (VICT) (Ojeda et al., 2022). Such responses contribute to adherence to the practice of physical activity (Ojeda et al., 2022; Rhodes & Kates, 2015). In addition, other advantages can still be highlighted in HIIT-BW, such as: 1) Easy applicability; 2) easy

access; 3) low cost; 4) no need for any materials for its practice; 5) can be performed in small spaces in the environment; and 6) requires little time.

Despite the variation in the HIIT-BW protocols found in the literature, there are diverse outcomes. For example, Gist et al. (2014) evaluated the effect of the HIIT-BW session on cardiorespiratory responses using only one exercise in their training protocol. The session consisted of four block sessions of three sets of the burpee exercise with 30 seconds of stimulation and 4 minutes of active interval.

The study by Evangelista et al. (2017) used HIIT-BW protocol, which consisted of a 5-minute warm-up followed by eight sets of 20-second exercises at all-out intensity and passive intervals of 10 seconds between sets. The following exercises were used: burpee, jumping jack, climber, and squat and thrust. The authors evaluated the effects of HIIT-BW on mood response and affectivity. An increase in fatigue and small reductions in anger, depression, tension, confusion, and stamina were found after the HIIT-BW session. The subjective perception of recovery (SPR) (3rd series onwards) and the feeling of pleasure (4th series onwards) were gradually reduced throughout the exercise series (Evangelista et al., 2017).

Another configuration of the HIIT-BW protocol found in the literature consists of 20 sets, five sets for each exercise, of 30 seconds of exercise in all-out intensity and passive interval of 30 seconds between the series with the following exercises: jumping jacks, climber, burpee, and jump squat (Filho et al., 2022; Machado et al., 2020, 2022; Machado et al., 2018a; Machado et al., 2018b; Rica et al., 2018; Rosa et al., 2022).

Ojeda et al. (2022) also evaluated a HIIT-BW session, with an exercise protocol based on 10 sets of 5-second

burpee in all-out intensity and passive interval of 35 seconds. These data evidence that various configurations of HIIT-BW sessions exist in the literature.

The acute HIIT-BW session may also influence the training load during the series after a single session as described by Machado et al. (2018a). HIIT-BW altered physiological parameters by increasing subjective perception of exertion (SPE) and blood lactate after the session. The complex exercises used in the HIIT-BW session, such as the burpee and jump squat, presented higher values for absolute and maximum heart rate (HR), as well as a lower number of movements (external load) during the series, reflecting the difficulty of maintaining the exercise during the session. The subjective perception of recovery (SPR) was also reduced after the second series and remained low until the end of the session. Such results may suggest that the high intensity of the HIIT-BW protocol may generate great psychophysiological stress during the session.

In another study, Machado et al. (2018b) assessed the sweating rate of a HIIT-BW session in subjects with different fitness levels. The sweating rate increased for all volunteers after the HIIT-BW session, and it appears to be influenced by exercise intensity and internal training load ($RPE \times$ duration of the training session in minutes).

Machado et al. (2020) also reported increased HR after the second series of acute HIIT-BW session. Changes in the cardiac autonomic response (Schaun and Vecchio, 2018) are also described in the literature after a HIIT-BW session, resulting in HR increase and reduced HR variability parameters.

Considering energy expenditure, Machado et al. (2020) demonstrated that a session of HIIT-BW generated a caloric expenditure of approximately 250 Kcal. Evangelista et al. (2021), associating the practice of HIIT-BW without and with the use of electrostimulation, also evidenced caloric expenditure of around 249 Kcal in sessions performed without the equipment after four exercises (30 seconds), organized in two blocks of sessions with three sets of each exercise and 15 seconds between sets and exercises, and 180 seconds between passive rest block sessions. Even considering a limited amount of studies investigating caloric expenditure in HIIT-BW sessions, these results suggest that energy expenditure during ~20 minutes of a HIIT-BW session is similar to typical high-intensity exercise.

In comparative terms, two studies used an ergometer (traditional) to evaluate the effect of an acute session of HIIT-BW and HIIT, resulting in similar cardiorespiratory responses (Gist et al., 2014; Schaun & Del Vecchio, 2018). The Study by Machado et al. (2018b), compared HIIT to a session of moderate continuous exercise, and they presented higher responses in the variables of training load and sweating rate, regardless of the fitness level of the subjects.

Gist et al. (2014), to determine the effectiveness of the HIIT-BW session, compared the peaks of acute cardiorespiratory, metabolic, and perceptual responses to a sprint protocol in the cycle ergometer. Similar cardiorespiratory responses ($\%VO_{2peak}$ and $\%HR_{peak}$) were

observed between the two exercise protocols. The authors suggest that such results may generate cardiorespiratory and metabolic adaptations and physical performance improvements, similar to those reported by studies using sprints (Gist et al., 2014).

The Study by Machado et al. (2018b) compared the effects of a session of HIIT-BW and moderate intensity sprint in individuals with different physical activity levels. The HIIT-BW protocol consisted of 20 sets of 30 seconds with an all-out intensity of the following exercises: jumping jacks, climber, burpee, and jump squat, followed by 30 seconds of passive interval. The moderate sprint protocol consisted of 40 minutes of running at moderate intensity (75% of HRmax). Similar responses were found for the reduction of body mass. However, the sweating rate and internal load ($RPE \times$ session duration in minutes) presented higher values after the HIIT-BW session.

Ojeda et al. (2022) demonstrated a significant increase in RPE and a greater negative response in the sensation of pleasure for the SIT compared to the HIIT-BW protocol, which consisted of 10 5-second series of burpee with a passive interval of 35 seconds. In addition, the data found were higher for the intention to perform exercises reported in PACES and preference than Vigorous Intensity Continuous Training (Ojeda et al., 2022).

One study evaluated the acute responses of different block sessions and circuit HIIT-BW structures on physiological parameters (Machado et al., 2021). In the block session, five sets of each exercise were performed before starting the next proposed exercise, whereas the circuit session was performed in one series of each exercise alternately and repeatedly until the end of the five sets for each exercise. The training sessions consisted of 5 minutes of warm-up followed by 20 sets of 30 seconds of exercise with all-out intensity followed by 30 seconds of passive interval. The exercises used were jumping jacks, burpee, climber, and jump squat, in this order (Machado et al., 2021). Different acute responses were observed for the variables evaluated, such as: higher recovery rate and lower lactate concentration for circuit session (Machado et al., 2021).

Some practical implications could be indicating aiming for the quality of HIIT-BW session. When compared with another exercise modality, it can be suggested that changes in the structure of HIIT-BW (block sessions or circuits) demonstrate different acute responses, such as greater perception of recovery and lower lactate concentration for the structured session in circuits. Using ergometers as measuring tools, HIIT-BW presents acute cardiorespiratory responses similar to HIIT. Regarding moderate continuous exercise, HIIT-BW seems to present greater responses in the sweating rate and training load, regardless of the fitness level of the individual, and leads to a greater feeling of pleasure, preference, and intention for the practice of this modality with a frequency of five days per week when compared with Vigorous Intensity Continuous Training (VICT). However, only one study evaluated the effect of music during HIIT-BW sessions, and an increase in perception of pleasure and number of movements

was found in the group that used music they liked compared to the groups that used music they disliked or no music at all. Such results help to project possible effects caused by HIIT-BW, which can provide long-term improvement in physical fitness indicators as well as contribute to the planning of sessions aimed at improving the lifestyle and overall health of its practitioners. In conclusion, based on data from studies found in the literature, HIIT-BW sessions promote increased feelings of fatigue, anger, mood disorder, RPE, HR, lactate, sweating rate, body size perception, caloric expenditure, and VO₂. Conflict of interest. The authors would like to disclose a conflict of interest in this publication as the AFM and ALE sells clinics and workshops associated with the manuscript topic.

Authors' Contribution

Each author made significant individual contributions to this manuscript. PVCZ, CDFL, RLR, BMB, DSB preparation of the entire research project, writing, selection of studies and data collection, data review and analysis, editing, statistical analysis, discussion of results and execution of the revision; PVCZ, CDFL, BMB, RLR revision and correction analysis; AFM, EAM, ALE, RDL, VGB critical review, text analysis and writing; RDL, VGB, DSB: intellectual concept and revision; EAM, AFM, PVCZ, ALE, DSB guidance for the preparation of the project and study design, selection of participants and data collection, discussion of results, intellectual concept, contribution to the conception and editing and revision.

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Datos de los/as autores/as y traductor/a:

Paulo Vinicios C. Zovico	vinicios_cz@hotmail.com	Autor/a
Carine C. D. F. Leite	carinecleite@gmail.com	Autor/a
Roberta L. Rica	robertarica@hotmail.com	Autor/a
Bruna M. Barros	massarotosaroto@gmail.com	Autor/a
Alexandre F. Machado	xdmachado@gmail.com	Autor/a
Elis A. Morra	elis.morra@gmail.com	Autor/a
Alexandre L. Evangelista	contato@alexandrelevangelista.com.br	Autor/a
Richard D. Leite	rdleite@gmail.com	Autor/a
Valerio G. Barauna	barauna2@gmail.com	Autor/a
Danilo S. Bocalini	bocaliniht@hotmail.com	Autor/a – Traductor/a