RESEARCH PAPER

High Intensity Interval Training Versus Whole Body Vibration on Irisin Exerkine in Obese Hypertensive Patients: A Randomized-Controlled Trial

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ABSTRACT

Background: Systemic hypertension and obesity are important risk factors for chronic disease burden. Despite recent medical advances, it remains rampant as a precursor of atherosclerotic cardiovascular disease.

Purpose: This study compares between the effect of high intensity interval training (HIIT) and whole-body vibration (WBV) on Exerkine in obese hypertensive patients.

Methods: Sixty-three obese hypertensive women followed their traditional medications were recruited from an out-patient clinic-Tanta University Hospital for these four weeks study, and randomly assigned equally into three groups: HIIT group, WBV group, and control group who didn't follow any structured exercise. Irisin Exerkine level, systolic and diastolic blood pressure (SBP, DBP), body mass index (BMI), and patient satisfaction were evaluated pre- and post-intervention.

Results: HIIT and WPV groups exhibited significantly greater reductions in BMI compared with the control group ($P<0.001$, $P<0.001$, $P = 0.005$; respectively) with no statistically significant differences post-intervention among HIIT, WBV, and control groups for SBP and DBP ($P1=0.856$, $P2=0.143$, $P3=0.356$; respectively, and $P1=0.948$, $P2=0.807$, $P3=0.618$; respectively). Regarding Irisin, both the HIIT and WPV groups showed statistically significant increases from pre- to post-intervention ($P = 0.001$ and $P < 0.001$, respectively), while the control group showed a significant decrease ($P = 0.014$). For patient satisfaction, there was no statistically significant difference regarding the satisfaction score between the HIIT and WBV groups ($P = 0.541$).

Conclusion: Across all evaluated endpoints, HIIT and WBV yielded results that were largely equal, with positive metabolic and cardiovascular health benefits.

Keywords: Cardiovascular diseases, fibronectins, high intensity interval training, patient satisfaction, vibration

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1 Introduction

Hypertension is a well-established pathology and a primary risk factor for systemic disease. Extensive studies demonstrate that elevated blood pressure, specifically systolic pressure ≥115 mmHg significantly increases the rate of cardiovascular events, including stroke, myocardial infarction, heart failure, atrial fibrillation, and premature mortality [1].

Obesity, defined as the abnormal accumulation of adipose tissue, impairs health by increasing the risk of diabetes mellitus, cardiovascular disease, hypertension, and hyperlipidemia. Visceral obesity, in particular, is proposed to be a key driver in the pathogenesis of hypertension. [2] Adipose tissue acts as a major endocrine organ by secreting bioactive substances known as adipocytokines, including leptin, tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), angiotensinogen, and non-esterified fatty acids. These adipocytokines are believed to contribute directly to the development of hypertension [3].

Irisin has been identified as a mediator of the "browning" of white adipose tissue (WAT), a process that enhances energy expenditure and protects against diet-induced weight gain [4]. Although primarily a myokine, irisin is also secreted by adipocytes. In the context of obesity, irisin secretion may increase as a compensatory response to metabolic disturbances, such as insulin resistance and glucose intolerance. Consequently, elevated irisin levels in obese subjects may represent a physiological adaptation aimed at improving impaired glucose tolerance [5].

Circulating irisin levels have been reported to correlate positively with body mass index (BMI) [6] and serum glucose levels. However, conflicting data exists; other studies have observed a negative correlation between irisin levels and age, insulin, cholesterol, adiponectin, and obesity markers [7]. Furthermore, irisin plays a crucial regulatory role in glucose utilization and lipid metabolism [8].

It has been demonstrated that High-Intensity Interval Training (HIIT) plays a significant role in increasing blood irisin concentrations, enhancing physical performance, and reducing fat content. These findings suggest that HIIT may accelerate basal metabolism, offering a potential therapeutic strategy for the prevention and treatment of obesity [9].

Whole-body vibration (WBV) training has been shown to positively impact lipid profiles, specifically by reducing triglycerides (TG) in adults. These findings highlight WBV as a viable intervention strategy for chronic disease management, supporting its efficacy in promoting metabolic health [10].

Furthermore, WBV training modulates the secretion of key cytokines, including adiponectin and irisin. Improvements in these biomarkers are associated with reduced arterial stiffness (AS) [11]. Building on evidence regarding the positive effects of acute WBV exposure, long-term WBV training is posited to confer sustained benefits for vascular health and arterial compliance [12].

To assess the quality of care, the 18-item Patient Satisfaction Questionnaire-Revised (PSQ-R) serves as a robust instrument. Validated for its reliability and measurement invariance, the PSQ-R effectively evaluates healthcare service quality and medical staff proficiency, factors critical for optimizing patient outcomes and managing healthcare costs [13].

While evidence suggests that both HIIT and WBV significantly influence irisin levels, few studies have directly compared their efficacy. Therefore, this study aims to compare the effects of HIIT versus WBV on serum irisin levels, anthropometric measures, and patient satisfaction in hypertensive patients. We hypothesized that there would be no significant difference between the HIIT and WBV interventions regarding the exerkine response in obese hypertensive patients.

2 Materials and methods

2.1 Study Design and Participants

This randomized controlled study included 63 obese hypertensive women recruited from the outpatient clinic- Tanta University Hospital following physician referral. Throughout the study period, which lasted from December 2023 to November 2024, participants kept taking their regular prescription drugs and randomly allocated into three equal groups (n = 21 per group): a (HIIT) group, a (WBV) group, and a control group. Details of participant flow through the trial phases (enrollment, allocation, and analysis) are illustrated in **Fig. 1**

This study was reported in compliance with the standards of the Consolidated Standards of Reporting Trials (CONSORT) and complied with the Helsinki Declaration. The study's protocol was approved by the Faculty of Physical Therapy Ethical Committee under the P.T.REC\012\004480 number.

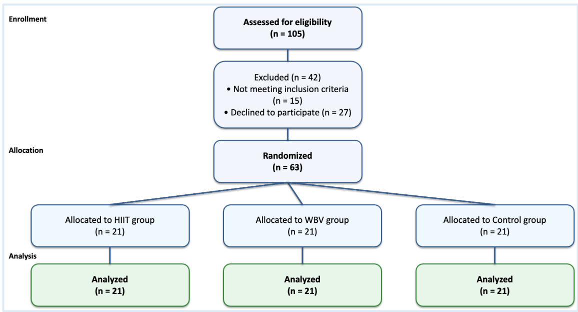

Fig. 1. Participant Flow Diagram (Recruitment and Final Analysis). CONSORT-style flow of participants through enrollment, allocation, and analysis. HIIT, high-intensity interval training; WBV, whole-body vibration.

Participants were medically stable women; aged 45–55 years with class I obesity (BMI 30–35 kg/m²); able to perform exercise, and stage 1 or 2 hypertension (SBP 130–139 mmHg and/or DPB 80–89 mmHg) or (SBP ≥140 mmHg and/or DBP ≥90 mmHg), respectively. All participants were free from chronic cardiovascular or orthopedic disorders, liver disease, current cancer treatment or active infection, significant peripheral vascular disease, anemia, chronic renal failure, cognitive impairment interfering with exercise compliance, and musculoskeletal or neurological limitations to exercise. Following an in-person meeting where informed consent was acquired and eligibility was confirmed, patients consented to participate.

Randomization was carried out by a computer-generated random sequence table with a balanced block design (GraphPad Software, Inc., CA, USA). The randomization list was created by an independent researcher, and the list was kept up to date by a study team member who was not involved in the participants' evaluation or intervention.

Since independent therapists conducted the assessments and treatments, the assessor was unaware of the participants' assignments. Each intervention procedure was performed by the same qualified physiotherapist who was unaware of the purpose of the study.

2.2 Interventions

A physical examination and medical data of the participants were gathered. It was advised that participants abstain from alcohol, stimulants (such as caffeine), and high-calorie beverages for two hours before the session. Additionally, they were advised to sleep for at least 7 to 8 hours the night before data collection and to refrain from engaging in any physical activity that was more strenuous than routine activities for the 24 hours before to the sessions. Every measurement was carried out in the same setting and by the exact same researcher.

The HIIT group (n = 21) performed treadmill-based high-intensity interval walking for one month according to previous study [14], at a frequency of three sessions per week. Each session lasted 40 minutes and included a 10-minute warm-up (50%–60% of HRpeak), four 4-minute high-intensity intervals at 85%–95% of peak heart rate (HRpeak), each separated by 3-minute active recovery periods at 50%–60% of HRpeak, followed by a 5-minute cool-down (40%–50% of HRpeak). Training was conducted using a motorized treadmill (CARNIELLI EL-500S, China; AC 3 OHP motor, speed range 0.8–12 km/h)

Training was supervised and was ended if the patient encounters: hypertension or angina in the chest, lightheadedness or dizziness, abrupt, acute dyspnea (out of proportion to effort), and unusual joint discomfort or claudication (calf pain) [15].

The WBV group (n = 21) underwent whole-body vibration training for one month, also at three sessions per week. Each session lasted 22 minutes and consisted of a 5-minute warm-up, a 12-minute main phase, and a 5-minute cool-down. The main phase involved vibration at 30 Hz for 1 minute followed by 1 minute of rest, repeated for six series, consistent with previously published protocol [16]. Training was performed using an electronic WBV device (Confidance Power Plus, 600 W, 50–60 Hz). Finally, the control group (n = 21) received standard care without any additional exercise interventions. No negative hazards were recorded after the intervention till the end of the study period.

2.3 Outcomes and measurement

Blood irisin concentration (primary outcome) was assessed using commercially available enzyme-linked immunosorbent assay (ELISA) kits, including the EASTBIOPHARM kit (Hangzhou Eastbiopharm Co. Ltd., China) and kit BYEK2733 (96T; Chongqing Biospes Co., Ltd., China), with readings obtained using an Awareness Technologies ELISA microplate reader (Stat Fax 2100; Gama Trade, USA), following established methods [17]. The assay employed a double-antibody sandwich ELISA technique. Samples were added to wells pre-coated with anti-human irisin monoclonal antibody, incubated, then treated with biotin-labeled anti-irisin antibody and streptavidin–HRP to form an immune complex. After washing to remove unbound conjugates, chromogen solutions A and B were added, producing a blue color that turned yellow after acidification. Color intensity was directly proportional to irisin concentration.

Body mass index was assessed using a bioelectrical impedance analyzer (InBody 570, Medineed, Korea), based on multisegmental and multifrequency bioelectrical impedance principles [18]. Arterial blood pressure was measured using a mercury sphygmomanometer and stethoscope (Spirit CK-105) under standardized seated conditions, with the participant's feet flat on the floor and the arm supported at heart level. The cuff was placed around the upper arm with the stethoscope positioned over the brachial artery, and systolic/diastolic pressures were determined during gradual cuff deflation using standard auscultatory methods [19].

Patient satisfaction was evaluated using the PSQ-18 questionnaire (a brief survey used in the medical field to gauge patient satisfaction with treatment). General satisfaction, technical quality, interpersonal manner, communication, financial aspects, time spent with doctor, and accessibility and convenience are the subscales that provide seven distinct ratings. Scores range from 1 to 5 in which a higher score usually denotes greater satisfaction because some items are reverse scored (for example, "Strongly Agree" is worth 1 instead of 5) [20].

2.4 Statistical Analysis

Version 25 of the Statistical Package for Social Sciences (SPSS) program (IBM Analytics, Armonk, New York, USA) was utilized for data analysis. First, the normality of the variable distributions was evaluated using the Shapiro-Wilk test for continuous data. For normally distributed data, the range and mean ± SD (standard deviation) was used to express the data. An independent t-test was used to compare the two groups, and a one-way ANOVA was employed to compare more than two groups. Tukey adjustments were then applied for pairwise comparisons in post-hoc analysis.

The differences between baseline and post-intervention were assessed using a paired t-test. For each group, the mean difference (MD) between baseline and post-intervention was computed, along with a 95% confidence interval (CI). To evaluate the effects of group and time interaction, a mixed repeated-measures ANOVA was also performed. Effect sizes were estimated using partial eta-squared (ηp^2) values (small: 0.01, medium: 0.06, and large: 0.14). P-values were deemed statistically significant if they were less than 0.05.

G*Power 3.1 was used to calculate the a priori sample size based on the pilot study in which 21 individuals reported significant differences with a moderate effect size (d = 0.69 in irisin level). With a power of 80% and a statistical significance of 0.05, 58 participants were considered adequate. The calculation was done using a repeated-measures ANOVA within-between interaction, assuming a correlation of 0.6 between repeated measures.

3 Results

3.1 participant flow and baseline characteristics

A total of 63 obese hypertensive women completed the trial and were included in the final analysis (21 participants per group: HIIT, WBV, and control), as presented in **Fig. 1**. Baseline comparability was confirmed across groups: there were not statistically significant differences in age, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), or serum irisin before intervention (**Table 1**). This indicates that randomization produced clinically and statistically comparable groups at study entry.

Table 1.

Baseline demographic and clinical characteristics of the study groups

Variables	Total (n=63)	HIIT group (n=21)	WPV group (n=21)	Control group (n=21)	Test of significance	*p*-value
Age (Years)	49.13 ±3.05 45.00 - 55.00	49.76 ±3.36 45.00 - 55.00	48.71 ±3.02 45.00 - 55.00	48.90 ±2.79 45.00 - 55.00	F=0.696	0.503
BMI (kg/m2)	32.77 ±1.61 30.10 - 35.00	32.71 ±1.56 30.10 34.70	33.04 ±1.62 30.10 - 35.00	32.54 ±1.67 30.10 - 34.90	F=0.520	0.597
SBP (mm Hg)	132.22±8.37 120.00-145.00	130.95±8.16 120.00-145.00	131.67±7.96 120.00-145.00	134.05±9.03 120.00-145.00	F=0.783	0.462
DBP (mm Hg)	87.22 ±6.01 80.00 - 95.00	87.62 ±5.15 80.00 - 95.00	86.90 ±6.42 80.00 - 95.00	87.14 ±6.63 80.00 - 95.00	F=0.075	0.928

Data are presented as mean ± standard deviation (SD) for continuous variables and number (percentage) for categorical variables, as applicable. Baseline between-group differences were tested using one-way ANOVA (continuous variables) and chi-square test (categorical variables). p *< 0.05 indicates statistical significance.*

3.2 Multivariate analysis

Body mass index: Following the intervention period, BMI decreased significantly within all three groups. However, the magnitude of change differed between groups, with greater reductions observed in the HIIT and WBV groups than in the control group (**Table 2**). Between-group post-intervention comparisons showed significant superiority of both active interventions over control, while the difference between HIIT and WBV was not statistically significant. Repeated-measures analysis further supported significant time effects and a significant time-by-group interaction, indicating that BMI changed differentially according to intervention type.

Table 2.

Changes in body mass index (BMI) after intervention (within-group pre–post change)

Variables	HIIT group (n=21)	WPV group (n=21)	Control group (n=21)	*P*-value [a]	Post-hoc	Time effect	Group effect	Time X Group interaction
BMI (kg/m^2)								
Pre-intervention	32.71±1.56	33.04±1.62	32.54±1.67	0.597	P1=0.783 P2=0.941 P3=0.579	F=86.525 P<0.001** ηp²=0.591	F=3.797 P =0.028* ηp²=0.112	F=8.578 P =0.001** ηp²=0.222
Post-intervention	28.48±1.99	29.53±3.26	31.40±1.68	0.001**	P1=0.343 P2=0.001**P3=0.038*			
MD (95% CI)	-4.23 (-5.25, -3.20)	-3.51 (-5.04, -1.99)	-1.14 (-1.91, -0.38)					
% of change P-value[b]	12.93%↓ <0.001**	10.62%↓ <0.001**	3.50%↓ 0.005**					
SBP (mmHg)								
Pre-intervention	130.95±8.16	131.67±7.96	134.05±9.03	0.462	P1=0.959 P2=0.461 P3=0.630	F=64.496 P<0.001** ηp²=0.518	F=1.718 P=0.188 ηp²=0.054	F=0.113 P=0.893 ηp²=0.004
Post-intervention	122.14±7.17	123.33±6.58	126.43±7.93	0.150	P1=0.856 P2=0.143 P3=0.356			
MD (95% CI)	-8.81 (-11.94, -5.68)	-8.34 (-10.53, -6.13)	-7.62 (-12.79 , -2.45)					
% of change P-value[b]	6.73%↓ <0.001**	6.33%↓ <0.001**	5.68% ↓ 0.006**					
DBP (mmHg)								
Pre-intervention	87.62±5.15	86.90±6.42	87.14±6.63	0.928	P1=0.924 P2=0.965 P3=0.991	F=66.016 P<0.001** ηp²=0.524	F=0.158 P=0.854 ηp²=0.005	F=0.484 P=0.618 ηp²=0.016
Post-intervention	81.90±5.80	81.43±4.23	82.86±4.63	0.636	P1=0.948 P2=0.807 P3=0.618			
MD (95% CI)	-5.72 (-7.91, -3.52)	-5.47 (-8.06, -2.89)	-4.28 (-6.36, -2.21)					
% of change P-value[b]	6.53%↓ <0.001**	6.29%↓ <0.001**	4.91%↓ <0.001**					

Values are mean ± SD. Within-group pre–post comparisons were performed using paired t *tests. Between-group post-intervention differences were assessed using one-way ANOVA with Tukey post hoc correction. Mixed ANOVA was used to test time, group, and time × group effects. MD = mean difference; CI = confidence interval; ηp² = partial eta squared.* $p < 0.05$ *indicates statistical significance.*

Blood pressure: Both SBP and DBP improved significantly within each group from pre- to post-intervention (**Table 3**). Nonetheless, between-group comparisons at post-intervention did not show significant differences for either SBP or DBP. In other words, although blood pressure improved over time in the cohort overall, neither HIIT nor WBV demonstrated statistically greater BP reduction than control under the present study conditions. Mixed-model analysis confirmed strong time effects but non-significant group and interaction effects for BP variables.

Table 3.

Pre- and post-intervention systolic and diastolic blood pressure (SBP and DBP) within and between groups

Within-group pre–post change

Variable	Group	Mean Difference (Post − Pre), mmHg	95% CI	*p* value
SBP	HIIT	−8.81	−11.94 to −5.68	<0.001
SBP	WBV	−8.34	−10.53 to −6.13	<0.001
SBP	Control	−7.62	−12.79 to −2.45	0.006
DBP	HIIT	−5.72	−7.91 to −3.52	<0.001
DBP	WBV	−5.47	−8.06 to −2.89	<0.001
DBP	Control	−4.28	−6.36 to −2.21	<0.001

Between-group comparison

Variable	Baseline *p*	Post-intervention *p*
SBP	0.462	0.150
DBP	0.928	0.636

Mixed ANOVA

Variable	Effect	F	*p* value	ηp²
SBP	Time	64.496	<0.001	0.518
SBP	Group	NS	>0.05	—
SBP	Time × Group	NS	>0.05	—
DBP	Time	66.016	<0.001	0.524
DBP	Group	NS	>0.05	—
DBP	Time × Group	NS	>0.05	—

SBP = systolic blood pressure; DBP = diastolic blood pressure; NS = non-significant. Within-group changes were tested using paired t tests; between-group comparisons were assessed by one-way ANOVA; longitudinal effects were tested by mixed ANOVA.

Serum irisin: It demonstrated a distinct response profile (**Table 4**). Both intervention groups showed significant increases in circulating irisin from baseline, whereas the control group showed a significant decrease. Post-intervention between-group analysis demonstrated significantly higher irisin concentrations in both HIIT and WBV compared with control, while the HIIT–WBV comparison remained non-significant. These findings were reinforced by repeated-measures analysis showing significant time, group, and time-by-group interaction effects, consistent with intervention-specific modulation of irisin.

Table 4.

Changes in serum irisin concentration after intervention

Within-group pre–post change

Group	Mean Difference (Post −	95% CI	% Change	*p* value

	Pre), mg/dL			
HIIT	+5.17	2.35 to 7.98	+87.90%	0.001
WBV	+3.57	1.78 to 5.36	+70.06%	<0.001
Control	−0.99	−1.76 to −0.22	−23.57%	0.014
Between-group post-intervention comparison				
Comparison	*p* value (Tukey post hoc)			
HIIT vs Control	<0.001			
WBV vs Control	0.017			
HIIT vs WBV	0.448			
Mixed ANOVA				
Effect	F	*p* value	ηp²	
Time	22.312	<0.001	0.271	
Group	5.715	0.005	0.111	
Time × Group	11.386	<0.001	0.275	

Values are mean ± SD. Within-group changes were analyzed using paired t *tests; between-group post-intervention comparisons used one-way ANOVA with Tukey post hoc testing. Mixed ANOVA assessed time, group, and time × group interaction effects. MD = mean difference; CI = confidence interval; ηp² = partial eta squared. Percent change was calculated as [(post − pre)/pre] × 100.* p *< 0.05 indicates statistical significance.*

Patient satisfaction: It was evaluated between the two active intervention groups (HIIT and WBV) and showed no statistically significant difference (**Table 5**). Mean satisfaction scores were high in both groups, indicating good acceptability of both HIIT and WBV protocols in this patient population.

Table 5.
Patient satisfaction score comparison between HIIT and WBV groups

Variable	HIIT (n = 21)	WBV (n = 21)	Mean Difference	95 % CI	*T*	*p* value
Patient satisfaction score	87.52 ± 2.71	86.95 ± 3.26	0.57	−1.30 to 2.44	0.617	0.541

Values are mean ± SD. Between-group comparison was performed using independent-samples t *test. MD = mean difference; CI = confidence interval.* p *< 0.05 indicates statistical significance.*

Overall, the results indicate that both HIIT and WBV were associated with favorable short-term changes in BMI and serum irisin, while blood pressure improved over time across all groups without significant between-group separation. HIIT and WBV produced broadly comparable outcomes across the assessed endpoints.

4 Discussion

The present randomized controlled trial compared the effects of HIIT and WBV, each added to usual medical care, on BMI, blood pressure, circulating irisin, and patient satisfaction in obese hypertensive women. The principal findings were as follows: (1) BMI improved significantly in all groups, with larger reductions in HIIT and WBV versus control; (2) SBP and DBP decreased significantly within groups over time but without significant between-group differences at post-intervention; (3) irisin increased significantly in both HIIT and WBV, whereas it decreased in the control group; and (4) patient satisfaction did not differ significantly between the two active interventions. Overall, these results suggest that both HIIT and WBV are effective short-term adjuncts for improving metabolic-related outcomes, particularly adiposity and exerkine response, with comparable acceptability in this population.

4.1 BMI

The greater BMI reduction in the exercise groups, especially with HIIT, is biologically plausible and consistent with the higher metabolic demand typically induced by interval training. HIIT can increase post-exercise oxygen consumption and improve substrate oxidation, which may contribute to larger short-term changes in body composition. This interpretation aligns with prior evidence showing favorable effects of HIIT on adiposity-related indices [9, 21]. WBV also produced a meaningful BMI decline versus control, which is consistent with reports supporting WBV as a useful adjunct intervention in overweight/obese adults, particularly when conventional exercise adherence is challenging [10, 16, 22].

4.2 Blood pressure

Both intervention groups and the control group showed significant pre–post reductions, but no between-group superiority was detected for SBP or DBP. These findings indicate a strong time effect, potentially reflecting usual care continuation, behavioral changes during study participation, regression to the mean, or nonspecific trial effects over the 4-week period. This pattern is directionally compatible with the literature reporting clinically relevant BP improvements with exercise modalities, including HIIT and WBV, but the current study may have been underpowered and too short to detect between-group separation in BP endpoints. Previous meta-analytic and interventional studies have shown BP reductions with HIIT in hypertensive populations [23-25] and with WBV in cardiometabolic-risk populations [22], while effect size magnitude varies by protocol duration, intensity, and baseline risk profile.

4.3 Irisin level

A major strength of the current work is the parallel assessment of irisin as an exercise-responsive exerkine. Both HIIT and WBV significantly increased circulating irisin, whereas the control group demonstrated a significant decrease. These findings support an intervention-specific physiological signal beyond usual care and are consistent with the concept that exercise can modulate myokine/adipokine crosstalk and energy homeostasis [5, 8]. Prior studies have reported heterogeneous irisin responses, with some showing significant acute or training-related increases and others showing null effects depending on population, training status, assay approach, and timing of blood sampling [26-28]. Thus, the present results add to evidence that both interval-based aerobic loading and WBV can elevate irisin in metabolically vulnerable groups, with HIIT showing a numerically larger gain in this cohort.

Mechanistically, irisin may contribute to cardiometabolic benefit through improved glucose handling, fatty-acid oxidation, and potential vascular effects. Experimental data suggest links between irisin signaling and endothelial function pathways, including AMPK-Akt-eNOS-NO signaling, and possible antihypertensive actions in animal models [29, 30]. Clinical correlations between irisin and blood pressure in humans remain mixed and may be confounded by age, adiposity, and physical activity level [31]. Therefore, while the robust irisin increase in the active groups is encouraging, causality between irisin change and BP change cannot be concluded from this trial alone.

4.4 Patient satisfaction

The absence of a significant satisfaction difference between HIIT and WBV suggests that both interventions were similarly acceptable to participants. This is clinically relevant because adherence and patient-perceived feasibility influence long-term implementation in chronic disease management. The use of a structured satisfaction tool is aligned with established patient-reported quality frameworks [13, 20]. From a pragmatic perspective, WBV may offer an alternative for patients with lower tolerance for conventional high-intensity exercise, whereas HIIT may be preferred when maximizing metabolic stimulus is the primary goal.

4.5 Limitations and future directions

This study has several limitations. First, the sample size was relatively small and restricted to women aged 45–55 years with class I obesity, limiting generalizability to men, younger/older groups, or other obesity classes. Second, intervention duration was short (4 weeks), which may be insufficient to capture full vascular remodeling and sustained BP divergence between groups. Third, participants continued usual medications; although ethically appropriate, medication effects may have attenuated between-group differences in hemodynamic outcomes. Fourth, biomarker interpretation should consider known pre-analytical and analytical variability in circulating mediators and assay methodology. Finally, although the manuscript conclusion currently mentions nitric oxide, nitric oxide outcomes are not consistently presented in the methods/results tables of the current version and should be reconciled before submission for internal consistency.

Future studies should include larger multicenter samples, longer follow-up, stratification by antihypertensive regimen, and standardized sampling windows for irisin to reduce biological variability. Including men and broader phenotypes (e.g., varying obesity grades and comorbidity burden) would improve external validity. Trials that jointly model body composition, vascular function, and exerkines may clarify whether irisin is a mediator of training effects or primarily a parallel biomarker of exercise exposure. Comparative effectiveness and adherence-focused designs could also determine which modality—HIIT or WBV—is more sustainable in real-world hypertension care pathways.

5 Conclusion

In summary, the present findings indicate that both HIIT and WBV are effective short-term adjunct interventions for obese hypertensive women, with significant benefits for BMI reduction and irisin elevation versus control and no significant difference in patient satisfaction between active modalities. Blood pressure improved over time in all groups, but intervention-specific superiority for SBP/DBP was not demonstrated within the current timeframe. These results support incorporating structured exercise—either HIIT or WBV—into comprehensive cardiometabolic risk management, while highlighting the need for longer, adequately powered trials to confirm differential vascular effects.

Authors' contributions

M.A.T wrote the original draft, formal analysis, and conceptualization. E.N.N conducted the methodology, investigation, and formal analysis. Z.M.H visualized, validated, and supervised the entire study. A.M.B carried out data curation and conceptualization. The manuscript was reviewed by all authors.

Ethical considerations

The study's protocol was approved by the Faculty of Physical Therapy Ethical Committee under the (P.T.REC\012\004480 number. Informed consent was obtained before inclusion.

Conflict of interest

The authors declare that they have no competing interests.

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