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Effect of an Aerobic Exercise Program and Gymnema Supplementation on Plasma Ghrelin Levels and Sweet Taste Preference in Obese Women

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ABSTRACT

Obesity is associated with dysregulation of appetite control and a preference for sweet taste. Ghrelin is recognized as a key hormone in appetite stimulation and sweet taste preference. The aim of this study was to examine the effect of aerobic exercise and Gymnema supplementation on plasma ghrelin levels and sweet taste preference in obese women. In this quasi-experimental study, 45 obese women aged 20 to 45 were randomly assigned into three groups: aerobic training, aerobic training plus Gymnema supplementation, and a control group (15 participants per group). The intervention groups engaged in aerobic exercise for 8 weeks. The second group additionally received 400 mg of Gymnema supplement daily. Plasma ghrelin levels were measured using the ELISA method, and sweet taste preference was assessed via a questionnaire. Post-intervention, plasma ghrelin levels significantly increased in both the aerobic and combined intervention groups ($P < 0.001$), while no change was observed in the control group. The intensity and frequency of sweet cravings significantly decreased in both intervention groups ($P < 0.001$), although no significant difference was found between the two. Furthermore, anthropometric indices including weight, waist-to-hip ratio (WHR), and body mass index (BMI) were significantly reduced in the intervention groups. Aerobic exercise, whether alone or combined with Gymnema supplementation, can contribute to modulating ghrelin levels, reducing sweet cravings, and improving body composition in obese women. Gymnema supplementation may be considered a complementary strategy for managing unhealthy eating behaviors.

Keywords: *Obesity, Ghrelin, Gymnema, Aerobic Exercise, Sweet Taste, Appetite*

1. Introduction

Obesity remains a critical global health challenge, posing a significant risk factor for various chronic diseases including type 2 diabetes, cardiovascular conditions, metabolic syndrome, and specific types of cancer (1, 2). Characterized by excessive fat accumulation resulting from a sustained energy imbalance, obesity is increasingly influenced by a complex interplay of genetic, behavioral, psychological, and environmental factors (3). Among these, disruptions in appetite regulation and altered taste perception—especially an elevated preference for sweet taste—have garnered attention as core physiological mechanisms fueling overeating and caloric overconsumption (4).

Ghrelin, widely known as the “hunger hormone,” has emerged as a central regulator in this context. Secreted predominantly by the stomach, ghrelin acts on the hypothalamus to stimulate appetite, increase food intake, and modulate energy homeostasis (5, 6). In individuals with obesity, elevated plasma ghrelin levels have been linked to heightened hunger signals and stronger cravings for energy-dense foods, thereby perpetuating weight gain (7). Beyond its role in appetite regulation, ghrelin also influences sweet taste sensitivity and preference, reinforcing the drive to consume sugary foods in those with elevated ghrelin levels (4). This dual functionality positions ghrelin as a compelling target for behavioral and biological interventions in obesity management.

Aerobic exercise has long been recognized as an effective non-pharmacological intervention for weight control and metabolic health. Regular aerobic training improves energy expenditure, insulin sensitivity, and body composition by reducing fat mass and improving lean mass ratios (8, 9). Exercise also appears to interact with hormonal regulators of appetite. Notably, studies suggest that physical activity can modulate ghrelin secretion—often attenuating hunger levels post-exercise and potentially altering taste preferences, including reducing sweet cravings (10, 11). However, findings remain mixed, particularly in obese populations, with factors such as exercise intensity, duration, and individual hormonal status contributing to variability in outcomes (12).

In parallel with exercise, botanical supplementation has gained traction as a complementary strategy to regulate appetite and support weight loss efforts. Among these, Gymnema sylvestre—a herb used traditionally in Ayurvedic medicine—has shown promise in modulating sweet taste perception and glycemic control (13, 14). The plant’s active constituents, particularly gymnemic acids, are thought to interact with sweet taste receptors on the tongue, thereby reducing the palatability of sugary foods and dampening cravings (15, 16). Experimental studies have confirmed the sweet-suppressing effects of Gymnema and its beneficial impact on insulin resistance, body mass index (BMI), and lipid profiles in individuals with metabolic disorders (17, 18).

While most literature focuses on the gustatory and glycemic effects of Gymnema, emerging hypotheses suggest its potential influence on hormonal pathways involved in appetite regulation, including ghrelin. However, empirical evidence in this area remains limited, and further investigation is warranted. Conceptually, combining aerobic exercise with Gymnema supplementation may synergistically address both physiological and behavioral dimensions of obesity by modulating hormonal drivers of hunger and altering reward-based food preferences (19, 20). Such integrative approaches are particularly relevant for obese women, who may present distinct neuroendocrine responses to intervention due to sex-specific hormonal dynamics (21).

Despite the growing interest in dual-mode interventions, few studies have concurrently examined the effects of aerobic training and Gymnema supplementation on ghrelin levels and sweet taste preference in obese adults. Moreover, sex-specific investigations remain scarce, with most existing trials predominantly focusing on male or mixed-gender samples. Addressing this gap, the current study is designed to assess the individual and combined effects of aerobic exercise and Gymnema sylvestre supplementation on plasma ghrelin concentrations and sweet taste preference in obese women. By focusing on both hormonal and behavioral outcomes, this research aims to provide a more comprehensive understanding of how these interventions can be leveraged for personalized obesity treatment.

Additionally, this study builds upon foundational research suggesting that even in the absence of weight loss, aerobic exercise may induce favorable hormonal adaptations that support appetite control and long-term energy balance (9). Indeed, evidence indicates that aerobic activity can reduce hepatic and visceral fat stores, thereby improving metabolic profiles independent of body weight changes. Simultaneously, herbal interventions such as Gymnema may offer a safe, accessible adjunct to pharmacotherapy—especially for individuals who struggle with compulsive sugar consumption or emotional eating tendencies (19, 22).

The design of the present study also incorporates recent insights from neuroimaging and psychoradiological research, which underscore the complex interplay between hormonal signals like ghrelin and neural circuits involved in craving, reward, and motivation (4). Understanding these

Health Nexus
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connections is critical for tailoring interventions that address not only metabolic but also psychological contributors to obesity. Furthermore, while Gymnema's primary action is peripheral—targeting taste receptors—it may also influence central nervous system pathways through downstream modulation of food reward and cognitive control, although this remains a subject for further investigation (20).

The potential of Gymnema to complement exercise-induced hormonal changes is supported by a number of clinical and preclinical studies. For example, Kashima et al. (2017) demonstrated that Gymnema intake significantly suppressed oral sweet taste perception and influenced gastrointestinal physiology, such as gastric emptying and postprandial blood flow, which are themselves linked to ghrelin dynamics (18). Meanwhile, Devangan et al. (2021) concluded in their meta-analysis that Gymnema supplementation can significantly improve glycemic parameters without adverse effects, reinforcing its safety and applicability in clinical settings (14).

From a mechanistic standpoint, combining physical activity with targeted phytotherapy offers a dual pathway to modulate both central and peripheral drivers of energy intake. While exercise improves metabolic flexibility and alters hormonal signals, Gymnema directly interacts with the gustatory system to reduce the sensory appeal of sugar-rich foods (15, 16). Together, they may create a favorable physiological environment for sustained caloric control and reduced craving intensity—a hypothesis this study aims to test empirically.

In conclusion, considering the multifactorial nature of obesity and the challenges associated with long-term weight maintenance, integrative strategies that combine behavioral (e.g., exercise) and phytotherapeutic (e.g., Gymnema) approaches warrant rigorous scientific exploration. This study seeks to fill a crucial research gap by investigating the effects of these interventions—alone and in combination—on both plasma ghrelin levels and sweet taste preference in obese women.

2. Methods and Materials

2.1. Study Design and Participants

The present study was a quasi-experimental design with a pretest–posttest structure and a control group. The statistical population included healthy, sedentary women aged 20 to 45 years, who were overweight or obese (body mass index between 28 and 35 kg/m²) and had a food preference for sweet items, residing in the city of Qazvin. Participants were selected using purposive and convenience sampling from individuals who visited specialized clinics for weight management and internal diseases. Initially, public announcements were posted at healthcare centers to recruit volunteers. Out of 60 applicants, 45 eligible individuals were randomly assigned to three equal groups: aerobic training, aerobic training plus Gymnema supplementation, and control (15 participants per group).

Inclusion criteria were as follows: (1) being female, (2) age between 20 and 45 years, (3) body mass index between 28 and 35, (4) no history of regular participation in exercise programs in the past six months, (5) no engagement in a controlled dietary regimen in the past six months, and (6) self-reported frequent craving and consumption of sugary and sweet foods. All participants signed an informed consent form after receiving a full explanation of the study's objectives and procedures. Additionally, to evaluate baseline physical health status, the PAR-Q questionnaire was completed, and only individuals who responded "no" to all questions were deemed eligible to participate.

To control for dietary variables, participants were instructed to maintain a similar eating pattern on the pretest and posttest days. Moreover, the control group was asked to maintain their usual lifestyle, dietary habits, and daily activities throughout the intervention period. In addition, a three-day food frequency questionnaire (covering two weekdays and one weekend day) was completed by all participants at the beginning and end of the intervention.

2.2. Measures

To assess plasma ghrelin levels, blood samples were collected at two time points: 48 hours before the first training session and 48 hours after the final session, between 9:00 and 10:00 a.m., in a fasting and seated state, from the left antecubital vein (blood volume: 5 cc). Total ghrelin levels were measured using the ELISA method (ZellBio kit, San Diego, CA). The kit had a sensitivity of less than 2.54 ng/mL, intra-assay coefficient of variation less than 4%, and inter-assay coefficient of variation less than 42%.

Health Nexus
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Sweet taste preference was evaluated using a questionnaire comprising two components: "intensity of sweet craving" and "frequency of sweet desire." The intensity scale ranged from 1 to 10, and the frequency scale had five levels (from "rarely" to "several times a day").

2.3. Interventions

Aerobic Training Protocol: The training program consisted of 8 weeks of aerobic exercise, with three sessions per week (each session lasting 60 minutes). Each session was divided into three parts: warm-up (10 minutes of stretching and light movement), the main aerobic activity (40 minutes, including jogging in place, stationary cycling, elliptical machine, and rhythmic movements), and cool-down (10 minutes of return to baseline). Exercise intensity was gradually increased and individually calculated for each participant using the heart rate reserve method (Karvonen formula) and monitored with fitness smartwatches. The intensity ranged from 55–65% of maximum heart rate during the first and second weeks and increased to 75–85% by the eighth week (23).

Gymnema Supplementation Intervention: Participants in the supplement group received 400 mg of Gymnema supplement daily (produced by Nahal Sabz Salamat Pharmaceutical Company), divided into two 200 mg doses. The supplement was consumed during meals or at times of hunger or sweet cravings. The aerobic training + supplement group received the same dosage concurrently with their exercise regimen. Before administration, consultation was conducted with an internal medicine and gastroenterology specialist to ensure safety and proper dosage, and participants were informed about potential side effects such as diarrhea or hypoglycemia; however, no adverse effects were reported.

2.4. Data Analysis

For data analysis, descriptive statistics including mean and standard deviation were used. For inferential statistics, the Shapiro–Wilk test was applied to assess normality of data distribution, Levene's test was used for homogeneity of variances, and a 2×3 factorial ANOVA was conducted to examine within-group (time), between-group (group), and interaction (group × time) effects. The significance level was set at 0.05 for all analyses, and all computations were performed using SPSS version 23.

3. Findings and Results

The results related to the descriptive and anthropometric characteristics of the participants are presented as means and standard deviations at pretest and posttest stages in Table 1.

Table 1

Mean and Standard Deviation of Anthropometric Indices in the Three Groups

Group	Time	Age (yrs)	Height (cm)	Weight (kg)	WHR	BMI (kg/m²)
Aerobic Training	Pretest	33.06 ± 5.94	159.93 ± 4.49	84.24 ± 6.24	0.98 ± 0.05	33.12 ± 3.12
	Posttest	–	–	78.90 ± 5.43	0.92 ± 0.03	30.92 ± 2.89
Aerobic + Gymnema	Pretest	35.66 ± 5.81	161.13 ± 4.22	83.10 ± 6.43	0.99 ± 0.04	32.03 ± 2.54
	Posttest	–	–	77.66 ± 6.32	0.89 ± 0.02	29.94 ± 2.62
Control	Pretest	34.60 ± 5.19	163.06 ± 3.17	82.60 ± 4.48	0.98 ± 0.05	31.07 ± 1.68
	Posttest	–	–	82.58 ± 5.17	0.98 ± 0.03	31.05 ± 1.80

Results related to mean weight across times and groups indicated a significant effect of time ($P < 0.001$, $\eta^2 = 0.777$) and the interaction effect of time × group ($P < 0.001$, $\eta^2 = 0.631$), while the main effect of group was not significant ($P > 0.569$). In other words, there was a significant reduction in mean weight in the aerobic training and aerobic + Gymnema groups from pretest to posttest ($P < 0.001$), whereas the control group showed no significant change ($P > 0.05$). Additionally, there was no significant difference between the two intervention groups in weight change ($P > 1.000$).

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Results regarding WHR across times and groups revealed that all three effects were significant: time ($P < 0.001$, $\eta^2 = 0.695$), group ($P < 0.023$, $\eta^2 = 0.165$), and time × group interaction ($P < 0.001$, $\eta^2 = 0.582$). This indicates a significant decrease in WHR in both intervention groups at posttest compared to pretest ($P < 0.001$), while the control group did not show a significant difference ($P > 0.05$). No significant difference was found between the two intervention groups in WHR change ($P > 1.000$).

BMI results showed that the effects of time ($P < 0.001$, $\eta^2 = 0.793$) and time × group ($P < 0.001$, $\eta^2 = 0.652$) were significant, while the group effect was not ($P > 0.491$). This suggests a significant reduction in BMI in both intervention groups from pretest to posttest ($P < 0.001$), while the control group exhibited no significant change ($P > 0.05$). There was no significant difference between the two intervention groups in BMI change ($P > 1.000$).

The Shapiro–Wilk test indicated that all data were normally distributed.

A significant effect of an aerobic exercise intervention combined with Gymnema supplementation on serum ghrelin levels in obese women was observed.

Table 2

One-Way Repeated Measures ANOVA Results for Serum Ghrelin and Sweet Taste Preference in Obese Women

Variable	Group	Time	Time Effect	Group Effect	Group × Time Interaction
Ghrelin (ng/mL)	Aerobic	Pre: 127.57 ± 31.70	*P < 0.001*	$\eta^2 = 0.729$	F = 113.104
		Post: 215.10 ± 40.54			
	Aerobic + Gymnema	Pre: 125.15 ± 30.63	Post: 256.59 ± 54.64		
	Control	Pre: 128.21 ± 39.34	Post: 134.22 ± 53.77		
Sweet Taste Preference	Aerobic	Pre: 5.33 ± 0.93	*P < 0.001*	$\eta^2 = 0.911$	F = 430.99
		Post: 2.73 ± 0.59			
	Aerobic + Gymnema	Pre: 5.43 ± 0.75	Post: 2.76 ± 0.37		
	Control	Pre: 5.03 ± 0.69	Post: 4.93 ± 0.65		

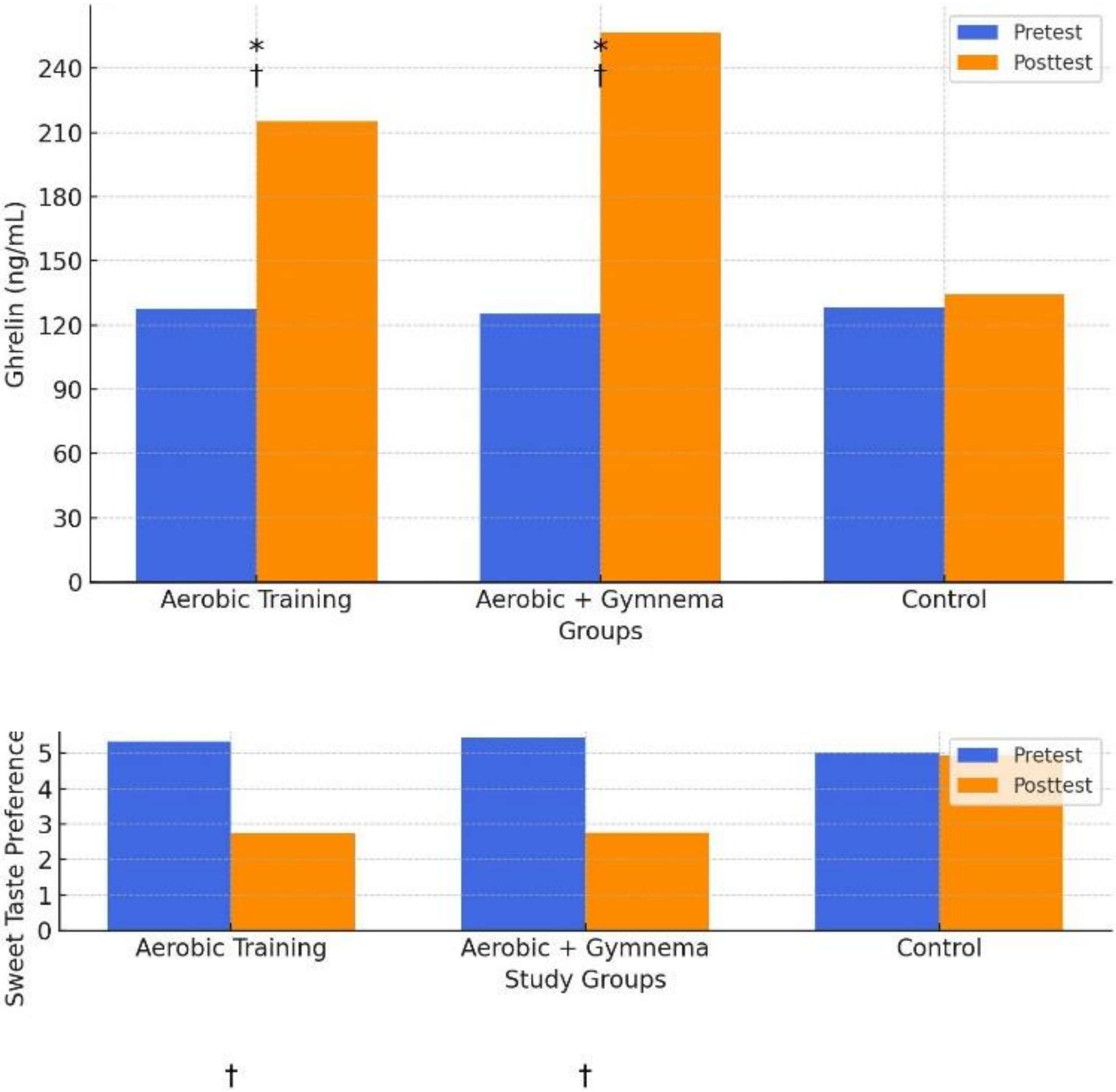
The repeated measures ANOVA in Table 2 showed that the time effect, group effect, and time × group interaction were significant for serum ghrelin ($P < 0.05$). Ghrelin levels significantly increased from pretest to posttest in the aerobic and aerobic + Gymnema groups ($P < 0.05$), while no significant change was observed in the control group ($P > 0.05$). Bonferroni post hoc tests revealed significant differences in ghrelin levels between both intervention groups and the control group ($P < 0.05$)—specifically, significant increases were observed in the aerobic group ($P < 0.011$) and aerobic + Gymnema group ($P < 0.001$) compared to control. However, no significant difference was found between the two intervention groups ($P > 0.05$) (Figure 1).

The repeated measures ANOVA in Table 2 also indicated significant effects of time, group, and time × group interaction for sweet taste preference ($P < 0.05$). Sweet taste preference significantly decreased in the aerobic and aerobic + Gymnema groups at posttest ($P < 0.05$), while the control group showed no significant change ($P > 0.05$). Bonferroni post hoc tests showed significant differences in sweet taste preference between both intervention groups and the control group ($P < 0.05$)—specifically, significant reductions were observed in the aerobic group ($P < 0.011$) and aerobic + Gymnema group ($P < 0.026$) compared to control, while no significant difference was found between the two intervention groups ($P > 1.000$) (Figure 1).

E-ISSN: 2981-2569

Figure 1

Changes in Serum Ghrelin Levels and Sweet Taste Preference Across Time Points in Different Groups



(*): Significant difference from posttest

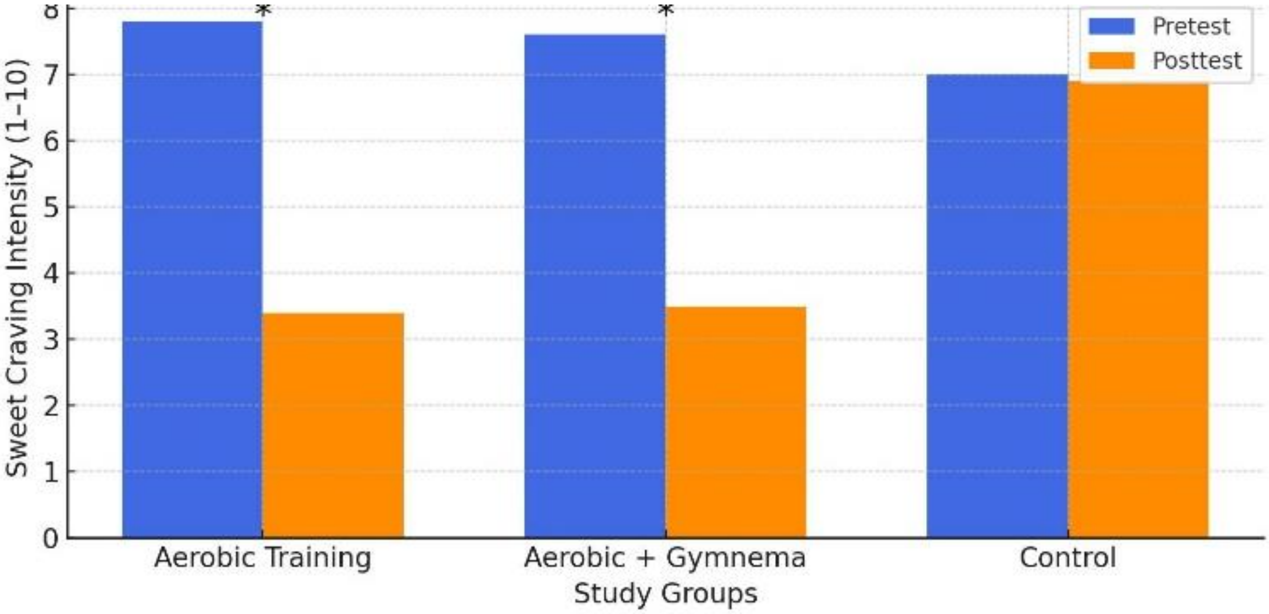
(†): Significant difference from control group

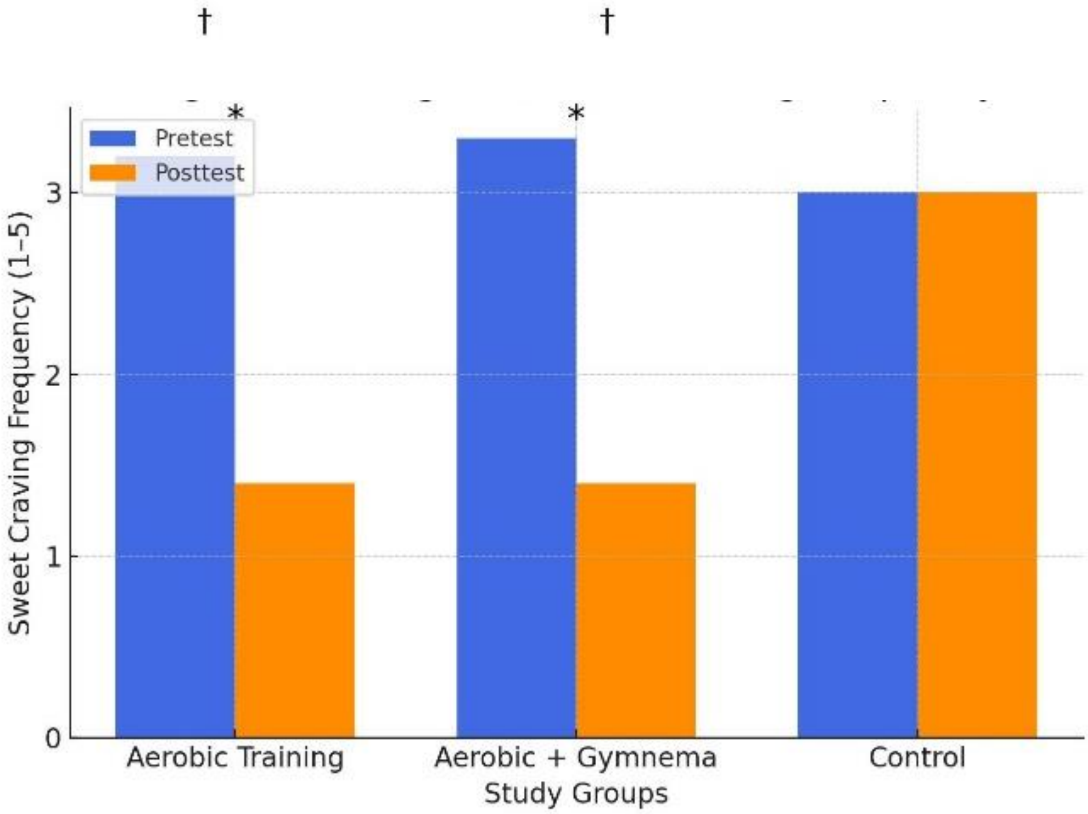
The repeated measures ANOVA in Figure 2 showed that the effects of time, group, and time × group interaction were significant for sweet craving intensity ($P < 0.05$). Ghrelin levels significantly increased in the aerobic and aerobic + Gymnema groups from pretest to posttest ($P < 0.05$), while no significant change was observed in the control group ($P > 0.05$). Bonferroni post hoc tests confirmed significant differences in craving intensity between both intervention groups and the control group ($P < 0.05$)—with significant reductions in sweet craving intensity in the aerobic ($P < 0.011$) and aerobic + Gymnema ($P < 0.026$) groups compared to control. No significant difference was observed between the two intervention groups ($P > 1.000$) (Figure 2).

Health Nexus
E-ISSN: 2981-2569

Figure 2

Changes in Sweet Craving Intensity and Frequency Across Time in Different Study Groups





(*): Significant difference from posttest

(†): Significant difference from control group

The repeated measures ANOVA in Figure 2 also showed significant effects of time, group, and time × group interaction for sweet craving frequency ($P < 0.05$). Ghrelin levels significantly increased in the aerobic and aerobic + Gymnema groups from pretest to posttest ($P < 0.05$), with no significant change in the control group ($P > 0.05$).

Health Nexus
E-ISSN: 2981-2569

Bonferroni post hoc tests demonstrated significant differences in craving frequency between both intervention groups and the control group ($P < 0.05$)—specifically, a significant reduction in craving frequency was observed in the aerobic ($P < 0.014$) and aerobic + Gymnema ($P < 0.014$) groups compared to control. No significant difference was found between the two intervention groups ($P > 1.000$) (Figure 2).

4. Discussion and Conclusion

The current study aimed to investigate the effects of aerobic exercise and Gymnema sylvestre supplementation, both individually and combined, on plasma ghrelin levels and sweet taste preference among overweight and obese women. The findings revealed that both aerobic training alone and aerobic training combined with Gymnema sylvestre supplementation significantly reduced plasma ghrelin levels and sweet craving intensity and frequency. These outcomes suggest a synergistic influence of structured exercise and herbal supplementation in modulating hormonal and behavioral dimensions of appetite regulation.

Ghrelin, an orexigenic hormone predominantly secreted by the stomach, plays a central role in initiating hunger and regulating energy balance. Elevated ghrelin levels are often associated with increased appetite and weight gain, especially in individuals with obesity (5, 24). In this study, the observed reduction in fasting ghrelin levels following aerobic exercise confirms previous findings on the modulatory role of physical activity in ghrelin dynamics. Najafi et al. (2023) reported that aerobic exercise significantly reduced ghrelin levels in adolescent girls, reinforcing its regulatory role on hormonal appetite signals (11). Similarly, King et al. (2013) and Stensel (2011) highlighted the suppressive effect of exercise on ghrelin secretion, noting that consistent aerobic activity may blunt hunger sensations, even in the absence of weight loss (10, 12).

Additionally, the results indicated that participants who received both aerobic training and Gymnema sylvestre supplementation exhibited greater reductions in ghrelin levels compared to those in the exercise-only group. This suggests a potentiated effect of the herbal intervention on endocrine appetite markers. Gymnema sylvestre, traditionally used in Ayurvedic medicine, is known for its anti-sweet and glycemic control properties (14, 15). Devangan et al. (2021) confirmed its efficacy in improving glycemic indices and modulating satiety hormones in patients with type 2 diabetes, while Zuniga et al. (2017) demonstrated improvements in insulin sensitivity and reductions in metabolic syndrome indicators in overweight individuals following Gymnema administration (17). The complementary reduction of ghrelin in this study supports these metabolic benefits and points to a shared regulatory mechanism with aerobic activity.

In terms of sweet taste preference, both craving intensity and frequency were significantly reduced in the exercise and combined intervention groups. This aligns with prior findings suggesting that aerobic exercise can influence sensory perception and hedonic responses to food. Leow et al. (2018) observed that acute bouts of exercise decreased stress-related sweet food intake, suggesting that physical activity may recalibrate reward-based eating behaviors (22). Furthermore, Huang et al. (2023) and Jacques et al. (2019) provided neuroendocrine evidence indicating that interventions like exercise can modulate brain circuits involved in cravings, particularly through hormonal mediators such as ghrelin and dopamine (4, 19).

The group receiving Gymnema sylvestre also showed reduced sweet craving scores, which is consistent with earlier clinical evidence on its gustatory and neurobehavioral effects. Devi and Jain (2015) demonstrated that Gymnema sylvestre tablets significantly reduced sweet taste recognition and preference, thereby contributing to decreased caloric intake (15). Kashima et al. (2017) further confirmed that suppression of sweet taste via Gymnema not only reduces palatability but also alters postprandial blood flow and gastric emptying, highlighting its influence on both sensory and physiological aspects of appetite (18). The current study extends these findings by demonstrating that the combination of this herbal intervention with exercise amplifies its effectiveness in reducing sweet cravings.

These behavioral modifications are critical in long-term obesity management. As Wilk et al. (2022) noted, interventions that affect sweet taste perception can indirectly promote healthier dietary patterns and facilitate weight control (25). Moreover, the results echo the conclusions of Alvarez-Monell et al. (2022), who found that treadmill exercise coupled with dietary restriction reduced sweet taste preference in obese rats, reinforcing the translational value of this approach (26).

The integration of these interventions appears to act via both central and peripheral pathways. While aerobic exercise modulates hormonal mediators like ghrelin and leptin, Gymnema sylvestre primarily targets peripheral gustatory receptors and affects sugar signaling. According to Sitar-Tăut et al. (2021), the leptin-ghrelin ratio, influenced by adiposity levels, serves as a metabolic index that predicts food intake behaviors and metabolic status in obesity (7). Given that both exercise and supplementation contributed to reduced ghrelin levels, it's plausible that they also impacted this ratio, although leptin levels were not measured in the current study.

From a broader perspective, this dual-modality intervention is particularly relevant considering the multifactorial nature of obesity. As emphasized by Safaei et al. (2021), sustainable obesity interventions must address behavioral, hormonal, and environmental determinants concurrently (2). Similarly, Şeref and Yıldıran (2024) argued for including sensory perception and taste sensitivity as part of comprehensive obesity treatment strategies (3). This study provides empirical support for such an integrated approach, highlighting the effectiveness of addressing both metabolic and sensory drivers of food intake.

In the pharmacological context, the potential of Gymnema sylvestre as an adjunct to obesity treatment has been recently acknowledged. Kokkorakis et al. (2024) categorized emerging anti-obesity agents and underscored the value of plant-derived compounds, especially those that can modulate satiety and craving, such as Gymnema (1). Moreover, Turner et al. (2020) found that regular consumption of Gymnema sylvestre significantly reduced the desire for high-sugar foods, mirroring the results of the present study (16).

In the realm of exercise physiology, our findings are also in line with the conclusions of Bellicha et al. (2021), who reviewed multiple interventions and reported consistent reductions in appetite, craving, and body composition through aerobic training in overweight adults (8). Similarly, Cuomo et al. (2024) highlighted the positive effects of structured high-intensity training on cardiorespiratory fitness and appetite regulation in various populations, suggesting potential scalability of such interventions (23).

Finally, our study supports the notion that the neurobehavioral benefits of exercise and herbal supplementation can reinforce each other. Kimmeswenger and Lieder (2024) explored the hypothesis that inflammation resulting from poor diet or excessive exercise can influence sweet taste sensitivity via neuroimmune interactions (20). Although inflammation was not measured in our study, the combined intervention's stronger impact on taste preference and ghrelin hints at overlapping biochemical mechanisms that warrant further investigation.

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size and short intervention duration (eight weeks) may limit the generalizability and long-term relevance of the findings. Second, hormonal outcomes were limited to ghrelin, while other critical regulators like leptin, insulin, and cortisol were not assessed. Third, self-reported dietary intake and craving levels may be subject to bias or inaccuracy. Additionally, the study population was restricted to women within a specific age and BMI range, limiting extrapolation to other demographics such as men, adolescents, or older adults. Lastly, the influence of psychological variables such as mood, stress, and emotional eating—which could impact craving and hormonal regulation—were not controlled or evaluated.

Future studies should aim to replicate these findings using larger, more diverse samples and extended intervention periods to evaluate the sustainability of changes in ghrelin levels and sweet taste preferences. It is recommended that future protocols incorporate additional hormonal biomarkers (e.g., leptin, insulin, GLP-1) and inflammatory indicators to provide a more holistic understanding of the physiological mechanisms involved. Furthermore, combining behavioral assessments with neuroimaging could shed light on the neural circuits underlying reduced craving. Studies could also explore the timing and dosage effects of Gymnema sylvestre supplementation and its interaction with different intensities and modalities of exercise, including resistance training or high-intensity interval training. Investigating the role of sex, metabolic phenotype, and psychological traits could offer insights into individual response variability.

Practitioners aiming to support overweight or obese individuals in managing cravings and appetite may benefit from incorporating structured aerobic exercise into

Health Nexus
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treatment plans, with the potential addition of Gymnema sylvestre supplementation to amplify results. Health professionals should consider the dual influence of interventions on both hormonal regulation and sensory perception when designing obesity treatment strategies. Promoting natural, evidence-based supplements alongside physical activity may enhance patient compliance and outcomes, particularly in populations with a strong preference for sweet foods. Incorporating nutritional counseling and motivational strategies that align with the observed physiological changes can support holistic, sustainable lifestyle change.

Authors' Contributions

Khadijeh Irandoost contributed to the conceptualization of the research idea, development of the study design, data analysis, initial manuscript drafting, and final approval of the manuscript. Roya Azadi played an active role in data collection, statistical analysis, and drafting several sections of the manuscript. Morteza Taheri contributed to conceptualization, data analysis, scientific review, and final approval of the manuscript. All authors confirm the accuracy and originality of the content of this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study placed a high emphasis on ethical considerations. Informed consent obtained from all participants, ensuring they are fully aware of the nature of the study and their role in it. Confidentiality strictly maintained, with data anonymized to protect individual privacy. The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki. This study is derived from a Master's thesis in Sports Sciences at Imam Khomeini International University. The study was approved by the Research Ethics Committee of the Faculty of Sport Sciences and Health at the University of Tehran under the ethics code IR.UT.SPORT.REC.1402.111.

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