

Original Article

The Effect of Tabata Interval Training on Body Composition, Salivary Cortisol, and Alpha Amylase in Young Girls with Different Body Mass Indexes: A Randomized Controlled Clinical Trial

Zahra Mirzashaeri¹, Farshad Ghazalian^{1*}, Shahin Salehi², Mohammad Ali Azarbayjani³

¹Department of Physical Education and Sport Science, SR.C., Islamic Azad University, Tehran, Iran

²Department of Sports and Exercise Medicine, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

³Department of Exercise Physiology, CT.C., Islamic Azad University, Tehran, Iran

Received: 08 August, 2025; Accepted: 08 July, 2026

DOI: 10.22037/nbm.v14i4.49016

Abstract

Background: Young overweight sedentary females are at increased risk of dysregulation of stress-regulating systems, including the hypothalamic–pituitary–adrenal axis (HPA) and the sympatho-adrenomedullary system (SAM). High-intensity interval training (HIIT), particularly the Tabata protocol, may improve body composition and modulate stress-related biomarkers, but evidence in individuals with different body compositions remains limited. This study compared the effects of an 8-week Tabata-based HIIT program on body composition, salivary cortisol, and alpha-amylase in overweight and normal-weight female students.

Materials and Methods: In a randomized controlled trial, 52 female students (20–25 years) were randomly assigned to four groups: training–normal weight, training–overweight, control–normal weight, and control–overweight. Training groups performed Tabata interval sessions three times per week for eight weeks, while controls continued usual physical activity. Body weight, BMI, and body fat percentage were assessed using an InBody 370 device. Salivary cortisol and salivary alpha-amylase were measured by ELISA. Data were analyzed using a two-way repeated-measures ANOVA (2×4 RM-ANOVA) with Bonferroni post-hoc tests.

Results: Significant time $\times$ group interactions were observed for body weight, BMI, body fat percentage, salivary cortisol, and salivary alpha-amylase (all $p < 0.05$). The most pronounced reductions occurred in the overweight training group ($p < 0.05$), whereas the control groups showed no significant changes.

Conclusion: Short-term Tabata-based HIIT improves body composition and stress-related biomarkers in overweight female students. These findings suggest that HIIT may enhance HPA axis regulation and reduce physiological stress responses, supporting its potential as a time-efficient intervention in this population.

Keywords: Tabata training, Body composition, Hypothalamic–pituitary–adrenal axis, Sympathoadrenal system, Female students

***Corresponding Author:** Dr. Farshad Ghazalian, Department of physical education and sport science, SR.C., Islamic Azad University, Tehran, Iran; Email: F.Ghazalian@iau.ir. ORCID ID: 0000-0002-5805-0559

Please cite this article as: Mirzashaeri Z, Ghazalian F, Salehi Sh, Azarbayjani MA. The Effect of Tabata Interval Training on Body Composition, Salivary Cortisol and Alpha Amylase in Young Girls with Different Body Mass Indexes: A Randomized Controlled Clinical Trial. Novel Biomed. 2026;14(4):163-72.

Introduction

One of the major health threats of the 21st century is

the epidemic of overweight and obesity. According to projections, more than one-fifth of the world's population will be affected by 2030¹. Type 2 diabetes,

cardiovascular disorders, and metabolic syndrome are associated with this condition. Health and welfare systems are also burdened by its psychological, social, and economic effects. Recent research has highlighted the critical role physiological systems involved in stress regulation, such as the hypothalamic-pituitary-adrenal axis (HPA) and the sympathoadrenal system (SAM), in obesity pathophysiology². In chronic stress, the HPA and cortisol secretion are persistently activated, leading to heightened appetite, emotional eating, and abdominal fat accumulation³. Furthermore, dysfunction of the SAM, as indicated by markers like salivary alpha-amylase (sAA), which reflects sympathetic activity, also increases obesity risk⁴. Female students are particularly vulnerable to high-risk lifestyles, including physical inactivity, unhealthy eating habits, academic stress, and sleep disturbances. As a result of these factors, body composition indexes can increase and physiological axis such as HPA and SAM can be impaired⁵. Research has shown that high hair cortisol levels, a marker of chronic stress, are associated with obesity prevalence⁶. In this context, researchers are increasingly focusing on low-cost, time-efficient, and effective interventions like high-intensity interval training (HIIT). The Tabata protocol is one of the most widely used types of HIIT. A brief period of intense effort is followed by a brief period of rest. According to some studies, HIIT is more effective than moderate-intensity continuous exercise in reducing body fat and improving VO₂max. In addition to improving body composition, HIIT can also affect physiological stress markers; in particular, salivary cortisol and alpha-amylase levels-biological indicators of the HPA and SAM have been shown to change following intense exercise^{7, 8}. Although numerous studies have examined the effects of HIIT on cardio-respiratory fitness or weight loss in various populations, the impact of HIIT on biochemical stress markers in girls with a variety of body types (normal weight and overweight) remains quite limited and scattered⁹. The assessment of body composition indices such as fat mass, muscle mass, and VO₂max in a semi-experimental design within this population has seldom been conducted¹⁰. Due to its non-invasive nature and ease of collection, saliva is a valuable tool for monitoring hormonal changes associated with

physical activity and stress. There is a strong correlation between salivary cortisol and blood cortisol levels, and salivary alpha-amylase is a reliable indicator of sympathetic nervous system activity^{11, 12}. A comprehensive investigation of the Tabata protocol as a practical and efficient intervention in university settings—aimed at combating obesity and improving the function of stress-related axis—is of significant research and practical importance, as stress responses and hormonal adaptations depend on exercise intensity, duration, and structure. The present study examines the effects of Tabata training on the body composition of girls of normal weight and overweight. Additionally, salivary cortisol levels and alpha-amylase levels are examined as indicators of the HPA and SAM. It can be used to design preventative and exercise-based interventional programs at universities.

Methods

Participants: During the 2024–2025 academic year, female students at the Qazvin branch of the Islamic Azad University were screened for eligibility. Of the 73 volunteers who responded to the public invitation, 13 were excluded because they engaged in regular physical activity (n=4), had hormonal or thyroid disorders (n=5), or fell outside the eligible age or BMI range (n=4). The remaining 52 eligible participants were randomly allocated, using a random number table, to four groups: Tabata-training-normal weight (n=15), Tabata-training-overweight (n=11), control-normal weight (n=14), and control-overweight (n=12). Participants in the normal-weight Tabata training group and the overweight Tabata training group completed an eight-week Tabata training program. Participants in the control group were instructed to maintain their usual lifestyle and daily activities throughout the study period, without any intervention, and to participate only in the pre-test and post-test assessments. Figure 1 presents the flow diagram of participant recruitment, allocation, follow-up, and analysis.

Inclusion and exclusion criteria: Eligible participants were female students aged 20 to 25 years with a BMI of 18.5 to 29.9 kg/m². Inclusion criteria were non-smoking status, physical inactivity, absence of menstrual irregularities, and no history of using medications known to affect the nervous or endocrine systems.

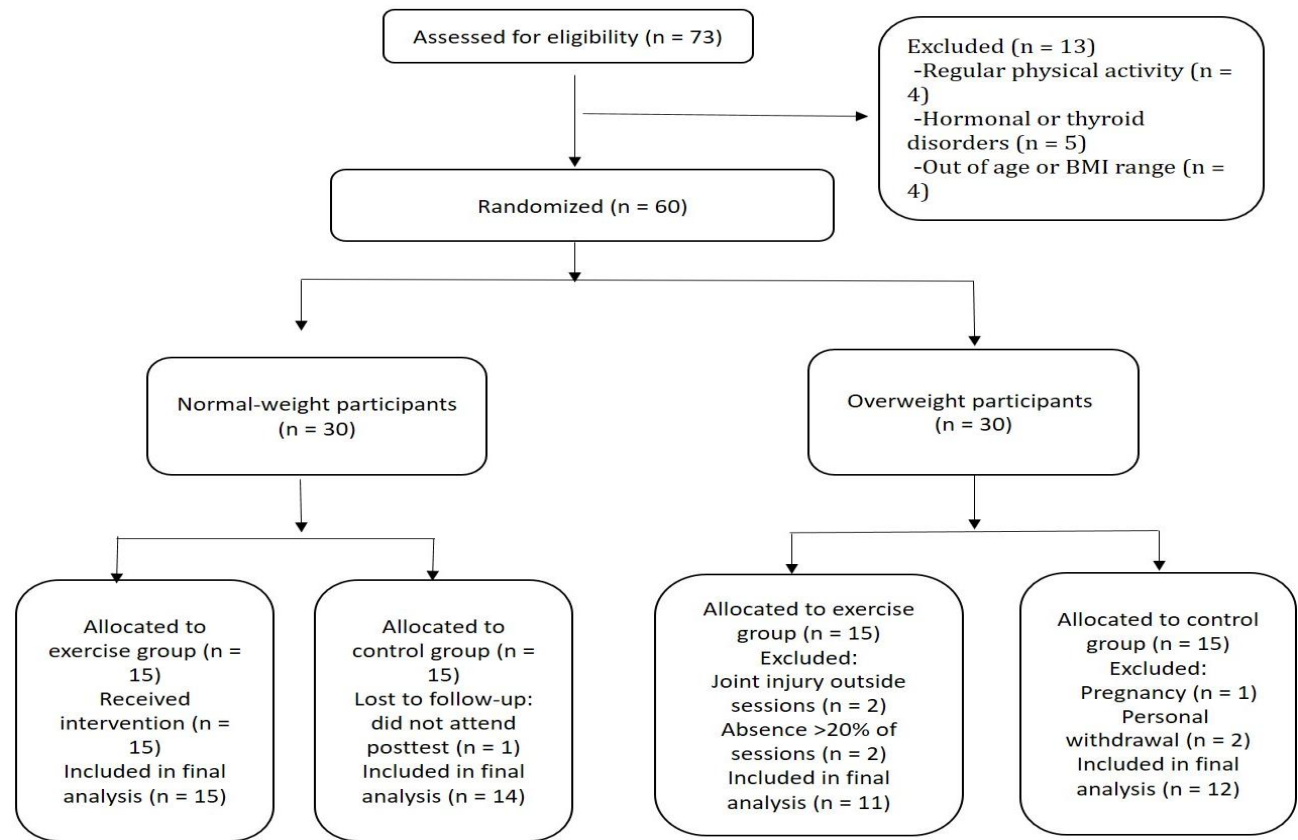


Figure 1. The participant recruitment, allocation, follow-up, and analysis flow diagram.

Exclusion criteria included injury, initiation of any new medication or supplement during the study, and attendance at fewer than 80% of the training sessions. After selection, the study procedures and potential risks were explained to the participants in a meeting, and written informed consent was obtained prior to enrollment.

Ethical considerations and trial registration: This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Islamic Azad University,

Science and Research Branch, Tehran, Iran (approval code: IR.IAU.SRB.REC.1403.359). The trial was registered in the Iranian Registry of Clinical Trials (IRCT) under registration number IRCT20241229064200N1. Before enrollment, all participants were informed of the study objectives, procedures, and potential risks, and written informed consent was obtained from each participant.

Tabata interval training: The training group performed a Tabata-based HIIT program three times

Table 1. Tabata training protocol across the 8-week intervention period.

Weeks	Rounds per Session	Selected Exercises	Reference
Weeks 1–2	3 rounds (12 min)	Narrow-stance squats, butt kickers, toe touches, lunges, mountain climbers, jumping jacks, abdominal twists, squat to side	[13]
Weeks 3–4	4 rounds (16 min)	Jumping jacks, squat jumps, mountain climbers, plank jacks, high knees, push-ups, bicycle crunches, seal jacks	[14]
Weeks 5–6	4 rounds (16 min)	Same as Weeks 1–2	[13]
Weeks 7–8	5 rounds (20 min)	Same as Weeks 3–4	[14]

per week for 8 weeks, on Saturdays, Mondays, and Wednesdays, between 4:00 PM and 6:00 PM. Each session included a 10–12-minute warm-up, 3-5 Tabata rounds, and a cool-down period. Each Tabata round consisted of 8 cycles of 20 s of exercise followed by 10 s of rest, with 1 min of rest between rounds. Training intensity was controlled at 75–85% HRmax using a Polar H10 heart rate monitor.

To reduce joint loading and injury risk, overweight participants performed modified, low-impact movements in place of jumping and high-knee exercises. In line with the protocols of Domaradzki et al. (2020) and Reppa et al. (2023), training volume was gradually adjusted according to participants' physical characteristics. Table 1 summarizes the Tabata intervention protocol.

Body composition measurement: Body composition was measured using the InBody 370 device under standardized conditions at baseline and after Completion of the training period. Participants were instructed to fast for at least 4 h, avoid coffee and chocolate, empty their bladder before testing, and refrain from physical activity for 24 h prior to the assessment. To reduce potential variation related to menstrual-cycle phase, measurements were conducted during the same menstrual-cycle phase for all participants. To control for circadian rhythm, measurements were taken at baseline and at the end of the period at a specific time of day (8-9 AM). Participants were asked to wear light clothing and avoid carrying metal objects during measurement. The device was used to determine body weight, BMI, body fat percentage, and skeletal muscle mass.

Saliva Sampling and Biochemical Analyses: Unstimulated saliva samples (5 mL) were collected from all participants at baseline and after 8 weeks of intervention under standardized conditions. Participants were instructed to refrain from tooth

brushing and mouthwash use prior to sampling and to attend the sampling session in a fasting state. Before sample collection, participants rinsed their mouths with cool distilled water (13°C) to minimize contamination. Saliva samples were obtained using the passive drool technique in accordance with established protocols provided by Salimetrics and Nationwide Children's Hospital^{15,16}. To control for circadian variation, all samples were collected between 08:00 and 09:00 a.m. Immediately following collection, samples were stored at -70°C until analysis. Salivary cortisol concentrations were determined using a commercially available enzyme-linked immunosorbent assay (ELISA) kit (DiaMetra S.r.l., Italy; product code: DK0020; lot number: 6029A). Salivary alpha-amylase activity was measured using a colorimetric assay kit (ZellBio GmbH, Germany; product code: ZB-AMZ-96; lot number: ZB-OC24031) in accordance with the manufacturer's instructions^{17,18}. Data collection procedures are outlined in Figure 2.

Statistics model: Data are presented as mean $\pm$ standard deviation. Prior to inferential analyses, the assumptions of the repeated-measures analysis of variance (rmANOVA) were examined. We assessed normality using the Kolmogorov–Smirnov test and evaluated homogeneity of variances across groups with Levene's test.

Repeated-measures ANOVA was used to assess the effects of time, group, and the time $\times$ group interaction. When a significant main effect or interaction was observed, pairwise comparisons were conducted using the Bonferroni post hoc test to control for multiple comparisons. Mauchly's test of sphericity was nonsignificant ($p > 0.05$) for all repeated measures, supporting the assumption of sphericity; Greenhouse–Geisser corrections were applied when required. Within-group changes over time were further evaluated using paired-samples *t*-tests to clarify the magnitude and direction of the observed effects. Effect sizes for

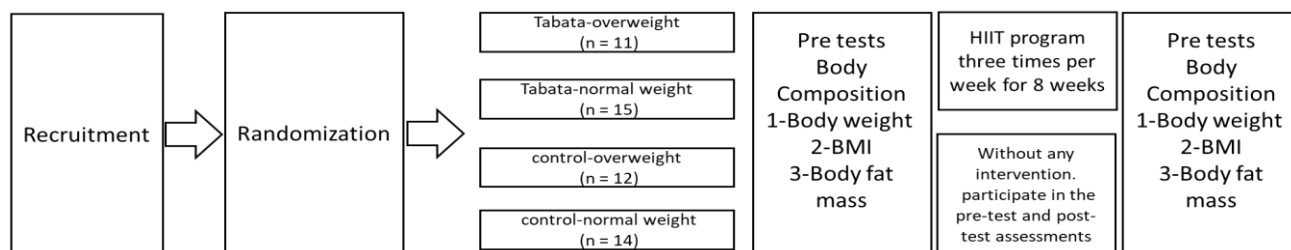


Figure 2. Data collection procedures outline.

between-group differences were quantified using Cohen's d . For pairwise comparisons, Cohen's d was interpreted according to conventional criteria as small ($d \approx 0.20$), medium ($d \approx 0.50$), and large ($d \approx 0.80$). All statistical tests were conducted at a significance level of $p < 0.05$. Analyses were performed using SPSS version 26.

Results

Body Composition: No significant main effect of time was observed for body weight ($F=1.69$, $P=0.200$, $\eta^2=0.034$), whereas the group effect was significant ($F=13.94$, $P=0.001$, $\eta^2=0.466$). A significant time $\times$ group interaction was also found ($F=6.67$, $P=0.001$, $\eta^2=0.294$), indicating differential changes across groups during the intervention. Post hoc analysis revealed that Tabata training significantly reduced body weight in the overweight group (-1.80% , $P=0.006$, $95\% \text{ CI}=0.456$ to 2.11 , $d=0.14$) and in the normal-weight group (-0.76% , $P=0.016$, $95\% \text{ CI}=0.098$ to 0.805 , $d=0.09$).

No significant changes were observed in the overweight control group ($+0.46\%$, $P=0.272$, $95\% \text{ CI}=-0.964$ to 0.299 , $d=-0.05$) or the normal-weight control group ($+0.01\%$, $P=0.117$, $95\% \text{ CI}=-1.45$ to 0.297 , $d=0.07$). The reduction in body weight was significantly greater in the overweight group compared with the normal-weight group ($P=0.034$) Figure 3A.

For BMI, the main effect of time was not significant ($F=1.13$, $P=0.292$, $\eta^2=0.023$), while the group effect was significant ($F=28.29$, $P=0.001$, $\eta^2=0.639$). The time $\times$ group interaction was also significant ($F=8.29$, $P=0.001$, $\eta^2=0.341$). Only the overweight group showed a significant reduction in BMI following Tabata training (-4.5% , $P=0.011$, $95\% \text{ CI}=0.385$ to 2.28 , $d=0.55$), with no significant changes in the other groups. The decrease in BMI was significantly greater in the overweight group than in the normal-weight group ($P=0.01$) Figure 3B.

For body fat mass, no significant main effect of time was detected ($F=3.44$, $P=0.070$, $\eta^2=0.067$), whereas the group

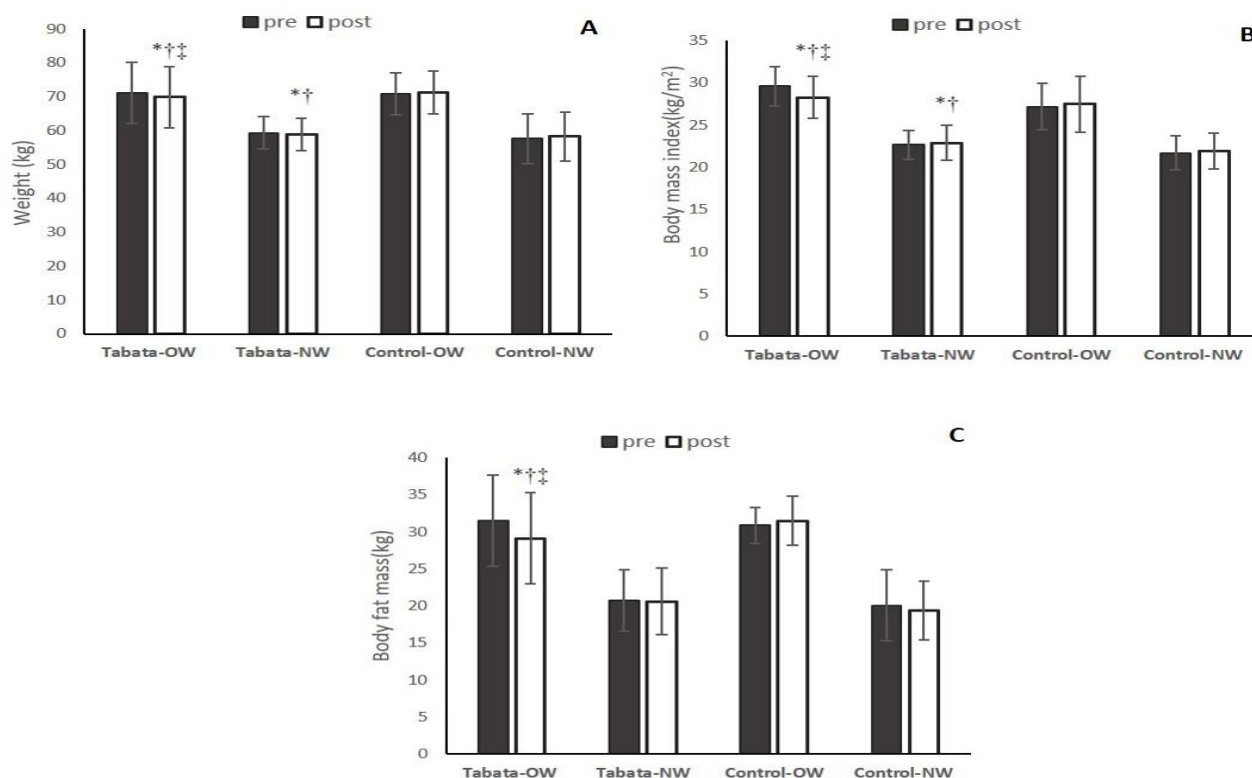


Figure 3. Effect of Tabata training on body composition in young girls. (A) Body mass index (BMI). (B) Body fat mass. NW: Normal weight; OW: Overweight. Data are presented as mean $\pm$ SD. Statistical analysis was performed using repeated-measures ANOVA followed by Bonferroni post hoc test. Significantly different compared with pre-test ($p < 0.05$). $\dagger$ Significantly different compared with the control group ($p < 0.05$). $\ddagger$ Significantly different compared with the Tabata-normal weight training group ($p < 0.05$).

effect was significant ($F=25.07$, $P=0.001$, $\eta^2=0.610$). A significant time $\times$ group interaction was observed ($F=2.94$, $P=0.042$, $\eta^2=0.157$). Tabata training significantly reduced body fat mass in the overweight group (-4.41% , $P=0.034$, $95\% \text{ CI}=0.114$ to 2.73 , $d=0.38$), with no significant changes in the other groups. The reduction was significantly greater in the overweight group compared with the normal-weight group ($P=0.006$) Figure 3C.

Salivary Cortisol: Salivary cortisol showed a significant main effect of time ($F=50.46$, $P=0.001$, $\eta^2=0.510$) and group ($F=10.37$, $P=0.001$, $\eta^2=0.393$), along with a significant time $\times$ group interaction ($F=26.04$, $P=0.001$, $\eta^2=0.619$). Post hoc analysis indicated significant reductions in both the overweight (-16.41% , $P=0.001$, $95\% \text{ CI}=2.13$ to 4.22 , $d=1.60$) and normal-weight groups (-17.31% , $P=0.001$, $95\% \text{ CI}=1.86$ to 4.40 , $d=1.44$), while no significant changes were observed in the control groups. The magnitude of reduction did not differ significantly between groups ($P=0.757$) Figure 4A.

Salivary Alpha-Amylase: A significant main effect of time was observed for salivary alpha-amylase ($F=27.49$, $P=0.001$, $\eta^2=0.364$), but not for

group ($F=2.16$, $P=0.105$, $\eta^2=0.119$). The time $\times$ group interaction was significant ($F=14.90$, $P=0.001$, $\eta^2=0.482$). Tabata training significantly decreased alpha-amylase levels in both the overweight (-5.73% , $P=0.011$, $95\% \text{ CI}=1.60$ to 9.59 , $d=0.61$) and normal-weight groups (-7.39% , $P=0.001$, $95\% \text{ CI}=4.33$ to 8.56 , $d=0.54$), with no significant changes in the control groups. No between-group difference was found for the magnitude of reduction ($P=0.661$) in Figure 4B.

Discussion

According to the present study, high-intensity interval training based on the Tabata protocol (HIIT-Tabata) for eight weeks can improve physiological stress-related markers. In overweight young women, salivary stress hormones (cortisol and alpha-amylase) were reduced, body composition (including weight and body mass index) improved, and aerobic capacity increased. These changes may be related to physiological adaptations involving the HPA, SAM, and energy-sensing AMPK pathways.

Physiological Responses of HPA and SAM to HIIT: Exercise such as HIIT stimulates the hypothalamus to

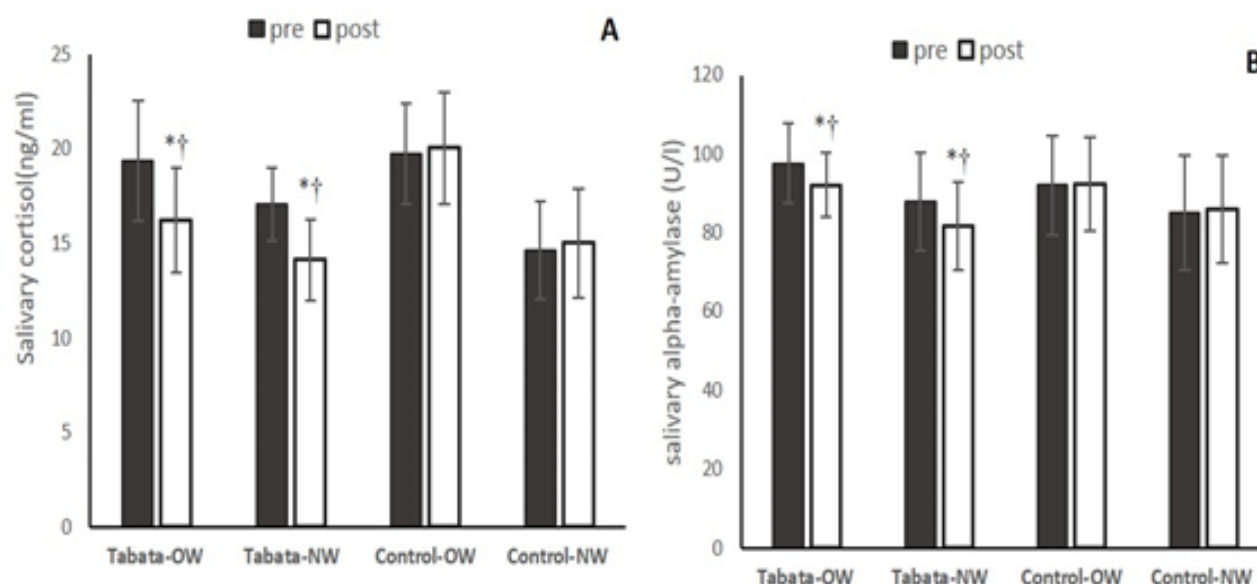


Figure 4. Effect of Tabata training on salivary cortisol(A) and alpha-amylase in young girls. NW: Normal weight; OW: Overweight. Data are presented as mean $\pm$ SD. Statistical analysis was performed using repeated-measures ANOVA followed by Bonferroni post hoc test. Significantly different compared with pre-test ($p^* < 0.05$).

†Significantly different compared with the control group ($p < 0.05$).

‡Significantly different compared with the Tabata-normal weight training group ($p < 0.05$).

release corticotropin-releasing hormone (CRH), activating the HPA axis. Following the release of adrenocorticotrophic hormone (ACTH) from the pituitary gland, cortisol is released from the adrenal cortex. In addition to regulating a wide range of physiological responses to environmental stressors, cortisol also interacts with another pathway known as the SAM. Catecholamines such as epinephrine and norepinephrine are released from the adrenal medulla when the sympathetic nerves are stimulated. Furthermore, salivary glands are stimulated, leading to increased alpha-amylase production. As a noninvasive and rapidly responsive biomarker associated with immediate sympathetic nervous system activity, this enzyme is widely used¹⁹. Alpha-amylase levels typically increase faster and more sharply than cortisol levels, according to Engert et al. (2011) and Holt et al. (2020). Glucocorticoid receptor (GR) sensitivity may increase with repeated and chronic exercise, potentially enhancing the HPA axis' negative feedback mechanism and reducing basal cortisol levels^{19, 20}. After eight weeks of HIIT-Tabata training, resting cortisol and alpha-amylase levels were significantly reduced in the training group. Neuroendocrine adaptation to physiological stress and improved stress-regulation efficiency may explain these changes.

AMPK Pathway: A Key Regulator of Energy Balance and Inflammation in Response to Intense Exercise. During the body's adaptation to intense exercise, the AMPK (5' AMP-activated protein kinase) pathway plays a vital role in regulating cellular energy balance and inflammation. Metabolic stress induced by physical activity activates this pathway by increasing the AMP-to-ATP ratio in cells. When energy demands increase, AMPK regulates various metabolic pathways to maintain energy homeostasis²¹.

There are several physiological effects associated with AMPK activation:

- Inhibition of the anabolic mTOR pathway, which may contribute to reduced protein synthesis and regulation of stress-related metabolic processes;
- Reduction of inflammatory factors such as NF- κ B and IL-6 involved in chronic stress and low-grade inflammation;
- The glucocorticoid receptors (GR) may become more sensitive at the cellular level, potentially contributing

to faster hormonal balance restoration^{22,23}.

In addition to its role in stress responses, Chen et al. (2017) and Neumann et al. (2019) have demonstrated that this pathway also contributes to improved metabolic health. As a result of AMPK-mediated stimulation, mitochondrial biogenesis and oxygen consumption may be increased^{20, 23}. On the other hand, evidence from meta-analyses and clinical trials, including studies by Guo et al. (2023) and Reppa et al. (2023), has shown that HIIT, especially the Tabata protocol, can improve cardiorespiratory fitness and reduce body fat, potentially involving AMPK-related pathways^{24, 25}. Given AMPK's potential anti-inflammatory, regulatory, and energy-related effects, these mechanisms may contribute to the reduction in baseline cortisol and alpha-amylase levels observed in the present study.

Improvement in Body Composition, Aerobic Capacity, and Hormonal Balance: In overweight young women, high-intensity interval training (HIIT), particularly the Tabata protocol, may improve body composition. In accordance with Martinez-Rodriguez et al. (2021) and Guo et al. (2023), the present study demonstrated that HIIT reduced body weight, body mass index (BMI), and body fat mass^{24,26}. These changes may be related to increased energy expenditure during and after exercise (EPOC), increased fat oxidation, and stimulation of metabolic pathways involved in fat utilization²⁷. In addition, some researchers have proposed certain salivary indicators, such as increased salivary flow, as markers of increased parasympathetic activity and reduced sympathetic activity, potentially indicating improved autonomic nervous system regulation after training. Such regulation may contribute to physiological adaptation and stress regulation after exercise.

Mitochondrial Biogenesis and Improved Aerobic Capacity: In addition to reducing body fat, high-intensity interval training (HIIT) can improve aerobic performance. This improvement may involve activation of the transcription factor PGC-1 α , which promotes mitochondrial biogenesis and may increase mitochondrial content in muscle cells. With these adaptations, aerobic energy production may become more efficient, potentially increasing oxygen

Table 2. Summary of physiological pathways and chronic adaptations in response to tabata training.

Pathway	Acute Trigger	Chronic Adaptation	Molecular Mechanism
HPA Axis	CRH → ACTH → Cortisol	Increased glucocorticoid receptor (GR) sensitivity, resulting in reduced basal cortisol levels	Negative feedback modulation via GR sensitivity
SAM Axis	Sympathetic activation → Increased salivary α-amylase	Reduced sympathetic tone and basal α-amylase secretion	Autonomic nervous system recalibration and parasympathetic restoration
AMPK Pathway	Increased AMP/ATP ratio	Upregulation of PGC-1α, enhanced mitochondrial biogenesis, decreased NF-κB/IL-6 signaling, and inhibition of mTOR	Regulation of cellular energy homeostasis, inflammation suppression, and enhanced metabolic adaptation

Abbreviations: HPA=Hypothalamus–Pituitary–Adrenal axis; SAM = Sympatho–Adrenal–Medullary axis; PGC-1α=Peroxisome proliferator-activated receptor gamma coactivator 1-alpha; AMPK = AMP-activated protein kinase; NF-κB/IL-6 = Nuclear factor kappa B / Interleukin 6; mTOR = Mechanistic target of rapamycin; GR = Glucocorticoid receptor.

Note: This table summarizes the principal physiological pathways proposed to be involved in the response to high-intensity interval training (HIIT), such as the Tabata protocol. It illustrates a proposed transition from acute stress responses to chronic physiological adaptations that may contribute to changes in stress-related biomarkers and metabolic outcomes. The mechanisms presented in the table are based on existing physiological and molecular evidence and were not directly measured in the present study.

consumption and physical endurance. In overweight young women with lower aerobic capacity, such improvements may have favorable implications for metabolic health and overall quality of life^{21, 28}.

Regulation of the Anabolic-Catabolic Balance: A common marker of hormonal status in athletes is the testosterone-to-cortisol ratio (T/C), which indicates the balance between anabolic (muscle-building) and catabolic (muscle breakdown) processes. Previous research, including Ambroży et al. (2021), has suggested that HIIT, especially the Tabata protocol, may influence hormonal balance by maintaining or increasing the T/C ratio even during high physical activity²⁹.

This change may be related to a chronic reduction in cortisol levels (contrasting with the transient increase immediately after exercise), increased sensitivity of anabolic receptors, and potential effects on the hypothalamic–pituitary–gonadal (HPG) axis, ultimately contributing to changes in free testosterone. Hormonal balance may contribute to metabolic health and muscle function, particularly in overweight young women who may experience hormonal dysregulation and insulin resistance.

Comparing Immediate Responses to Stable Physiological Adaptations to Exercise: To interpret physiological changes accurately, it is crucial to distinguish acute (immediate) responses from chronic adaptations. According to Holt et al. (2020), salivary alpha-amylase levels typically rise faster and more sharply than cortisol levels. Activation of the sympathetic–

adrenal–medullary (SAM) axis is faster and shorter-lived than activation of the hypothalamic–pituitary–adrenal (HPA) axis.²⁰.

The body, on the other hand, develops long-term regulatory adaptations in response to repeated, chronic exercise such as HIIT, which may include increased glucocorticoid receptor sensitivity, enhanced HPA axis negative feedback, and reduced activity of inflammatory pathways. In the end, these adaptive processes may contribute to the reduction in basal levels of cortisol and alpha-amylase, potentially reflecting improved physiological regulation and homeostasis³⁰.

Integrated Mechanisms of HIIT-Tabata Training: Through simultaneous activation of the neuroendocrine axis (HPA and SAM) and energy-regulating pathways such as AMPK, HIIT-Tabata training may not only reduce biological stress markers like cortisol and alpha-amylase but also enhance aerobic capacity, regulate body composition, and potentially contribute to hormonal balance through neuroendocrine adaptations involving the HPA and SAM axes.

In the HPA axis, these exercises may improve glucocorticoid receptor sensitivity. In addition, they may reduce sympathetic activation in the SAM axis and increase expression of PGC-1α in the AMPK pathway—all proposed features of chronic physiological adaptation^{19, 22, 25}. HIIT-Tabata training may modulate stress responses and metabolic regulation through integrated molecular mechanisms illustrated in Table 2.

Practical Applications and Health Recommendations: Based on the identified

physiological mechanisms, HIIT-Tabata training may be a practical, effective, and flexible approach to promoting health in overweight young women. Here are some practical recommendations:

- This type of training is highly suitable for integration into school physical education programs due to its short duration, high intensity, and minimal equipment requirements. Students, especially young adults at risk of overweight, may benefit from regular HIIT sessions to reduce obesity risk and improve cardiorespiratory fitness.
- In order to evaluate the effectiveness of an exercise program, it is recommended to periodically assess biological markers such as salivary cortisol and alpha-amylase, the testosterone-to-cortisol ratio (T/C), and inflammatory markers such as IL-6. These assessments may provide a better understanding of hormonal and stress-related physiological adaptations.
- Exercise Prescription: Training protocols should be tailored to a person's nutritional status, psychological condition, fitness level, age, and hormonal profile. This personalized approach can help prevent overtraining and physiological stress.
- Multidimensional Interventions: By combining HIIT with other exercise modalities, such as resistance training or yoga, you can strengthen metabolic systems, improve neurohormonal balance, and improve mental health.

Limitations: Several limitations of this study should be acknowledged. First, the sample size was relatively small, particularly in the Tabata-training-overweight group ($n = 11$), which may have limited the statistical power to detect small-to-moderate effects and reduced the generalizability of the findings. Second, although efforts were made to control for menstrual cycle phase and circadian rhythm, residual confounding by hormonal fluctuations cannot be entirely ruled out. Third, The eight-week follow-up period was relatively short, precluding conclusions about the long-term sustainability of the observed effects on body composition and stress biomarkers. Future studies with larger, more diverse samples, longer intervention durations, and objective monitoring of physical activity and diet are warranted to confirm and extend the present findings.

Conclusion

The present study demonstrated that eight weeks of HIIT-Tabata training significantly reduced salivary cortisol and alpha-amylase levels and improved selected measures of body composition and physical fitness in young women. In overweight participants, the intervention was associated with significant reductions in body mass, body mass index, and body fat mass, together with improvements in aerobic performance. Cortisol and alpha-amylase also decreased following training in both normal-weight and overweight participants. Overall, these findings support HIIT-Tabata as a time-efficient and practical exercise strategy for improving stress-related biomarkers, body composition, and physical fitness in young women, particularly those with overweight. The findings are consistent with previous international research and further support the potential value of structured high-intensity interval exercise in this population. Future studies with larger samples and longer follow-up periods are warranted to confirm the durability of these effects and to further characterize the physiological responses to HIIT-Tabata training.

Acknowledgment

The authors sincerely thank the participating students at Islamic Azad University, Qazvin Branch, for their valuable cooperation. We also gratefully acknowledge the Qazvin Sports Medicine Board for providing access to the facilities required for the study.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Funding

None.

References

1. World Obesity Federation. World Obesity Atlas 2022. [serial online]. 2022 [cited 2025 Jul]. Available from: <https://www.worldobesity.org/resources/resource-library/world-obesity-atlas-2022>
2. Dallman MF, Pecoraro NC, la Fleur SE. Chronic stress and comfort foods: self-medication and abdominal obesity. *Brain Behav*

Immun. 2005;19(4):275-80.

3. Dallman MF, Pecoraro N, Akana SF, la Fleur SE, Gomez F, Houshyar H, et al. Chronic stress and obesity: a new view of “comfort food”. *Proc Natl Acad Sci U S A*. 2003;100(20):11696-11701.

4. Nater UM, Rohleder N. Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: current state of research. *Psychoneuroendocrinology*. 2009;34(4):486-96.

5. Samuolis J, McGeorge L. Co-occurring health risk behaviors and their association with self-rated health among female college students. *Am J Health Educ*. 2020;51(4):257-64.

6. Rodrigues KL, Scaranni POS, Pereira ENGS, da Silva VVD, Silveiras RR, de Araujo BP, et al. Hair cortisol levels are associated with overweight and obesity in the ELSA-Brasil cohort. *Front Endocrinol*. 2024;15:1361715.

7. Costigan SA, Eather N, Plotnikoff RC, Taaffe DR, Lubans DR. High-intensity interval training for improving health-related fitness in adolescents: a systematic review and meta-analysis. *Br J Sports Med*. 2015;49(19):1253-61.

8. Honceriu C, Curpan AS, Ciobica A, Ciobica A, Trus C, Timofte D. Connections between different sports and ergogenic aids—focusing on salivary cortisol and amylase. *Medicina (Kaunas)*. 2021;57(8):753.

9. Lu Y, Wiltshire HD, Baker JS, Wang Q, Ying S. The effect of Tabata-style functional high-intensity interval training on cardiometabolic health and physical activity in female university students. *Front Physiol*. 2023;14:1095315.

10. Bogataj Š, Trajković N, Cadenas-Sanchez C, Sember V. Effects of school-based exercise and nutrition intervention on body composition and physical fitness in overweight adolescent girls. *Nutrients*. 2021;13(1):238.

11. Cvijetic S, Keser I, Jurasović J, Orct T, Babić Ž, Boschiero D, et al. Diurnal salivary cortisol in relation to body composition and heart rate variability in young adults. *Front Endocrinol*. 2022;13:831831.

12. Strahler J, Skoluda N, Kappert MB, Nater UM. Simultaneous measurement of salivary cortisol and alpha-amylase: application and recommendations. *Neurosci Biobehav Rev*. 2017;83:657-77.

13. Domaradzki J, Cichy I, Rokita A, Popowczak M. Effects of Tabata training during physical education classes on body composition, aerobic capacity, and anaerobic performance of under-, normal- and overweight adolescents. *Int J Environ Res Public Health*. 2020;17(3):876.

14. Reppa CM, Bogdanis GC, Stavrou NAM, Psychountaki M. The effect of aerobic fitness on psychological, attentional and physiological responses during a Tabata high-intensity interval training session in healthy young women. *Int J Environ Res Public Health*. 2023;20(2):1005

15. Salimetrics LLC. Saliva Collection and Handling Recommendations [serial online]. [cited 2025 Jul]. Available from: <https://salimetrics.com/saliva-collection-handbook/>.

16. Nationwide Children's Hospital. Salivary Cortisol Collection Guidelines [serial online]. 2024 [cited 2025 Jul]. Available from:

<https://www.nationwidechildrens.org>

17. DiaMetra S.r.l. Cortisol Saliva ELISA Kit Manual [serial online]. 2024. Available from: <https://www.diametra.com>

18. ZellBio GmbH. α -Amylase Assay Kit—Colorimetric [serial online]. 2024. Available from: <https://zellbio.com>

19. Engert V, Vogel S, Efanov SI, Duchesne A, Corbo V, Ali N, et al. Investigation into the cross-correlation of salivary cortisol and alpha-amylase responses to psychological stress. *Psychoneuroendocrinology*. 2011;36(9):1294-302

20. Chen C, Nakagawa S, An Y, Ito K, Kitaichi Y, Kusumi I. The exercise-glucocorticoid paradox: How exercise is beneficial to cognition, mood, and the brain while increasing glucocorticoid levels. *Front Neuroendocrinol*. 2017;44:83-102.

21. Spaulding HR, Yan Z. AMPK and the adaptation to exercise. *Annu Rev Physiol*. 2022;84:209-27.

22. Smith JAB, Murach KA, Dyar KA, Zierath JR. Exercise metabolism and adaptation in skeletal muscle. *Nat Rev Mol Cell Biol*. 2023;24(9):607-32.

23. Neumann D, Viollet B. AMP-activated protein kinase signalling. *Int J Mol Sci*. 2019;20(3):766.

24. Guo Z, Li M, Cai J, Gong W, Liu Y, Liu Z. Effect of high-intensity interval training vs. moderate-intensity continuous training on fat loss and cardiorespiratory fitness in the young and middle-aged: a systematic review and meta-analysis. *Int J Environ Res Public Health*. 2023;20(6):4741.

25. Wang Y, Yang X, Deng J, Wang Z, Yang D, Han Y, Wang H. Combined high-intensity interval and resistance training improves cardiorespiratory fitness more than high-intensity interval training in young women with overweight/obesity: a randomized controlled trial. *Front Endocrinol (Lausanne)*. 2024;15:1450944.

26. Martínez-Rodríguez A, Rubio-Arias JA, García-De Frutos JM, Vicente-Martínez M, Gunnarsson TP. Effect of high-intensity interval training and intermittent fasting on body composition and physical performance in active women. *Int J Environ Res Public Health*. 2021;18(12):6431

27. Panissa VL, Fukuda DH, Staibano V, Marques M, Franchini E. Magnitude and duration of excess of post-exercise oxygen consumption between high-intensity interval and moderate-intensity continuous exercise: a systematic review. *Obes Rev*. 2021;22(1):e13099.

28. Little JP, Safdar A, Wilkin GP, Tarnopolsky MA, Gibala MJ. A practical model of low-volume high-intensity interval training induces mitochondrial biogenesis in human skeletal muscle: potential mechanisms. *J Physiol*. 2010;588(6):1011-1022.

29. Ambroży T, Rydzik Ł, Obmiński Z, Błach W, Serafin N, Błach B, Jaszczur-Nowicki J, Ozimek M. The effect of high-intensity interval training periods on morning serum testosterone and cortisol levels and physical fitness in men aged 35-40 years. *J Clin Med*. 2021;10(10):2143.

30. Dote-Montero M, Carneiro-Barrera A, Martinez-Vizcaino V, Ruiz JR, Amaro-Gahete FJ. Acute effect of HIIT on testosterone and cortisol levels in healthy individuals: a systematic review and meta-analysis. *Scand J Med Sci Sports*. 2021;31(9):1722-1744.