The effectiveness of Muay Thai training on stress biomarkers and body composition in young adults

La eficacia del entrenamiento de muay thai sobre los biomarcadores del estrés y la composición corporal en adultos jóvenes

Authors

Warayot Laha [1]
Yanyong Phanpheng [1]

[1] Loei Rajabhat University (Thailand)

Corresponding author:
Yanyong Phanpheng
yanyong.pha@lru.ac.th

Received: 24-06-25
Accepted: 15-08-25

How to cite in APA

Laha, W., & Phanpheng, Y. (2025). The effectiveness of Muay Thai training on stress biomarkers and body composition in young adults. *Retos, 72*, 492-501. https://doi.org/10.47197/retos.v72.116896

Abstract

Introduction: Elevated stress levels and unfavorable body composition in college students highlight the need for effective physical interventions. Muay Thai a high-intensity martial art combining aerobic and anaerobic activity may simultaneously improve metabolic health and reduce stress, though current empirical evidence is limited.
Objective: This study investigated the effects of an 8-week Muay Thai (MTT) training program on muscle mass, body fat percentage, and salivary alpha-amylase (sAA) levels, in comparison with brisk walking (BWE) among college students.
Methodology: Sixty-four students were randomized into MTT (n=32) or BWE (n=32) groups. Both interventions consisted of 60-minute sessions, 3 times/week for 8 weeks, with intensity maintained at 60–80% of maximum heart rate. Body composition (BMI, % body fat, visceral fat) and sAA levels were assessed at baseline, 4 weeks, and post-intervention. Statistical analyses included paired t-tests and comparisons between the groups (p<0.05).
Results: The MTT group showed greater reductions in body fat % (31.59% to 30.06%, p=0.029) and visceral fat (7.63 to 6.94, p=0.016) compared to BWE. Energy expenditure was significantly higher in the MTT (532 Kcal/session vs. 494 Kcal, p=0.011). While sAA levels transiently increased at 4 weeks in both groups (adaptation phase), MTT demonstrated a greater decline at 8 weeks (51.25 to 50.13 KU/L vs. BWE: 51.71 to 53.47 KU/L, p=0.041), indicating sustained stress modulation.
Conclusions: Muay Thai training significantly improves body composition and reduces sympathetic nervous system activity compared to moderate aerobic exercise. These findings support its integration into the university's health programs as an effective intervention

Keywords

Muay Thai; stress; salivary biomarkers; body composition; sympathetic nervous system.

Resumen

Introducción: Los niveles elevados de estrés y una composición corporal desfavorable en los estudiantes universitarios ponen de manifiesto la necesidad de intervenciones físicas eficaces. El Muay Thai, un arte marcial de alta intensidad que combina actividad aeróbica y anaeróbica, puede mejorar simultáneamente la salud metabólica y reducir el estrés, aunque la evidencia empírica actual es limitada.
Objetivo: Este estudio examinó los efectos de un programa de entrenamiento de Muay Thai (MTT) de 8 semanas sobre la masa muscular y el porcentaje de grasa corporal, así como sobre los biomarcadores de estrés (sAA), en comparación con la caminata rápida (BWE) en estudiantes universitarios.
Metodología: Sesenta y cuatro estudiantes fueron asignados aleatoriamente a los grupos MTT (n = 32) o BWE (n = 32). Ambas intervenciones consistieron en sesiones de 60 minutos, 3 veces por semana durante 8 semanas, con una intensidad mantenida entre el 60 y el 80% de la frecuencia cardíaca máxima. La composición corporal (IMC, % de grasa corporal, grasa visceral) y los niveles de sAA se evaluaron al inicio, a las 4 semanas y después de la intervención. Los análisis estadísticos incluyeron pruebas t pareadas y comparaciones entre grupos (p < 0,05).
Resultados: El grupo MTT mostró mayores reducciones en el porcentaje de grasa corporal (31,59% a 30,06%, p = 0,029) y en la grasa visceral (7,63 a 6,94, p = 0,016) en comparación con BWE. El gasto energético fue significativamente mayor en MTT (532 Kcal/sesión vs. 494 Kcal, p = 0,011). Aunque los niveles de sAA aumentaron transitoriamente a las 4 semanas en ambos grupos (fase de adaptación), el MTT presentó una mayor disminución a las 8 semanas (51,25 a 50,13 KU/L vs. BWE: 51,71 a 53,47 KU/L, p = 0,041), lo que indica una modulación sostenida del estrés.
Conclusiones: El entrenamiento de Muay Thai mejora significativamente la composición corporal y reduce la actividad del sistema nervioso simpático en comparación con el ejercicio aeróbico moderado. Estos hallazgos respaldan su integración en los programas de salud universitarios como una intervención eficaz.

Palabras clave

Muay Thai; estrés; biomarcadores salivales; composición corporal; sistema nervioso simpático.

Introduction

Global mental health reports indicate that today's young people experience higher stress levels than previous generations (Prince et al., 2021). Effective anxiety management is essential for promoting overall well-being, supporting academic achievement, and safeguarding long-term health (Carlson et al., 2004). Among college students, common stressors include academic demands, social challenges, and career-related uncertainties, which can escalate to anxiety or depression (Chipchase et al., 2017). Contributing factors to elevated stress in young people include academic pressure, social media influence, financial strain, and health or lifestyle issues (Johnson, 2022). The prevalence of anxiety and stress is substantial: one in seven individuals aged 10–19 has a mental health disorder, with anxiety being among the most common (WHO, 2023). In the United States, 63% of college students reported experiencing overwhelming anxiety in the past year (Lederer & Hoban, 2022), while a study in Nutrients found that 38% of European college students suffer from moderate to severe stress (Du et al., 2021). Similarly, a National Health Service (NHS) survey revealed that 42% of individuals aged 16–24 reported high stress levels linked to academic and financial pressures (Demetriou, 2024).

Anxiety and stress can have several negative impacts on young people, including an increased risk of depression and panic disorders (Prince et al., 2021), sleep disturbances (insomnia or excessive sleeping) (Lehmann et al., 2021), a weakened immune system leading to frequent illness (Marcus et al., 2022), and high blood pressure and heart-related problems (Fatma et al., 2024). These issues can also have social and academic consequences, such as decreased focus, lower academic performance, social disengagement, low motivation, and increased college dropout rates (Chipchase et al., 2017). The human response to stress involves two main systems: the hypothalamic-pituitary-adrenal (HPA) axis, which increases the release of stress hormones such as cortisol, and the sympathetic adrenal-medulla (SAM) axis (Cohen et al., 2007; Binder & Nemeroff, 2010; Hackett & Steptoe, 2017). Non-invasive methods have been developed to detect changes in neuronal activity using oral fluids such as saliva (Nater et al., 2007; Granger et al., 2012). Salivary biomarkers offer benefits such as the rapid emergence of proteins in saliva in response to stimuli and the ease of testing for salivary alpha-amylase (sAA) (Yamaguchi et al., 2003). Salivary alpha-amylase levels correlate with plasma concentrations of nor-epinephrine and are used to assess stress on the sympathetic nervous system (Kang, 2010; Kono et al., 2018). Addressing the causes of stress and employing stress-relieving techniques can help reduce mental health problems.

Psychological coping strategies include cognitive behavioral therapy, which reduces anxiety symptoms (Garnefski et al., 2022), mindfulness practices, which can lower stress hormone levels (Carlson et al., 2004), and expressive writing, which helps process emotions and reduce anxiety (Pennebaker et al., 1990). Lifestyle changes for stress reduction involve avoiding caffeine, sugar, and processed foods in excess, getting 7-9 hours of sleep per night, and engaging in routine physical activity for at least 30 minutes to elevate mood and decrease stress levels (Gerber et al., 2014).

Physical activity is an effective health promotion strategy with positive effects on both physical health and mental well-being (Park & Han, 2003). Exercise can help maintain organ function, which is as vital as prolonging life. Muay Thai is a popular form of exercise among people of all ages, known for its high energy expenditure through intense body movements. Adaptations from Muay Thai training may include improvements in body composition, muscular endurance, muscle power, agility, flexibility, and cardiorespiratory fitness. Muay Thai, the national sport of Thailand, is a martial art that uses punches, kicks, push kicks, elbow strikes, and knee strikes. Rapkiewicz et al. (2018) reported that Muay Thai training improves health-related physical fitness and functional movement, while Cannataro et al. (2020) found that it helps reduce stress hormones. Steptoe et al. (2009) reported that positive affect benefits health by reducing cortisol levels. Salivary cortisol and alpha-amylase (sAA) are reliable biological markers of stress for the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis, respectively (Engert et al., 2011). Exercising at 70–85% of maximum heart rate can reduce body mass (Azarbayjani et al., 2011) and long-term emotional stress (Phanpheng & Laha, 2023). Muay Thai is a popular exercise among people of all ages, known for its high energy consumption through intense body movements. Muay Thai training adaptations can include improvements in body composition, muscle endurance, muscle power, agility, flexibility, and cardiorespiratory fitness.

Muay Thai, the national sport of Thailand, is a martial art that uses punches, kicks, kicks, elbows, and knees. Rapkiewicz et al. (2018) reported that Muay Thai training improves health-related physical fitness and functional movement, and Cannataro et al. (2020) found that it helps reduce stress hormones. Steptoe et al. (2009) reported that positive affect benefits health by reducing cortisol.

This research aims to promote cultural appreciation along with physical and mental health by evaluating the effects of a Muay Thai training program on stress reduction and body composition in adolescents. The study evaluates changes in cumulative stress levels and body composition ratio, as measured by salivary alpha-amylase, over the training period, recognizing that physical fitness influences emotional well-being and reduces daily stress.

Method

Participants

The study participants consisted of 64 students (32 males, 32 females) aged 19 to 22 years from Loei Rajabhat University. Participants maintained sedentary lifestyles with no regular exercise routine prior to the intervention. A power analysis was conducted using G*Power 3.1.9.7 software to determine the appropriate sample size, with parameters defined in effect size = 0.80, α = 0.05 and power = 0.8. This resulted in a minimum requirement of 28 participants per group (df = 29, critical value = 1.8454). Taking into account the design of the control group and the potential attrition, the study involved 64 participants in total (32 per group) through simple random sampling. The study established clear inclusion and exclusion criteria to ensure safety, methodological rigor, and reliable results. Participants were undergraduate students aged 19–22 at Loei Rajabhat University with a sedentary lifestyle for at least three months, Considering the assessment value of sAA ≥ 46 KU/L. Eligibility required passing a health screening, completing the PAR-Q+, providing informed consent, and committing to three supervised sessions per week for eight weeks. Exclusions applied to individuals with injuries, chronic diseases, medical contraindications, ongoing training, certain medications, substance use, or low attendance. These measures ensured a representative sample of sedentary young adults at risk of poor body composition and elevated stress. The research protocol received ethical approval from the Human Research Ethics Committee of Loei Rajabhat University (H 019/2567, dated March 4, 2024).

Procedure

This study used a quasi-experimental approach with two groups submitted to pre-test-post-test tests. The study was carried out in three stages: (I) pre-test, (II) implementation of the specified training program and (III) post-test. During the intervention phase, all subjects were instructed to continue with their usual routines, including eating and daily activities.

Training program

All groups exercised for 60 minutes, three times a week, for a total of eight weeks at the Laboratory of Sport and Exercise Sciences. The experimental group performed Muay Thai training (MTT = 32 males: 16: females 16) for 10 minutes, including a dynamic warm-up, before beginning the 40-minute workout. There were six Muay Thai skill training instruments: punches, kicks, push kicks, elbow strikes, knee strikes, and stretching for 10 minutes. The MTT group completed an eight-week progressive overload program designed to enhance adaptation and performance. Trainings variables volume, intensity, and skill complexity were adjusted every two weeks while maintaining 60–80% HRmax. Weeks 1–2 established a baseline of 3 sets per skill with 1-minute rests, focusing on basic strikes. Weeks 3–4 increased volume by drills 2 minutes with 1-minute rests overall 4 sets, and introduced two to three strike combinations. Weeks 5-6 raised volume by time/sets, and added one defensive and three to four counterattack drills 3 minutes with 1.30-minute rests, 5 sets. Weeks 7-8 reached peak load with an increase volume by 2 defensive and 5-6 counterattack drills 3 minutes, 2-minutes rests, total 6 sets. MTT program based on complex, moderate intensity combinations. The control group did brisk walking exercise by treadmills (BWE = 32 males 16: females 16) at with warm-up, dynamic warm-up for 10 minutes, walking at normal speed for 40 minutes, and stretching for 10 minutes. Every 2 weeks progressive overload involved increasing walking time, speed and percentage of heart rate (Figure 1). For each training group, the training variables determined the level of intensity, monitored via heart rate, and the complexity of the skill introduced.

Instrument

Intensity and energy expenditure were controlled in both groups, with intensity ranging from 60 to 80% of maximum heart rate throughout each workout. Intensity and energy expenditure were measured during training with MTT and BWE. All participants wore Polar Team Pro (Finland) heart rate monitors, with the signal transmitted to an Apple iPad. During The following results were presented: heart rate (bpm), percentage of mean heart rate (%AVG^{HR}), percentage of mean maximum heart rate (%AVG^{HRmax}) and exercise energy expenditure in kilocalories (Kcal) (Figure 2).

Assessment protocol

The assessment of body composition variables was evaluated at the Laboratory of Sport and Exercise Sciences of the Faculty of Science and Technology of Loei Rajabhat University, during the morning sessions (08:30-12:00 am.). Stress levels were assessed as a dependent variable using the NIPRO salivary alpha-amylase (sAA) monitor (Osaka, Japan). Participants were required to abstain from oral activities (brushing their teeth, smoking, eating, drinking) for one hour before the test. Following the standardized protocol, the subjects took two deep breaths before the measurement (Phanpheng & Laha, 2023). A specialized collection chip was placed sublingually for saliva absorption and then analyzed by the sAA monitor to determine amylase activity after 60 seconds. The results were categorized as: no stress (0-30 KU/L), mild stress (31-45 KU/L), moderate stress (46-60 KU/L), or severe stress (61-200 KU/L) based on established criteria (Nagai et al., 2020).

Figure 1. Outline of training and testing schedule

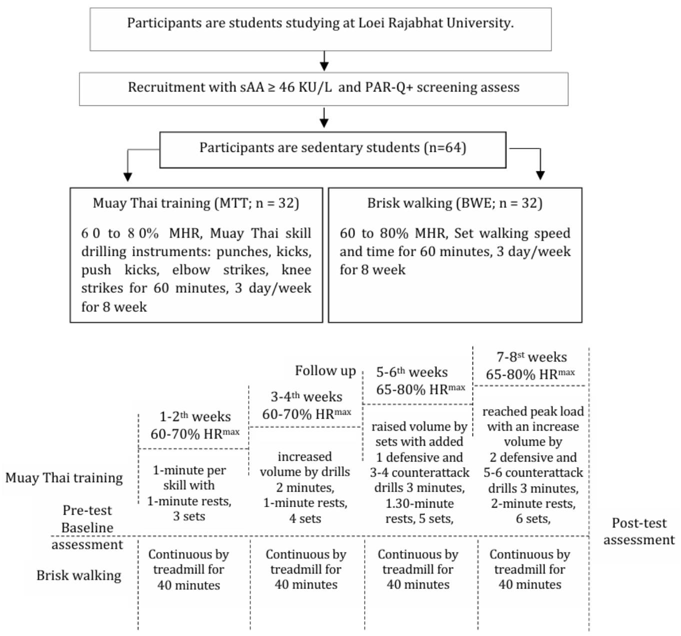

Figure 2. Left kicks skill (A) and intensity and energy expenditure were measured while training (B).

Data analysis

The characteristics of the sample were described using descriptive statistics. The normality of the data was assessed using the Shapiro-Wilk test. Within-group changes were analyzed before and after training using the paired t-test, and between-group differences were analyzed using independent t-test statistics at an acceptable level of significance of p<0.05 using SPSS 17.0 (SPSS Inc. Released in 2008). SPSS Statistics for Windows, version 17.0 (Chicago: SPSS Inc.).

Results

The baseline characteristics between the two groups, such as demographic information, the ages of the participants were 20.14 for the MTT group and 20.62 for the BWE group. Similarly, the BMIs of the MTT and BWE groups were 23.56 kg/m^2 and 23.48 kg/m^2, respectively. In addition, Table 1 shows the salivary alpha-amylase levels for the MTT and BWE groups, which were 51.25 and 51.71 KU/L, respectively. The demographic characteristics of the subjects in the two groups did not differ significantly based on the overall values of the variables. did not differ significantly (p > 0.05).

Table 1. Demographic variables of the study participant

Demographic variables	Muay Thai training (MTT = 32)	Brisk walking (BWE = 32)	*p-value*
Gender (male: female)	16 : 16	16 : 16	-
Age (year)	20.14±2.78	20.62±2.33	0.847
Salivary alpha-amylase; sAA (KU/L)	51.25±6.44	51.71±6.81	0.377
Body mass index; BMI (kg/m^2)	23.56±3.81	23.48±3.93	0.412
Training sessions	22.1±0.3 (89.16%)	23.7±0.6 (93.61%)	-

In terms of adherence to training programs, the Muay Thai training group participated in 22.1 ± 0.3 sessions (89.16%), the brisk walking group participated in 23.7 ± 0.6 sessions (93.61%) out of a total of 24 sessions of the program. All participants in both groups participated in more than 80% of their exercise classes. No adverse events occurred during or outside of the training sessions.
Analysis performed using the independent t-test revealed that both groups experienced reductions in body weight and BMI; however, there were no significant differences between the two groups. Mean fat mass also decreased when compared to pre-test values. Notably, the percentage of body fat and visceral fat showed significant reductions between the experimental groups (p < 0.029 and p < 0.011, respectively). In addition, both groups exhibit increased levels of SAA from the initial stages up to the 4-week follow-up period, and it was predicted that these levels would continue to increase in the later stages compared to the pre-exercise phase. After 8 weeks of activity, sAA levels tended to decrease, but no statistically significant difference was observed between the experimental groups. At the end of the 8 weeks, the MTT group had lower sAA levels compared to the BWE group (Table 2).

Table 2. The comparison of Salivary alpha-amylase and body composition measurements following 8-week exercise programs.

Variables	Muay Thai training (MTT = 32)			Brisk walking (BWE = 32)			*p-value*
	Pretest	Follow up 4 weeks	8 weeks	Pretest	Follow up 4 weeks	8 weeks	
Salivary alpha-amylase; sAA (KU/L)	51.25±6.44	72.74±11.87	50.13±9.88	51.71±6.81	59.42±6.72	53.47±5.62	0.141
Body weight; kg	67.23±7.66	67.11±9.22	66.52±6.06	68.11±11.10	67.84±11.85	68.04±7.45	0.081
Body mass index; BMI (kg/m^2)	23.56±3.81	23.52±5.22	23.12±3.27	23.48±3.93	23.48±4.10	23.39±6.71	0.112
Percent body fat (%)	31.59±8.93	30.82±11.14	30.06±11.84	31.66±10.17	31.71±13.11	31.68±9.43	0.029*†
Fat mass (kg)	15.80±6.41	14.74±4.12	14.02±4.54	16.11±4.87	15.93±5.14	15.74±5.66	0.050*
Muscle mass (kg)	34.11±9.42	34.06±9.11	34.94±9.14	35.02±7.48	35.25±8.62	35.10±8.33	0.087
Visceral fat	7.63±1.14	7.03±1.11	6.94±0.38	7.42±0.64	7.39±1.81	7.21±1.66	0.016*†
Energy expenditure (Kcal)	414±51.22	518±57.32	532±61.18	449±41.55	461±48.87	494±54.11	0.001*†

* Means there was a significant difference from before the experiment at the 0.05

† Means differences from the experimental group were statistically significant.

Figure 3. Comparing salivary alpha-amylase (sAA) levels and visceral fat level between the Muay Thai training (MTT) and brisk walking exercise (BWE) groups at three time points.

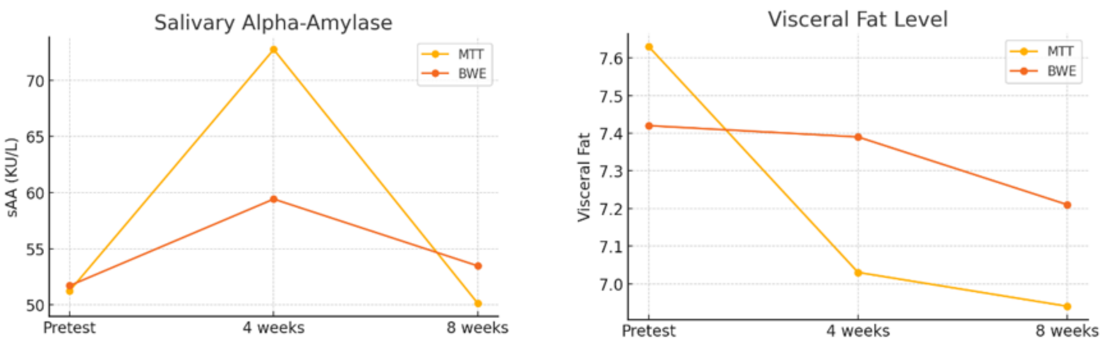

Figure 3 compared changes in salivary alpha-amylase (sAA) and visceral fat between the Muay Thai Training (MTT) and Brisk Walking Exercise (BWE) groups over 8 weeks. Both groups showed an initial rise in sAA at week 4, but by week 8, the MTT group recorded a reduction below baseline, while the BWE group remained slightly elevated. Visceral fat decreased in both groups, with the MTT group showing a greater reduction. These findings indicated that Muay Thai training was more effective in lowering stress biomarkers and reducing visceral fat than brisk walking.

Discussion

Muay Thai training is a dynamic full-body movement that combines aerobic and anaerobic demands. This is in contrast to the steady-state nature of brisk walking (BWE), which, while effective for overall health, may not have the intensity variability required for optimal stress adaptation. The present study investigated the effectiveness of an 8-week Muay Thai training program on stress levels, measured by salivary alpha-amylase (sAA) and body composition, among college students, compared to brisk walking. Key findings revealed that both interventions improved body composition, with Muay Thai training demonstrating superior reductions in body fat percentage, visceral fat, and increased energy expenditure. However, no statistically significant change in muscle mass was found in male and female subjects.

The interaction between fat loss and stress reduction deserves attention. Elevated visceral fat is associated with chronic inflammation and dysregulated activity of the HPA axis, exacerbating stress responses (Hackett & Steptoe, 2017). The reduction in sAA levels observed in this study supports the hypothesis that Muay Thai training can mitigate stress responses in adolescents. This is consistent with previous research linking physical activity to decreased stress biomarkers such as cortisol and sAA (Engert et al., 2011; Rapkiewicz et al., 2018). The high-energy full-body movements characteristic of Muay Thai likely stimulate endorphin release and improve autonomic regulation, thereby counteracting the physiological effects of stress (Aguiar et al., 2021; Steptoe et al., 2009). In addition, improvements in body composition corroborate the findings of Azarbayjani et al. (2011), who reported that exercise at 70-85% of maximum heart rate improves metabolic health and reduces emotional stress.

The decline in sAA levels further supports the findings of Cannataro et al. (2020) and Phanpheng & Laha (2023), who linked martial arts training to the reduction of stress biomarkers. However, the transient increase in sAA at the consistent 4-week follow-up in both groups may reflect the initial physiological adaptation to exercise-induced stress (Engert et al., 2011). This aligns with Steptoe et al. (2009), who noted that acute stress responses often precede habituation and long-term resilience. Notably, levels of sAA, a biomarker of sympathetic nervous system (SNS) activity, decreased most significantly in the Muay Thai training group at the 8-week outcome, suggesting its potential as a stress-reducing intervention (Figure 3). The reduction in sAA levels (from 51.25 KU/L to 50.13 KU/L) indicates a decrease in SNS activity, as sAA is a sensitive biomarker of noradrenergic activation (Nater et al., 2007). Several mechanisms may explain this: I) The interval nature of Muay Thai (alternating bursts of high intensity with brief recovery) may enhance vagal tone recovery by creating a "transfer" effect that dampens daily academic stress (Kono et al., 2018). II) Art's emphasis on alternating limb movements (e.g., left jab/right kick) can improve interhemispheric communication through the corpus callosum, potentially improving emotion regulation capacity (Granger et al., 2012). III) Forced exhalations during blows ("screaming" techniques) can increase pulmonary gas exchange and reduce blood acidosis, subsequently decreasing stimulation of the adrenal medulla (Cohen et al., 2007).

The reduction in body fat and visceral fat observed in the Muay Thai training group corroborates previous studies that highlight the metabolic advantages of Muay Thai (Figure 3), such as increased energy expenditure and muscle engagement (Fuentes-Barría et al., 2024; Rapkiewicz et al., 2018).

The decline in body fat percentage (from 31.59% to 30.06%) and visceral fat (from 7.63 to 6.94) in the Muay Thai training group aligns with evidence that high-intensity, multidirectional exercise increases lipolysis and fat oxidation (Mahyudi et al., 2025; Azarbayjani et al., 2011). Unlike steady-state aerobic exercise (e.g., brisk walking), the explosive movements of Muay Thai (kicks, knees) recruit fast-twitch muscle fibers, which require greater post-exercise energy recovery, potentially elevating resting metabolic rate (Rapkiewicz et al., 2018) and increasing the release of growth hormone (GH) levels into the bloodstream (Pranoto et al., 2024). This may explain the Muay Thai training group's superior energy expenditure (532 Kcal/session vs. 494 Kcal/session in brisk walking), corroborating the findings that high-intensity intermittent exercise sustains caloric burn longer than moderate continuous activity (Phanpheng & Laha, 2023; Simón Mora et al., 2021).

The key points discovered in this study are the Muay Thai training group's parallel reductions in visceral fat and sAA imply that Muay Thai can disrupt this cycle: I) Reduction of systemic inflammation: Adipose tissue secretes pro-inflammatory cytokines (e.g., IL-6), which amplify the production of the stress hormone. Exercise-induced fat loss can attenuate this pathway (Marcus et al., 2022). II) Improve autonomic regulation: High-intensity exercise increases vagal tone, counteracting overactivation of the SNS (Kono et al., 2018). This aligns with the decline in the sAA of the Muay Thai training group, reflecting improved resilience to stress. In addition, the combined metabolic and psychological benefits position Muay Thai as a time-efficient strategy for students juggling academic demands. Unlike traditional gym-based exercises, structured Muay Thai exercises can increase adherence by: I) Providing skill-based progression, which promotes motivation (Chipchase et al., 2017). II) Offer social engagement, as group training can cushion stress through peer support (Gerber et al., 2014).

These findings make the case for integrating Muay Thai into university wellness programs, particularly for students facing academic stress. Its structured, skills-based nature can increase adherence by offering psychological engagement alongside physical benefits, a critical factor in long-term behavior change (Pineda-Espejel et al., 2020; Park & Han, 2003). Universities can collaborate with sports science departments to design scalable Muay Thai training modules, ensuring accessibility and maintaining fidelity to protocol intensity (maximum heart rate of 60-80%).

Conclusions

This study demonstrates that an eight-week Muay Thai training program significantly reduces stress biomarkers and improves body composition among university students, suggests that Muay Thai may mitigate metabolic syndrome risks, a pertinent concern for sedentary students. These findings highlight Muay Thai's dual efficacy as both a stress-reduction and a metabolic enhancer intervention, supporting its integration into physical education curricula.

Acknowledgements

This research project was financially supported by the Research and Development Institute Loei Rajabhat University 1177/2566. The authors also deeply thanks to all participants at the Loei Rajabhat University, Loei Province, Thailand everyone who cooperated well in this research.

References

Aguiar, R. S., Lopes, G. C., Pinto de Castro, J. B., Prince, V. A., Mazini Filho, M. L., Nogueira da Gama, D. R., ... Vale, R. G. (2021). Effects of high-intense resistance training on salivary cortisol in trained individuals: a systematic review (Efectos del entrenamiento de resistencia de alta intensidad sobre el cortisol salival en individuos entrenados: una revisión sistemática). Retos, 41, 265–271. https://doi.org/10.47197/retos.v0i41.82770

Azarbayjani, M. A., Fatolahi, H., Rasaee, M. J., Peeri, M., & Babaei, R. (2011). The effect of exercise mode and intensity of sub-maximal physical activities on salivary testosterone to cortisol ratio and α-amylase in young active males. International journal of exercise science, 4(4), 283- 293. https://doi: 10.70252/TLCE3265

Binder, E.B. & Nemeroff, C.B. (2010). The CRF system, stress, depression and anxiety insights from human genetic studies. Molecular psychiatry, 15(6), 574-588. https://doi:https://doi.org/10.1038/mp.2009.141.

Cannataro, R., Cione, E., Gallelli, L., Marzullo, N., & Bonilla, D. A. (2020). Acute effects of supervised making weight on health markers, hormones and body composition in muay thai fighters. Sports,8(10), 37. https://doi.org/10.3390/sports8100137

Carlson, L. E., Speca, M., Patel, K. D., & Goodey, E. (2004). Mindfulness-based stress reduction in relation to quality of life, mood, symptoms of stress and levels of cortisol, dehydroepiandrosterone sulfate (DHEAS) and melatonin in breast and prostate cancer outpatients. Psychoneuroendocrinology, 29(4), 448-474. https://doi.org/10.1016/S0306-4530(03)00054-4

Chipchase, L., Davidson, M., Blackstock, F., Bye, R., Clothier, P., Klupp, N., ... & Williams, M. (2017). Conceptualising and measuring student disengagement in higher education: A synthesis of the literature. International Journal of Higher Education, 6(2), 31-42. https://doi.org/10.5430/ijhe.v6n2p31

Cohen, S., Janicki-Deverts, D. & Miller, G.E. (2007). Psychological stress and disease. The Journal of the American Medical Association JAMA, 298(14),1685-1687. https://doi.org/10.1001/jama.298.14.1685.

Demetriou, P. (2024). Supporting the Mental Health and Wellbeing of Learners in Post-16 Education. Taylor & Francis.

Du, C., Zan, M. C. H., Cho, M. J., Fenton, J. I., Hsiao, P. Y., Hsiao, R., ... & Tucker, R. M. (2021). The effects of sleep quality and resilience on perceived stress, dietary behaviors, and alcohol misuse: a mediation-moderation analysis of higher education students from Asia, Europe, and North America during the COVID-19 pandemic. Nutrients, 13(2), 442. https://doi.org/10.3390/nu13020442

Engert, V., Vogel, S., Efanov, S. I., Duchesne, A., Corbo, V., Ali, N., & Pruessner, J. C. (2011). Investigation into the cross-correlation of salivary cortisol and alpha-amylase responses to psychological stress. Psychoneuroendocrinology, 36(9), 1294-1302. https://doi.org/10.1016/j.psyneuen.2011.02.018

Fatma, H., Srivastava, P., Johri, P., Rajput, M. S., Syed, S., & Trivedi, M. (2024). Hypertension and Cardiovascular Problems-An Outlook Associated with Adolescents' Lifestyles. In Lifestyle Diseases in Adolescents: Diseases, Disorders, and Preventive Measures. Bentham Science Publishers, 88-107. https://doi.org/10.2174/97898152744311240101

Fuentes-Barría, H., Sperberg-Aniñir, A., Peña-Gallegos, M. F., Aguilera-Eguía, R., & Alarcón-Rivera, M. (2024). Effects of physical activity on salivary pH and cariogenic risk in Chilean musicians from the Biobío region. Cross-sectional study. Retos, 61, 583–588. https://doi.org/10.47197/retos.v61.109671

Garnefski, N., Legerstee, J., Kraaij, V., van Den Kommer, T., & Teerds, J. A. N. (2002). Cognitive coping strategies and symptoms of depression and anxiety: A comparison between adolescents and adults. Journal of adolescence, 25(6), 603-611. https://doi.org/10.1006/jado.2002.0507

Gerber, M., Brand, S., Herrmann, C., Colledge, F., Holsboer-Trachsler, E., & Pühse, U. (2014). Increased objectively assessed vigorous-intensity exercise is associated with reduced stress, increased mental health and good objective and subjective sleep-in young adults. Physiology & behavior, 135, 17-24. https://doi.org/10.1016/j.physbeh.2014.05.047

Granger, D.A., Johnson, S.B., Szanton, S.L. & Out, D. (2012). Incorporating Salivary Biomarkers into Nursing Research: An Overview and Review of Best Practices. Biological Research for Nursing, 14(4), 347–356. https://doi.org/ 10.1177/1099800412443892.

Hackett, R.A. & Steptoe, A. (2017). Type 2 diabetes mellitus and psychological stress - a modifiable risk factor. Nature Reviews Endocrinology, 13(9), 547-560. https://doi.org/ 10.1038/nrendo.2017.64.

Johnson, K. F. (2022). Symptoms of anxiety in college students and the influence of social determinants of health. Journal of College Student Psychotherapy, 36(4), 339-354. https://doi.org/10.1080/87568225.2020.1827114

Kang, Y. (2010). Psychological stress-induced changes in salivary alpha amylase and adrenergic activity. Nursing & Health Sciences, 12, 477-84. https://doi.org/10.1111/j.1442-2018.2010.00562.x.

Kono, Y., Kubota, A., Taira, M., Katsuyama, N. & Sugimoto, K. (2018). Effects of oral stimulation with capsaicin on salivary secretion and neural activities in the autonomic system and the brain. Journal of Dental Sciences, 13(2)13,116-23. https://doi.org/10.1016/j.jds.2017.08.007.

Lederer, A. M., & Hoban, M. T. (2022). The development of the American College Health Association-National College Health Assessment III: An improved tool to assess and enhance the health and well-being of college students. Journal of American College Health, 70(6), 1606-1610. https://doi.org/10.1080/07448481.2020.1834401

Lehmann, S., Gärtner Askeland, K., & Hysing, M. (2021). Sleep among youths in foster care: Associations with potentially traumatic events, PTSD and mental health. Child & Family Social Work, 26(1), 111-121. https://doi.org/10.1111/cfs.12794

Mahyudi, Y. V., Ningrum, D. T. M., Hafizah, H., & Setyawan, D. A. (2025). Effect of Structured Physical Activity Programs on Physical Fitness and Body Compotition Among Junior High School: A Randomized Controlled Trial: English. Retos, 68, 249–257. https://doi.org/10.47197/retos.v68.111620

Marcus, C., Danielsson, P., & Hagman, E. (2022). Pediatric obesity—Long-term consequences and effect of weight loss. Journal of internal medicine, 292(6), 870-891. https://doi.org/10.1111/joim.13547

Nagai, A., Kubota, M. & Higashiyama, Y. (2020). Relationship between taste acuity and fatigue or stress in Japanese elementary school children. Journal of Japan Society of Nutrition and Food Sciences, 66, 249-54. https://doi:10.4327/jsnfs.66.249.

Nater, U.M., Rohleder, N., Schlotz, W., Ehlert, U. & Kirschbaum, C. (2007). Determinants of the diurnal course of salivary alpha-amylase. Psychoneuroendocrinology, 32, 392-401. https://doi.org/10.1016/j.psyneuen.2007.02.007.

Park, J., & Han, S.H. (2003). The effect of exercise program on health and depression in the elderly. Journal of Korean Community Nursing, 33(2), 220-227. https://doi.org/10.4040/jkan.2003.33.2.220.

Pennebaker, J. W., Colder, M., & Sharp, L. K. (1990). Accelerating the coping process. Journal of personality and social psychology, 58(3), 528-537. https://doi.org/10.1037/0022-3514.58.3.528

Phanpheng, Y., & Laha, W. (2023). The Efficiency of Thai Rhythm Calisthenics Movement on Salivary Alpha-Amylase and Health Performance in the Elderly. International Journal of Kinesiology and Sports Science, 11(2), 25-34. https://doi.org/10.7575/aiac.ijkss.v.11n.2p.25

Pineda-Espejel, H. A., Trejo, M., García, K. B., Garza, K. J., Vázquez-Jiménez, G., Machado-Contreras, J. R., … Rodríguez, S. (2020). Respuesta de cortisol salival y ansiedad precompetitiva en nadadores (Salivary cortisol response and precompetitive anxiety in swimmers). Retos, 38, 1–7. https://doi.org/10.47197/retos.v38i38.72229

Pranoto, A., Rejeki, P. S., Miftahussurur, M., Yosika, G. F., Ihsan, M., Herawati, L., … Halim, S. (2024). Aerobic Exercise Increases Release of Growth Hormone in the Blood Circulation in Obese Women. Retos, 51, 726–731. https://doi.org/10.47197/retos.v51.99944

Prince, E. J., Siegel, D. J., Carroll, C. P., Sher, K. J., & Bienvenu, O. J. (2021). A longitudinal study of personality traits, anxiety, and depressive disorders in young adults. Anxiety, Stress, & Coping, 34(3), 299-307. https://doi.org/10.1080/10615806.2020.1845431

Rapkiewicz, J. A., Nunes, J. P., Mayhew, J. L., Ribeiro, A. S., Nabuco, H. C., Fávero, M. T., & Amarante Do Nascimento, M. (2018). Effects of Muay Thai training frequency on body composition and physical fitness in healthy untrained women. Journal Sports Med Phys Fitness, 58(12), 1808-1814.

Simón Mora, R. M., Sánchez Oliver, A. J., Suárez Carmona, W., & González Jurado, J. A. (2021). Effect of a physical exercise program on physical fitness and visceral fat in people with obesity. Retos, 39, 723–730. https://doi.org/10.47197/retos.v0i39.78997

Steptoe, A., Dockray, S., Wardle, J. (2009). Positive affect and Psychobiological processes relevant to health. Journal Personal, 77, 1747–1776. https://doi.org/10.1111/j.1467-6494.2009.00599.x

World Health Organization. (2023). Noncommunicable diseases and mental health in small island developing states. World Health Organization.

Yamaguchi, M., Kanemaru, M., Kanemori, T. & Mizuno, Y. (2003). Flow-injection-type biosensor system for salivary amylase activity. Biosensors & Bioelectronics, 18, 835-840. https://doi.org/10.1016/s0956-5663(03)00007-1.

Authors' and translators' details:

Warayot Laha	warayot.lah@lru.ac.th	Author
Yanyong Phanpheng	yanyong.pha@lru.ac.th	Author