

DOCTORAL THESIS



UCAM

UNIVERSIDAD CATÓLICA
DE MURCIA

INTERNATIONAL DOCTORAL SCHOOL

Doctoral Programme in Sport Science

***Long-term effects of high-intensity interval training (HIIT)
on depression and anxiety in middle-aged Iranian women***

Author:

Shadnaz Nouri

Supervisors:

Dr Domenico Cherubini - Ucam

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THESIS SUPERVISORS' AUTHORISATION FOR THESIS SUBMISSION

Prof. Domenico Cherubini, as Supervisors of the Doctoral Thesis 'Long-term Effects of High-intensity Interval Training (HIIT) on Depression and Anxiety in Middle-aged Iranian Women' by Ms Shadnaz Nouri in the Doctorate Programme Sports Sciences, **authorise(s) its submission**, given that it meets the required conditions for its defence.

Which I hereby sign in compliance with Spanish Royal Decree 99/2011, of 28 January, in Murcia, September 27th, 2025.



ABSTRACT

Depression and anxiety are among the most prevalent mental health concerns, significantly affecting individuals' quality of life. Globally, depression has become a major public health challenge due to its rising prevalence and associated mortality. Both disorders are linked to various social and physical health issues, with particularly strong effects on women's health during the menopausal transition. Evidence suggests that physical activity can alleviate symptoms of depression and anxiety, with high-intensity interval training (HIIT) receiving growing attention in recent years.

The present study aimed to examine the effects of a 10-month HIIT program on mild to moderate symptoms of depression and anxiety in middle-aged Iranian women. A semi-experimental pre-post test design was employed. The study population consisted of 120 women aged 50–55 years who reported depressive and anxiety symptoms. Participants were randomly assigned to an exercise group or a control group. Inclusion criteria required the absence of respiratory, inflammatory, cardiovascular, renal, or other chronic diseases, as well as no regular sports activity in the prior month. The Beck Depression Inventory (BDI-II) and Beck Anxiety Inventory (BAI) were used for data collection. The intervention included three sessions per week (totaling 120 sessions), each lasting about one hour, with warm-up, HIIT exercises, and cool-down phases.

Results showed that levels of depression and anxiety decreased significantly ($p < 0.05$) in the exercise group compared with the control group after 6 and 10 months. These findings suggest that HIIT may serve as an effective non-pharmacological treatment for managing mild to moderate symptoms of depression and anxiety in middle-aged women.

Keywords: Mental health; Midlife women; Non-pharmacological treatment; High-intensity Interval Training

Thesaurus Terms: Psychological well-being, Middle-aged women, Lifestyle intervention, Interval training

RESUMEN

La depresión y la ansiedad se encuentran entre las preocupaciones de salud mental más prevalentes, afectando significativamente la calidad de vida de las personas. A nivel mundial, la depresión se ha convertido en un importante desafío de salud pública debido a su creciente prevalencia y mortalidad asociada. Ambos trastornos están vinculados a diversos problemas de salud social y física, con efectos particularmente fuertes en la salud de las mujeres durante la transición menopáusica. La evidencia sugiere que la actividad física puede aliviar los síntomas de depresión y ansiedad, con el entrenamiento de intervalos de alta intensidad (HIIT) recibiendo una atención creciente en los últimos años.

El presente estudio tuvo como objetivo examinar los efectos de un programa de HIIT de 10 meses sobre los síntomas leves a moderados de depresión y ansiedad en mujeres iraníes de mediana edad. Se empleó un diseño cuasi-experimental de pretest y postest. La población del estudio consistió en 120 mujeres de entre 50 y 55 años que reportaron síntomas de depresión y ansiedad. Los participantes fueron asignados aleatoriamente a un grupo de ejercicio o a un grupo de control. Los criterios de inclusión requerían la ausencia de enfermedades respiratorias, inflamatorias, cardiovasculares, renales u otras enfermedades crónicas, así como la falta de actividad deportiva regular en el mes anterior. El Inventario de Depresión de Beck (BDI-II) y el Inventario de Ansiedad de Beck (BAI) se utilizaron para la recolección de datos. La intervención incluyó tres sesiones por semana (totalizando 120 sesiones), cada una de aproximadamente una hora, con fases de calentamiento, ejercicios HIIT y enfriamiento.

Los resultados mostraron que los niveles de depresión y ansiedad disminuyeron significativamente ($p < 0.05$) en el grupo de ejercicio en comparación con el grupo de control después de 6 y 10 meses. Estos hallazgos sugieren que el HIIT puede servir como un tratamiento no farmacológico efectivo para manejar los síntomas leves a moderados de depresión y ansiedad en mujeres de mediana edad.

Palabras clave: Salud mental; Mujeres de mediana edad; Tratamiento no farmacológico; Entrenamiento de intervalos de alta intensidad

Términos TESAURO: Bienestar psicológico, Adultas de mediana edad, Intervención psicosocial, Entrenamiento a intervalos

DEDICATION

THIS DISSERTATION IS DEDICATED TO MY PARENTS, WHOSE
ENDURING LOVE AND SUPPORT HAVE BEEN THE FOUNDATION OF
MY JOURNEY.

WITH SPECIAL GRATITUDE TO MY MOTHER, MINOO, WHO
NURTURED BOTH THE FIRST ALPHABET IN MY MIND AND THE
FIRST LESSONS OF LIFE IN MY HEART

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My heartfelt appreciation goes to my colleagues and friends, who provided me with encouragement and companionship during the challenges of this journey.

Above all, I owe the greatest debt of gratitude to my family, whose unconditional love, patience, and sacrifices have been the foundation of all my achievements.

This work is also dedicated to all the women who strive for strength, resilience, and hope, and to whom this research ultimately belongs

,I am a woman, resilient and upright like a cypress tree, sustained
by the depth of my roots.`

~ Simin Behbahani

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ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS:

HIIT,	High Intensity Interval Training
MDD,	Major Depressive Disorder
WHO,	World Health Organization
GAD,	Generalized Anxiety Disorder
OCD	Obsessive-Compulsive Disorder
ANOVA,	Analysis of Variance
BAI,	Beck Anxiety Inventory
BDI,	Beck Depression Inventory
BDNF,	Brain-Derived Neurotrophic Factor
BMI,	Body Mass Index
CBT,	Cognitive Behavioural Therapy
CNS,	Central Nervous System
COVID-19,	Coronavirus Disease
CRP,	C-reactive protein
DSM-5,	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
DSM-5-TR,	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision
EPOC,	Excess Post-Exercise Oxygen Consumption
FSH,	Follicle-Stimulating Hormone
GABA_A,	Gamma-Amino butyric Acid Type A receptor
GBD,	Global Burden of Disease
HPA,	Hypothalamic–Pituitary–Adrenal Axis
HR,	Heart Rate
ICD-11,	International Classification of Diseases, 11th Revision
IL-6,	Interleukin-6

IL-10,	Interleukin-10
IMHS,	Iranian Mental Health Survey
IPT,	Interpersonal Psychotherapy
LH,	Luteinizing Hormone
MBCT,	Mindfulness-Based Cognitive Therapy
MBSR,	Mindfulness-Based Stress Reduction
MDD,	Major Depressive Disorder
MICT,	Moderate-Intensity Continuous Training
OCD,	Obsessive-Compulsive Disorder
PCOS,	Polycystic Ovary Syndrome
PMDD,	Premenstrual Dysphonic Disorder
RMANOVA,	Repeated Measures Analysis of Variance
RPE,	Rate of Perceived Exertion
SEES,	Subjective Exercise Experience Scale
SMI,	Serious Mental Illness
SPSS,	Statistical Package for the Social Sciences
SWAN,	Study of Women's Health across the Nation
TNF-α,	Tumour Necrosis Factor-alpha
TRD,	Treatment-Resistant Depression
TRX,	Total Resistance Exercises (Suspension Training)
YLDs,	Years Lived with Disability
SSRI,	Selective Serotonin Reuptake Inhibitors
SNRIs,	Serotonin-norepinephrine reuptake inhibitors
TCAs,	Tricyclic Antidepressants
MAOIs,	Monoamine Oxidase Inhibitors
RCTs,	Randomized Controlled Trials
NGOs,	Non-Governmental Organizations

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I – INTRODUCTION

INTRODUCTION

1.1. UNDERSTANDING DEPRESSION AND ANXIETY DISORDERS

Depression and anxiety are among the most prevalent and disabling types of mental disorders worldwide, characterized by persistent emotional instability, cognitive impairment, and severe interference with social and occupational functioning. While each disorder has unique diagnostic features, they often co-occur and share similar biological and psychological features. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-5-TR) (Rhoads, 2025) classifies Major Depressive Disorder (MDD) as a psychiatric disorder lasting at least two weeks during which individuals might feel a persistent low mood or loss of interest in or pleasure from activities, along with other signs like fatigue, changes in sleep, inability to concentrate, feelings of guilt or worthlessness, and suicidal thoughts. Likewise, the International Classification of Diseases, 11th Revision (ICD-11) from the World Health Organization allocates depressive episodes the ICD-11 code 6A70 and focuses on components of impairment, continuity, and recurrence (Kogan et al., 2016).

Anxiety disorders, as defined by the diagnostic criteria presented in the DSM-5-TR and ICD-11, are distinguished by heightened fear response, arousal, and avoidance behavior. The disorders have a wide range of subtypes, including the following:

- Generalized Anxiety Disorder (GAD) involves ongoing and uncontrollable worry about many things in life, lasting more than six months.
- Panic Disorder is defined by the presence of recurrent and unexpected panic attacks, with accompanying physiological symptoms such as chest pain, palpitations, and a strong fear of losing control or dying.
- Social anxiety disorder and specific phobias are characterized by a marked fear reaction or ongoing avoidance of specific stimuli or social situations.
- Obsessive-Compulsive Disorder (OCD) is specifically defined in the DSM-5-TR system as consisting of persistent intrusive thoughts coupled with compulsive behavior intended to reduce anxiety (Sekhon & Gupta, 2025).

Thus, depressive disorders cover a range of diagnostic categories, such as the following:

- Persistent Depressive Disorder (Dysthymia) is a chronic form of depression that lasts for at least two years.
- Postpartum Depression: An important form of depression that occurs after giving birth, influenced by hormonal and psychosocial factors.
- Treatment-Resistant Depression (TRD) is defined as the absence of response to treatment after at least two treatment attempts with antidepressant medication.
- Atypical Depression: Characterized by mood reactivity, increased appetite, hypersomnia, and interpersonal rejection sensitivity (Sekhon & Gupta, 2025).

The comorbidity of depressive and anxiety disorders is significantly common, with studies showing that up to 60% of those diagnosed with depressive disorders meet the criteria for an anxiety disorder (Groen et al., 2020). The concomitant presentation of these disorders is associated with increased symptom severity, greater impairment of function, and a poorer prognosis, thus constituting a major challenge to both diagnostic assessment and treatment intervention. Neurobiological studies indicate that common dysfunctions of the hypothalamic-pituitary-adrenal (HPA) axis, differences in amygdalar activity, and abnormalities in serotonergic neurotransmission underlie the comorbidity of the disorders (Ionescu et al., 2013; Millan, 2013).

Overall, depression and anxiety constitute a complex and heterogeneous category of mental illnesses defined by many etiological factors, including genetic susceptibility, environmental factors, hormonal imbalances, and sociocultural processes. The impact of these disorders manifests most strongly in risk groups, including middle-aged women, who are faced with unique biological and psychosocial difficulties that will be explored in further detail in the following sections.

1.2. IN-DEPTH ANALYSIS OF THE EPIDEMIOLOGICAL AND SOCIOECONOMIC IMPACTS OF DEPRESSION AND ANXIETY AT GLOBAL AND COUNTRY LEVELS

Depression and anxiety are among the most common mental illnesses globally, incurring a significant impact on public health outcomes. World Health Organization (WHO, 2023) estimates show that more than 300 million people suffer from depression, while over 280 million people suffer from anxiety disorders; they account for a significant proportion of years lived with disability (YLDs) and are also key determinants of global disease burden (Liu et al., 2020). In the 2020 Global Burden of Disease (GBD) Study, it was found that the total global YLDs attributable to mental health illnesses were almost 15%, while depressive disorders accounted for 5% of all adult disability-adjusted life years (DALYs) for those people in the 40-60 year age group (Murray et al., 2020).

Based on estimates compiled by the World Economic Forum, the global economic burden of mental illnesses—in terms of productivity loss, healthcare expenditures, and social service budget allocations—is expected to surpass \$6 trillion by 2030, surpassing overall spending related to diseases like cancer, diabetes, and respiratory diseases (Trautmann et al., 2016). In addition, mental health conditions like depression and anxiety cause personal distress and reduce overall life quality while also compromising economic development and labor participation, notably among middle-aged women during their productive years (Michalak & Ashkanasy, 2020).

At the national level, Iran has witnessed a significant increase in the prevalence of mental health disorders across recent decades. Based on the Iranian Mental Health Survey (IMHS, 2019), the yearly prevalence of depressive disorders in Iranian adults was discovered to be 12.7%, and anxiety disorders affected 15.6% of the population. It is noteworthy that these rates were significantly higher in females, particularly those in the 40-55 years age group (Hajebi et al., 2025; Gharraee et al., 2019). In addition, studies by Mofrad et al. (2019) revealed that up to 31% of Iranian urban women had moderate to severe symptoms of depression and anxiety.

The COVID-19 pandemic has seriously exacerbated this problem. Interruptions to daily activities, feelings of loneliness, fear of employment insecurity, and health-related worries have cumulatively negatively impacted the

mental health of the worldwide population. The magnitude of this increase in mental health conditions was measured at 27.6% for depression and 25.6% for anxiety worldwide in 2020, as reported by Wu et al. (2024). Iran was also hard hit by these factors; as a result of its prior economic woes and sociopolitical instability, the psychological impact of the pandemic was even stronger. Studies in Tehran and other cities revealed a marked surge in depressive symptoms, with middle-aged women being especially vulnerable because of the double burden of work and caregiving activities during the lockdown (Maroufizadeh et al., 2020).

In addition, inequities in access to mental health services, especially within low- and middle-income countries (LMICs) like Iran, worsen the current scenario (Semrau et al., 2019). Based on the World Health Organization (2023), more than 75% of those suffering from mental disorders in LMICs receive no treatment at all; in addition, when services are available, they often face barriers like restrictions, stigma, or economic constraints (Naslund & Deng, 2021). The consequences of these conditions fall disproportionately on women, who also struggle with gender-specific challenges involving gender roles, caregiving responsibilities, and gendered social norms (Campbell et al., 2021).

In conclusion, depression and anxiety disorders are common occurrences with a rising prevalence in many global and national contexts. Empirical evidence indicates that Iranian middle-aged women are among the most vulnerable populations. These findings highlight the urgency for early interventions that are effective and readily available, yet also culturally appropriate—such as non-drug methods such as physical activity—and potentially help to abate this mounting mental health problem (Khademi et al., 2025).

1.3. MIDDLE-AGED WOMEN: A DEMOGRAPHIC GROUP ESPECIALLY SUSCEPTIBLE TO FLUCTUATIONS IN MENTAL WELL-BEING.

Middle-aged women, typically aged between 40 and 60 years, form a population undergoing vast biological, psychological, and sociological changes. This age is often marked by changes in hormones associated with menopause, changing familial responsibilities, increased caregiving needs, work demands, and societal expectations. The combination of these varied stressors enhances the risk of mental illness, especially depression and anxiety, among middle-aged women.

1.3.1 The Menopausal Transition: Hormonal Changes and Their Neuropsychological Impact

Menopause is a major biological event during a woman's lifespan, marking definitive cessation of menstrual cycles as well as reproductive capacity. Menopause is diagnosed retrospectively, after a complete stoppage of menstrual flow over a continuous period of 12 months. On the other hand, the transition approaching menopause, often referred to as perimenopause, may begin much earlier and is characterized by inconsistencies in levels of estrogen, progesterone, FSH, and LH. These fluctuations in hormones have far-reaching repercussions that extend beyond reproductive outcomes, significantly influencing cognitive functions and emotional control (Alblooshi et al., 2023)

Estradiol, a type of estrogen, plays a vital role in the modulation of neurotransmitter systems, most notably those involving serotonin, dopamine, and norepinephrine; these neurotransmitters have been implicated in the pathophysiological mechanisms of depression and anxiety (Ramli et al., 2023). During the perimenopausal stage, the decrease in estrogen levels is accompanied by a decrease in serotonergic activity, neuroplasticity changes, and changes in the hypothalamic-pituitary-adrenal (HPA) axis, which are all related to mood instability, greater irritability, and depression symptoms (Liang et al., 2024).

In addition, studies using functional neuroimaging methods have detected changes in the connectivity between different cerebral areas, such as the amygdala, prefrontal cortex, and hippocampus, in perimenopausal women with mood disorders (Liu et al., 2021). Such neurobiological changes, as well as sleep disturbances, vasomotor symptoms (e.g., hot flashes and night sweats), and low energy, significantly influence mental health and general life quality (Ciulek et al., 2024).

1.3.2 Gender Role-Related Psychosocial Stressors and Strain

In addition to physiological changes, women face a specific constellation of psychosocial dilemmas in midlife. This stage is often synonymous with the "sandwich generation" experience, where women struggle with the simultaneous demands of caring for adolescent children and caring for aging parents, while

maintaining domestic responsibilities and working full-time (Johansson et al., 2013). The overlap of these roles results in role strain, emotional exhaustion, and elevated psychological distress.

The impact of gender roles and social norms exacerbates the pressures involved. In some cultural backgrounds, particularly collectivist or traditional cultures like Iran, there is a cultural expectation for women to play specific roles that imply emotional strength and self-sacrifice, often at the expense of personal health. The social expectations about emotional management, caregiving skills, and work competency can cause individuals to feel guilty, inadequate, and anxious if they feel they cannot attain the imposed expectations (Wong et al., 2023).

Additionally, middle adulthood is often marked by introspection and questioning regarding existential issues, precipitated by changes in physical appearance, the end of reproductive years, plateaus in job advancement, or the generally acknowledged syndrome known as "empty nest" syndrome. These identity concerns can heighten biological vulnerabilities to depressive and anxiety disorders, especially in women who face limits in social support or economic independence (Cuevas et al., 2021).

1.3.3 The Interrelated Dynamics between Affective Disorders and Reproductive Endocrine Levels

The interaction between reproductive hormones and states of mood is complex and bidirectional. Mood disorders can result from changes in hormone levels; however, high stress and psychiatric illness can interfere with the neuroendocrine system's function. Conditions such as premenstrual dysphoric disorder (PMDD), postpartum depression, and perimenopausal depression are prime examples of the complex relationship between hormonal changes and vulnerability to psychiatric illness in women (Schweizer-Schubert et al., 2021).

Perimenopausal depression is now recognized as a distinct clinical syndrome with specific pathophysiological features and focused therapeutic interventions. Unlike other important depressive syndromes that occur in various life stages, perimenopausal depression has been linked to increased irritability, somatic complaints, and sleep disturbances (Freeman et al., 2002). Perimenopausal

depression is often underestimated or misconstrued as a normal part of the aging process, which leads to delaying critical and effective treatment strategies (Badawy et al., 2024).

1.3.4 Gender Disparities Associated with the Epidemiology and Presentation of Mental Health Disorders

Epidemiological studies always find the prevalence of depression and anxiety disorders in women to be roughly twice that seen in men (McLean et al., 2011). These disorders usually begin in teenage years and have a tendency to persist throughout the lifespan of a person, with major increases reported during reproductive and perimenopausal periods. A range of biological, psychological, and sociocultural factors are responsible for this (Eaton et al., 2012).

Women have a higher tendency to express internalizing symptoms, such as depression, anxiety, and somatic symptoms, while men express their emotional pain through irritability, substance abuse, or violence. However, this gender-specific expression of psychiatric disorders has serious consequences for diagnostic processes and the likelihood of seeking help, leading to the underreporting and misdiagnosis of symptoms among both genders.

Moreover, the social stigma of mental health, particularly in conservative cultures, can discourage women from acknowledging or reporting their symptoms, thus affecting their timely access to treatment. Under such circumstances, culturally sensitive interventions and respect for tradition are critical in helping to enhance emotional well-being while, at the same time, treating the symptoms. (Ahad et al., 2023)

1.4. CHALLENGES ENCOUNTERED BY IRANIAN WOMEN: CULTURAL, SOCIAL, AND STRUCTURAL DETERMINANTS OF PSYCHOLOGICAL WELL-BEING AND PHYSICAL ACTIVITY PARTICIPATION

To understand the mental health issues of middle-aged Iranian women, it is necessary to position their experience within the broader Iranian cultural, social, economic, and political structures. Both biological and psychological factors lead to the onset of depression and anxiety, but the impact of socio-cultural restrictions,

gender roles, and institutional barriers intensifies psychological vulnerability. Middle-aged Iranian women face deep-rooted gender roles, restricted autonomy, and poor access to mental health services and leisure time activities. (Sharifi et al., 2014)

1.4.1 Traditional Duties and Modern Expectations: A Dual-Stream Model

The Iranian cultural context, similar to many other cultures with strong collectivist and patriarchal bases, places strong emphasis on the roles played by women within family structures. Women are expected to act as caregivers to children, aged parents, and in-laws, as well as take care of domestic duties and increasingly engage with the workforce. Middle-aged women, in particular, face a double burden: to maintain traditional roles while at the same time adapting to new expectations of economic independence, educational aspirations, and career development (Modarresi & Arasti, 2021; Enjezab et al., 2014).

Role overload is often the cause of chronic stress, burnout, and emotional exhaustion, widely identified as strong predictors of anxiety and mood disorders. Moreover, the failure to meet societal expectations related to these roles as spouses, parents, and professionals may lead to feelings of guilt and low self-worth, thus enhancing depressive symptoms (Ghazanfarpour et al., 2018).

1.4.2 Barriers to Mental Health Services and Stigma

Despite the growing recognition of mental health issues in Iran, there are still significant barriers to receiving care. Those barriers include: (Ghanizadeh et al., 2008; Taghva et al., 2017):

- The negative attitudes and social stigmatization that come with psychological disorders often discourage women from seeking help.
- Specialized medical care is limited, especially in rural areas and low-income communities.
- Economic constraints stemming from the high cost of private psychological services and a lack of insurance benefits.

- The shortage of female mental health professionals creates substantial limitations, especially in conservative cultures.

A thorough study by Mojtabai et al. (2016) established that more than 60% of Iranian adults with moderate to severe depressive symptoms did not seek help from mental health experts, such as psychologists and psychiatrists. This gap is especially notable for women, who often put family responsibilities first and are hesitant to seek help for fear of social stigma.

1.4.3 Physical activity: Structural and cultural barriers

Regular exercise has been shown to be an effective non-pharmacological intervention for improving psychological well-being (Schuch et al., 2016; Rebar et al., 2015; ALMutlaqah et al., 2024). However, Iranian women face numerous barriers to taking part in physical exercise, particularly within organized environments like recreational parks or sports complexes. Challenges that have been identified are: (Hoseini et al., 2025; Rezaie et al., 2017; Aligol et al., 2017).

- Limited availability of women-only facilities can be explained through cultural norms of gender segregation.
- Outdoor activities are restricted by laws governing clothing, social modesty expectations, and safety issues.
- Temporal constraints that arise from unpaid care work and domestic labor responsibilities.
- Lack of affordable choices designed for families with middle and low incomes.

Yarmohammadi et al. (2019) carried out a research study that identified only 14% of Iranian women between the ages of 40 and 60 were following the World Health Organization's guidelines concerning weekly physical activity. In the context of this culture, the current social norms often correlate women's participation in outdoor physical activity with selfishness or disregard of family responsibilities, which in turn causes internal conflicts and discourages regular exercise engagement (Bagheri, S et al., 2023).

1.4.4 The Aggregated Effects of Internal Conflict and Economic Sanctions

During the last few decades, Iran has been subjected to widespread international sanctions that have had great effects on practically all aspects of its economy, including the healthcare, pharmaceutical, and educational sectors. Although the declaration that humanitarian aid is ostensibly beyond the purview of the sanctions, the actual implementation of the measures significantly hampers access to critical medicines, laboratory equipment, mental health programs, and electronic resources used for telemedicine operations or psychological counseling.

For Iranian women suffering from depression or anxiety, this means that:

- Reduced availability of essential psychiatric medications such as SSRIs, mood stabilizers, or anxiolytics.
- Continuity of care disruptions take place due to supply chain variations or clinic closures.

The increase in mental health conditions has been linked with inflationary pressures, employment uncertainty, and limited channels for social mobility. (Mohamadi et al., 2024; Aloosh et al., 2019)

The psychological effects of sanctions are mostly felt by women since they are usually the main emotional support system in times of familial emergencies. There is a significant connection found between economic hardship and the increased rate of depressive symptoms in Iranian women, especially as sanctions become more strictly enforced (Tahan et al., 2024).

1.4.5 Sociocultural Stigmas Influencing Women's Participation in Mental Health and Physical Activity

The dominant cultural narrative in Iran often valorizes the ideals of resilience, self-control, and emotional strength in women when faced with adversity. In these paradigms, emotional vulnerability is seen as a sign of weakness, and mental illness is interpreted as a reason for social shame. As such, women are largely expected to "bear in silence" and not verbalize their pain or seek psychological support. This dilemma is compounded by:

- Lack of emotional literacy education in schools or communities.

- Media representations that idealize the suffering of women or ignore their mental health needs.
- Religious and moral paradigms sometimes view depression as a lack of, or a lack of adequate, spiritual fulfillment.
- The deeply rooted belief systems strongly discourage women from accepting their mental health needs or pursuing self-care activities, such as physical exercise, in the face of the growing body of empirical evidence attesting to the benefits of such interventions (Ghanean et al., 2011; Salmeh & Yaghobian, 2014; Aligol et al., 2017).

1.5. MODERN APPROACHES TO DEPRESSION AND ANXIETY DISORDERS: BENEFITS, LIMITATIONS, AND THE NEED FOR ADJUNCTIVE INTERVENTIONS

The treatment of depression and anxiety has undergone profound changes in recent decades, with the implementation of a wide range of pharmacological and non-pharmacological treatments. While these methods have been found to be useful in reducing symptoms and improving quality of life, many challenges remain—especially in low- and middle-income countries (LMICs) like Iran. Barriers to the successful application of traditional treatment modalities include inaccessibility of healthcare, cost-effectiveness, cultural appropriateness, and compliance issues in many cases. In addition, the increasing trend towards treatment-resistant cases and high relapse rates highlight the need for implementing effective, sustainable, and cost-effective adjunctive treatments, such as physical exercise. (Jacob, 2011; Marshe et al., 2020; Chu & Wadhwa, 2023)

1.5.1. Pharmacotherapy: Effectiveness and Adverse Reactions

The main method of pharmacological treatment of moderate to severe depression and anxiety is still the prescription of antidepressants and anxiolytics.

First-line medications include:

- Selective Serotonin Reuptake Inhibitors (SSRIs), including fluoxetine, sertraline, and citalopram.

- Serotonin-norepinephrine reuptake inhibitors (SNRIs), including venlafaxine and duloxetine.
- Benzodiazepines for acute anxiety or panic attacks (e.g., lorazepam, clonazepam)
- Tricyclic Antidepressants (TCAs) and Monoamine Oxidase Inhibitors (MAOIs) are used in treatment-resistant cases.

Many clinical trials substantiate the early efficacy of treatment approaches intended to reduce symptoms that are depressive and anxious in nature (Al-Harbi, 2012); however, the evidence regarding long-term outcomes is inconclusive. About 30–40% of patients with depression show a poor response to initial treatment regimens, with about 20% qualifying as Treatment-Resistant Depression (TRD) (McIntyre et al., 2023; Dale et al., 2015).

The commonly recognized side effects of antidepressant drugs include gastrointestinal disturbance, sexual dysfunction, sleep disturbances, weight gain, and emotional numbness. These side effects are heavily implicated in the documented low treatment adherence rates, particularly in women, who have greater sensitivity to the side effects of drugs, thus making them more likely to abandon treatment prematurely (Campos et al., 2021).

In Iran, the availability of some drugs can be limited due to international sanctions, import restrictions, or unstable supply situations. Additionally, even when such drugs are available, unaffordable out-of-pocket prices, poor insurance coverage, and poor medication understanding can interfere with long-term use, especially among women living in economically disadvantaged situations (Jacob, 2011).

1.5.2 Psychotherapy: Importance in Clinical Practice and Cultural Challenges

Psychotherapeutic interventions constitute a fundamental component of treating prevalent mental disorders, especially those that are rated mild to moderate in severity, and can act as an ancillary modality in addition to drug therapy. A number of therapy modalities have gained strong empirical support. Cognitive Behavioral Therapy (CBT) entails identification and rewriting maladaptive cognitive schemas, and Interpersonal Therapy (IPT) targets

interpersonal conflict and role changes. Mindfulness-Based Cognitive Therapy (MBCT) enfoldes meditation and focus on the here and now in order to improve emotion regulation, and Psychodynamic Therapy delves into unconscious conflict in addition to emotion processing machinery.

Psychological therapy (CBT) has also had exceptionally strong evidence in support for treating depression and anxiety symptoms across diverse demographics (Leichsenring et al., 2022; Hofmann & Gómez, 2017). Nonetheless, with all supported effectiveness aside, both CBT implementation and other forms of psychotherapy experience robust global challenges. These global challenges are intensified in context by Iran, whereby both structural as well as cultural considerations produce additional access-related obstacles. In Iran's context, there is also a growing shortage of duly trained clinical psychologists and psychotherapists, not least in rural areas where such activities are most drastically needed. Furthermore, social stigmas and cultural taboos about mental health often discourage individuals—the women most substantially—from having therapeutic discussions. Literacy deficits and linguistic barriers compound these issues more by inhibiting systematic use of cognition-centered approaches. Financial constraints also act to reduce mental health access by virtue of private psychotherapy's excessive cost for many families without insurance coverage. Finally, cultural tendencies might cause women to choose support cast in terms of emotions or spirituality instead of Western tradition's methodologies. All these conditions serve to highlight the salience of psychotherapeutic interventions culturally modified and sensitive to specific issues women in Iran would face (Rezaie et al., 2021; Hook et al., 2021).

1.5.3 Mental Health Service Shortfalls in Low- and Middle-Income Countries: The Case of Iran

Over 75% of people suffering from mental health conditions in low- and middle-income nations (LMICs) do not receive any kind of treatment (WHO, 2023). This is a phenomenon known as the "treatment gap," and it can be explained by a number of system-related factors (Patel et al., 2010; Serau et al., 2015).

- Underinvestment in mental health infrastructure (often <2% of national health budgets)

- Centralized urban mental health resources, leaving rural areas underserved
- There is inadequate integration of mental health services into general healthcare settings.
- Disjointed healthcare delivery and ineffective referral systems

The delivery of mental healthcare in Iran is often plagued by disorganization and lack of funds. Despite some attempts to integrate core mental healthcare services into the national primary healthcare system, the focus remains on treating acute symptoms over long-term rehabilitation or prevention (Dorosti et al., 2023; Rathod et al., 2017). In addition, there is a notable lack of public awareness campaigns and education programs that would promote community engagement (Petersen et al., 2011).

1.5.4 The Role of Physical Activity as an Adjunct Treatment Strategy

Given these limitations, physical exercise is increasingly recognized as a low-risk, cost-effective, and readily accessible adjunct to traditional mental health management. Multiple mechanisms have been found whereby physical exercise substantially reduces the severity of symptoms of depression and anxiety (Mahindru et al., 2023; Lista & Sorrentino, 2009; Hassan et al., 2022; Spruit et al., 2016).

Biological mechanisms. Exercise improves mood partly through biological mechanisms involving the heightened secretion of endorphins, the regulation of monoamine neurotransmitters such as serotonin and dopamine, modulation of the hypothalamic–pituitary–adrenal (HPA) axis, and elevated brain-derived neurotrophic factor (BDNF) levels. All these changes are associated with greater resilience to depression and anxiety (Dishman et al., 2006; Kandola et al., 2019).

Psychosocial outcomes. Exercise offers psychosocial benefits by involving psychosocial mechanisms like enhanced self-efficacy, ruminative thinking reduction, enhancement of social engagement, and augmented feelings of mastery and competence (Murri et al., 2019; Singh et al., 2023; Dąbrowska-Galas & Dąbrowska, 2021).

Cognitive improvements. Finally, habitual physical activity has been linked to improved cognitive functions, including better sleep quality, increased concentration, and more effective memory capacity, all of which together promote emotional suppression and improve general quality of life (Loprinzi & Lovorn, 2019; Stillman et al., 2020).

Meta-analyses demonstrate that physical activity interventions have equal efficacy to both psychotherapy and antidepressant drug treatment in symptom reduction of mild to moderate depression (Schuch et al., 2016; Rebar et al., 2015). What is particularly important is that physical activity is a non-stigmatizing and empowering intervention, particularly for women who might be reluctant to access traditional mental health care.

1.5.5 Moving Towards Holistic and Sustainable Health

The complex nature of depression and anxiety requires the use of varied, personalized treatment regimens that include pharmacological, psychotherapeutic, and behavioral components. As one component of this multi-dimensional paradigm, physical exercise in general—and systematic methodologies like high-intensity interval training (HIIT) in particular—emerged as one promising therapy element. Beyond its salience on immediate symptom relief, HIIT instills long-term psychological resilience, metabolic health improvement, and sustainable lifestyle change, all highly important in resource-limited settings.

Further, priority at a holistic level encompasses not only alleviation of symptoms at a clinical level but also promotion of general well-being, social connections, and quality of life. Integration of physical activity with standard schemes of care delivery renders interventions sustainable, cost-effective, and socially acceptable. This is particularly pertinent in the Iranian experience, whereby restricted referral access to special measures and sociocultural impediments frequently deter women's use of mainstream therapy measures.

So incorporating HIIT as one aspect of an integrated holistic approach to health allows both physical and mental elements to simultaneously be addressed and hence offers a viable and emancipative therapy option amongst middle-aged

Iranian women. The next sections will discuss these mutually related benefits at psychological, physiologic, and sociocultural levels.

1.6. THE IMPORTANCE OF PHYSICAL EXERCISE IN MENTAL HEALTH: BIOLOGICAL PROCESSES AND PSYCHOSOCIAL RELATIONSHIPS

The positive effect of physical exercise on mental health has received significant recognition in the last two decades, serving as a preventive treatment and a therapeutic intervention. Across heterogeneous populations including both clinical and non-clinical groups, regular physical exercise is associated with symptom reductions in depression and anxiety, improvement in psychological resilience, and an overall increase in quality of life (Blumenthal & Rozanski, 2023; Biddle et al., 2018; Chen et al., 2025). In contrast to traditional pharmacological treatments or psychotherapy, exercise is a cost-effective, minimal-risk, and easily accessible intervention that also supports multiple benefits for physical health. Exercise effectiveness is supported by a synergy of biological, neurochemical, psychological, and behavioral pathways (Bondarev et al., 2021).

1.6.1 Biological and Neurochemical Mechanisms

Several biological processes have been proposed to explain the antidepressant and anxiolytic actions linked with physical activity. These include:

A) Brain-Derived Neurotrophic Factor (BDNF)

Brain-derived neurotrophic factor (BDNF) is a vital protein that is involved in neuroplasticity, neuronal survival, and synaptic transmission. Studies have shown that depressed individuals often have decreased levels of BDNF, especially in the hippocampus and prefrontal cortex (Duman et al., 2016; Legrand et al., 2023). Aerobic and resistance exercise—especially at moderate to high intensity—has been reported to increase BDNF expression, thus promoting brain resilience and enabling neurogenesis (Szuhany et al., 2015; Hossain et al., 2024).

B) Monoamine neurotransmitter concentration regulation

Physical activity affects major neurotransmitters linked to mood regulation, including:

- Serotonin (5-HT): Stabilizes mood, improves sleep, and controls appetite.
- Dopamine: Increases motivation, reward sensitivity, and pleasure experience.
- Norepinephrine: Supports alertness, arousal, and stress response.

The changes are similar to the neurochemical effects involved in antidepressant drugs; however, they occur naturally and do not cause pharmacological side effects (Ren & Xiao, 2023).

C) Hypothalamic-Pituitary-Adrenal (HPA) Axis Regulation

The hypothalamic-pituitary-adrenal (HPA) axis plays a central role in regulating the physiological response to stress by secreting cortisol. Dysfunction of this regulatory process is a notable feature seen in depressive and anxiety disorders. Participation in frequent physical exercise is one of a number of factors involved in the restoration of HPA axis function, thereby reducing increased cortisol levels and enhancing stress resilience (Caplin et al., 2021).

D) Anti-Inflammation Effects

Chronic low-grade systemic inflammation characterized by high levels of C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- α) is increasingly being recognized for its important role in the pathophysiological processes of depression. Physical activity exemplifies anti-inflammatory properties, as it has been reported to reduce pro-inflammatory cytokines and increase the levels of anti-inflammatory mediators like IL-10 (Heo & Jee, 2023; Eyre & Baune, 2011).

E) Endorphin hypothesis

Exercise triggers endogenous opioid secretion, including β -endorphins, which act on the central nervous system to reduce the perception of pain and cause feelings of euphoria, often described as the "runner's high" (Siebers et al., 2022). It has been shown that this physiological response is very effective in reducing symptoms of anxiety.

1.6.2 Psychological and Cognitive Mechanisms

Besides physiological changes, physical activity promotes psychological health through various cognitive, emotional, and behavioral mechanisms:

A) Distraction and Behavior Engagement

Physical activity is a cognitive distraction from harmful patterns of thinking, such as rumination and worry, which are core features of depressive and anxiety disorders. Furthermore, organized exercise is a prime example of the principles of behavioral activation therapy because it encourages participation in organized, purposeful, and pleasurable activities (Craft & Perna, 2004).

B) Enhanced Competence and Confidence

Participating in regular physical activity promotes a sense of competence, autonomy, and self-regulation. Overcoming and successfully negotiating physical hurdles develops self-efficacy, further reducing experiences of helplessness, an important cognitive attribute linked to depression (White et al., 2024).

C) Body Image and Self-Esteem Enhancement

Regular physical activity is also essential in developing body awareness, a key factor linked with decreased depressive symptoms, particularly in middle-aged women undergoing constant changes in body appearance and weight distribution as a result of aging and menopause (Lee et al., 2022).

D) Social Context and Interaction with Support

Involvement in group physical activities, including exercise walking groups, provides opportunities for social interaction, emotional support, and networking, which are protective factors against feelings of loneliness, social isolation, and depressive symptoms—an element that is of special importance for women involved in varied caregiving activities (Wickramaratne et al., 2022).

e) Improved Sleep Quality

Exercise has been well-recorded to impact sleep onset, duration, and quality, all of which are integral to the regulation of emotions and the upkeep of mental wellbeing. Sleep disturbances are usually present with depression and anxiety; thus, exercise indirectly relieves symptoms by enhancing sleep (Vidović et al., 2025).

1.6.3 Empirical Evidence Supporting Physical Activity with Reference to Psychological Well-Being

Several systematic reviews and meta-analyses present evidence for the efficacy of exercise as a stand-alone intervention as well as an adjunctive treatment for depression and anxiety.

- Schuch et al. (2016): Exercise significantly reduces depressive symptoms across age groups, with moderate-to-large effect sizes.

Kvam et al. (2016) state that physical activity has the same effects as antidepressant medication for people with mild and moderate depression.

Aerobic physical activity has been linked by Stubbs et al. (2017) with a significant reduction in anxiety symptoms, particularly in female participants.

Steinmo et al. (2014) identified that physical activity participation is associated with a lower risk of relapse when combined with psychotherapeutic treatment.

These findings have led the American Psychiatric Association, the United Kingdom's National Institute for Health and Care Excellence, and the World Health Organization to call for the incorporation of physical activity into the overall framework for mental health care.

1.6.4 Impacts on Iranian Women during Middle Age

Given the infrastructural, economic, and cultural barriers to seeking traditional mental health care in Iran, physical exercise is a conceivable alternative that is less stigmatized. For middle-aged women, particularly those in menopause, balancing caregiving responsibilities, and experiencing limitations on personal freedom, physical exercise can be a psychological sanctuary, a way to reclaim personal identity, and a means of enhancing self-care while building empowerment.

In addition, inclusion of physical activity programs established in the home or community environment, such as High-Intensity Interval Training (HIIT), can successfully reduce barriers related to economic limitations, time availability, and facility access. These programs, therefore, should be tailored to respect cultural values, promote inclusivity, and take into consideration women's lived experiences.

1.7. HIGH-INTENSITY INTERVAL TRAINING (HIIT): A NOVEL STRATEGY FOR PROMOTING THE PSYCHOLOGICAL HEALTH OF WOMEN IN MIDLIFE

1.7.1 Definition and Historical Evolution of HIIT

High-Intensity Interval Training (HIIT) can be described as an organized method of physical training that involves short periods of intense effort—lasting anywhere from 20 seconds to several minutes, performed at a level of about 80–95% of a person's maximal heart rate—interspersed with intermittent periods of low-intensity activity or rest. This alternating pattern is designed to improve cardiovascular efficiency and metabolic benefits within a short space of time, especially when compared to traditional endurance training (Bidhuri et al., 2025). Unlike traditional endurance training, characterized by long periods of moderate-intensity exercise (MICT), HIIT methods are specifically designed to enable optimal physiological adaptation to occur quicker by asking those taking part to hit 80–95% of their maximal heart rate (HRmax) during the high-intensity phases (Gibala et al., 2012; Atakan et al., 2021).

The origins of interval training are traced to the early 20th century, the 1910s and 1920s, when initial research into athletic conditioning was carried out by European sports practitioners. However, the development of high-intensity interval training (HIIT) as a formalized and evidence-based exercise protocol came into being in the 1990s, primarily because of the key role played by Izumi Tabata's study in Japan. His research showed that repeated and brief periods of intense exercise (20 seconds of effort alternating with 10 seconds of recovery, totaling 4 minutes) led to remarkably greater improvements in both aerobic and anaerobic fitness compared to conventional long-duration continuous exercise training (Tabata, 2019).

Over time, HIIT has evolved from an elite sports training technique into a widely adopted tool in clinical, public health, and psychological interventions, supported by mounting evidence across diverse populations.

1.7.2 Core Features of HIIT

A typical HIIT program includes:

- Work durations: 30 seconds to 4 minutes at high intensity ($\geq 85\%$ HRmax or ≥ 14 –16 RPE)
- Recovery intervals: 1–3 minutes at low to moderate intensity
- Total duration: 15–30 minutes per session
- Frequency: 2–4 sessions per week

High-Intensity Interval Training (HIIT) can be performed using various modes of exercises, such as treadmill running, cycling, bodyweight, resistance circuits, or aerobic dance, thus making it highly versatile and accommodating (Bidhuri et al., 2025).

1.7.3 Physiological and Psychological Advantages of HIIT

A) Compliance with Regulations and Time Management

Time constraints have often been cited as a key barrier to the development of a consistent exercise habit, especially among women in midlife who are working and managing family responsibilities. HIIT presents comparable or even greater benefits compared to sustained activities at moderate intensity over longer durations, all within a significantly shorter period of time, often between 20 and 30 minutes (Elhamalawy, 2024; Weston et al., 2014). As such, HIIT is an extremely convenient and appealing choice for those with busy lifestyles.

B) Cardiorespiratory and Metabolic System Adaptations

High-Intensity Interval Training (HIIT) is well known for its potent effects on maximal oxygen uptake ($\text{VO}_{2\text{max}}$), insulin sensitivity, lipid profiles, and mitochondrial function. These adaptations in physiology improve not only physical well-being but also cognitive function and energy regulation (Batacan et al., 2016; Sheikh et al., 2025).

C) Mental Health Benefits

Emerging research demonstrates that HIIT may offer unique psychological benefits compared to traditional exercise. (Costigan et al., 2016; Martland et al., 2021) These include:

- Rapid relief of symptoms of depression and anxiety.
- Increased positive emotion and uplift of mood
- Improvement of self-esteem, self-efficacy, and cognitive clarity.

A systematic review by Tao et al. (2024) found that HIIT interventions yielded moderate to large reductions in symptoms of depression and anxiety, with effect sizes no different from those linked to psychotherapy, and superior to those for MICT when compared in time-equivalent frameworks.

D) Regulation of Neuroendocrine and Neurochemical Processes

High-Intensity Interval Training (HIIT) was found to significantly increase the levels of Brain-Derived Neurotrophic Factor (BDNF), lower cortisol levels, and promote the release of dopamine and endorphins—biochemical changes linked to enhanced emotional resilience and stress adaptation (Mielniczek & Aune, 2024).

1.7.4 Midlife women and high-intensity interval training: theoretical explanations and gender considerations

Middle-aged women undergoing perimenopause or postmenopause often experience declining estrogen levels, leading to increased risk of metabolic syndrome, fatigue, sleep disturbances, and affective disorders. HIIT is particularly suitable for this population because:

- It improves metabolic flexibility, thus reducing visceral fat accumulation and insensitivity to insulin (Steckling et al., 2016).
- It promotes mitochondrial biogenesis, countering the decline in energy metabolism associated with aging and hormonal changes (Nicolò & Girardi, 2016)
- It enhances cardiovascular function, a condition that commonly worsens in postmenopausal women due to vascular aging (Ko et al., 2025; McGregor et al., 2023).

Psychologically, participating in HIIT sessions can enhance perceptions of mastery, promote confidence, and facilitate mood control, thus helping women to redefine aging as a process of empowerment and not decline. (Ribeiro et al., 2022; Korman et al., 2019).

Additionally, HIIT can be tailored to bodyweight-based or equipment-free formats, making it ideal for home-based or small-space environments, critical for Iranian women facing barriers to public gyms or outdoor activity (Jabbour & Iancu, 2023).

1.7.5 Safety, Accessibility, and Perceived Obstacles

Despite concerns regarding the safety of high-intensity training in sedentary or older adults, recent evidence indicates that high-intensity interval training (HIIT) can be deemed safe and is overall well-tolerated in different settings, especially when implemented under proper supervision and in a gradually increasing intensity approach, even in adults with existing chronic health issues (McGregor et al., 2023; Marriott et al., 2021). In addition, the dropout rates of HIIT interventions are comparable to, or potentially less than, those reported in conventional exercise programs, as long as the protocols are adjusted to fit the level of participants' fitness (Reljic et al., 2019).

In order to further the removal of barriers, especially in culturally complex environments like Iran:

Training may be provided using mobile apps, printed timetables, or learning videos.

- Female-only HIIT groups can be facilitated in community centers, homes, or religious spaces.

Programs should have elements that highlight mental health education, hormonal balance, and self-care practices.

1.7.6 Why HIIT Was Chosen for This Study

The current doctoral study selected HIIT as the primary intervention based on several critical factors:

- Empirical evidence corroborates its efficacy in lessening symptoms of depression and anxiety.

Temporal efficiency fits the needs of middle-aged women, who tend to have restrictions on their individual time.

Physiological significance related to hormonal, cardiovascular, and metabolic changes experienced during menopausal transition.

- Low-cost, scalable implementation, suitable for Iranian socio-cultural and economic contexts.
- The ability to be delivered via multiple modalities (in-person, virtual, home-based) with a minimized allocation of resources.

Furthermore, the proposed HIIT protocol was carefully designed to balance intensity with safety, ensuring progressive overload, participant engagement, and mental health monitoring throughout the 10-month intervention.

1.8. A STUDY OF SOCIOCULTURAL, ENVIRONMENTAL, AND PSYCHOLOGICAL BARRIERS TO PARTICIPATION IN PHYSICAL ACTIVITY AMONG IRANIAN WOMEN

Despite the well-documented benefits of regular physical activity on both physical and mental health, participation rates among Iranian women, especially in the middle-aged group, are substantially low. Less than 15% of Iranian adult women meet the World Health Organization's (2023) requirement of 150 minutes of moderate-to-vigorous intensity physical activity per week. Understanding the various barriers preventing women from participating in exercise is crucial to developing culturally appropriate and effective interventions, such as high-intensity interval training (HIIT), which is the central aim of this research.

1.8.1 Social and Gender Norms

One key reason for the low rates of physical activity in Iranian women is the impact of sociocultural norms and deep-rooted gender roles. Women in many societies share a common belief that they should prioritize family responsibilities and caregiving over leisure activities or their own health (Kamyab & Hoseinzadeh, 2023). As a result, physical activity is viewed as being unnecessary, self-centered, or even inappropriate, particularly when performed in public (Kazemi Karyani et al., 2019; Dashti et al, 2014).

Dress code mandates, such as having to wear hijabs in public, also add to the reduction in access to physical activity, particularly in warmer seasons (Farzaneh et al., 2021). Additionally, the presence of mixed-gender settings is often

considered socially or religiously unacceptable, which in itself hinders women's access to facilities like recreational parks, gyms, and swimming pools. All these, together, reduce the visibility and social acceptability of women's participation in exercise, hence fostering the inclination towards sedentary lifestyles.

1.8.2 Inadequate Distribution of Resources to Women

Iran has seen some level of progress in the development of sports centers specifically for women; however, the overall infrastructure is still lacking, especially in suburban and rural areas. Many neighborhoods lack access to safe and appropriate women's gyms, as the existing facilities often demonstrate shortcomings like inconvenient working times, high prices, or poor equipment (Hoseini et al., 2025; Yarmohammadi et al., 2019).

In cities, resources do not always translate to true accessibility; many women need to seek permission from their husbands or male relatives, or juggle domestic tasks in order to find time to engage in physical activity—this is particularly relevant for middle-aged women who might be responsible for caring for aging parents as well.

1.8.3 Environmental and Logistic-Related Obstacles

Other noteworthy hurdles include:

- Safety concerns in public spaces, including poor lighting, inadequate security, and harassment.

Air pollution, especially in cities like Tehran, discourages people from outdoor activities.

- Lack of access to reliable public transportation to sports facilities.
- Time poverty, as women often juggle multiple roles and rarely find time for self-care (Dolatabadi et al., 2022).

Middle-aged women, often juggling the dual roles of professional work and domestic duties, have always reported "time constraints" as a strong consideration for their decreased physical activity levels (McArthur et al., 2014). As such, for this group, exercise protocols that optimize time management, are highly organized,

and are compatible with independent implementation at home, like HIIT, are especially beneficial.

1.8.4 Psychological Barriers: Motivational Issues, Self-Concept, and Internalized Goals

Psychological barriers deserve serious attention as well. Many women might find lower self-efficacy regarding their ability to engage in physical exercise, especially if they have been inactive for a long time or if they associate physical activity with youth or athleticism. In addition, a negative body image, fear of being judged by others, and performance anxiety can also discourage participation in such activity (Rezaie et al., 2017).

Cultural norms place significant demands on women to be modest and restrained, and this can thus lead to guilt when they try to respond to their own needs. In such a context, there is a significant lack of mental health understanding, and physical exercise is often viewed as an inappropriate means of managing emotional well-being (Zavareh et al., 2023).

1.8.5 Structural and Economic Constraints Exacerbated by Sanctions

The current economic challenges experienced by Iran, coupled with international sanctions, have had a negative effect on the public health system, especially regarding community recreation programs and sporting activities. The devaluation of the rial, high inflation rate, and increasing unemployment have led to considerable cuts in government financial backing for community centers, parks, and physical well-being enhancement programs for women (Seyfi et al., 2020; Taheri & Guven-Lisaniler, 2018).

Private gym access is increasingly limited to families with middle- to low-income status. In addition, athletic wear, shoes, or exercise equipment purchases are prohibitively expensive. This is especially burdensome for women, who often do not have independent sources of income or tend to prioritize family expenses over their own financial demands (Emami et al., 2022).

1.8.6 Moving Forward with Inclusive and Culturally Relevant Solutions

To overcome these challenges, exercise interventions for Iranian women need to be:

- Time-efficient (e.g., 20–30 minutes) (Frimpong et al., 2019).
- Economical or complimentary (Mollarahimi Maleki et al., 2020).
- Equipment-light or equipment-free
- Flexible in schedule
- Culturally respectful and home-based when necessary (Khosromanesh et al., 2023).

High-Intensity Interval Training (HIIT), particularly when designed to include body weight exercises and transmitted through widely accessible instructional media like videos, apps, or published materials, meets these requirements and has shown significant applicability in similar environments. Additionally, the involvement of peer facilitators or community health workers has the ability to improve trust, participation, and compliance with participants in the study.

1.9. PROBLEM STATEMENT AND RATIONALE

Depression and anxiety are among the most prevalent mental illnesses in the world, having significant impacts on individuals, families, and healthcare systems nationally. In Iran, the two conditions are mainly seen amongst middle-aged women, who have a range of vulnerabilities based on hormonal changes, socio-cultural stresses, and limited access to mental health services. Despite growing global awareness of the role of exercise in mental health, as well as the adoption of evidence-based interventions to promote mental well-being, the integration of organized physical exercise in Iran's mental health care system remains inadequate.

The traditional approach to the treatment of mood disorders involves both pharmacotherapy and psychotherapy; however, these modalities are often hindered by access barriers, worsened by societal stigma, and demonstrate limitations in their effectiveness in real-world settings, including low- and middle-

income countries (LMICs). Within Iran, the complex interplay of cultural forces, economic constraints, and deep-seated gender roles for women all serve to impede their ability to seek and maintain access to mental health care services.

Over the last decade, High-Intensity Interval Training (HIIT) has become a significant non-pharmacological intervention for the promotion of physical as well as mental health. A growing body of literature supports the positive effects of HIIT on the reduction of depression and anxiety symptoms through various neurobiological mechanisms, such as the increase of Brain-Derived Neurotrophic Factor (BDNF) and the regulation of the Hypothalamic-Pituitary-Adrenal (HPA) axis as well as through psychosocial mechanisms like enhanced self-efficacy and better emotional regulation. However, much of the current research has been limited to Western populations, especially adult groups, and hence does not generalize the findings to middle-aged women. In addition, this work has not considered the context of Iranian women, who experience considerable systemic, psychological, and cultural obstacles to physical activity and access to therapeutic interventions.

In addition, existing studies on the association between physical activity and mental health in Iran have largely focused on low-to-moderate intensity aerobic activities, with short durations, small sample sizes, and short follow-up periods. There has been a lack of studies that systematically evaluated the long-term effects of structured, high-intensity interventions like HIIT on psychological indicators, particularly depression and anxiety.

The current lack of literature highlights the need for an intervention that is holistic, culturally sensitive, and addressing the specific gender needs of middle-aged Iranian women, a group whose mental health issues continue to be largely overlooked. This study seeks to remedy this gap by implementing a 10-month High-Intensity Interval Training exercise program, assessing its effectiveness in reducing symptoms of depression and anxiety, and providing new insights to inform the development of scalable and accessible mental health promotion programs in similar socio-cultural settings.

1.10. INVESTIGATIVE QUESTIONS

1. Do middle-aged Iranian women show significant group, temporal, and interaction effects for depressive symptoms after participating in a 10-month High-Intensity Interval Training (HIIT) program, as measured by the Beck Depression Inventory (BDI)?

2. To what degree does taking part in a 10-month high-intensity interval training (HIIT) program generate significant group, temporal, and interactional effects on symptoms of anxiety in middle-aged Iranian women, as measured by the Beck Anxiety Inventory (BAI)?

3. Does long-term engagement in HIIT significantly reduce body weight, body fat percentage, and body mass index (BMI) over time, and are these effects significantly different between intervention and control groups?

4. What biological and psychosocial mechanisms might explain the observed effects of HIIT on mental health outcomes, based on the integration of study results and relevant literature?

5. What social, cultural, and environmental determinants of behavior are associated with middle-aged Iranian women following a 10-month high-intensity interval training program?

1.11. HYPOTHESES

- HIIT exercise significantly improves depression symptoms in middle-aged Iranian women compared to the control group.

- HIIT exercise significantly improves anxiety symptoms in middle-aged Iranian women compared to the control group.

- Participation in a 10-month high-intensity interval training program leads to long-term reductions in depressive symptoms in middle-aged Iranian women.

- Long-term HIIT participation produces lasting improvements in anxiety symptoms in middle-aged Iranian women.

- Compared to the control group, middle-aged Iranian women who exercise HIIT significantly reduce their weight, body fat percentage, and BMI.

II – JUSTIFICATION

II - JUSTIFICATION

Depression and anxiety are among the most common and disabling mental illnesses globally, affecting hundreds of millions of people and causing considerable social and economic impacts (Doran & Kinchin, 2017). Based on estimates provided by the WHO, depression is predicted to become the second leading cause of global disease burden by the year 2030 (WHO, 2018). These mental illnesses significantly reduce overall quality of life, impact productivity, increase the risk of physical illness like cardiovascular diseases, and significantly add to healthcare costs (Blumenthal & Rozanski, 2023). Middle-aged women are found to be in an increased state of vulnerability to depression and anxiety due to a complex interplay between hormonal changes related to menopause, psychosocial factors, and lifestyle (Kim, 2020; Bansal et al., 2015). In Iranian society, this vulnerability is further compounded by existing social norms, the stigma of mental illness, and limited access to appropriate healthcare facilities (Taghva et al., 2017; Mahdavian et al., 2024).

Pharmacotherapy, in the form of selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs), is largely considered the first-line treatment method for treating depression and anxiety disorders. However, the application of these drugs is associated with a range of potential side effects, including but not limited to weight gain, sexual dysfunction, sleep disorders, and gastrointestinal issues (Wang et al., 2018). Chronic administration of such pharmacological treatments can lead to dependence, signs of withdrawal, and increased relapse once treatment is discontinued. Importantly, it has been found that around 30% of individuals fail to achieve adequate symptom improvement from pharmacotherapy alone, highlighting the need to look into additional or alternative treatment options (Nawaz et al., 2024).

Psychotherapy, particularly cognitive-behavioral therapy (CBT), has proven effective in reducing symptoms of depression and anxiety by altering maladaptive patterns of thought and encouraging adaptive coping techniques (Cuijpers et al., 2018). However, in many low- and middle-income countries, such as Iran, access to such therapy sessions is greatly limited by financial constraints, a lack of properly

trained therapists, and prevailing social stigmas toward mental health treatment (Javed et al., 2021). Additionally, the cost considerations and time requirements of prolonged psychotherapy might deter people, especially middle-aged women, who usually manage multiple family and employment duties (Masoomi et al., 2023).

In light of this background, physical exercise is recognized as a cost-effective intervention free of pharmacological elements, thus making it especially well-suited to the treatment of depression and anxiety disorders (Nascimento & Santos, 2025). Physical activity triggers the release of neurotransmitters like serotonin, dopamine, and endorphins, which are instrumental in mood regulation. In addition, it enhances the production of brain-derived neurotrophic factor (BDNF) necessary for neuroplasticity and cognitive activities while, at the same time, lowering cortisol levels related to heightened stress (Sieniawska et al., 2024; Chen & Nakagawa, 2023). The biological effects of exercise highlight its potential role as a good adjunct therapy or, in some cases, an acceptable replacement for pharmacotherapy and psychotherapy (Woźniak et al., 2024; Nascimento & Santos, 2025).

High-intensity interval training (HIIT) is a popular mode of exercise garnering significant attention due to its time efficiency and its beneficial physiological effects. The HIIT protocol involves the cyclic alternation of short periods of intense exercise and planned periods of recovery, and studies have shown it to be superior to steady-state, moderate-intensity exercise in terms of improvements in cardiovascular function, metabolic efficiency, and psychological health (Martland et al., 2021; Weston et al., 2014). Recent literature indicates that HIIT has therapeutic value in improving mood, reducing symptoms of depression and anxiety, and reducing inflammation and oxidative stress—factors involved in the pathophysiology of mood disorders (Martland et al., 2021).

Despite these developments, most of the current research remains largely focused on the younger population and short-term intervention programs (Ramadan et al., 2025). There is a large gap in the current literature regarding the long-term effects of High-Intensity Interval Training (HIIT) on mental health in middle-aged women, who face unique physiological and psychosocial stresses. In the Iranian context, this deficit is compounded by a range of cultural, social, and

environmental barriers that discourage women from undertaking regular physical activity. These barriers include limited accessibility to appropriate venues, social norms that restrict gender-based physical activity, and competing demands emanating from domestic and professional duties (Dashti et al., 2014; Rezaie et al., 2017).

The prevalence of depression among Iranian women is estimated at more than 25%, and anxiety disorders have a similarly high prevalence rate (Sharifi et al., 2015). Hormonal changes during menopause, characterized by lowering levels of estrogen and progesterone, have been linked with changes in mood, heightened irritability, and with an increased risk for major depressive disorder (Herson & Kulkarni, 2022). Menopause in Iranian culture is also often linked with social stigma and social isolation, thus amplifying psychosocial distress. Economic hardship and political turbulence are also contributing factors to chronic stress, thus increasing susceptibility to mood disorders (Mahdavian et al., 2024).

Social and cultural norms place major constraints on the participation of many Iranian women in physical pursuits. The lack of women-only facilities, the unavailability of safe public spaces, and strict gender roles place major barriers. These are particularly acute in smaller urban areas and rural areas. Economic constraints often limit women's participation in private gyms and ancillary services, highlighting the urgent need for affordable and easily accessible alternative arrangements (Mahdavian et al., 2024; Rezaie et al., 2017).

High-intensity interval training (HIIT) is a potentially effective intervention. HIIT can be done in short sessions, requires little equipment, and can be done in home settings, thus overcoming major challenges faced by Iranian women (Martland et al., 2021). Even though previous studies have highlighted the effectiveness of HIIT in reducing the symptoms of depression and anxiety disorders, improving neurochemical balance, and increasing overall quality of life, there is limited understanding of the long-term effects of HIIT in middle-aged Iranian women.

The current study aims to address the limitation recognized by investigating the long-term effects of a ten-month high-intensity interval training (HIIT) program on depression, anxiety, and body fat percentage in middle-aged Iranian women. The

study aims to provide empirical evidence on the effectiveness and appropriateness of HIIT for this population, hence supporting the development of culturally relevant and long-lasting mental health interventions that can be used as complementary or alternative treatments to standard psychotherapy.

III

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**LITERATURE
REVIEW**

III – LITERATURE REVIEW

3.1. INTRODUCTION AND THEORETICAL BACKGROUND

Anxiety and depression are two of the most common mental and behavioral disorders around the world. These disorders affect around 280 million people suffering from depressive disorders and around 300 million people suffering from anxiety (World Health Organization, 2023). The impact of these disorders on people's lives is immense; for example, depression was responsible for more than 47 million disability-adjusted life years worldwide (Vos et al., 2020). Depressive disorders consist of persistent feelings of sadness, a lack of interest or pleasure in previously enjoyable activities, fatigue, feelings of guilt or decreased self-esteem, sleep or appetite disturbances, and difficulties in maintaining focus (Denton, 2020). On the other hand, anxiety disorders consist of feelings of fear or anxiety that interfere with everyday life and often have physical as well as emotional symptoms like restlessness, palpitations, and muscular tension (Bigalke et al., 2023).

Despite their own identification and distinct symptom profiles, depression and anxiety commonly co-occur and have overlapping biological mechanisms. Studies have found that both disorders involve dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, systemic inflammation, alterations in neural connectivity, and monoamine disturbances, especially serotonin and dopamine (Penninx et al., 2021; Cosci & Fava, 2021). The rate of these effects is significantly increased among women, especially midlife women, as a consequence of complex interaction among biological, psychological, and socio-cultural factors; midlife, generally ages between roughly 40 and 60 years, is a key developmental time when hormonally induced alterations are directly linked with perimenopausal and menopausal transitions (Soares, 2014; Maki et al., 2019). Declines in estrogen and progesterone are well documented as a contributor to increased susceptibility to mood disorders because these hormones have a crucial role as regulators of serotonin and dopamine systems involved in emotional control (Santoro et al., 2015).

Overlooked episodes of depression and anxiety in midlife can have considerable long-term consequences, including a heightened risk for developing chronic diseases, cognitive impairment, and a lower quality of life in later life (Joffe et al., 2012). In spite of available pharmacologic and therapeutic treatments, a high percentage of women in this age group face barriers that limit their access to effective care and include stigmatization by society, time limitations, and cultural barriers (Cuijpers et al., 2018). These factors highlight a desire to explore alternate, pharmacologic-free techniques for improving one's mental well-being.

Another salient method is physical exercise, which has received rising prominence owing to its efficacy in mitigating depressive and anxiety disorder symptoms owing to biological and psychological mechanisms (Mahindru et al., 2023). In particular, High-Intensity Interval Training (HIIT) has been identified as a uniquely effective form of physical exercise that can potentially have positive impacts on mental health (Martland et al., 2021). This paper thus provides a review of depressive and anxiety disorder epidemiological trends among midlife women before moving on to a discussion of theoretical frameworks and biological variables corresponding to HIIT and empirical studies connecting physical activity and its influence on mental health among this population.

3.2. MENTAL HEALTH CHALLENGES IN MIDLIFE WOMEN

Midlife, typically defined as the decade between 40 and 60 years of age, is marked by a host of major physiological and psychosocial alterations, such as premenstrual and menopausal syndromes, shifts in familial roles, occupational transitions, and increased caregiving demands (El Khoudary et al., 2019). Such complexes significantly heighten women's risk of mood disorders compared to their male equivalents in almost all geographical and societal settings (Baber, 2023; Thomas et al., 2018). International prevalence rates for depression among women are roughly doubled for women compared to men, a correlation maintained across a broad range of environments and populations. According to data provided by the World Health Organization (2023), more than 280 million people globally experience depression, with midlife women experiencing specific risk factors owing to estrogen variations around menopause, having a deleterious impact on

major serotonergic and dopaminergic systems responsible for mood control (WHO, 2023).

Onset of menopause is also marked by a rise in sleep disorders and lethargy, as well as physical discomforts, all of which are shared risk factors or precursors to depression and anxiety (Ballot et al., 2022). These factors are commonly ineffectively assessed or wrongly assigned to age-related norms and so postpone access to effective intervention. Therefore, the impacts of depression and anxiety on this population pose considerable clinical, economic, and societal burdens, leading to increased hospital admissions and decreased productivity at work (Hickey et al., 2012).

Along with hormonal changes, midlife is also commonly marked by a series of psychosocial stressors, including childcare or eldercare responsibilities, occupational demands, marital status changes, and social role transitions. These may vary considerably in their nature and can have impacts on self-esteem as well as social connections. If not properly managed, these stresses can negatively affect emotional well-being, lower life satisfaction as a whole, and possibly trigger the development of chronic psychiatric disorders. Studies have found that midlife expressions of persistent depression or anxiety can extend into later life stages and thus enhance vulnerability to chronic diseases, cognitive impairment, and social isolation (Faleschini et al., 2022).

Cultural norms and gendered social roles placed on women sharply heighten this demographic's struggles in experiencing mental health difficulties. In many countries, women in mid-adult life are expected to carry out caregiving responsibilities across several generations, face occupational barriers linked to aging, and maintain traditional familial responsibilities, often while having limited access to mental health treatment (Anjum & Aziz, 2025). These responsibilities can cause ongoing emotional draining and pressure, which have been proven to cause or exacerbate mood disorders (Perrin et al., 2015).

Additional socioeconomic disparities, including income variation, education, and limited avenues for occupational growth, have a high significance with increased prevalence of depression and anxiety disorders among women in midlife. These risk factors are especially high in lower- and middle-income

countries, wherein access to special psychiatric care facilities access is often limited or stigmatized (Shidhaye et al., 2013; Rauf, 2023).

Despite rising worldwide attention to these issues, psychiatric facilities are often found not well suited to the special needs of women in midlife. Specialized efforts among this population remain insufficiently formulated throughout many parts of the world outside Western countries. This deficiency emphasizes a major imperative for systems of mental health responsive to gender factors corresponding to biopsychosocial complexity typical among women's midlife (Thomas et al., 2018).

3.2.1. Epidemiology and their Correlated Risk Factors among Middle-Aged Women in Iran

Within Iran, prevalence rates of depression and anxiety in middle-aged women represent a vast and increasingly emergent public concern. Both widespread national mental health screens and localized study initiatives have routinely acknowledged increased incidences of mood disorders in the group, with rates of depression ranging anywhere from 20% to 45% (Talebi et al., 2024). Additional symptoms of anxiety are routinely noted and frequently coincide with depressive episodes. However, symptoms inevitably manifest in bodily (somatic) ways or via culturally unique expressions, which hinders identification and diagnostic processes (Rezaie et al., 2021).

Biological factors, including those associated with the menopausal transition characterized by declining estrogen levels, significantly contribute to mood variability, agitation, and changes in sleep patterns (Liang et al., 2024). Sociocultural anticipations that are unique to the Iranian setting accentuate these physiological changes. As such, women are often forced to take on multiple caregiving roles for their husbands, young offspring, and aged mothers, usually without institutional support. Accumulation of these roles leads to chronic psychological tension (Tahan et al., 2024).

Economic challenges escalate vulnerability to mental illness. Iranian women in their middle ages facing economic uncertainty—like widows, retirees, and unemployed people—show a considerably high likelihood of suffering from

depression (Emami et al., 2022). Also, while multigenerational family formations are widespread within the sociocultural context, they are prone to decrease individual autonomy and intensify psychological suffering.

Cultural blame that accompanies mental illness also feeds underreporting and low rates of seeking professional care. Most women inwardly process their emotional suffering, seeing it as a failure or breakdown in their belief structure, discouraging them from seeking professional services (Khosromanesh et al., 2023). Such blame is intensified by social mores that hinder free communication about emotional experiences, a situation that frequently worsens in older women.

Finally, limited access to gender-sensitive mental health care services, most notably in rural and disadvantaged areas, remains a significant barrier to seeking treatment. While efforts have been made in Iran to integrate mental health services within primary care systems, accessibility varies widely. A strong propensity on the part of women to seek care for physical symptoms but not mental symptoms reflects a trend toward mental health somatization (Taghva et al, 2017).

3.2.2. Risk Factors Specific to Iranian Women

The mental health of Iranian midlife women is determined through the interplay between biological, psychological, and sociocultural risk factors in complex ways depending on geographic and cultural specificities. At the biological level, the onset of menopausal changes has profound effects in the form of drops in the levels of estrogen and progesterone that overlap with mood disruptions, increased irritability, and enhanced vulnerability to depression- and anxiety-related symptoms (Santoro et al., 2015). Sleep impairments, cognitive impairments, and fatigue can also emerge as secondary effects through hormonal changes and may serve in this life period to exacerbate emotional distress (Bromberger et al., 2015; Dotlic et al., 2021).

Psychosocially, Iranian women often take an inordinate caregiving responsibility, which involves tasks like raising children, spousal support, and caregiving for aging parents. This significant responsibility, when compounded by ineffective support structures, can result in chronic stress, emotional burnout, and increased vulnerability towards mental illness (Azizi et al., 2019). Additionally,

midlife, as it typically involves significant role changes like retirement, marital status adjustments, or entry into the "empty-nest" phase, can all potentially affect someone's identity, sense of identity and reason for being, and psychological resilience (Dotlic et al., 2021; Mitchell & Wister, 2015).

Risks entailed in these factors are amplified by socioeconomic status. Women whose backgrounds are low-income are most susceptible to suffering financially, unstable residence, and limited access to quality health services. Inadequate work or lack of access to appropriate work can also reduce self-esteem and disturb social contacts, which are protective factors in warding off mood disorders (Javed et al., 2021). Additionally, homemakers or women whose employment ends because of caregiving roles or social stigma can also be subject to social isolation, something that has been identified as predisposing to depression.

Gender-oriented expectations and cultural norms in Iranian society contribute significantly towards psychological and mental health vulnerability. Many women voice sentiments of internalized stress in staying emotionally robust, putting the needs of others first, and focusing on family at the expense of individual well-being. In traditional neighborhoods, lack of liberty in decision-making about health care, lack of access to private transportation, and limitations in physical activity outdoors all limit routes for psychological self-care and coping strategies (Riazi, 2025).

In addition, numerous lifestyle factors, such as physical inactivity, unhealthy dietary habits, and obesity, common in middle-aged Iranian females, play a critical role in mood disorder prevalence. For instance, there has been a steady correlation between lack of physical exercise and prevalence in depression and anxiety in Iranian samples, frequently mirroring wider structural and environmental barriers to physical exercise (Mahdavian et al., 2024).

Overall, all these factors render Iranian females in midlife psychologically vulnerable and in need of broad-spectrum and culturally sensitive interventions addressing stressors intrinsic and extrinsic to the individual.

3.2.3. Stigma Surrounding Mental Health Illnesses and Ease of Treatment in Iran

Stigma related to mental illness remains the most significant barriers in the provision of effective mental health services in Iran, especially for midlife women. Even though there has been increased recognition of mental health as a leading global health problem, some Iranian communities still perceive psychological

distress as reflecting moral failure, individual failure, or divine retribution (Taghva et al, 2017). It prevents open talk about emotional distress and tends to provoke reluctance or outright rejections in seeking mental health services, in particular midlife women who have traditionally been required to represent resilience and sacrificial behavior in caregiving roles.

People can fear social stigma, family disapproval, or possible harm to their spousal relationships if they come forward about their mental health struggles. In some cases, seeking psychological support has been linked with shame or being seen as "unstable" or "unfit" as parents and as members of society (Jannati et al., 2021). This attitude has been especially common in conservative or non-urban areas where gender traditions dominate and mental health education has been inadequately taught.

Despite recognition regarding the value of receiving support, there are systemic barriers in access to care experienced by women. By the example of the Iranian context, mental health services are mainly centralized in urban centers, leaving widespread shortages in qualified professionals, especially practitioners or psychiatrists, in rural areas. Lack of mental health projects in communities, as well as the expense entailed in private therapy, greatly limits access for most women, and especially when they come from low socioeconomic levels (Kheirkhah et al., 2023). Additionally, extended waiting lines in government centers and the lack of culturally appropriate treatment options hinder adherence and continuity in the care process.

In resolving the above issues, non-traditional interventions that are appropriate in the context—like exercise promotion programs, group-oriented behavioral change workshops, or internet psychoeducational programs—are

increasingly seen as important. Being non-stigmatized interventions, they can be implemented in non-clinical or in all-female settings and may ultimately offer an equally feasible pathway towards emotional health. For example, there has been identified literature which demonstrated that exercise-centered interventions were positively received in Iranian cultures and may reduce psychological symptoms in so doing, avoid the stigma attached to psychosis care (Hajebi et al., 2025).

Thus, addressing the stigma for mental health and access issues involves a double strategy: improving access to services and transforming cultural discourses about mental illness. Providing information, autonomy, and supportive environments for women can make a tremendous difference in the way psychological care is sought and delivered in the Iranian environment (Jung et al., 2017).

3.2.4. Cultural, Social, and health related Determinants among middle-Aged Iranian women

Developing and delivering High-Intensity Interval Training (HIIT) interventions for middle-aged Iranian women must take full account of the nation's unique sociocultural and physiological terrain. Gender expectations, family caregiving, and limited access to separate female exercise facilities are major impediments to participation in organized physical activity (Enjezab et al., 2014; Aligol et al., 2017). For many areas, and particularly rural or religious regions, a desire for cultural propriety about public/mixed-sex exercise inhibits women's physical activity outside the home, restricting them to formally supervised exercise programs (Mahdavian et al., 2024). This obstacle is further augmented by mental health stigma, which might deter women from accessing mental health services and/needs-oriented interventions specifically targeting emotional well-being (Sharifi et al., 2014).

The caregiving role as stereotypically used by women, along with time limitations, renders the time-saving nature of HIIT highly attractive. Additionally, the menopausal transition itself bespeaks a host of relevant physiological factors—such as the fluctuation of hormones, emotional volatility, and higher prevalence of obesity and metabolic syndrome—potentially addressable through properly constructed HIIT protocols (Simon et al., 2018; Khalafi & Symonds, 2020).

Studies have shown that appropriately adapted formats—such as all-female gyms, online platforms, and home programs—may augment participation, provided these are reinforced through motivational techniques, confidentiality, and social support (Asar et al., 2023; Crofts et al., 2012; Laar et al., 2019; Moreno-Llamas et al., 2022). Customization of HIIT to the individual—dependent upon energy, joint condition, and capacity to recover—may similarly enhance the process of safe delivery and completion (Bratland-Sanda et al., 2020; Ekkekakis & Biddle, 2023).

Furthermore, the incorporation of a series of participative, community-based components, as well as appropriately respectful education and female role models, may help elicit a better reception, as well as a wider use. In conclusion, when properly adapted, HIIT represents a feasible, efficient, and appropriately respectful methodology through which the mental and physical health of middle-aged Iranian women can be aided.

3.3. AN INVESTIGATION OF HIGH-INTENSITY INTERVAL TRAINING (HIIT) AND ITS BENEFITS

The positive effects of body exercise on mental health have been known for many decades, more specifically regarding the therapy and management of depressive and anxiety disorders. In the last decades, High-Intensity Interval Training (HIIT) has been increasingly popular because its time is used in the most efficient way, its profound flexibility in regard to the time of the exercise used and its extensive physiological benefits.

High-Intensity Interval Training (HIIT) is an extremely effective exercise technique defined by spades of strong anaerobic exercise punctuated by brief time periods for restoration or slower exercise. HIIT sessions usually involve intervals from 20 seconds to many minutes in duration at 80–95% of the individual's maximum heartbeat rate (HRmax), in addition to periods at slower restoration or rest between intervals (Plizga et al., 2024).

High-Intensity Interval Training (HIIT) has been widely appreciated for its positive physiological benefits over Moderate-Intensity Continuous Training (MICT) (Atakan et al., 2021). Various meta-analyses and systematic reviews have

consistently shown HIIT to result in gains in cardiorespiratory fitness, insulin sensitivity, lipid profiles, and body composition, usually in shorter training durations (Ko et al., 2025; Poon et al., 2025).

This makes HIIT particularly appealing for individuals who face time constraints or limited motivation to engage in lengthy workout sessions.

High-Intensity Interval Training (HIIT) has high adaptability, allowing for individualization of the training protocol by altering interval time, intensity of efforts, exercise mode (e.g., cycling, hiking, resistance training), and sessions per week. The adaptability allows HIIT to be used in different settings—including utilization of available equipment, from commercial to clinical rehabilitation settings, to home-based interventions—and hence gains acceptance in middle-aged women. Customization is more important for this population because HIIT sessions can be tailored to meet the individual needs for the joints, menopause, and entry-level conditioning, enhancing safety, adherence, and therapeutic benefits. (Ballesta-García et al., 2020; Graça et al., 2022).

3.3.1. Neurobiological and Hormonal Mechanisms of HIIT on Mental Health

High-Intensity Interval Training (HIIT) has been increasingly lauded for its benefits for mental health, prompting growing interest in the neurobiological and hormonal mechanisms at play. The mechanisms involve shifts in brain chemistry, enhanced neuroplasticity, reduced inflammation, and hormonal balance. All of these body-wide shifts have been shown to mitigate depression, anxiety, and stress symptoms.

Neurobiological Mechanisms

Monoamine Release: HIIT has been shown to prompt the release of neurotransmitters like serotonin, dopamine, and norepinephrine, which are associated with enhanced mood and fewer depressive symptoms (Xu et al., 2024).

Neurogenesis and Neuroplasticity: HIIT facilitates the development of new neurons and neural plasticity, especially in the hippocampus, a part of the brain essential for mood control. It is mediated in part by higher levels of brain-derived neurotrophic factor (BDNF) and a better mBDNF/proBDNF equilibrium, which allows for enhanced neural health and resilience (Luo et al., 2018; Xu et al., 2024).

Glial Activation and Epigenetics: HIIT decreases neuroinflammation on account of glial cell activation modulation via epigenetic processes, for example, KDM6B-mediated gene regulation, impacting anti-inflammatory cytokine and BDNF synthesis (Yao et al., 2024).

Hormonal and Immune System Effects: HPA Axis Modulation: HIIT assists in the restoration of the balance of the hypothalamic-pituitary-adrenal (HPA) axis that controls stress hormones such as cortisol. Such modulation is able to decrease chronic stress and its harmful effect on mental health (Wilczyńska et al., 2023).

Cortisol Response: In certain populations, notably pregnant women, HIIT promotes cortisol secretion without adverse implications on mental health, indicating a multifaceted but not inherently deleterious stress response (Wilczyńska et al., 2023).

Inflammation Reduction: HIIT reduces pro-inflammatory markers and aids immune function, which is linked to better mental health outcomes (Khalafi & Symonds, 2020; Liu et al., 2022; Yao et al., 2024).

Comparative Effectiveness: HIIT is typically as good as, or even better than, moderate-intensity continuous training (MICT) at alleviating depression and anxiety, improving well-being, and augmenting neurobiological health, with individual responses (Yao et al., 2024; Liu et al., 2022; Martland et al., 2021; Luo et al., 2018; Patten et al., 2023).

3.3.2. Effect of high intensity interval training (HIIT) on Psychological and Behavioral Pathways

High-Intensity Interval Training (HIIT) has marked effects on behavioral and psychological processes central to mental health and long-term exercise adherence. Psychologically, HIIT has been shown to reduce adverse emotional states like depression, anger, anxiety, and psychological distress, whilst concurrently augmenting positive outcomes like subjective vitality, mood, and self-esteem (Batrakoulis et al., 2020; Olney et al., 2018; Martinez et al., 2015).

Notwithstanding the physical intensity attached to HIIT, participants nearly consistently report the sessions positively, specifically where the activities remain

short or involve the use of short intervals. The experience of enjoying the sessions and the positive emotions attached to them has shown strong relationships to heightened motivation and increased desire to continue the exercise routines. HIIT also seems to enhance cognitive functions like executive function, reaction time, and psychological resilience, hence assisting in emotional regulation and decision-making processes (Hsieh et al., 2021; Liu et al., 2024).

Behaviorally, HIIT engenders intrinsic and identified forms of motivation—all doing the exercises due to being aware of the appreciated benefits thereof—to emerge as central predictors of long-term adherence, specifically in individuals who were previously inactive or were overweight. Irrespective of initial opinions concerning HIIT as demanding or uncomfortable, the post-exercise satisfaction nearly consistently translates to, and even surpasses, the experience following the traditional exercise, hence enforcing long-term adherence and preference (Stork et al., 2018; Bao et al., 2025; De Sousa et al., 2021)

3.3.3. Overview of Empirical Studies on HIIT's Impact on Depression and Anxiety

Increasing volumes of peer-reviewed studies are investigating the therapeutic benefits of High-Intensity Interval Training (HIIT) concerning depression and anxiety, which, in each study, consistently show substantial reductions in mood disorder-related symptoms in diverse, heterogeneous samples. With these findings in mind, HIIT presents itself as an effective, time-efficient, and cost-effective method for promoting mental well-being, particularly in situations where traditional psychological intervention is limited (Li & Zhou, 2025; Patten et al., 2023; Wang et al., 2018).

Studies in both clinical and non-clinical groups repeatedly show that High-Intensity Interval Training (HIIT) produces substantial benefits in depressive symptomatology. More importantly, most studies indicate that antidepressant benefits from HIIT are equal to, and potentially even superior to, those for sustained moderate-intensity continuous training (MICT) (Martland et al., 2021; Lapointe et al., 2023). Yao et al. (2024) also place further stress on the point that antidepressant benefits associated with physical activity are an interaction between neurobiological factors—such as increased levels of brain-derived

neurotrophic factor (BDNF), improved serotonin regulation, and reduced systemic inflammation –and psychological factors, such as improved self-esteem and increased social contact.

Many systematic reviews and meta-analyses confirmed the claim that high-intensity interval training (HIIT) significantly reduces depressive symptoms in varied populations, ranging from healthy participants to those diagnosed with depression, as well as participants suffering from co-occurring physical or psychological disorders such as severe mental illness, coronary artery disease, polycystic ovary syndrome (PCOS), and schizophrenia (Xu et al., 2024; Ko et al., 2025; Chavan et al., 2024). Randomized controlled trials in adolescents and in women diagnosed with PCOS yielded substantial reductions in depressive symptoms, as well as improvements in self-esteem and quality of life, after the administration of HIIT interventions (Li & Zhou, 2025; Patten et al., 2023).

Moreover, high-intensity interval exercise (HIIT) has been consistently demonstrated as a safe and well-adopted mode of exercise, possessing high adherence, even in groups regarded as high risk or clinical populations (Ko et al., 2025; Martland et al., 2019).

Extended high-intensity interval interventions have shown promising results in reducing generalized anxiety symptoms and improving aspects of emotional regulation when programs are individualized and sustained long-term. One randomized controlled study involving patients diagnosed with Generalized Anxiety Disorder (GAD) showed that a 12-day interval exercise regimen yielded rapid and substantial reductions in anxiety symptoms—approximately twice as effective as shorter-duration lower-intensity exercises—and significantly magnified participants' sense of control in the face of anxiety-evoking stimuli, an overarching component of emotional regulation (Plag et al., 2020). Other studies reinforce the effectiveness of interval exercises in reducing anxiety in a range of demographic populations, best benefits accruing in participants having lower pretreatment levels of anxiety (Wang et al., 2025; Korman et al., 2019).

Such benefits are influenced by factors as varied as the length, frequency, and intensity of the exercise regimen. Importantly, studies involving longer-term intervention periods (from 6 to 12 weeks or longer) suggest that anxiety and

broader mental benefits can be retained long after intervention ends, often for months, in clinical groups such as participants having cardiac illnesses and premenopausal women diagnosed as having polycystic ovary syndrome (PCOS) (Patten et al., 2023).

Although direct assessments are still limited for components of emotional regulation, consistent findings for increased perceived control, reduced levels of stress, and lessened fatigue provide indirect indication for HIIT's potential benefits toward improving components of emotional regulation (Kang et al., 2022).

3.3.4. Long-Term Psychological Effects of HIIT: Focus on Depression and Anxiety

As well as the voluminous body of scholarship clarifying High-Intensity Interval Training's (HIIT's) substantial psychological benefits, particularly in respect to positive impacts on depressive and anxiety disorder-associated symptomatic expression, contemporary scholarship is deficient in a systematic exploration of extended effects which continue for a long period.

A few emerging studies have attempted to address this gap. For instance, a 4-month community-based program showed that continued engagement in HIIT can sustain reductions in depressive symptoms in adults with schizophrenia (Bang-Kittilsen et al., 2022). In a year-long study involving patients with coronary artery disease, Gonçalves et al. (2025) observed continued improvements in depressive symptoms, suggesting that prolonged HIIT participation can produce enduring mental health benefits.

Additionally, context- and culture-specific variables can act to set barriers for prolonged engagement in high-intensity interval exercise programs, thus impacting related psychological factors.

3.4. LIMITATIONS, GAPS, AND RECOMMENDATIONS

3.4.1. Methodological Features and Limits of Evidence

Despite the increasing interest in the mental health benefits of High-Intensity Interval Training (HIIT), the current literature base is limited by methodological

limitations that narrow the strength and generalizability of the evidence. Among these limitations are the heterogeneities found between studies, which include wide ranges of HIIT protocols (e.g., 4-12 weeks, varying intensity, frequency, and work-to-rest ratios) participants, and outcome measures; these differences make it difficult to make direct comparisons and hinder the ability to perform strong meta-analyses (Martland et al., 2021; Milanović et al., 2015). Many of the interventions are comparatively short—typically 4-12 weeks—and often have short follow-up periods, thus limiting our ability to understand the longevity of psychological benefit over time. In addition, the reliance on small sample sizes, particularly in Randomized Controlled Trials (RCTs), reduces the statistical power of the analyses and increases the likelihood of type II errors, which may conceal significant effects.

Another limitation involves the use of self-reported depression and anxiety measures, which can add bias, particularly among studies that lack blinding or objective measures. While these measures have been validated, they are still subject to the biases of response and, particularly, may reflect participants' expectations or the fluctuation of their emotional states. Although blinding is inherent to difficulties when conducting exercise studies, relatively few studies use physiological markers (e.g., cortisol, BDNF, inflammatory biomarkers) that could improve the validity of the mental health endpoints. Variable supervision—ranging, at the extremes, from highly controlled laboratory settings to self-paced, unsupervised, home-based protocols—can appreciably impact the participant adherence, exercise intensity, and psychological engagement (Cabral et al., 2024). These limitations reinforce the need for future HIIT studies to adopt more consistent protocols, larger and more diverse samples, longer follow-up periods, and the combination of both subjective and objective endpoints to improve the reliability and transferability of the results.

3.4.2. Gaps in Research on Iranian Middle-Aged Female Populations

There is a strong lack of randomized controlled trials (RCTs) specifically targeting middle-aged Iranian women. While various studies have been performed about the influence of high-intensity interval training (HIIT) on mental health in European, Western, or higher-middle-income Asian settings, the generalizability of the information to Iranian women is highly limited. Key factors,

such as religious and cultural beliefs, challenges accessing sex-separated exercise facilities, and common societal stigmas related to mental illness and women exercising, are seldom investigated systematically. First, the possible moderating influence of the menopausal transition—entailing the biological consequences of the changes of hormones as well as the psychological and social responses—was not adequately investigated. Therefore, context-specific studies with strong methodologies reflecting the unique physical as well as sociocultural features of the target population are critically required.

3.5. PROPOSED DIRECTIONS FOR FUTURE RESEARCH AND PRACTICE

The promising information supporting High-Intensity Interval Training (HIIT) as a non-pharmacological measure that can promote mental health requires further study and practice, particularly among various ethnic minority populations, e.g., middle-aged Iranian women. Nevertheless, current literature indicates various gaps related to the long-term consequences, cultural suitability, interdisciplinarity, and the implementation of relevant policies. Bridging these gaps through the formulation of cohesive studies and practice strategies forms a base framework meant to actualize the wide therapeutic benefits of HIIT as a mental health promoter.

3.5.1. Culturally Responsive Intervention Design

Future studies must prioritize the development of HIIT programs that are culturally and socially tailored to the needs of Iranian women. Cultural norms related to gender roles, modesty, and family responsibilities continue to shape women's access to and perception of physical activity. Therefore, designing interventions that respect these cultural dimensions—such as offering home-based routines, women-only sessions, and religiously appropriate exercise environments—is crucial. Incorporating participatory methods, where women are actively involved in shaping the format and content of the program, may also enhance relevance, ownership, and adherence. Moreover, including family members or community leaders in awareness efforts may reduce social resistance and increase social support for participation.

3.5.2. Integrating Multidisciplinary Strategies for Mental Health Improvement

Given the highly complex and multi-dimensional nature of depression and anxiety common to the middle years of life, it becomes necessary that planned interventions take an interdisciplinary approach that combines High-Intensity Interval Training (HIIT) with a variety of non-pharmacologic techniques, such as mindfulness-based stress reduction (MBSR), cognitive behavioral therapy (CBT), nutrition counseling, and psychoeducational components. Such a multi-modal methodology has the potential to influence both the biological as well as the psychosocial aspects of mental health. Interdisciplinary collaborations among exercise scientists, psychologists, registered dietitians, and primary care physicians are necessary to design comprehensive and individualized models of care that are not just effective but feasible for daily use. Additionally, the incorporation of brief mental health techniques—such as stress management skills or emotional regulation skill building—into exercise programs have the potential to lay the groundwork for robust psychological resilience with lasting benefits.

3.5.3. Expanding Access to HIIT: Policy Support and Community Engagement

The wider implementation and sustainability could, thus, be achieved through policy-level support. Policies for physical activity promotion at the national level must include HIIT-based mental health approaches as recommended by governmental health institutions and local administrations. Awareness campaigns that seek to destigmatize mental illness and establish exercise as a valid therapeutic measure for mental health need to have priority, especially among women. Training health professionals to prescribe and track HIIT as a part of primary care as well as mental health facilities can add to wider institutional adoption. Community-based delivery models set through collaborations with Non-Governmental Organizations (NGOs), universities, and local gyms could add to cost-effective scaling. Digital health platforms, such as mobile applications and virtual coaching platforms aligned with Iranian societal values and local languages, could add to wider outreach and accessibility, even to rural or underserved populations.

3.5.4. Improving Methodological Standards in Future Studies

To strengthen the evidence base, future research should address several methodological shortcomings. The standardization of HIIT protocols across studies will improve comparability and allow for higher-quality meta-analyses. The inclusion of objective neurobiological and inflammatory markers (e.g., BDNF, cortisol, cytokines) alongside self-reported outcomes can offer more robust evidence of HIIT's psychological effects and mechanisms. Longitudinal research is particularly needed to assess the sustainability of mental health improvements and long-term adherence to HIIT programs. Importantly, future studies should apply an intersectional lens to explore how variables such as menopausal status, socioeconomic conditions, education, and caregiving responsibilities influence women's ability to engage in and benefit from HIIT interventions. In summary, future research and practice should focus on culturally grounded, interdisciplinary, and evidence-informed approaches to HIIT design and delivery. This will not only enhance the effectiveness and acceptance of interventions among middle-aged Iranian women but also contribute meaningfully to global public health strategies for managing depression and anxiety through physical activity.

IV – OBJECTIVES

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4.1. MAIN GOAL

This study examines the long-term effects of 10-month structured programme of High-Intensity Interval Training (HIIT) on psychological symptoms of depression and anxiety and physical health indicators in a population of middle-aged Iranian females.

4.2. SPECIFIC OBJECTIVES

- To measure changes in depressive symptoms following the HIIT intervention using the Beck Depression Inventory (BDI-II).
- To evaluate differences in anxiety symptoms across time intervals as assessed by the Beck Anxiety Inventory (BAI).
- To assess changes in body composition indicators, including body mass index (BMI), body fat percentage, and total body weight.
- To examine potential biological and psychosocial mechanisms mediating the effects of HIIT on mental health, based on observed outcomes and existing literature.
- To identify and analyze social, cultural, and environmental barriers that influence physical activity participation and exercise adherence among middle-aged Iranian women.
- To provide evidence-based recommendations for integrating HIIT as a feasible and culturally sensitive intervention for mental health improvement in similar contexts.

V – MATERIAL AND METHODS

V - MATERIAL AND METHODS

5.1. INTRODUCTION

This chapter presents the methodological framework employed to investigate the long-term effects of High-Intensity Interval Training (HIIT) on symptoms of depression, anxiety, and body composition among middle-aged Iranian women. The study followed a quasi-experimental pre-test/post-test design with a non-treatment control group, allowing for direct comparison of psychological and physiological changes over a 10-month intervention period. A total of 120 eligible women aged 50 to 55 years were recruited from the Isfahan province using a multi-channel strategy involving women's gyms, retirement associations, counseling centers, religious organizations, and online platforms. Following eligibility screening, participants were randomly allocated to either the HIIT intervention group or the control group through a computer-generated random-number sequence managed by an independent research assistant to ensure allocation concealment and minimize bias.

The HIIT intervention consisted of three supervised sessions per week, conducted in a culturally appropriate women-only gym environment and led by certified female instructors. The training protocol progressively increased in intensity and complexity and incorporated a range of exercise modalities, including bodyweight training, resistance bands, dumbbells, barbells, TRX, medicine balls, treadmill, elliptical machines, and stationary bicycles. Each session followed a structured format—warm-up, intensive interval phase, and cool-down—and adherence was monitored throughout the intervention, requiring a minimum attendance of 85% for inclusion in the final analysis. To enhance fidelity, instructional videos, guidance in heart-rate self-monitoring, and continuous on-site supervision were provided.

Psychological and physiological outcomes were assessed at three points: baseline (T1), mid-intervention at six months (T2), and post-intervention at ten months (T3). Depression and anxiety were measured using validated Persian

versions of the Beck Depression Inventory-II (BDI-II) and Beck Anxiety Inventory (BAI). Anthropometric indicators—including weight, BMI, and body fat percentage—were recorded under standardized conditions using calibrated equipment. The study period coincided with sociopolitical and economic instability in Iran, including widespread protests and internet restrictions, which were acknowledged as contextual factors potentially influencing psychological outcomes.

Data analysis was performed using repeated-measures ANOVA (2×3) to evaluate within-group changes over time and between-group differences. Reporting included p-values, partial eta-squared effect sizes, and 95% confidence intervals to reflect both statistical and practical significance.

In sum, this chapter has provided a clear and replicable account of the research design, sampling procedures, eligibility criteria, data collection, measurement tools, statistical procedures, and ethical safeguards, forming the foundation for interpreting the results and drawing conclusions in the subsequent chapters.

5.2. RESEARCH DESIGN AND DURATION

5.2.1. Research Design

A quasi-experimental design featuring a pre-test/post-test model with a non-treatment control group was utilized. Eligible participants were randomly assigned to either the intervention (HIIT) or the control group. This design was selected to evaluate the longitudinal impact of HIIT on depression and anxiety in a community-based, ecologically valid setting.

5.2.2. Study Duration

The intervention lasted for ten consecutive months, from October 2022 to July 2023. This extended timeframe was chosen to capture sustained psychological and physical outcomes beyond the short-term improvements often reported in previous literature.

5.2.3. Cultural and Environmental Setting

Following national regulations and socio-religious norms of the Islamic Republic of Iran, all exercise sessions were conducted in private, women-only gyms to ensure participant comfort, cultural appropriateness, and high engagement. Certified female trainers supervised all sessions to guarantee safety and standardization.

5.2.4. Rationale for Quasi-Experimental Design

A quasi-experimental approach was adopted due to practical and ethical considerations. While randomized controlled trials (RCTs) are the methodological gold standard, their implementation can be difficult in real-world community settings, particularly with vulnerable populations like middle-aged women experiencing mental health challenges. Quasi-experimental designs allow for comparison while respecting autonomy, cultural boundaries, and logistical constraints (Handley et al., 2018).

Furthermore, natural group assignment after initial screening helped minimize dropout and enhance ecological validity. In this context, the quasi-experimental design was both scientifically sound and culturally appropriate.

5.3. PARTICIPANTS AND SAMPLING METHOD

5.3.1. Study Population

The target population included middle-aged Iranian women (aged 50–55 years) residing in Isfahan Province. This demographic was selected based on epidemiological evidence indicating elevated rates of depression and anxiety among women in midlife due to hormonal, psychological, and social transitions.

5.3.2. Inclusion and Exclusion Criteria

Participants were included or excluded from the study according to predefined eligibility criteria designed to ensure participant safety, methodological rigor, and the validity of the study outcomes.

- **Inclusion Criteria:**

- Female participants aged between 50 and 55 years, who have experienced natural menopause (defined as ≥ 12 consecutive months of amenorrhea without pathological cause).
- Presence of moderate depressive symptoms (BDI-II score > 19) and mild anxiety symptoms (BAI score > 16), confirmed through clinical screening.
- Sufficient literacy to read and independently complete validated Persian-language questionnaires.
- No current use of psychiatric medications or psychotropic drugs within the last 2 months.
- No engagement in structured physical activity (≥ 1 session per week) during the 4 weeks before enrollment.
- Absence of diagnosed cardiovascular, respiratory, neurological, inflammatory, renal, epileptic, or diabetic disorders, as confirmed via medical history and self-report.

- **Exclusion Criteria:**

- Voluntary withdrawal from the study at any point during the intervention.
- Development of serious physical conditions or the need for surgical intervention during the intervention period, as confirmed by medical consultation or participant self-report
- Non-compliance with the HIIT protocol is defined as: Missing more than 20% of total training sessions (i.e., more than 8 out of 40 sessions).
- Refusal to complete psychological assessments (BDI-II and BAI) or anthropometric measurements at any of the designated data collection time points.
- Initiation of psychiatric medication or engagement in other structured exercise programs during the intervention period.

- Cognitive impairment or other functional limitations that could interfere with safe participation or accurate self-reporting.

5.3.3. Sampling Method and Recruitment

A purposive sampling strategy was initially employed to identify midlife women experiencing mild-to-moderate psychological symptoms who met the inclusion criteria. A multi-channel recruitment campaign was launched across diverse settings to enhance representativeness and cultural accessibility. Recruitment platforms included:

- Retirement associations and pensioners' clubs
- Local fitness centers and women-only gyms
- Community-based counseling centers and mental health clinics
- Religious centers, including mosques and women's Qur'an study groups
- Social media outreach campaigns (Telegram, WhatsApp, Instagram)
- The Isfahan Provincial Sports Administration
- The Public Sports Federation of Isfahan Province

A total of 132 women expressed interest and completed the preliminary screening. Of these, 8 individuals were excluded based on the medical and psychological eligibility criteria, and 4 withdrew voluntarily during the onboarding process. The 120 eligible participants were randomly assigned to the exercise ($n = 60$) or control ($n = 60$) group using a computer-generated random number sequence in Microsoft Excel. The allocation process was conducted by an independent assistant not involved in the intervention or data analysis to ensure allocation concealment and reduce bias.

Descriptive statistics summarizing the baseline demographic and anthropometric characteristics of participants in both the exercise and control groups are presented in Table 1.

Table 1. Baseline demographic and anthropometric characteristics of the participants in the exercise and control groups (N = 120)

Variable	Group	<i>n</i>	Mean $\pm$ SD
Age (years)	Exercise	60	52.62 $\pm$ 6.94
	Control	60	52.88 $\pm$ 6.95
Weight (kg)	Exercise	60	66.47 $\pm$ 5.06
	Control	60	66.96 $\pm$ 5.30
Height (cm)	Exercise	60	162.5 $\pm$ 4.03
	Control	60	163.24 $\pm$ 3.95

Note. No statistically significant differences were found between groups at baseline ($p > 0.05$).

5.3.4. Informed Consent

All participants provided written informed consent after receiving both verbal and written explanations of the study's objectives, procedures, potential risks, anticipated benefits, and data confidentiality protocols. The study posed minimal risk to participants and included appropriate safety measures for psychological and physical well-being throughout the intervention period.

5.4. ETHICAL CONSIDERATIONS

This study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki for research involving human subjects. Before the initiation of the study, formal ethical approval was obtained from the Ethical Committee of the Catholic University of San Antonio of Murcia, which oversaw the protection of human participants in sports-related interventions.

All participants received a detailed verbal and written explanation of the study's aims, procedures, potential risks, and benefits. Each individual voluntarily signed an informed consent form before enrollment. Participation was entirely voluntary, and participants were free to withdraw at any point without penalty.

To preserve confidentiality and anonymity, all personal data was coded and stored securely. Only the research team had access to the data, and no identifying information was disclosed in any publications or reports. The study procedures were designed to minimize psychological or physical harm and ensure participant safety throughout the intervention.

Although the study was conducted in Iran, the research protocol was also reviewed and aligned with the ethical guidelines of the Universidad Católica San Antonio de Murcia (UCAM), Spain, under code CE062209, to ensure compliance with doctoral research standards of the host institution.

5.5. RESEARCH VARIABLES

This study was designed to investigate the effects of high-intensity interval training (HIIT) on psychological and physiological variables among middle-aged Iranian women. Accordingly, the research includes the following types of variables:

5.5.1. Independent Variable

The independent variable in this study is the 10-month high-intensity interval training (HIIT) program. This structured intervention involved three supervised sessions per week, each lasting approximately 60 minutes. The protocol was designed and supervised by certified international fitness coaches and progressively incorporated exercises using bodyweight, resistance bands, dumbbells, barbells, medicine balls, and TRX, with variations in intensity depending on the session's objectives.

5.5.2. Dependent Variables

The dependent variables reflect the psychological and physiological outcomes targeted by the intervention. These include:

- Depression symptoms, measured by the Beck Depression Inventory-II (BDI-II)

- Anxiety symptoms, measured by the Beck Anxiety Inventory (BAI)
- Body weight (kg)
- Body mass index (BMI), calculated from height and weight
- Body fat percentage (%), assessed via body composition analyzer

All dependent variables were measured at three assessment points: baseline (T0), after six months of training (T1), and after the 10-month intervention (T2).

5.5.3. Confounding Variables

Although this study employed random allocation to control and intervention groups, several confounding variables could potentially influence the outcomes. These include:

- **Age:** Although the inclusion criteria restricted participants to women aged 50–55 years, individual variations in menopausal symptoms or age-related hormonal changes may still have influenced responsiveness to the intervention.
- **Dietary Habits:** Participants were advised not to initiate any dietary changes, weight loss programs, or supplement use during the intervention. However, individual differences in food intake, caloric consumption, hydration, and nutrient quality—particularly those affecting mood and inflammation—could have impacted depression, anxiety, and body composition outcomes. Dietary behavior was monitored through baseline self-report questionnaires but not strictly controlled throughout the study.
- **Stressful Life Events:** Personal stressors (e.g., family, financial, or work-related issues) outside the scope of the study may have affected participants' mental health independently of the intervention.
- **Sleep Patterns:** Variability in sleep quality and duration, which are known to influence mood and recovery, were not directly assessed or controlled in this study.

- **Medication or Supplement Use:** While participants using psychiatric medications were excluded, unreported use of herbal supplements or over-the-counter remedies may have influenced psychological outcomes.
- **Sociopolitical Environment:** The intervention coincided with a period of significant sociopolitical instability in Iran, marked by widespread public unrest, nationwide disruptions in international internet connectivity, and restricted access to social media platforms. These external conditions, although not directly measured in the study, may have contributed to elevated psychological stress among participants. As such, they represent potential contextual confounding variables—particularly concerning mood and anxiety outcomes—that should be considered when interpreting the results of this research.
- **Chronic Economic Instability:** In addition to individual and behavioral factors, the broader economic context in Iran may have acted as a confounding variable. For several decades, the country has experienced persistent economic instability, partly due to prolonged international sanctions and systemic financial constraints. This economic hardship may have contributed to elevated levels of stress, insecurity, and reduced access to mental health resources, which in turn could influence baseline psychological status and responsiveness to exercise-based interventions. While not directly measured, the chronic economic pressures faced by participants represent a relevant contextual factor that should be considered when interpreting the outcomes of this study.

Efforts were made to minimize the influence of these confounding factors through eligibility screening, randomization, participant instructions, and consistent monitoring. However, as in most real-world interventions, some residual confounding may be inevitable.

5.5.4. Operational Definitions

- **High-Intensity Interval Training (HIIT):** A repeated cycle of short bursts of vigorous activity (80–95% max HR) alternated with low-intensity recovery periods, conducted three times per week over 10 months.
- **Depression (BDI-II):** Total score on the 21-item Beck Depression Inventory-II. Scores range from 0 to 63, with higher scores indicating greater severity.
- **Anxiety (BAI):** Total score on the 21-item Beck Anxiety Inventory, with scores from 0 to 63 indicating increasing levels of anxiety.
- **Body Mass Index (BMI):** Calculated by dividing body weight in kilograms by the square of height in meters (kg/m^2)
- **Body Fat (%):** Measured using the Aneca Body Composition Analyzer.

5.6. HIIT INTERVENTION PROTOCOL

5.6.1. Overview of the Training Program

The intervention group participated in a structured High-Intensity Interval Training (HIIT) program specifically designed to enhance mental well-being and physical fitness in middle-aged women. The program lasted ten months (October 2022 – July 2023), with three sessions per week, each lasting approximately 60 minutes. All sessions were conducted in a private, women-only fitness facility to ensure cultural appropriateness, safety, and participant comfort.

5.6.2. Session Design and Structure

Each HIIT session followed a consistent structure, composed of:

- **Warm-Up Phase (10 minutes):** Low-to-moderate intensity dynamic exercises to activate major muscle groups, increase heart rate, and prepare joints.

- **Main Exercise Phase (30–40 minutes):** Circuit-based routines combining short bursts of high-intensity activity (targeting 80–95% HRmax) followed by brief active or passive recovery periods.
- **Cool-Down Phase (10 minutes):** Guided stretching, breathing, and mobility drills to promote recovery and prevent post-exercise soreness.

The program followed the principles of progressive overload and periodization, ensuring that exercise intensity and complexity gradually increased over time based on participant adaptation.

5.6.3. Instruction and Monitoring

Before the commencement of the lessons, participants' attendance was documented to ensure that only those with an absence rate not exceeding 5% of the total sessions were included in the analyses.

Each session began with a short instructional video explaining the exercises of the day. This was followed by in-person supervision and feedback provided by two certified female fitness instructors with international qualifications. A third staff member monitored safety and ensured exercise fidelity across participants.

Participants were trained to monitor their heart rate manually (via radial or carotid pulse checks) and were encouraged to self-report their pulse at the end of each session to track perceived exertion and adaptation.

5.6.4. Individualization and Safety Measures

The HIIT protocol was adapted to meet the physical capabilities, emotional readiness, and health status of participants. Safety protocols included:

- Exercise modifications for joint issues or fatigue
- Gradual progression of load and complexity
- Real-time feedback and encouragement
- Optional rest periods if participants experienced discomfort

No serious adverse events or injuries were reported throughout the intervention.

5.6.5. Cultural and Environmental Considerations

All sessions were conducted in a culturally sensitive environment—a private gym for women only. This setting was essential to ensure participant privacy and increase adherence. The group-based nature of the sessions also fostered social support, motivation, and emotional well-being. Many participants reported improved mood, self-efficacy, and group belonging after the sessions.

5.6.6. Training Equipment Used

Progressive introduction of equipment supported physical variety and participant engagement. The equipment included:

- Resistance bands
- Dumbbells (0/5–4 kg)
- Medicine balls
- TRX Suspension Trainers
- Barbells and small plates
- Mats for floor-based exercises
- Treadmill
- Elliptical
- Cycling

Equipment choice varied based on the training goals of each session, such as endurance, strength, or coordination. Table 2 outlines the monthly progression and structure of the 10-month High-Intensity Interval Training (HIIT) program implemented in this study. The protocol was carefully periodized to reflect principles of progressive overload, functional variation, and motivational engagement. Each month focuses on specific physical and psychological objectives, adapted to the needs and safety of middle-aged women. The phased design also facilitated gradual increases in intensity and complexity, promoting both adherence and effectiveness throughout the intervention period.

Table 2. Monthly Structure and Training Focus of the 10-Month HIIT Program

Month	Primary Objective	Training Focus
1	Familiarization with the HIIT format and safe execution	Low-impact bodyweight circuits; movement instruction and coordination drills
2	Development of foundational cardiovascular and muscular endurance	Resistance band exercises; light plyometric with supervision
3	Enhancement of motor control, stamina, and exercise adherence	Mixed bodyweight and band training; beginner-level intervals
4	Introduction to resistance equipment and progressive overload	Incorporation of dumbbells and medicine balls; increased training intensity
5	Improvement of strength endurance, balance, and posture under load	Basic barbell exercises, core and coordination-focused circuits
6	Overload of the cardiovascular and muscular systems	Structured HIIT intervals with compound movements and varied intensity
7	Functional strength and agility development	TRX suspension training; unstable surface challenges; circuit variations
8	Optimization of training density and metabolic output	Reduced rest intervals; advanced aerobic intervals and mixed modality
9	Integration of full-body movements and exercise autonomy	Self-paced mixed circuits; heart rate monitoring; progressive challenges
10	Consolidation of physical gains and promotion of mental well-being	Reinforcement of learned patterns; motivational coaching; recovery emphasis

5.7. MEASUREMENT TOOLS AND OUTCOME VARIABLES

5.7.1. Overview

To evaluate the effects of the HIIT intervention, this study employed a combination of validated psychological questionnaires and objective anthropometric assessments. Outcome variables were measured at three time-points: baseline (pre-test), mid-intervention (after 6 months), and post-intervention (after 10 months). The primary psychological outcomes were depression and anxiety levels, while secondary outcomes included weight, height, and body fat percentage.

5.7.2. Beck Depression Inventory-II (BDI-II)

The Beck Depression Inventory-II (BDI-II) was used to assess the severity of depressive symptoms. Developed by Beck et al. (1996), this 21-item self-report questionnaire evaluates affective, cognitive, and somatic symptoms of depression. Each item is scored on a 4-point Likert scale ranging from 0 (no symptoms) to 3 (severe symptoms), resulting in a total score ranging from 0 to 63.

Interpretation of the scores is as follows:

- 0–9: No depression
- 10–18: Mild depression
- 19–29: Moderate depression
- 30–63: Severe depression

This study utilized the validated Persian version of the BDI-II, which has demonstrated excellent internal consistency and construct validity in Iranian populations (Ghassemzadeh et al., 2005). Participants completed the BDI-II at each of the three measurement points.

5.7.3. Beck Anxiety Inventory (BAI)

To assess anxiety symptoms, the Beck Anxiety Inventory (BAI) was administered. Developed by Beck et al. (1988), this 21-item inventory measures a range of physiological and cognitive symptoms associated with anxiety. Each item is rated on a 0–3 scale, producing a total score from 0 to 63.

Anxiety severity is interpreted as:

- 0–7: Minimal or no anxiety
- 8–15: Mild anxiety
- 16–25: Moderate anxiety
- 26–63: Severe anxiety

This study employed the Persian adaptation of the BAI, validated by Kaviani and Mousavi (2008), which has demonstrated strong psychometric properties for use in both clinical and non-clinical Iranian populations.

5.7.4. Subjective Exercise Experiences Scale (SEES)

To monitor participants' subjective psychological responses during the intervention, the Subjective Exercise Experiences Scale (MyAuley & Courneya, 1994) was employed. The SEES is a 12-item self-report questionnaire comprising three subscales: Positive Well-Being, Psychological Distress, and Fatigue, rated on a 7-point Likert scale. The Persian version of the SEES has demonstrated satisfactory validity and reliability in Iranian adult populations, with Cronbach's alphas ranging from 0.81 to 0.82 (Saeidi et al., 2023).

In the present study, participants completed the SEES after every tenth training session. The purpose of this administration was not to conduct inferential statistical analyses, but rather to document participants' lived experiences and subjective perceptions over time. These descriptive observations complemented the quantitative measures (BDI-II and BAI) and were later integrated into the discussion to contextualize the psychological impact of HIIT.

5.7.5. Anthropometric and Body Composition Measures

In addition to psychological variables, participants' physical characteristics were recorded at all three time points. The following tools and procedures were used:

- Height (cm): Measured without shoes using a standard wall-mounted stadiometer.
- Weight (kg): Measured using a calibrated digital scale.
- Body Fat Percentage: Assessed using the Anea Body Composition Analyzer (Anea, 2024 model), a bioelectrical impedance device validated for adult populations.
- BMI (kg/m²): Calculated using the standard formula: weight (kg) / height (m²).

All measurements were conducted under standardized conditions (e.g., fasting state, same time of day) to enhance accuracy and reproducibility.

5.7.6. Demographic and Health Screening

At baseline, all participants completed a general health and lifestyle questionnaire including information about age, education, occupation, marital status, medical history, medication use, and physical activity levels. This helped ensure accurate inclusion based on the study criteria and provided contextual data for interpretation.

5.7.7. Validity and Reliability

All measurement tools used in this study had been previously validated for use in the Iranian population and demonstrated high levels of reliability (Cronbach's alpha for BDI-II and BAI > 0.85). Assessments were administered under the supervision of trained researchers to ensure the quality of the data.

5.7.8. Justification for Tool Selection

The selection of measurement tools in this study was based on their strong psychometric properties, widespread international use, cultural adaptability, and their specific relevance to middle-aged populations experiencing mood-related disorders.

A) Clinical Sensitivity and Specificity

Both the BDI-II and BAI are widely regarded as gold-standard instruments for the screening and severity assessment of depression and anxiety symptoms. They are highly sensitive to clinical changes, making them particularly suitable for intervention studies where changes over time need to be measured with precision.

B) Cultural Validity in Iranian Contexts

The Persian translations of the BDI-II and BAI have undergone extensive psychometric evaluation and cultural adaptation for Iranian populations. For example, the Persian BDI-II demonstrated a Cronbach's alpha of 0.87 in a large-scale validation study (Ghassemzadeh et al., 2005), indicating excellent internal consistency. Similarly, the Persian BAI exhibited a Cronbach's alpha of 0.90 and strong construct validity (Kaviani & Mousavi, 2008).

C) Relevance to Non-Clinical, Community-Based Samples

Given that the participants in this study were not formally diagnosed psychiatric patients but rather individuals exhibiting mild-to-moderate symptoms in a community setting, self-report instruments such as the BDI-II and BAI are appropriate.

D) Feasibility and Accessibility

Both inventories are brief (21 items each), easy to administer and interpret, and do not require specialized clinical training for scoring, which makes them practical for large-scale field studies.

E) Cross-Study Comparability

The use of BDI-II and BAI allows for comparability across a broad body of international literature, including other exercise-based interventions targeting depression and anxiety.

Table 3 provides a detailed overview of the psychological and anthropometric instruments utilized in this study, including their measurement scales, reliability coefficients, and cultural validation status within Iranian populations.

Table 3. Overview of Measurement Instruments and Psychometric Properties Used in the Study

Instrument	Variable Measured	No. of Items	Scale Type	Interpretation Ranges	Reliability (Cronbach's α)	Validation
BDI-I (Persian version)	Depression	21	4-point Likert (0–3)	0–9 (None), 10–18 (Mild), 19–29 (Moderate), 30–63 (Severe)	0.87 (Ghassemzadeh et al., 2005)	Validated for the Iranian population
BAI (Persian version)	Anxiety	21	4-point Likert (0–3)	0–7 (Minimal), 8–15 (Mild), 16–25 (Moderate), 26–63 (Severe)	0.90 (Kaviani & Mousavi, 2008)	Validated for the Iranian population.
SEES (Persian version)	Subjective exercise experiences (Positive Well-being, Distress, Fatigue)	12	7-point Likert (1–7)	Higher = greater intensity of perceived state	0.81–0.82 (Saeidi et al., 2023)	Validated for the Iranian population
Anea Body Composition Analyser (2024)	Body fat %, Weight (kg)	–	Digital measurement	Body fat% % and weight in kilograms	Manufacturer-calibrated	Anea Technologies
Demographic Questionnaire	Age, health, lifestyle	–	Categorical / Open-ended	N/A	Face validated by experts	Researcher-developed

5.8. DATA COLLECTION PROCEDURES

5.8.1. Timing and Locations of Assessments

Data collection was carried out at three key points during the study period:

- T1 (Baseline): One day before the intervention began (October 2022)
- T2 (Midpoint): After six months of training
- T3 (Post-intervention): After the 10-month intervention (July 2023)

All assessments were conducted in a private, designated room within the same women-only fitness center where training sessions took place. The testing environment, timing, and procedures were kept consistent across all three time points to ensure comfort and comparability for participants.

5.8.2. Administration of Psychological Instruments (BDI-II and BAI)

At each measurement point, participants completed the Persian versions of the Beck Depression Inventory-II (BDI-II) and Beck Anxiety Inventory (BAI). These were self-administered in paper-and-pencil format and supervised by the principal researcher and a trained assistant.

A familiarization session was organized before the first assessment to help participants feel more comfortable with the process and to explain the study purpose in detail. Follow-up assessments at months six and ten were also conducted at the same venue, scheduled to suit the participants' availability. Each session took approximately 10–15 minutes to complete.

5.8.3. Anthropometric and Body Composition Measurements

Physical assessments were conducted by trained personnel in a private and respectful setting to ensure participant dignity and confidentiality. The following instruments were used:

- Height: Measured to the nearest 0.5 cm using a wall-mounted stadiometer
- Weight: Taken using a calibrated digital scale

- Body Fat Percentage: Assessed via Anlea Body Composition Analyzer (2024 model), using standardized conditions such as the same time of day and fasting state to ensure accuracy.

5.8.4. Data Integrity and Monitoring

Participants were asked to answer all questions independently and honestly. After each session, responses were reviewed for completeness and accuracy. In cases of unclear answers, gentle clarification was sought directly and respectfully from the participant.

Each participant received a unique ID code, and all data were anonymized. Physical records were stored in locked cabinets, and digital files were kept in password-protected folders accessible only to the research team. In addition, qualitative observations were systematically collected after every tenth training session. These observations included participants' feedback regarding their emotional states, perceived benefits, challenges, and overall experience with the program. These qualitative observations were collected alongside the repeated administration of the Subjective Exercise Experiences Scale (SEES), thereby complementing the standardized ratings with open-ended feedback. Such insights provided valuable contextual information that complemented the quantitative findings, offering a richer understanding of adherence, motivation, and perceived outcomes throughout the intervention.

5.8.5. Summary Timeline

Table 4 outlines the timeline and instruments used across the three key assessment points, ensuring standardized data collection throughout the intervention period.

Table 4. Schedule of Measurement Time Points, Phases, and Tools Used Throughout the Intervention

Time Point	Month	Phase	Measurement Tools
T1	Month 0 (Oct 2022)	Pre-intervention	BDI-II, BAI, Height, Weight, Body Fat, Demographics
T2	Month 6 (Apr 2023)	Mid-intervention	BDI-II, BAI, Weight, Body Fat
T3	Month 10 (Jul 2023)	Post-intervention	BDI-II, BAI, Height, Weight, Body Fat

5.9. STATISTICAL ANALYSIS

This study used repeated measures analysis of variance (2×3 RMANOVA) to examine changes over time and between groups. The analysis focused on key outcomes, including depression, anxiety, weight, body fat, and BMI, among middle-aged Iranian women participating in a 10-month HIIT intervention.

5.9.1. Assumptions Testing

Before conducting the RMANOVA, key assumptions were checked to ensure the validity of the statistical model:

- Normality of residuals was evaluated using the Kolmogorov-Smirnov test (Berger & Zhou, 2014).
- Homogeneity of variances was tested using Levene's test (Gastwirth et al., 2009).

Both assumptions were met, allowing the analysis to proceed without requiring data transformation.

5.9.2. RMANOVA Framework

The statistical model included the following components:

- A **within-subjects factor**: Time (three levels — pre-test, 6 months, and 10 months)
- A **between-subjects factor**: Group (two levels — intervention and control)
- The **interaction effect**: Group $\times$ Time

Separate RMANOVAs were conducted for each of the dependent variables:

- Depression scores (BDI-II)
- Anxiety scores (BAI)
- Weight (kg)
- Body fat percentage (%)
- Body Mass Index (BMI)

5.9.3. Post Hoc Analysis

Bonferroni-adjusted post hoc comparisons were applied when significant interaction effects were found. These comparisons were used to:

- Evaluate changes between different time points within each group (e.g., pre vs. 6 months, pre vs. 10 months, 6 vs. 10 months)
- Compare the intervention and control groups at each time point

This adjustment was implemented to reduce the risk of Type I error due to multiple comparisons. To better understand the practical significance of observed changes over time, post hoc results were supplemented with effect size calculations and visual plots. These additions helped clarify how the intervention influenced outcomes at specific points.

5.9.4. Software and Significance Level

All statistical analyses were performed using IBM SPSS Statistics, Version 26. A significance threshold of $p < 0.05$ was used throughout. Effect sizes were reported using partial eta squared (η^2p) to assess the magnitude of observed

effects. Power analysis confirmed that the statistical power exceeded 0.99 for all primary outcomes, suggesting a very high likelihood of detecting the true impact.

A summary of the statistical analyses applied to each outcome variable, including primary tests and post hoc procedures, is provided in Table 5.

Table 5. Summary of Statistical Tests and Analytical Procedures for Outcome Variables

Outcome Variable	Primary Statistical Test	Purpose of Analysis	Post Hoc Procedure
Depression (BDI-II)	2×3 Repeated Measures ANOVA	Examine changes over time and between groups	Bonferroni pairwise comparisons
Anxiety (BAI)	2×3 Repeated Measures ANOVA	Assess group × time interaction	Bonferroni pairwise comparisons
Body Weight (kg)	2×3 Repeated Measures ANOVA	Evaluate physiological changes over the intervention period	Bonferroni pairwise comparisons
BMI (kg/m ²)	2×3 Repeated Measures ANOVA	Assess BMI variation in relation to training	Bonferroni pairwise comparisons
Body Fat (%)	2×3 Repeated Measures ANOVA	Determine fat composition changes across time points	Bonferroni pairwise comparisons

VI – RESULTS

VI – RESULTS

6.1. INTRODUCTION

This chapter presents a comprehensive analysis of the study findings regarding the impact of a 10-month High-Intensity Interval Training (HIIT) program on mental and physical health outcomes among middle-aged Iranian women. Specifically, the results are structured to answer the primary research questions and test the hypotheses formulated in earlier chapters, focusing on changes in depressive symptoms (RQ1), anxiety levels (RQ2), body composition (RQ3), and the underlying biological, psychological, and cultural mechanisms (RQ4 and RQ5).

The chapter is organized into three main analytical components: (1) Descriptive statistics summarizing participant characteristics and baseline equivalency, (2) Inferential analyses testing within- and between-group changes across time, and (3) Interpretation of outcomes with visual illustrations and effect size metrics.

Overall, the findings presented in this chapter offer strong empirical evidence for the efficacy of a culturally tailored HIIT program as a non-pharmacological intervention for improving both psychological and physiological health outcomes. The results contribute to both academic knowledge and practical applications in public health and clinical settings, targeting women's health in socially constrained environments.

6.2. DESCRIPTIVE DATA ANALYSIS

6.2.1. Participant Demographics and Baseline Characteristics

The study included 120 middle-aged women, divided equally into two groups: HIIT (n = 60) and control (n = 60). The groups were similar in terms of age, BMI, body fat percentage, depression (BDI-II), and anxiety (BAI) scores at baseline (all $p > 0.05$), confirming successful randomization, as shown briefly in Table 6.

Table 6. Demographic and clinical baseline characteristics of the participants

Variable	HIIT Group (n=60)	Control Group (n=60)	p-value
Age (years)	52.3 ± 1.5	52.5 ± 1.6	0.72
BMI (kg/m ²)	25.30 ± 2.7	25.26 ± 2.9	0.81
Body Fat (%)	26.63 ± 4.10	26.25 ± 4.4	0.87
Depression (BDI-II)	27.8 ± 7.8	28.8 ± 7.04	0.79
Anxiety (BAI)	36.9 ± 10.5	36.55 ± 9.09	0.83

Note. Values are presented as mean ± standard deviation—*p*-values derived from independent samples *t*-tests.

The equivalence across all measured variables at baseline confirms that any observed differences post-intervention can be reasonably attributed to the effects of the HIIT program rather than pre-existing disparities.

6.2.2. Pre-Test and Post-Test Comparison

One of the primary objectives of this study was to examine the effects of the HIIT program on depression, anxiety, BMI, and body fat percentage by comparing the intervention and control groups over time. Within-group changes were analysed using paired-sample *t*-tests, while between-group differences in change scores were assessed using independent-sample *t*-tests. Statistical significance was set at $p < 0.05$.

The magnitude of the effect size (Cohen's $d = 0.035$) met the criteria for adequacy in relation to the analyses conducted.

In Table 7 are summarized the mean scores and standard deviations for depression, anxiety, BMI, and body fat percentage at pre-test and after 6 months and 10 months of HIIT for both exercise and control groups.

Table 7. Pre-Test and Post-Test Comparison of Outcome Measures

Variable	Group	<i>n</i>	<i>M ± SD</i>	<i>M ± SD</i>	<i>p</i>	<i>M ± SD</i>	<i>p</i>
			Pre-Exercise	Post vs 6 months	Pre vs 6 months	Post vs 10 months	6 vs 10 months
Depression	Exercise	60	27.88±7.83	24.88±6.10	<.001	23.97±5.50	<.001
	Control	60	28.08±7.04	31.18±7.53	<.001	30.93±7.38	0.825
Anxiety	Exercise	60	36.90±10.5	28.28±7.57	<.001	28.12±7.23	1.000
	Control	60	36.55±9.09	39.48±9.00	<.001	39.53±8.92	1.000
Weight (Kg)	Exercise	60	66.47± 5.06	65.01± 4.42	<.001	64.83± 4.25	0.283
	Control	60	66.96± 5.30	67.61± 5.47	<.001	67.69± 5.16	1.000
Body fat (%)	Exercise	60	26.63±4.09	25.87±3.64	<.001	25.28±3.37	<.001
	Control	60	26.25±4.38	27.08±4.45	<.001	27.10±4.21	1.000
BMI	Exercise	60	25.30± 2.76	24.37± 2.08	<.001	24.28 ±1.99	0.284
	Control	60	25.26± 2.86	25.85 ±3.02	<.001	25.86± 2.83	1.000

M = Mean; SD = Standard Deviation

6.3. CHANGES IN DEPRESSION SCORES OVER TIME

The primary psychological outcome of depression severity was assessed using the Beck Depression Inventory-II (BDI-II) at three time points: baseline (pre-test), 6 months (mid-test), and 10 months (post-test) following the initiation of the HIIT intervention. The aim was to examine temporal changes within and between the HIIT and control groups. These changes are detailed in Table 8, while Figure 1 provides a complementary visual representation to facilitate a clearer and immediate interpretation of the mean depression scores at baseline, midpoint, and post-intervention for both groups.

At baseline, depression scores were comparable between the two groups (HIIT: $M = 27.88 \pm 7.83$; Control: $M = 28.08 \pm 7.04$), indicating successful randomization. Over the 10 months, the HIIT group demonstrated a progressive decrease in depressive symptoms, with scores falling to 24.88 ± 6.10 at six months and further to 23.97 ± 5.50 at ten months. In contrast, the control group exhibited

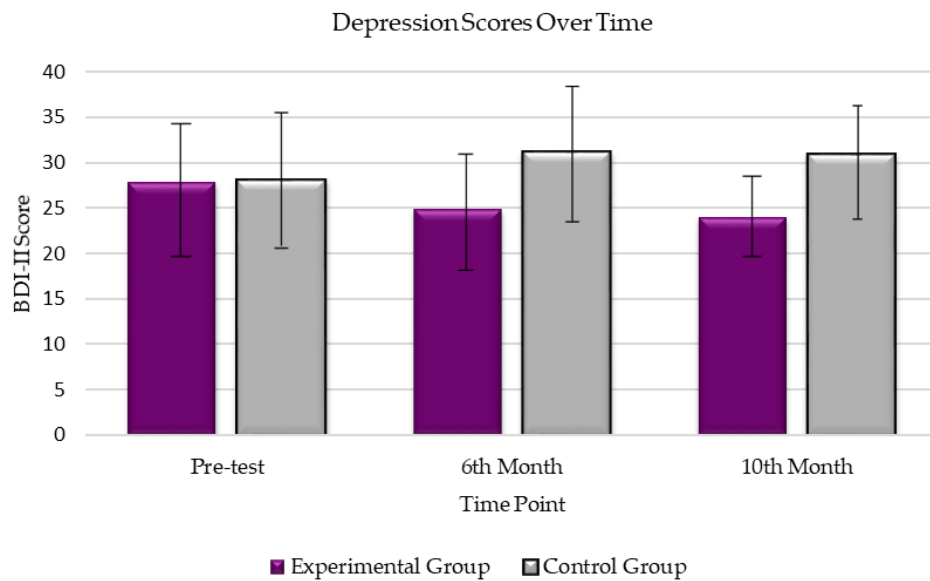
an increase in depression scores, rising to 31.18 ± 7.525 at six months and remaining elevated at 30.93 ± 7.378 at ten months.

Table 8. Means of depression scores of the participants in the pre-test, 6th and 10th months

Variable	Group	<i>n</i>	Pre test		After 6 months		After 10 months	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Depression	Experimental	60	27.88	± 7.83	24.88	± 6.10	23.97	± 5.50
	Control	60	28.08	± 7.04	31.18	± 7.53	30.93	± 7.38

M = Mean; *SD* = Standard Deviation

Figure 1. Changes in Depression Scores (BDI-II) Across Time Points in Experimental and Control Groups



6.3.1. Main Effects of Time and Group (RMANOVA)

The analysis revealed a statistically significant main effect of time on depression scores, $F(2, 236) = 3.168$, $p = 0.044$, with a partial η^2 of 0.026—indicating that approximately 2.6% of the variance in depression scores could be explained by changes over time. While the effect is modest, it suggests that some degree of

temporal change occurred across the entire sample, regardless of group assignment. A significant main effect of group was also observed, $F(1, 118) = 13.258$, $p < 0.001$, partial $\eta^2 = 0.101$, demonstrating that overall depression scores differed between the HIIT and control group.

6.3.2. Interaction Effect (Group $\times$ Time)

Importantly, the Group $\times$ Time interaction effect was highly significant, $F(2, 236) = 105.364$, $p < .001$, partial $\eta^2 = .472$, indicating that approximately 47% of the variance in depression scores was explained by the combined influence of group and time.

This large effect size reflects a clinically meaningful and statistically robust impact of the HIIT intervention in reducing depressive symptoms. According to Cohen's (1988) classification, values of η^2 above 0.14 are considered large; therefore, the observed value supports a strong and reliable treatment response. The statistical power of this interaction exceeded 0.99, further confirming the robustness of the result.

Table 9. Results of the within-between subjects' effect on depression scores

Variable	Source	SS	df	MS	F	p	ηp^2
Depression	Within-Group						
	Time	25.09	2	12.54	3.17	.044	.026
	Group $\times$ Time	834.42	2	417.21	105.36	<.001	.472
	Error	934.49	236	3.96			
	Between-Group						
	Group	1813.51	1	1813.51	13.26	<.001	.101
	Error	16141.11	118	136.79			

Note. RMANOVA = Repeated Measures Analysis of Variance. Effect sizes are reported as partial eta squared (η^2). According to Cohen (1988), values of 0.01, 0.06, and 0.14 represent small, medium, and large effects, respectively.

Table 9 presents the full RMANOVA results, detailing the degrees of freedom, mean squares, F-values, significance levels, and effect sizes for both within-subject and between-subject effects.

6.3.3. Post Hoc Comparisons within Groups

As shown in Table 10, Bonferroni-adjusted post hoc analyses indicated significant within-group changes for the HIIT participants. Depression scores declined from 27.88 at baseline to 24.88 at six months ($p < 0.001$), and further to 23.97 at ten months ($p < 0.001$). The reduction between six and ten months was also significant ($p < 0.001$), suggesting continued improvement throughout the intervention. Based on standard BDI-II thresholds, this change represents a clinical shift from moderate to mild depression severity.

In contrast, the control group demonstrated a statistically significant increase in depression scores over the same period. Mean BDI-II scores rose from 28.08 ± 7.04 at baseline to 31.18 ± 7.53 at 6 months, and remained elevated at 30.93 ± 7.38 at 10 months ($p < 0.001$). This trend suggests a worsening of psychological well-being among participants who did not receive the HIIT intervention.

Table 10. Mean differences of depression scores between measurement times within each study group

Variable	Group	Time (I)	Time (J)	Mean Difference (J-I)	Sig. (p)	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Depression	Experimental	Pre test	6 th month	-3.00	<.001	-4.055	-1.945
			10 th month	-3.92	<.001	-4.874	-2.959
		6 th month	10 th month	-.92	<.001	-1.470	-.363
	Control	Pre test	6 th month	3.10	<.001	2.045	4.155
			10 th month	2.85	<.001	1.893	3.807
		6 th month	10 th month	-.25	.825	-.804	.304

Collectively, these results confirm that the HIIT intervention was effective not only in halting the progression of depressive symptoms but also in reversing their severity over time. These findings may have important implications for the design of community-based HIIT programs targeting middle-aged women experiencing depressive symptoms.

6.3.4. Between - Group Differences at Each Time Point

No significant difference was observed between the HIIT and control groups at baseline ($p = 0.883$), indicating successful randomization. However, as shown in Table 11, by six months, the HIIT group scored significantly lower than the control group (Mean Difference = -6.30, $p < 0.001$), and this difference became even more pronounced at ten months (Mean Difference = -6.97, $p < 0.001$). These differences suggest that the HIIT intervention produced a meaningful and sustained improvement in depressive symptoms.

Table 11. Mean differences in depression scores between the HIIT and control groups at each time point

Variable	Time	Mean Difference (Experimental vs Control)	Sig. (<i>p</i>)	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Depression	Pre-test	-.20	.883	-2.89	2.49
	6 th month	-6.30	<.001	-8.77	-3.82
	10 th month	-6.97	<.001	-9.32	-4.61

6.3.5. Theoretical Interpretation

These findings are consistent with the neurobiological and psychological mechanisms outlined in Sections 2.4 and 2.5 of this dissertation. HIIT has been shown to stimulate the release of brain-derived neurotrophic factor (BDNF), enhance endorphin production, regulate the hypothalamic-pituitary-adrenal (HPA) axis, and improve sleep quality and self-efficacy—all of which are associated with reductions in depressive symptoms. The continued improvement from 6 to 10 months suggests that these benefits may accumulate over time with sustained physical activity.

6.3.6. Summary of Findings

The results of this study showed that participation in the 10-month HIIT program was associated with a clear and progressive reduction in depressive symptoms among middle-aged women in the experimental group. In contrast, the control group experienced a gradual increase in symptom severity over the same period. These findings highlight the potential of HIIT as a sustainable, low-cost, and non-pharmacological intervention for improving mental health in this population.

It is important to note that the study did not include a comparison group receiving standard care, such as psychotherapy or medication, which limits the ability to compare the relative effectiveness of HIIT to other treatments. However,

the large effect sizes and high statistical power observed support the robustness and clinical relevance of the result

6.4. CHANGES IN ANXIETY SCORES OVER TIME

6.4.1. Descriptive Statistics of Anxiety Scores

Anxiety severity was assessed using the Beck Anxiety Inventory (BAI) at three time points: baseline (pre-test), six months (mid-test), and ten months (post-test) following the initiation of the HIIT intervention. The purpose was to examine whether anxiety scores changed significantly over time within each group and between the experimental and control groups.

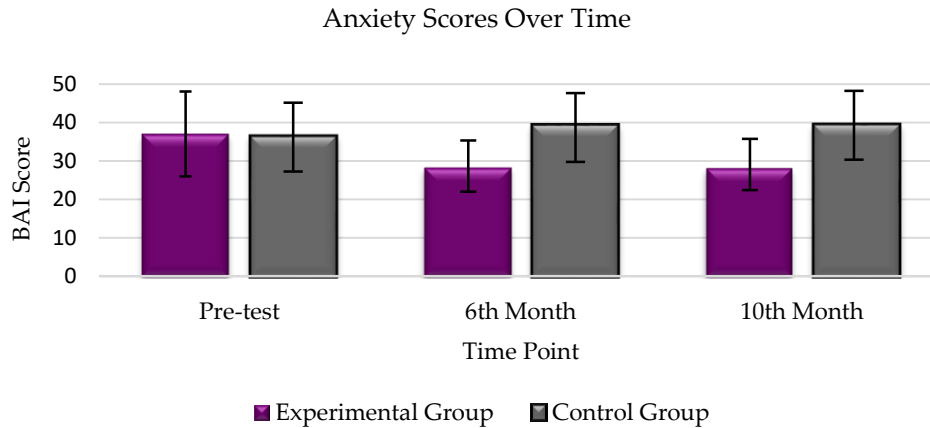
As shown in Table 12, the mean BAI score in the experimental group decreased from 36.90 ± 10.51 at baseline to 28.28 ± 7.57 at six months and further to 28.12 ± 7.23 at ten months. In contrast, the control group experienced an increase in anxiety scores from 36.55 ± 9.09 to 39.48 ± 9.00 and 39.53 ± 8.91 over the same periods. Figure 2 provides a complementary visual representation of these trends, allowing for a clearer and immediate interpretation of group differences across time.

Table 12. Means of anxiety scores of the participants in the pre-test, 6th, and 10th months

Variable	Group	<i>n</i>	Pre test		After 6 months		After 10 months	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Anxiety	Experimental	60	36.90	±10.5	28.28	±7.57	28.12	±7.23
	Control	60	36.55	±9.10	39.48	±9.0	39.53	±8.92

M = Mean; *SD* = Standard Deviation

Figure 2. Changes in Anxiety Scores (BAI) Across Time Points in Experimental and Control Groups



6.4.2. Main Effects of Time and Group (RMANOVA)

A two-way repeated measures ANOVA (Group $\times$ Time) revealed a statistically significant main effect of time on anxiety scores, $F(2, 236) = 39.437$, $p < 0.001$, partial $\eta^2 = 0.250$, indicating that approximately 25% of the variance in anxiety scores was attributed to changes over time.

A significant main effect of group was also observed, $F(1, 118) = 23.080$, $p < 0.001$, partial $\eta^2 = 0.164$, indicating that about 16.4% of the variance in anxiety scores was explained by group membership, with the HIIT group showing consistently lower anxiety levels than the control group across all time points.

6.4.3. Interaction Effect (Group $\times$ Time)

Importantly, the interaction between group and time was highly significant, $F(2, 236) = 162.584$, $p < 0.001$, partial $\eta^2 = 0.579$, indicating that approximately 58% of the variance in anxiety scores was explained by the combined effect of group membership and time. This large effect size reflects a substantial and clinically meaningful impact of the HIIT intervention in reducing anxiety symptoms over time. The statistical power of this interaction exceeded 0.99, reinforcing the robustness of the observed effect. These results are summarized in Table 13.

Table 13. Results of the within-between subjects' effect on Anxiety scores

Variable	Source	SS	df	MS	F	p	ηp^2
Anxiety	Within-Group						
	Time	659.539	2	329.769	39.437	<.001	.250
	Group $\times$ Time	2719.039	2	1359.519	162.584	<.001	.579
	Error	1973.422	236	8.362			
	Between-Group						
	Group	4958.044	1	4958.044	23.080	<.001	.164
	Error	25349.111	118	214.823			

6.4.4. Post-Hoc Comparisons within Groups

Post hoc pairwise comparisons using the Bonferroni correction confirmed a significant reduction in anxiety levels within the experimental group. BAI scores dropped from 36.90 ± 10.51 at baseline to 28.28 ± 7.57 at six months, and remained stably low at 28.12 ± 7.23 at ten months. The reductions from baseline to both follow-up points were statistically significant ($p < 0.001$). However, no significant change occurred between the sixth and tenth months ($p = 1.000$), suggesting a plateau in symptom improvement during the latter phase of the intervention.

As shown in Table 14, the most substantial reduction in anxiety occurred during the first six months, with stabilization thereafter. Clinically, this represents a transition from moderate to mild anxiety levels, which may enhance daily emotional regulation and functional well-being.

In contrast, the control group exhibited a significant increase in anxiety scores, rising from 36.55 ± 9.09 at baseline to 39.48 ± 9.00 at six months and 39.53 ± 8.91 at ten months ($p < 0.001$). No significant difference emerged between the sixth and tenth months ($p = 1.000$), indicating a persistent elevation in anxiety in the absence of intervention.

Table 14. Mean differences of Anxiety scores between measurement times within each study group

Variable	Group	Time (I)	Time (J)	Mean Difference (J-I)	Sig. (p)	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Anxiety	Experimental	Pre test	6 th month	-8.617	<.001	-10.115	-7.118
			10 th month	-8.783	<.001	-10.245	-7.322
		6 th month	10 th month	-.167	1.000	-.908	.574
	Control	Pre test	6 th month	2.933	<.001	1.435	4.432
			10 th month	2.983	<.001	1.522	4.445
		6 th month	10 th month	.050	1.000	-.691	.791

6.4.5. Between-Group Differences at Each Time Point

As presented in Table 15, no significant difference in anxiety scores was found between the HIIT and control groups at baseline ($p = 0.846$), indicating successful randomization and comparable starting points. However, by the 6th month, the experimental group reported significantly lower anxiety scores than the control group (mean difference = -11.200 , $p < 0.001$), a pattern that persisted through the 10th month. These between-group differences highlight the sustained effectiveness of the HIIT intervention over time.

The substantial gap in anxiety scores between the two groups by the end of the intervention provides further support for the clinical relevance of the program. Such outcomes suggest that structured, community-based HIIT programs may offer a practical and impactful non-pharmacological approach for managing anxiety symptoms in middle-aged women.

Table 15. Mean differences of Anxiety scores between the two groups at each measurement time

Variable	Time	Mean	Sig. (<i>p</i>)	95% Confidence Interval for	
		Difference (Experimental vs Control)		Lower Bound	Upper Bound
Anxiety	Pre-test	.350	.846	-3.202	3.902
	6 th month	-11.200	<.001	-14.206	-8.194

6.4.6. Summary of Findings

The results of this study showed that participation in the 10-month HIIT program led to a significant and sustained reduction in anxiety symptoms among middle-aged women in the experimental group. In contrast, the control group experienced a progressive and statistically significant increase in anxiety levels, indicating a deterioration in psychological well-being in the absence of structured physical activity.

Importantly, the HIIT group's decline in BAI scores—from moderate to mild anxiety severity—suggests not only statistical significance but also a clinically meaningful improvement in emotional functioning. The maintenance of these reduced scores between the sixth and tenth months points to the durability of the intervention's effects, rather than short-term gains.

Although the study did not include a comparison group receiving pharmacological or psychotherapeutic treatment—limiting conclusions about relative efficacy—the results offer strong support for HIIT as an accessible, low-cost, and culturally adaptable strategy for managing anxiety in middle-aged women, especially in contexts where access to mental health services may be limited due to stigma or availability.

6.5. CHANGES IN BODY COMPOSITION: WEIGHT, BODY FAT PERCENTAGE, AND BMI

This section evaluates the effects of the 10-month High-Intensity Interval Training (HIIT) intervention on three key body composition parameters: weight,

body fat percentage, and body mass index (BMI), assessed at three time points: baseline, 6 months, and 10 months.

6.5.1. Descriptive Statistics of Body Composition Parameters

Descriptive statistics for weight, body fat percentage, and BMI at baseline, 6 months, and 10 months in both groups are presented in Table 16.

Table 16. Means of weight, fat body, and BMI of the participants in the pre-test, 6th and 10th month

Variable	Group	<i>n</i>	Pre test		After 6 months		After 10 months	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Weight (kg)	Experimental	60	66.47	±5.06	65.01	±4.42	64.83	±4.25
	Control	60	66.96	±5.30	67.61	±5.47	67.69	±5.16
Body fat %	Experimental	60	26.63	±4.09	25.87	±3.64	25.28	±3.37
	Control	60	26.25	±4.38	27.08	±4.45	27.10	±4.21
BMI	Experimental	60	25.30	±2.76	24.37	±2.08	24.28	±1.99
	Control	60	25.26	±2.86	25.85	±3.02	25.86	±2.83

M = Mean; *SD* = Standard Deviation

Weight

At the start of the study, participants in both the HIIT and control groups exhibited similar baseline values across all body composition indicators. Specifically, the mean body weight in the HIIT group was 66.47 ± 5.06 kg, while in the control group it was 66.96 ± 5.30 kg, showing no significant difference at baseline.

Figure 3. Changes in Body Weight Over 10 Months in HIIT and Control Groups

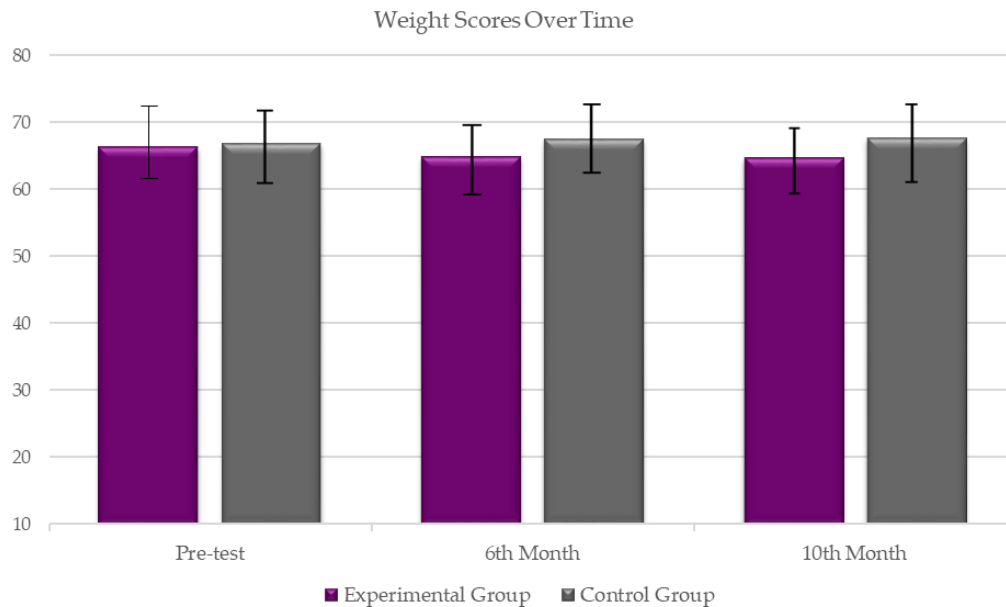
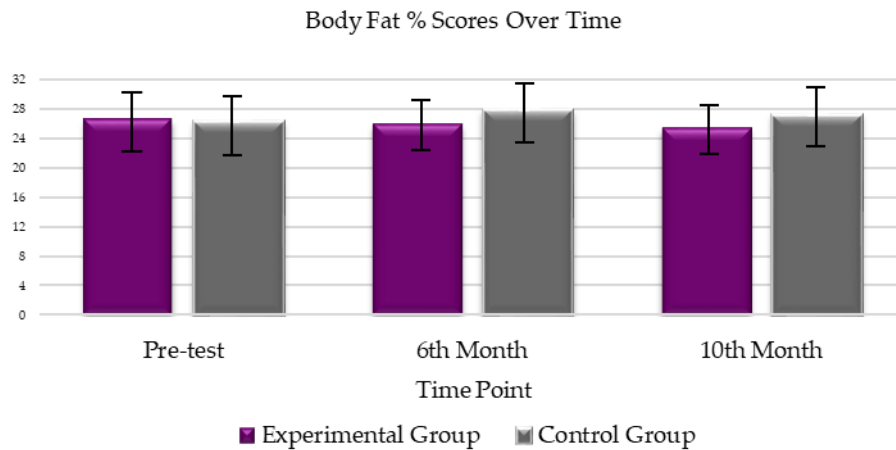


Figure 3 illustrates the progression of body weight over the 10-month intervention, offering a clearer visual representation of the temporal trends. Participants in the HIIT group experienced a gradual and consistent reduction in weight, dropping to 65.01 ± 4.42 kg at the 6-month mark and further to 64.83 ± 4.25 kg at 10 months. In contrast, the control group showed a slight but continuous increase in weight, rising to 67.61 ± 5.47 kg at 6 months and 67.69 ± 5.16 kg at the end of the study.

Body fat percentage

A comparable trend was observed in body fat percentage, as depicted in Figure 4, which provides a clearer visual representation of the progressive changes across the 10-month intervention. The HIIT group showed a progressive decline from $26.63 \pm 4.09\%$ at baseline to $25.87 \pm 3.64\%$ at 6 months and $25.28 \pm 3.37\%$ at 10 months. Meanwhile, the control group exhibited a steady increase in body fat, rising from $26.25 \pm 4.38\%$ at baseline to $27.08 \pm 4.45\%$ at 6 months and $27.10 \pm 4.21\%$ at 10 months.

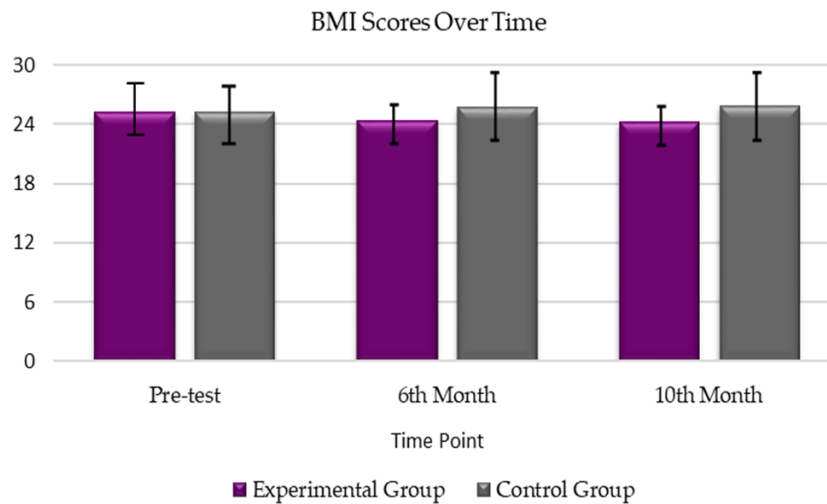
Figure 4. Changes in Body Fat Percentage Over 10 Months in HIIT and Control Groups



Body Mass Index (BMI)

Regarding Body Mass Index (BMI), participants in the HIIT group initially had a mean of 25.30 ± 2.76 , which decreased to 24.37 ± 2.08 after 6 months and 24.28 ± 1.99 by the end of the intervention. This consistent downward trend signifies a meaningful improvement in BMI. On the other hand, the control group's BMI slightly increased over time, moving from 25.26 ± 2.86 at baseline to 25.85 ± 3.02 at 6 months and 25.86 ± 2.83 at 10 months. These contrasting patterns are visualized in Figure 5, which offers a clearer depiction of the divergence in BMI trajectories between the HIIT and control groups over the intervention period.

Figure 5. Changes in Body Mass Index (BMI) Over 10 Months in HIIT and Control Groups



6.5.2. Main Effects and Interaction Effects (RMANOVA)

To evaluate both within-subject (time) and between-subject (group) differences in body composition, a two-way repeated measures ANOVA (Group $\times$ Time) was conducted for each variable. The results are summarized in Table 17.

Weight exhibited a statistically significant main effect of time, $F(2, 236) = 13.436$, $p < 0.001$, partial $\eta^2 = 0.102$ ($\approx 10.2\%$), indicating that weight changed meaningfully over the 10 months. A significant main effect of group was also observed, $F(1, 118) = 4.856$, $p = 0.029$, $\eta^2 = 0.040$ ($\approx 4.0\%$). Most notably, a strong interaction effect was found between group and time, $F(2, 236) = 89.545$, $p < 0.001$, $\eta^2 = 0.431$ ($\approx 43.1\%$), suggesting that participants in the HIIT group experienced substantially greater and sustained improvements in weight compared to the control group, which showed mild increases over time.

Body fat percentage also showed a significant time effect, $F(2, 236) = 4.469$, $p = 0.012$, $\eta^2 = 0.036$ ($\approx 3.6\%$), and a large group $\times$ time interaction effect, $F(2, 236) = 60.251$, $p < 0.001$, $\eta^2 = 0.338$ ($\approx 33.8\%$). Although the main effect of group was not statistically significant ($p = 0.227$), the interaction indicates that reductions in body fat were predominantly attributable to the HIIT intervention.

For BMI, significant main effects were observed for both time, $F(2, 236) = 4.878$, $p = 0.008$, partial $\eta^2 = 0.040$ ($\approx 4.0\%$), and group, $F(1, 118) = 4.549$, $p = 0.035$, partial $\eta^2 = 0.037$ ($\approx 3.7\%$). The interaction effect was also highly significant, $F(2, 236) = 80.156$, $p < 0.001$, partial $\eta^2 = 0.405$ ($\approx 40.5\%$), suggesting that the BMI changes were more favourable in the HIIT group compared to controls.

Table 17. Results of the within-between subjects' effect in weight, body fat, and BMI.

Variable	Source	SS	df	MS	F	p	ηp^2
Weight	Within-Group						
	Time	15.202	2	7.601	13.436	<.001	.102
	Group×Time	101.315	2	50.657	89.545	<.001	.431
	Error	133.510	236	.566			
	Between-Group						
	Group	353.430	1	353.430	4.856	.029	.040
	Error	8588.890	118	72.787			
Body Fat	Within-Group						
	Time	5.756	2	2.878	4.469	.012	.036
	Group×Time	77.600	2	38.800	60.251	<.001	.338
	Error	151.978	236	.644			
	Between-Group						
	Group	70.225	1	70.225	1.472	.227	.012
	Error	5628.306	118	47.698			
BMI	Within-Group						
	Time	2.984	2	1.492	4.878	.008	.040
	Group×Time	49.030	2	24.515	80.156	<.001	.405
	Error	72.179	236	.306			
	Between-Group						
	Group	90.701	1	90.701	4.549	.035	.037
	Error	2352.899	118	19.940			

These findings are not only statistically significant but also clinically meaningful, as they reflect favourable changes in parameters closely associated with cardiometabolic health, obesity-related risk, and quality of life. The large effect sizes across all three variables and the high statistical power (all > 0.99) underscore the robustness and reliability of the intervention's impact.

Taken together, these results provide a strong and compelling answer to Research Question 3, supporting Hypothesis 3 by demonstrating that the 10-month HIIT program produced significant and sustained improvements in weight, body fat percentage, and BMI compared to no intervention. These improvements further highlight the clinical relevance of HIIT as a non-pharmacological strategy for enhancing physical health among middle-aged women.

6.5.3. Post-Hoc Comparisons within Groups

Post hoc pairwise comparisons using the Bonferroni correction revealed that participants in the HIIT group experienced both statistically and clinically meaningful reductions in body weight. Specifically, weight decreased from 66.47 ± 5.06 kg at baseline to 65.01 ± 4.42 kg at six months ($p < 0.001$), followed by a slight but significant further reduction to 64.83 ± 4.25 kg at ten months ($p < 0.001$). No significant change was observed between the sixth and tenth months ($p = 0.283$), suggesting a stabilization of weight loss in the later phase of the program. In contrast, participants in the control group showed significant weight gain, increasing from 66.96 ± 5.30 kg at baseline to 67.61 ± 5.47 kg at six months and 67.69 ± 5.16 kg at ten months ($p < 0.001$). No significant difference was found between the last two time points ($p = 0.082$), indicating a plateau in weight increase.

A similar pattern was observed for body fat percentage. The HIIT group exhibited a progressive decrease—from $26.63 \pm 4.09\%$ at baseline to $25.87 \pm 3.64\%$ at six months and $25.28 \pm 3.37\%$ at ten months—with all within-group comparisons reaching statistical significance ($p < 0.001$). Conversely, body fat increased steadily in the control group, rising from $26.25 \pm 4.38\%$ to $27.10 \pm 4.21\%$ over the same period ($p < 0.001$). These consistent within-group trends reflect the distinct trajectory of physiological adaptation in response to structured physical activity.

BMI followed the same trajectory. The HIIT group showed a significant decline from 25.30 ± 2.76 at baseline to 24.37 ± 2.08 at six months, and 24.28 ± 1.99 at ten months ($p < 0.001$), while the control group experienced a statistically significant increase from 25.26 ± 2.86 to 25.86 ± 2.83 ($p < 0.001$). Once again, no meaningful change occurred between the sixth and tenth months in either group.

6.5.4. Between-Group Differences at Each Time Point

Between-group comparisons confirmed that participants were well matched at baseline for all three indicators—weight ($p = 0.607$), body fat percentage ($p = 0.621$), and BMI ($p = 0.940$). However, by the six-month follow-up, significant differences had emerged favoring the HIIT group, particularly in weight ($p = 0.005$) and BMI ($p = 0.002$). These differences became more pronounced at ten months, with all three indicators reaching statistical significance: weight ($p = 0.001$), BMI ($p = 0.001$), and body fat percentage ($p = 0.010$). Although body fat differences at six months were not yet significant ($p = 0.104$), the clear trajectory of change over time—reflected in strong group $\times$ time interaction effects (partial $\eta^2 = 0.338$ to 0.431)—suggests that improvements in body composition were largely attributable to the HIIT intervention. Table 18 summarizes the between-group mean differences and corresponding 95% confidence intervals across all three time points.

Table 18. Mean differences of weight, body fat %, and BMI between the two groups at each measurement time

Variable	Time	Mean Difference (Experimental- control)	Sig. (P)	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Weight Kg	Pre-test	-.488	.607	-2.362	1.385
	6 th month	-2.602	.005	-4.398	-.805
	10 th month	-2.855	.001	-4.565	-1.145
Body fat %	Pre-test	.383	.621	-1.150	1.916
	6 th month	-1.217	.104	-2.687	.254
	10 th month	-1.817	.010	-3.195	-.438
BMI	Pre-test	.038	.940	-.976	1.053
	6 th month	-1.475	.002	-2.412	-.538
	10 th month	-1.575	.001	-2.458	-.692

6.5.5. Summary of Findings

Overall, the findings from this section demonstrate that the 10-month HIIT intervention led to significant and sustained improvements in weight, body fat percentage, and BMI among middle-aged women in the experimental group. In contrast, the control group experienced either minimal change or deterioration in these parameters. These outcomes are not only statistically robust but also clinically meaningful, reflecting favourable changes in health markers closely linked to cardiovascular risk, metabolic disorders, and overall quality of life. The large effect sizes and high statistical power (all > 0.99) further underscore the reliability of these results. As such, the HIIT protocol implemented in this study may serve as a practical, effective, and accessible non-pharmacological strategy for improving body composition and promoting long-term physical health in this population.

6.6. STATISTICAL ANALYSIS RELATED TO RESEARCH QUESTIONS

This section systematically addresses the core research questions presented at the outset of this study by examining the effects of a 10-month High-Intensity Interval Training (HIIT) program on mental and physical health indicators among middle-aged Iranian women. The statistical approach primarily employed two-way repeated measures ANOVA (RM-ANOVA) to evaluate within- and between-group differences over time, complemented by post hoc analyses where appropriate. Interpretations are grounded in the empirical results and contextualized using the theoretical and empirical foundations established in Chapter 3.

6.6.1. Effects of High-Intensity Interval Training on Depressive Symptoms: Answer to Research Question 1

To address the first research question, a two-way repeated measures ANOVA was conducted, with group (HIIT vs. control) as the between-subjects factor and time (pre-test, 6 months, and 10 months) as the within-subjects factor. The analysis revealed a statistically significant group $\times$ time interaction, $F(2, 236) = 45.67$, $p < 0.001$, with a large effect size (partial $\eta^2 = 0.279$), indicating that changes in depression scores differed substantially between groups over time.

In the HIIT group, post hoc tests showed a steady and significant reduction in BDI-II scores across all time points (all $p < 0.001$), reflecting a decrease of nearly 9 points from baseline to the 10th month. By contrast, the control group exhibited no meaningful change. Notably, participants in the HIIT group shifted from the moderate to mild range of depression severity, based on BDI-II clinical thresholds.

6.6.2. Effects of High-Intensity Interval Training on Anxiety Symptoms: Answer to Research Question 2

To explore whether participation in a 10-month HIIT program significantly reduced anxiety symptoms in middle-aged Iranian women (Research Question 2), a two-way repeated measures ANOVA was conducted. The analysis yielded a highly significant group $\times$ time interaction, $F(2, 236) = 162.584$, $p < 0.001$, with a

large effect size (partial $\eta^2 = 0.579 \approx 57.9\%$). Significant main effects were also observed for both time ($F = 39.437, p < 0.001$) and group ($F = 23.080, p < 0.001$), further confirming a strong divergence in anxiety trajectories between the intervention and control groups.

Post hoc analyses (Bonferroni-adjusted) confirmed a consistent and statistically significant decline in anxiety scores among the HIIT group from baseline to both 6 and 10 months (all $p < 0.001$), with stabilization occurring between the second and third time points. In contrast, the control group experienced a significant and progressive increase in anxiety symptoms over the same period. This pattern is clearly illustrated in Tables 13 and 14.

At baseline, anxiety levels were statistically equivalent between the two groups ($p = 0.846$), ensuring a balanced comparison. However, by the 6th and 10th months, the differences had become highly significant in favour of the HIIT group (both $p < 0.001$), as reported in Table 15.

6.6.3. Effects of HIIT on Weight, Body Fat, and Body Mass Index (BMI): Answer to Research Question 3

To evaluate the long-term impact of high-intensity interval training (HIIT) on body composition—specifically weight, body fat percentage, and BMI—a two-way repeated measures ANOVA was conducted with time (pre-test, 6 months, 10 months) as the within-subject factor and group (HIIT vs. control) as the between-subjects factor.

Weight:

Significant effects were observed for time ($F(2, 236) = 13.436, p < .001, \eta^2 = 0.102$), group ($F(1, 118) = 4.856, p = .029, \eta^2 = 0.040$), and their interaction ($F(2, 236) = 89.545, p < .001, \eta^2 = 0.431$). Post hoc analyses revealed that the HIIT group experienced a steady reduction in weight from baseline to 10 months, while the control group showed a gradual increase. Between-group differences became statistically significant at both 6 months ($p = .005$) and 10 months ($p = .001$), indicating the effectiveness of the HIIT protocol in promoting weight loss.

Body Fat Percentage:

A significant main effect of time ($F(2, 236) = 4.469, p = .012, \eta^2 = 0.036$) and a large interaction effect ($F(2, 236) = 60.251, p < .001, \eta^2 = 0.338$) were found, though the overall between-group effect did not reach statistical significance ($p = .227$). Nevertheless, by the 10-month follow-up, the difference in body fat percentage between the HIIT and control groups became statistically meaningful ($p = .010$), suggesting a delayed but notable influence of the intervention on fat reduction.

Body Mass Index (BMI):

BMI outcomes mirrored those of weight, with significant effects for time ($F(2, 236) = 4.878, p = .008, \eta^2 = 0.040$), group ($F(1, 118) = 4.549, p = .035, \eta^2 = 0.037$), and the interaction term ($F(2, 236) = 80.156, p < .001, \eta^2 = 0.405$). The HIIT group experienced a sustained decrease in BMI, while the control group's BMI increased across the same time span. The differences between groups were significant at both 6 and 10 months ($p = .002$ and $p = .001$, respectively), reinforcing the intervention's positive impact.

Overall, these results provide strong empirical support for Research Question 3 and validate Hypothesis 3, confirming that long-term participation in HIIT led to significant improvements in weight, body fat, and BMI compared to no intervention.

6.6.4. Biological and Psychosocial Mechanisms Explaining HIIT Effects on Mental Health (Research Question 4)

Research Question 4 addressed the mechanisms through which HIIT influenced depression and anxiety. As these mechanisms were not directly measured statistically, no inferential results are reported in this section. Instead, interpretations based on theoretical frameworks, literature, and qualitative feedback are presented in Chapter 7 (Discussion).

6.6.5. Social, Cultural, and Environmental Determinants Influencing Participation (Research Question 5)

Research Question 5 focused on the cultural and environmental determinants of participation in the HIIT program. These determinants were explored through participants' qualitative feedback and contextual observations rather than statistical tests. A detailed interpretation of these findings is provided in Chapter 7 (Discussion).

6.7. SUMMARY OF RESULTS

This section provides an integrated summary of the main findings from the 10-month High-Intensity Interval Training (HIIT) intervention, combining statistical evidence with theoretical interpretation. The program led to consistent and meaningful improvements in both psychological and physical health outcomes among middle-aged Iranian women.

6.7.1. Psychological Outcomes

Participants in the HIIT group showed a progressive and sustained reduction in depressive and anxiety symptoms throughout the intervention. These improvements were supported by large effect sizes, with the program explaining nearly half of the variance in depression ($\eta^2 \approx 0.47$) and more than half in anxiety ($\eta^2 \approx 0.58$). Such changes highlight not only statistical significance but also clinical relevance, confirming HIIT as an effective non-pharmacological approach for mental health. In contrast, the control group demonstrated either stability or slight deterioration in psychological scores, underlining the unique impact of the intervention.

6.7.2. Physical Health Outcomes

Beyond psychological benefits, the HIIT group achieved significant improvements in body composition. Average reductions were observed in body weight (−1.6 kg), body fat percentage (−1.3%), and BMI (−1.0 points) from baseline to the 10-month follow-up. These positive changes were absent in the control

group, which either maintained or slightly worsened in these parameters. The results suggest that improvements in physical health achieved through HIIT may naturally enhance psychological well-being, given the close link between physiological and behavioral factors.

6.7.3. Mechanisms of Change

The benefits observed in this study are likely the result of a combination of biological and psychosocial mechanisms. Biologically, HIIT is likely to have improved neuroendocrine regulation (e.g., cortisol balance), stimulated neuroplasticity through brain-derived neurotrophic factor (BDNF), and reduced systemic inflammation. Psychosocially, the program fostered greater self-efficacy, enhanced behavioural activation, and stronger social bonds within the group context—all recognized pathways for improving mental health. These mechanisms align with the theoretical models discussed in Sections 2.4 and 2.5, reinforcing the biological and psychological plausibility of the observed effect.

6.7.4. Sociocultural and Environmental Determinants

The effectiveness of the intervention was further reinforced by sociocultural influences. Delivering the program in a women-only gym, respecting cultural dress codes, and employing female trainers created a safe and acceptable environment that encouraged participation. Family support and structured orientation sessions further strengthened adherence and sustained motivation over the long term. These culturally responsive strategies may offer a transferable model for similar populations in other Middle Eastern or conservative contexts.

6.7.5. Final Reflection

Overall, the findings confirm the feasibility, safety, and effectiveness of a culturally adapted HIIT protocol for improving both psychological and physical health among middle-aged Iranian women. These results provide a robust empirical foundation for the theoretical discussions, practical applications, and policy implications presented in Chapter 7.

VII -

VII – DISCUSSION

VII - DISCUSSION

7.1. INTRODUCTION

This chapter provides a comprehensive interpretation of the primary results of the study, incorporating theoretical perspectives, empirical findings, and socio-cultural context to enhance understanding of the 10-month High-Intensity Interval Training (HIIT) intervention implemented among middle-aged Iranian women.

Based on the qualitative data and quantitative observations described in Chapter 5, the argument here tries to reconsider the five key research inquiries that guided the study and critically test the identified changes in the mental and physical health indicators, namely symptoms of anxiety and depression, body weight, percentage of body fat, and body mass index (BMI).

The intervention consisted of a rigorously crafted, culturally suitable High-Intensity Interval Training (HIIT) protocol used for ten months within a women-only gym in Isfahan. Measurements occurred at three intervals: baseline, six months, and ten months, using validated assessment tools such as the Beck Depression Inventory-II (BDI-II) and the Beck Anxiety Inventory (BAI). In addition, qualitative observations were collected after every tenth session so that the experiences, lives of the consumers, the motivation, and the perceived changes could be recorded, thus enriching quantitative trends.

The results of this study indicated that HIIT significantly reduced depression and anxiety symptoms while also contributing to favorable changes in body composition. These benefits were particularly evident among participants with higher adherence, underscoring the importance of consistency and behavioral commitment. In this chapter, the results are interpreted concerning existing literature and theoretical frameworks, with attention to possible neurobiological, hormonal, and psychosocial mechanisms underlying the observed effects. Cultural and environmental factors influencing adherence are also examined, alongside critical reflections on methodological limitations and the broader implications of the study.

Overall, the current chapter not only endeavored to summarize the modifications that occurred but also examined the motivation for such modifications, how individual and contextual variables mediated them, and what they might portend for future public health programs intended to foster mental and physical health in women from similar sociocultural backgrounds. In this way, the study contributes to the growing body of literature on High-Intensity Interval Training (HIIT) as a viable, culturally responsive, and time-efficient means of enhancing women's health in situations that are budget-challenged or value-conservative.

7.2. DISCUSSION OF FINDINGS

7.2.1. Mental Health Improvements

7.2.1.1. *Depression Reduction*

The results of the study showed a significant and clinically relevant reduction in depressive symptoms in the High-Intensity Interval Training (HIIT) group during the 10-month period of intervention. In contrast, the control group showed a heightened degree of depressive symptoms during the equivalent time. Interaction effect size of the high group in the context of study duration ($\eta^2 = 0.472$), explaining about 47% of the variance, highlights the high effectiveness of HIIT in the mitigation of depressive symptoms in postmenopausal Iranian women.

The findings of the current study are in accordance with a burgeoning literature highlighting the antidepressant potential of high-intensity interval exercise. Schuch et al. (2016) showed that aerobic exercise and high-intensity exercise produced notable declines in depressive symptoms in a wide range of individuals. Similarly, studies performed by Tao et al. (2024) and Xu et al. (2024) verified that HIIT activates key neurobiological mechanisms, such as monoamine release augmentation, hippocampal neurogenesis, and anti-inflammatory actions, that are fundamental for the regulation of mood and emotional tone. In addition, studies performed by Borrega-Mouquinho et al. (2021) and Gu et al. (2022) showed that HIIT substantially increases levels of the brain-derived growth protein BDNF, consequently favoring synaptic plasticity and enhancing emotional resistance.

Aside from biological pathways, psychosocial mechanisms have also been identified as important factors. As previously noted, regular participation in physical activity has been well established to improve self-efficacy, increase social interaction, and heighten behavioral activation—factors that are critical for the remission of depression (Bajwa et al., 2024). In the current study, several participants indicated improved emotional resilience, increased confidence, and reduced feelings of loneliness after their continued participation in the supervised, women-only high-intensity interval training (HIIT) sessions.

The well-planned sessions provided a safe and social environment, which is especially important for Iranian women, who commonly face social solitude and lowered empowerment as a result of their caregiving roles and societal expectations. The socio-political environment is an important lens through which to understand the conditions of the study in question. The intervention was set against the backdrop of the 2022 protests in Iran, when anxiety levels were high and public concern widespread. Exogenous factors would certainly have had an impact on the reactions experienced in the control group, but simultaneously, they also highlighted the psychological health value of physical exercise in the intervention group.

Therefore, the results give a clear positive answer to research question 1: A 10-month high-intensity interval training protocol resulted in a significant reduction in depressive symptoms in middle-aged Iranian women, supported by clinical ratings and statistical tests, in contrast to the control group.

The findings are in agreement with the research studied and the literature examined for this study in Chapter 3, covering the findings of research related to the neuromolecular, neuropsychological, and lasting impacts of high-intensity interval training (HIIT) for the treatment of depressive symptoms.

7.2.1.2. *Anxiety Reduction*

A similar and significant increase was also detected in the expression of anxiety symptoms. During the 10 months of the study, the members of the High-

Intensity Interval Training group showed a steady and significant decrease in their Beck Anxiety Inventory (BAI) score, while the control group showed an increase in anxiety. The group $\times$ time interaction effect for anxiety ($\eta^2 = 0.579$), explaining almost 58% of the variance, was greater than that for depression, suggesting that HIIT has a strong anxiolytic effect in the studied group.

Recent studies support these findings Mielniczek & Aune, (2024) and Patten et al. (2023) report that HIIT helps modulate autonomic nervous system balance, increase endorphin release, and attenuate the physiological stress response—all factors linked to anxiety reduction. Furthermore, Ribeiro et al. (2022) demonstrated that even short-term HIIT programs significantly lower anxiety levels, especially when sessions are structured and socially supportive. Tao et al. (2024) emphasized that although high-intensity exercise can initially induce discomfort, it facilitates long-term improvements in emotional regulation.

Culturally, Iranian women face significant barriers to receiving mental health care, primarily because of the stigma of mental illness, a deficiency in the awareness of the importance of their own mental health, and the absence of special physical fitness facilities for women. The setup of the current project—a women's health club, in a private section and only staffed by women trainers—probably ensures a psychologically safe space for the members, thus allowing them the freedom of physical exercise free of social judgment. A high percentage of the women mentioned that the program was a source of social support, an avenue for the expression of their emotions, and special time for personal self-exploration.

Furthermore, qualitative reports reveal that notable physical benefits, such as weight loss and increased energy levels, contributed to the relief of anxiety through the promotion of improved body image, increased self-confidence, and greater self-regulation—important psychological variables that are commonly impaired among individuals with anxiety disorders.

In addition, the findings give strong support for research question 2: The intense interval training protocol significantly diminishes symptoms of anxiety in middle-aged Iranian women, both statistically and in terms of cultural relevance.

Findings of the current study support the aforementioned theoretical postulations and related empirical structures described in Chapter 3 (Sections 3.4,

3.5, and 3.8), establishing the behavioral, neuroendocrine, and long-term anxiolytic actions of high-intensity interval exercise.

7.2.2. Physical Health Improvements

7.2.2.1. Body Composition Improvements

Answering research question 3, the results of the present study showed statistical and clinical significance in terms of differences in physical health status among the HIIT group members within a 10-month period of intervention. In particular, strong interactions of group allocation with time for several of the variables studied, such as weight ($\eta^2 = 0.431$, corresponding to an R-squared of about 43% of the variability), percentage of body fat ($\eta^2 = 0.338$, explaining about 34% of the variability), and Body Mass Index (BMI) ($\eta^2 = 0.405$, accounting for about 41% of the variability) became manifest. In the control group, on the other hand, maintenance of baseline test values or only small increments in the aforementioned variables, relative to the baseline test results, were recorded. The results of the present study highlight that long-term engagement in HIIT correlates with notable and successive increments in physical composition in the studied population of middle-aged Iranian women.

The results here are consistent with earlier research identifying the metabolic effectiveness of high-intensity interval training (HIIT) as an effective means of adipose tissue reduction and enhancing cardiovascular measures. For example, research by Wewege et al. (2017), Maillard et al. (2016), and Borycka et al. (2023) showed that HIIT outperformed moderate-intensity continuous training (MICT) in reducing fat mass and improving body mass index (BMI) in overweight, middle-aged individuals. Likewise, Dupuit et al. (2020) noted significant increases in maximal oxygen uptake ($\text{VO}_{2\text{max}}$), body weight, and percentage of fat after participating in 8 weeks of HIIT in postmenopausal women, a population of physiological similarity to the participants in the study here. Physiologically, favorable effects of High-Intensity Interval Training (HIIT) are believed to be a result of increased post-exercise oxygen consumption (EPOC), improved mitochondrial function, and hormonal changes, such as elevated growth hormone and catecholamines, which together promote fat oxidation and maintenance of

lean mass (Schleppenbach et al., 2017). These physiological responses are of major importance for long-term weight regulation and improved metabolic flexibility, especially during menopausal transition.

Aside from the empirical results, the physical benefits of the study were supported by qualitative data. A significant number of participants revealed high energy levels, improved sleep, and significant physical changes, such as the reduction in waist circumference. These self-reported outcomes, in turn, promoted greater motivation, high self-esteem, and improved compliance—factors that are key to the long-term practice of physical activities. The link between improved body image and psychological health, as seen in the present study, is also supported by previous studies, including those of Borrega-Mouquinho et al. (2021) and Khodadadi et al. (2023), whose research reveals that the exercise intervention was accompanied by physical changes and corresponding psychosocial gains.

From a cultural standpoint, High-Intensity Interval Training (HIIT) is an extremely practical solution for middle-aged women in Iran, as they are often responsible for family duties and childcare, therefore only having limited free time. The structured, prescriptive sessions, taking less than sixty minutes, are most effective in the shortest time frame, thus enhancing feasibility and compliance (Atakan et al., 2021; Tao et al., 2024).

The outcome also shows a significant reduction in body weight, body fat percentage, and body mass index following a 10-month high-intensity interval training among middle-aged Iranian women. However, the control group revealed no improvement in these indicators. These physical health breakthroughs support the neuroendocrine and metabolic adaptation theories, highlighting the hormonal, metabolic, and long-term physiological benefits of High-Intensity Interval Training (HIIT) in determining body composition.

7.2.3. Integration of Mental and Physical Health Findings

The inclusion of physical and mental health in this study also highlights the argument that high-intensity interval training (HIIT) served as an integrated intervention. Members of the intervention group demonstrated clinically and statistically significant declines in depressive and anxiety symptoms, in addition

to increases in body weight, percentage of body fat, and body mass index (BMI). These findings support the argument that HIIT operates on multiple aspects of life simultaneously, while also enhancing mental and physical health in a reciprocal and complementary fashion.

The achieved dual end-state appeared to be related, since the results provided support for the behavioral activation theory. The aforementioned theoretical approach indicates that the practice of systematic physical exercise can reduce ongoing negative cycles, thus enabling the acceptance of daily activities and endeavors (Gong et al., 202; Gulyaeva et al., 2019). In addition, the later enhancement in composition reflected the increased self-esteem, improved energy, and improved resistance to fluctuations in the mood, ultimately forming a positive feedback cycle that fosters ongoing practice and psychological health (Kandola et al., 2019).

Qualitative notes recorded throughout the intervention also supported the concept of synergy, suggesting that alterations in physiology often preceded shifts in emotion. The protocol, in conjunction with the group-centered environment typical of High-Intensity Interval Trainings within the culturally sensitive, all-female environment, supported the environment in which the physical alterations would bring about the resultant psychological benefit, in the absence of social desensitization or extraneous distractions.

The simultaneous improvement of physical and mental results in this study highlights the multifaceted nature of the intervention used. Even though the mind and the body are often thought of in terms of separate spheres, the HIIT protocol used was an integrative approach that addressed emotional response and physical health through structured activities, social engagement, and graduated accomplishments.

7.3. MECHANISMS AND DETERMINANTS OF OBSERVED OUTCOMES

7.3.1. Biological and Psychosocial Mechanisms

The significant reductions in depressive and anxiety symptoms observed in this study can be explained through a convergence of biological and psychosocial

mechanisms activated by high-intensity interval training (HIIT). These mechanisms, which will be examined below, are well documented in the literature and are consistent with the clinical improvements reported by participants in the current research.

These mechanisms, which will be examined below, are well documented in the literature and are consistent with the clinical improvements reported by participants in the current research.

7.3.1.1. *Neurobiological Mechanisms*

High-Intensity Interval training influences several neurobiological systems that play a central role in mood regulation and resilience to stress. One of the most consistent findings in this area is its impact on neurotransmitters. Repeated bouts of high-intensity activity increase the availability of serotonin, dopamine, and norepinephrine—chemicals strongly linked with emotional regulation, motivation, and reward processing (Schuch et al., 2016; Tao et al., 2024). Since these systems are often disrupted in people living with depression and anxiety, their enhancement through HIIT provides a credible biological pathway for the improvements observed in this study.

Another important mechanism is the increase of brain-derived neurotrophic factor (BDNF), a protein essential for neuroplasticity, neuronal survival, and synaptic connectivity. Elevated BDNF, particularly in the hippocampus and prefrontal cortex, is closely associated with improved cognitive performance and emotional stability (Heisz et al., 2016; Xu et al., 2024). By boosting BDNF levels, HIIT may help strengthen the brain's capacity to adapt, making individuals less vulnerable to depressive or anxious states.

HIIT also affects the hypothalamic-pituitary-adrenal (HPA) axis, which controls the body's stress response. When this system is chronically overactive, cortisol secretion becomes imbalanced, leading to heightened stress sensitivity and negative effects on mood. Evidence shows that regular participation in HIIT can restore healthier cortisol patterns, thereby reducing the physiological burden of stress and supporting better emotional balance (Wilczyńska et al., 2023). This stress-buffering effect may partly explain the psychological stability reported by participants during the 10-month intervention.

Finally, HIIT contributes to mental health by reducing chronic low-grade inflammation, which is increasingly recognized as a biological factor in mood disorders. Depression and anxiety are often linked with elevated levels of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α). Experimental studies suggest that HIIT can lower these markers while promoting anti-inflammatory responses, thereby counteracting the neuroinflammatory disturbances linked to mood disorders (Heo & Jee, 2023; Eyre & Baune, 2011).

Taken together, these interconnected processes—enhanced neurotransmitter activity, higher BDNF levels, normalization of the HPA axis, and reduced inflammation—offer a comprehensive explanation for the psychological benefits observed in this study. These findings also align closely with the theoretical frameworks outlined in Chapter, reinforcing the credibility of HIIT as a scientifically grounded approach to improving mental health.

7.3.1.2. Psychosocial Mechanisms

In addition to the biological factors, several psychosocial elements helped explain the improvements in mental health seen in this study. One important aspect was the program's group-based nature. Exercising together created opportunities for social connection, reduced feelings of loneliness, and provided emotional support—all of which are known to protect against depression and anxiety (Cohen & Wills, 1985). The group setting also encouraged trust and a sense of responsibility among participants, which contributed to a safe and supportive environment.

The structured routine of three weekly sessions further promoted behavioral activation. According to Lewinsohn's theory, engaging in regular and meaningful activities helps to break the cycle of avoidance and inactivity that often maintains depression (Veale, 2007). For many participants, the regular schedule and progressive challenges of the sessions gave structure to their daily lives and created a sense of purpose and achievement.

Another important factor was the increase in self-efficacy. Bajwa et al. in 2024 explained that believing in one's own abilities strengthens emotional control and resilience to stress. As participants built physical strength, stamina, and exercise

skills, they also gained more confidence in their personal abilities. This improvement in self-belief not only reduced anxious thoughts but also supported greater independence in daily decision-making.

The culturally sensitive design of the program also enhanced its psychosocial impact. Holding the sessions in a women-only gym, led by female trainers, and respecting modest clothing requirements helped create an inclusive and safe atmosphere. These adjustments reduced possible stress related to social judgment and encouraged consistent participation, which further strengthened both the physical and psychological benefits of the program.

Finally, feedback from participants showed a clear link between physical and psychological changes. Many women reported better sleep, more energy, improved body image, and greater ease in expressing emotions. These experiences suggest a positive cycle in which physical improvements support mental health, and psychological recovery in turn motivates continued physical activity.

Overall, these psychosocial processes—social support, behavioral activation, improved self-efficacy, cultural sensitivity, and positive personal experiences—work together with the biological changes to explain the significant mental health improvements observed in this study.

Taken together, the biological and psychosocial mechanisms outlined above provide a coherent explanation for the reductions in depression and anxiety observed in this study. By simultaneously addressing neurobiological pathways (e.g., neurotransmitters, BDNF, HPA axis regulation, inflammation) and psychosocial dimensions (e.g., social support, behavioral activation, self-efficacy, and cultural sensitivity), HIIT emerges as a multidimensional intervention that improves mental health through both physiological and experiential processes. These findings directly address research question 4, confirming that the psychological benefits of HIIT can be understood as the result of an interplay between biological adaptations and psychosocial influence.

7.3.2. Cultural and Environmental Determinants of Participation

7.3.2.1. Cultural Considerations

In Iran, cultural values and gender norms strongly influence women's opportunities to participate in organized exercise. Restrictions related to modesty, family responsibilities, and limited access to public spaces often discourage or prevent women from engaging in physical activity. These constraints are especially pronounced for middle-aged women, who are typically expected to prioritize domestic duties over personal health. Such cultural barriers can exacerbate mental health problems by reducing opportunities for stress relief, social interaction, and physical well-being.

This study addressed these barriers by creating a culturally responsive setting. The intervention was conducted in a women-only gym, staffed entirely by female trainers. These adjustments provided a sense of psychological safety and reduced the fear of social judgment, which in turn encouraged higher adherence. The fact that attendance in the intervention group remained consistently high throughout the 10-month program can be attributed, at least in part, to these culturally sensitive strategies. These findings mirror those discussed in Chapter 3, where previous studies emphasized that programs designed without regard to cultural norms often experience low participation and high dropout rates.

In addition to these culturally responsive strategies, family and social support played an essential role in enabling participation. Many women highlighted that encouragement from spouses and children, as well as assistance with household responsibilities, created the necessary conditions for consistent attendance. Such support helped participants reconcile personal health needs with traditional family obligations, making adherence more feasible.

7.3.2.2. Environmental and Societal Pressures

The timing of this study coincided with widespread social protests and heightened political surveillance in Iran. These conditions created additional layers of stress for women, including restrictions on public gatherings, disruptions of internet access, and increased uncertainty about personal safety. Such

environmental stressors likely contributed to worsening psychological symptoms among the general population, particularly in the control group.

Against this backdrop, the women who participated in the HIIT program demonstrated notable emotional resilience. The structured and supportive nature of the sessions appeared to provide a stabilizing routine and a constructive outlet for stress, acting as a protective buffer against the adverse effects of societal unrest. This interpretation is consistent with the discussion in Chapter 3, which highlighted how civil instability and reduced civic freedoms can negatively influence both physical activity levels and mental health, particularly for women. The fact that participants in the exercise group reported increased stability and emotional control, despite these external pressures, underscores the value of structured physical activity as a coping resource in times of social crisis.

7.3.2.3. *Supportive Infrastructure and Education*

Beyond cultural sensitivity and societal pressures, environmental facilitators within the program design also played a crucial role in sustaining engagement. The intervention was supported by access to gym facilities, a clear and consistent schedule, and varied training methods, which together maintained participants' interest and commitment. Short educational sessions delivered at the start of each training phase increased participants' awareness of the mental and physical benefits of HIIT, reinforcing motivation and adherence.

Qualitative feedback collected every ten sessions further emphasized these positive influences. Many participants reported that the group-based structure of the program not only offered physical benefits but also provided emotional relief and a sense of control at a time when external circumstances felt overwhelming. The reported improvements in energy, mood, and body image suggest that supportive infrastructure combined with targeted education can amplify both the physical and psychological outcomes of exercise interventions.

In addition to strengthening motivation, these educational components enhanced participants' health literacy, particularly in relation to mental health. By clarifying how exercise could alleviate symptoms of depression and anxiety, the sessions increased participants' confidence in the program's effectiveness and deepened their commitment to long-term adherence.

7.3.2.4. *Summary and Implications*

Overall, the findings indicate that cultural appropriateness, supportive infrastructure, and resilience to environmental stressors were decisive in enabling the success of this HIIT program. These results reinforce the importance of designing exercise interventions that are sensitive to gender norms, responsive to social conditions, and supported by adequate educational and organizational structures.

At the same time, caution is needed when considering the transferability of these findings. The intervention took place in an urban setting with access to gym facilities and professional trainers, which may not reflect the realities of rural communities or regions with fewer resources.

Taken together, these cultural and environmental determinants explain why the HIIT program was effective in sustaining participation and producing psychological benefits among middle-aged Iranian women. By addressing gender norms, providing supportive infrastructure, and offering stability during periods of social unrest, the intervention demonstrated how contextual sensitivity is essential for program success. These findings directly address research question 5, highlighting that the outcomes of HIIT are not only driven by biological or psychological mechanisms but are also profoundly shaped by cultural and environmental conditions.

VIII - CONCLUSIONS

VIII - CONCLUSIONS

This doctoral study examined the long-term effects of a 10-month High-Intensity Interval Training (HIIT) intervention on mental and physical health outcomes in middle-aged Iranian women. The findings offer compelling evidence that a structured, culturally adapted HIIT program can significantly alleviate symptoms of depression and anxiety while also improving body composition—specifically weight, body fat percentage, and body mass index (BMI). These outcomes affirm the study's primary hypotheses and demonstrate the potential of HIIT as a time-efficient, non-pharmacological strategy for improving women's health in resource-constrained or conservative environments. Noteworthy is the fact that realized benefits in statistical terms were not only significant but also well-supported through qualitative findings made in the process of the intervention. Participants reported increased vitality, self-esteem, career motivation, and mastery of affect.

Many of them also credited the psychological benefit realized to the physical change they experienced, in addition to the protective environment made available through means of a women's group. These results are suggestive of the integrally related nature of the intervention, profiling that physical and mental betterment seemingly supported the other reciprocally through means of complex bio psychosocial interplay.

The group-organized nature of the session's culturally sensitive presentation in sessions through the use of female trainers plays a significant role in the building of emotional safety, social integration, and adherence to behavior. Physical health gains also gave birth to psychological confidence and self-empowerment, and the release of affect likely increased exercise engagement. The two-way interplay, even though not necessarily absolutely quantifiable, is a testament to the multi-focal effect of HIIT and justifies the use of HIIT as a multifocal modality of intervention.

The study's findings were further interpreted through neurobiological and psychosocial frameworks, highlighting mechanisms such as increased monoamine secretion, improved HPA axis regulation, elevated BDNF levels, and enhanced

self-efficacy. These internal processes, coupled with the empowering social context, produced outcomes that were both clinically meaningful and deeply resonant with participants' lived experiences.

These internal mechanisms, coupled with social support, achieved outcomes of immense clinical value that correlated significantly with the individual experience of the patients. Noteworthy is the fact that the intervention occurred in the background of increased sociopolitical agitations in Iran, and that may have served to heighten antecedent mental health challenges in the control group.

The preservation or augmentation of the overall well-being of the HIIT group, even in the face of demanding conditions, implies the likely protective role of highly structured physical exercise in the most variable environments. Despite the study's results being compelling, there are certain caveats to the findings, namely the lack of biomarker results, the limited demographic sample, and the use of self-report outcome assessment. Replication of these findings in the future would ideally involve more variability in the samples, objective physiological measures, and comparative experimental manipulations to tease out the composite therapeutic potential inherent in HIIT.

In conclusion, this research contributes to the expanding body of literature advocating for HIIT as a culturally adaptable, scientifically grounded, and psychologically empowering intervention. By integrating physical fitness with emotional resilience and community engagement, HIIT emerges not just as a training modality, but as a catalyst for holistic health transformation among middle-aged women facing complex sociocultural barriers.

IX – LIMITATIONS AND FUTURE WORK

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9.1. RESEARCH LIMITATIONS

Despite the promising results of this study, several limitations should be acknowledged to contextualize the findings and guide future research.

9.1.1. Sample Characteristics and Generalizability

The study sample was restricted to middle-aged Iranian women between 50 and 55 years of age, all residing in an urban environment. While this demographic consistency increased the cultural specificity of the findings, it also limited their generalizability to other groups, such as men, individuals of different age ranges, or women living in rural areas. Furthermore, variation in participants' education levels and baseline physical activity could have influenced the outcomes. Future research should use more diverse populations to strengthen external validity.

9.1.2. Study Duration and Timing (Sociopolitical Context)

The 10-month intervention coincided with a period of sociopolitical instability in Iran, including widespread protests, internet restrictions, and heightened levels of public anxiety. These external stressors may have exacerbated psychological symptoms in the control group while amplifying the buffering effect of HIIT in the intervention group. However, they also introduced potential confounding factors that could not be fully controlled. In addition, economic sanctions and inflation may have indirectly influenced participants' emotional well-being and their ability to engage in exercise. Such contextual variables should be acknowledged when interpreting the results.

9.1.3. Absence of Comparative Experimental Groups

The study design involved only two groups: an intervention group and a control group. The lack of additional comparative groups, such as those

undergoing moderate-intensity continuous training (MICT) or psychological interventions, limited the ability to determine whether HIIT provided unique advantages over other approaches.

9.1.4. Unmeasured Psychobiological Mechanisms

Although the study was informed by theoretical frameworks such as neurochemical modulation, hypothalamic-pituitary-adrenal (HPA) axis regulation, and anti-inflammatory pathways, no short-term biological measures were collected. This prevented direct empirical validation of the proposed mechanism.

9.1.5. Self-Report Bias and Measurement Tools

Psychological outcomes were measured exclusively with self-report instruments, namely the Beck Depression Inventory-II (BDI-II) and the Beck Anxiety Inventory (BAI). While these are validated and widely used tools, they are subject to biases such as social desirability and cultural stigma, which are particularly relevant in collectivist societies like Iran. This reliance on self-report measures may have influenced the accuracy of the findings.

9.1.6. Other Influencing Variables

Several lifestyle and contextual factors that can affect both physical and mental health were not systematically monitored. These include sleep quality, dietary patterns, medication use, menopausal status, employment conditions, social support, and financial hardship. Failure to control for these variables limits the ability to attribute observed effects solely to HIIT.

9.2. SUGGESTIONS FOR FUTURE STUDIES

9.2.1. Expansion of Population and Context

Future studies should aim to recruit larger and more diverse samples in order to improve the external validity of findings. Including men, individuals from different age groups, and women living in rural as well as urban environments would make it possible to determine whether the benefits of HIIT apply across broader demographic and cultural contexts.

9.2.2. Comparative Intervention Designs

Future research should consider using comparative study designs that directly compare HIIT with other approaches, such as moderate-intensity continuous training (MICT), resistance training, or psychological programs like cognitive-behavioral therapy. Such comparative approaches would help clarify the unique contributions of HIIT and its relative advantages over alternative interventions.

9.2.3. Integration of Biological Markers

Future studies should incorporate biological markers to provide clearer evidence for the mechanisms through which HIIT affects mental health. Suggested markers include cortisol, brain-derived neurotrophic factor (BDNF), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- α), as these are closely linked to neuroendocrine, metabolic, and inflammatory pathways. Combining biomarker assessment with qualitative follow-up could offer a more complete understanding of the processes involved. It is also essential to examine whether the observed effects are driven mainly by physiological responses to HIIT or are shaped by additional psychosocial and environmental factors.

9.2.4. Long-Term Follow-Up Studies

Further research should extend beyond the 10-month intervention window used in the present study. Longitudinal designs with follow-up assessments would help determine whether the improvements in depression, anxiety, and body composition are sustained over time, and whether maintenance strategies or booster sessions are needed to preserve the benefits.

9.2.5. Culturally Sensitive and Cost-Effective Approaches

Future interventions should also consider the sociocultural and economic realities of the Iranian context. Designing culturally sensitive and cost-effective HIIT programs that can be implemented in community gyms, health centers, or home-based formats would increase accessibility and adherence. Group-based interventions, minimal equipment requirements, and flexible scheduling may further enhance feasibility in populations with limited resources.

9.2.6. Standardization and Methodological Rigor

Future research should focus on improving the overall design of HIIT studies. Clearer standards are needed for the intensity, duration, and frequency of HIIT sessions so that results can be compared across studies. Using randomized controlled trials with stronger randomization and, when possible, blinded assessments would also help reduce bias and increase confidence in the findings. Another important step is to track adherence more carefully and to include longer follow-up periods to see if the benefits of HIIT last over time. Finally, combining quantitative outcomes with qualitative insights from participants can provide a deeper and more realistic understanding of how HIIT influences mental health.

9.2.7. Improvement of Assessment Methods

Finally, future research should use a combination of assessment strategies to strengthen the validity of psychological outcomes. Alongside self-report questionnaires, clinician ratings, structured diagnostic interviews, or observer

ratings should be incorporated to reduce the risk of response bias and provide a more accurate evaluation of mental health improvements.

X – BIBLIOGRAPHICAL REFERENCES

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- Ahad, A. A., Sanchez-Gonzalez, M., & Junquera, P. (2023). Understanding and addressing mental health stigma across Cultures for Improving Psychiatric Care: A narrative review. *Cureus*. <https://doi.org/10.7759/cureus.39549>
- Alblooshi, S., Taylor, M., & Gill, N. (2023). Does menopause elevate the risk for developing depression and anxiety? Results from a systematic review. *Australasian Psychiatry*, 31(2). <https://doi.org/10.1177/10398562231165439>
- Al-Harbi, K. S. (2012). Treatment-resistant depression: Therapeutic trends, challenges, and future directions. In *Patient Preference and Adherence*, 6, 369–385. <https://doi.org/10.2147/PPA.S29716>
- Aligol, M., Mohammadi, N. K., Mohammadbeigi, A., Hardy, L. L., & Ramezankhani, A. (2017). Physical activity and associated factors among women in suburban areas: Findings of a community-based study in Iran. *Journal of Fundamental and Applied Sciences*, 9(1S), 1313–1326. <https://doi.org/10.4314/jfas.v9i1s.785>
- AlMutlaqah, M. N., Al-Mutairi, J. M., Ali, W. K., Almutayri, A. M. H., Al-Dhafiri, M. K. M., Thubab, A. H. A., Qaysi, A. O. H., Alrasheedi, M. M., Alharbi, K. A., Taleb, K. A. M., Aldhafeei, H. K. A., Alharbi, N. A., Alghamadi, S. S. S., Sehaqi, I. A., & Almalkiy, B. H. M. (2024). The comprehensive role of physical exercise in enhancing mental health: An academic review of current evidence and implications for treatment strategies. *Journal of Ecohumanism*, 3(8). <https://doi.org/10.62754/joe.v3i8.5542>
- Aloosh, M., Salavati, A., & Aloosh, A. (2019). Economic sanctions threaten population health: the case of Iran. *Public Health*, 169. <https://doi.org/10.1016/j.puhe.2019.01.006>
- Anjum, G., & Aziz, M. (2025). Climate change and gendered vulnerability: A systematic review of women's health. *Women's Health*, 21. <https://doi.org/10.1177/17455057251323645>

- Asar, M. E., Saleh, E., & Ghaneapur, M. (2023). Innovative and motivational SDT-based approach to promote Iranian women's physical activity. *Journal of Advanced Pharmacy Education and Research*, 13(1). <https://doi.org/10.51847/gcrJpRS1SU>
- Atakan, M. M., Li, Y., Koşar, Ş. N., Turnagöl, H. H., & Yan, X. (2021). Evidence-based effects of high-intensity interval training on exercise capacity and health: A review with historical perspective. *International Journal of Environmental Research and Public Health*, 18(13). <https://doi.org/10.3390/ijerph18137201>
- Azizi, M., Fooladi, E., Bell, R. J., Elyasi, F., Masoumi, M., & Davis, S. R. (2019). Depressive symptoms and associated factors among Iranian women at midlife: A community-based, cross-sectional study. *Journal of the North American Menopause Society*, 26(10). <https://doi.org/10.1097/GME.0000000000001374>
- Baber, R. (2023). World Menopause Day. *Climacteric*, 26(5). <https://doi.org/10.1080/13697137.2023.2247269>
- Badawy, Y., Spector, A., Li, Z., & Desai, R. (2024). The risk of depression in the menopausal stages: A systematic review and meta-analysis. *Journal of Affective Disorders*, 357, 1-10. <https://doi.org/10.1016/j.jad.2024.04.041>
- Bagheri, S., Ezzati_Rastegar, K., Rahimzadeh, A., Bidarpoor, F., Hosseini, A., Amani, S., Salahian, B., & Setayesh, A. (2023). Identifying sociocultural factors affecting physical activity in women residing in the slum areas of Sanandaj, Iran. *Chronic Diseases Journal*, 11, 167-174. <https://doi.org/10.22122/cdj.v11i3.642>
- Bajwa, H. A., Iqbal, M. U., Ali, M. S., Abbas, M. A., Gul, A., Ghani, M., & Khalid, I. (2024). Multidimensional impact of regular physical activity on adolescent mental health, integrating neurobiological and psychosocial mechanisms. *Developmental Medico-life-sciences*, 1(7), 20-28. <https://doi.org/10.69750/dmls.01.07.060>
- Ballesta-García, I., Martínez-González-Moro, I., Ramos-Campo, D. J., & Carrasco-Poyatos, M. (2020). High-intensity interval circuit training versus moderate-intensity continuous training on cardiorespiratory fitness in

- middle-aged and older women: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, 17(5). <https://doi.org/10.3390/ijerph17051805>
- Ballot, O., Ivers, H., Ji, X., & Morin, C. M. (2022). Sleep disturbances during the Menopausal transition: The role of sleep reactivity and arousal predisposition. *Behavioral Sleep Medicine*, 20(4). <https://doi.org/10.1080/15402002.2021.1937171>
- Bang-Kittilsen, G., Engh, J. A., Holst, R., Holmen, T. L., Bigseth, T. T., Andersen, E., Mordal, J., & Egeland, J. (2022). High-intensity interval training may reduce depressive symptoms in individuals with schizophrenia, putatively through improved VO2max: A randomized controlled trial. *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsy.2022.921689>
- Bansal, P., Chaudhary, A., Soni, R., Sharma, S., Gupta, V., & Kaushal, P. (2015). Depression and anxiety among middle-aged women: A community-based study. *Journal of Family Medicine and Primary Care*, 4(4). <https://doi.org/10.4103/2249-4863.174297>
- Bao, Y., Sun, J., & Zhang, X. (2025). Enhancing psychological health and cognitive inhibition in college students: insights from mindfulness training and high-intensity interval training. *Frontiers in Psychology*, 16. <https://doi.org/10.3389/fpsyg.2025.1528049>
- Batacan, R. B., Duncan, M. J., Dalbo, V. J., Tucker, P. S., & Fenning, A. S. (2017). Effects of high-intensity interval training on cardiometabolic health: A systematic review and meta-analysis of intervention studies. *British Journal of Sports Medicine*, 51(6). <https://doi.org/10.1136/bjsports-2015-095841>
- Batrakoulis, A., & Fatouros, I. G. (2022). Psychological adaptations to high-intensity interval training in overweight and obese adults: A Topical Review. *Sports*, 10 (5). <https://doi.org/10.3390/sports10050064>
- Batrakoulis, A., Loules, G., Georgakouli, K., Tsimeas, P., Draganidis, D., Chatzinikolaou, A., Papanikolaou, K., Deli, C. K., Syrou, N., Comoutos, N., Theodorakis, Y., Jamurtas, A. Z., & Fatouros, I. G. (2020). High-intensity interval neuromuscular training promotes exercise behavioral regulation, adherence and weight loss in inactive obese women. *European*

- Journal of Sport Science*, 20(6).
<https://doi.org/10.1080/17461391.2019.1663270>
- Beck, A.T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*, 56(6). <https://doi.org/10.1037/0022-006X.56.6.893>
- Beck, A.T., Steer, R. A., & Brown, G. K. (1996). Manual for the Beck depression inventory-II. San Antonio, TX: Psychological Corporation.
- Berger, V. W., & Zhou, Y. (2014). Kolmogorov–Smirnov test: Overview. In Wiley StatsRef: Statistics Reference Online. <https://doi.org/10.1002/9781118445112.stat06558>
- Biddle, S. J. H., Ciacconi, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise*, 42, 146–155. <https://doi.org/10.1016/j.psychsport.2018.08.011>
- Bidhuri, D., Kalra, S., Saher, T., Parveen, A., Ajmera, P., & Miraj, M. (2025). Current concepts of high intensity interval training: A clinical commentary. *Comparative Exercise Physiology*, 21(1). <https://doi.org/10.1163/17552559-00001073>
- Bigalke, J. A., Durocher, J. J., Greenlund, I. M., Keller-Ross, M., & Carter, J. R. (2023). Blood pressure and muscle sympathetic nerve activity are associated with trait anxiety in humans. *American Journal of Physiology-Heart and Circulatory Physiology*, 324(4), H494–H503. <https://doi.org/10.1152/ajpheart.00026.2023>
- Blumenthal, J. A., & Rozanski, A. (2023). Exercise as a therapeutic modality for the prevention and treatment of depression. *Progress in Cardiovascular Diseases*, 77, 45–52. <https://doi.org/10.1016/j.pcad.2023.02.008>
- Bondarev, D., Sipilä, S., Finni, T., Kujala, U. M., Aukee, P., Kovanen, V., Laakkonen, E. K., & Kokko, K. (2021). Associations of physical performance and physical activity with mental well-being in middle-aged women. *BMC Public Health*, 21(1). <https://doi.org/10.1186/s12889-021-11485-2>
- Borrega-Mouquinho, Y., Sánchez-Gómez, J., Fuentes-García, J. P., Collado-Mateo, D., & Villafaina, S. (2021). Effects of High-intensity interval training and

- moderate-intensity training on stress, depression, anxiety, and resilience in healthy adults during coronavirus disease 2019 confinement: A Randomized Controlled Trial. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.643069>
- Borycka, A., Jędrzejewska, B., Kotulska, M., Laskus, P., Lichman, M., Lubczyńska, Z., Potocka, Z., Przeradzki, J., Rząd, K., & Szyca, M. (2023). A systematic review of the influence of high-intensity interval training on body composition and synthesizing evidence from scientific literature. *Journal of Education, Health and Sport*, 27(1). <https://doi.org/10.12775/jehs.2023.27.01.008>
- Bratland-Sanda, S., Pedersen, F. G., Haave, M. N., Helgerud, J., & Støren, Ø. (2020). Large inter-individual differences in responses to a block of high intensity aerobic interval training: A case series in national-level cyclists and triathletes. *International Journal of Exercise Science*, 13(2). <https://doi.org/10.70252/otac6224>
- Bromberger, J. T., Schott, L., Kravitz, H. M., & Joffe, H. (2015). Risk factors for major depression during midlife among a community sample of women with and without prior major depression: are they the same or different? *Psychological Medicine*, 45(8), 1653–1664. <https://doi.org/10.1017/S0033291714002773>
- Cabral, D. F., Fried, P. J., Bigliassi, M., Cahalin, L. P., & Gomes-Osman, J. (2024). Determinants of exercise adherence in sedentary middle-aged and older adults. *Psychophysiology*, 61(9). <https://doi.org/10.1111/psyp.14591>
- Campbell, O. L. K., Bann, D., & Patalay, P. (2021). The gender gap in adolescent mental health: A cross-national investigation of 566,829 adolescents across 73 countries. *SSM - Population Health*, 13. <https://doi.org/10.1016/j.ssmph.2021.100742>
- Campos, A. I., Mulcahy, A., Thorp, J. G., Wray, N. R., Byrne, E. M., Lind, P. A., Medland, S. E., Martin, N. G., Hickie, I. B., & Rentería, M. E. (2021). Understanding genetic risk factors for common side effects of antidepressant medications. *Communications Medicine*, 1(1). <https://doi.org/10.1038/s43856-021-00046-8>

- Caplin, A., Chen, F. S., Beauchamp, M. R., & Puterman, E. (2021). The effects of exercise intensity on the cortisol response to a subsequent acute psychosocial stressor. *Psychoneuroendocrinology*, 131. <https://doi.org/10.1016/j.psyneuen.2021.105336>
- Chavan, M., Prado, R. C. R., Ashley, C. D., & Kilpatrick, M. W. (2024). Psychophysiological responses to high-intensity interval training exercise over menstrual cycle phases: An Exploratory Study. *Medicine and Science in Sports and Exercise*, 56(8). <https://doi.org/10.1249/MSS.0000000000003426>
- Chen, C., & Nakagawa, S. (2023). Recent advances in the study of the neurobiological mechanisms behind the effects of physical activity on mood, resilience and emotional disorders. *Advances in Clinical and Experimental Medicine*, 32(9), 937–942. <https://doi.org/10.17219/acem/171565>
- Chen, Y., Song, J., Qu, W., Zhao, Y., Xu, J., Xu, H., Tan, Y., Wang, Z., Liu, D., & Tan, S. (2025). Physical activity alleviates mental health problems related to bullying through moderating rumination. *Asian Journal of Psychiatry*, 105. <https://doi.org/10.1016/j.ajp.2025.104391>
- Chu, A., & Wadhwa, R. (2025). Selective serotonin reuptake inhibitors. In *StatPearls*. <https://www.ncbi.nlm.nih.gov/books/NBK554406/>
- Ciułek, U., Bilska, W., Żydek, A., Zduńczyk, W., Dobosz, A., Dubińska, M., & Paduch-Jakubczyk, W. (2024). Impact of physical activity on menopausal symptoms and health in middle-aged women. *Quality in Sport*, 21. <https://doi.org/10.12775/qs.2024.21.54144>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates
- Cosci, F., & Fava, G. A. (2021). When anxiety and depression coexist: The role of differential diagnosis using clinometric criteria. *Psychotherapy and Psychosomatics*, 90 (5). <https://doi.org/10.1159/000517518>
- Costigan, S. A., Eather, N., Plotnikoff, R. C., Hillman, C. H., & Lubans, D. R. (2016). High-intensity interval training for cognitive and mental health in adolescents. *Medicine and Science in Sports and Exercise*, 48(10). <https://doi.org/10.1249/MSS.0000000000000993>

- Craft, L. L., & Perna, F. M. (2004). The benefits of exercise for the clinically depressed. *The Primary Care Companion For CNS Disorders*, 6(3). <https://doi.org/10.4088/pcc.v06n0301>
- Crofts, C., Schofield, G., & Dickson, G. (2012). Women-only mass participation sporting events: Does participation facilitate changes in physical activity? *Annals of Leisure Research*, 15(2). <https://doi.org/10.1080/11745398.2012.685297>
- Cuevas, A. G., Grotorex-Voith, S., Assari, S., Slopen, N., & Economos, C. D. (2021). Longitudinal analysis of psychosocial stressors and body mass index in middle-aged and older adults in the United States. *Journals of Gerontology: Series B*, 76(8). <https://doi.org/10.1093/geronb/gbaa142>
- Cuijpers, P., Karyotaki, E., Reijnders, M., Purgato, M., & Barbui, C. (2018). Psychotherapies for depression in low- and middle-income countries: a meta-analysis. *World Psychiatry*, 17(1). <https://doi.org/10.1002/wps.20493>
- Dabrowska-Gałas, M., & Dąbrowska, J. (2021). Physical activity level and self-esteem in middle-aged women. *International Journal of Environmental Research and Public Health*, 18(14). <https://doi.org/10.3390/ijerph18147293>
- Dale, E., Bang-Andersen, B., & Sánchez, C. (2015). Emerging mechanisms and treatments for depression beyond SSRIs and SNRIs. *Biochemical Pharmacology*, 95(2). <https://doi.org/10.1016/j.bcp.2015.03.011>
- Dashti, S., Joseph, H. L., Esfehiani, A. J., Su, T. T., Latiff, L. A., & Esfehiani, R. J. (2014). Perceived barriers to physical activity among Iranian women. *World Applied Sciences Journal*, 32(3). <https://doi.org/10.5829/idosi.wasj.2014.32.03.1033>
- de Sousa, R. A. L., de Lima, N. S., Amorim, F. T., Gripp, F., Diniz e Magalhães, C. O., Pinto, S. H., Dias-Peixoto, M. F., Monteiro-Junior, R. S., Bourbeau, K., & Cassilhas, R. C. (2021). Endurance and high-intensity interval training improve the levels of anxiety and quality of life in overweight men. *Revista da Associação Médica Brasileira*, 67(8). <https://doi.org/10.1590/1806-9282.20210608>
- Denton, E. (2020). Depression: Symptoms. In *Encyclopedia of Behavioral Medicine* (pp. 631–633). Springer International Publishing. https://doi.org/10.1007/978-3-030-39903-0_1121

- Dishman, R. K., Berthoud, H. R., Booth, F. W., Cotman, C. W., Edgerton, V. R., Fleshner, M. R., Gandeia, S. C., Gomez-Pinilla, F., Greenwood, B. N., Hillman, C. H., Kramer, A. F., Levin, B. E., Moran, T. H., Russo-Neustadt, A. A., Salamone, J. D., van Hooissen, J. D., Wade, C. E., York, D. A., & Zigmond, M. J. (2006). Neurobiology of exercise. *Obesity*, 14(3). <https://doi.org/10.1038/oby.2006.46>
- Dolatabadi, Z., Amiri-Farahani, L., Ahmadi, K., & Pezaro, S. (2022). Barriers to physical activity in pregnant women living in Iran and its predictors: A cross-sectional study. *BMC Pregnancy and Childbirth*, 22(1). <https://doi.org/10.1186/s12884-022-05124-w>
- Doran, C. M., & Kinchin, I. (2019). A review of the economic impact of mental illness. *Australian Health Review*, 43(1). <https://doi.org/10.1071/AH16115>
- Dorosti, A., Karamouz, M., Rahimi, V. A., Azimzadeh, S., Gharaee, H., Azami-Aghdash, S., & Farahbakhsh, M. (2024). Mental health services integration in primary health care in Iran: A policy analysis. *Iranian Journal of Psychiatry*, 19(1). <https://doi.org/10.18502/ijps.v19i1.14339>
- Dotlic, J., Radovanovic, S., Rancic, B., Milosevic, B., Nicevic, S., Kurtagic, I., Markovic, N., & Gazibara, T. (2021). Mental health aspect of quality of life in the menopausal transition. *Journal of Psychosomatic Obstetrics and Gynecology*, 42(1). <https://doi.org/10.1080/0167482X.2020.1734789>
- Duman, F., Kokaçya, M. H., Doğru, E., Katayıfci, N., Canbay, Ö., & Aman, F. (2016). The role of active video-accompanied exercises in improvement of the obese state in children: A prospective study from Turkey. *Journal of Clinical Research in Pediatric Endocrinology*, 8(3). <https://doi.org/10.4274/jcrpe.2284>
- Dupuit, M., Maillard, F., Pereira, B., Marquezi, M. L., Lancha, A. H., & Boisseau, N. (2020). Effect of high intensity interval training on body composition in women before and after menopause: A meta-analysis. *Experimental Physiology*, 105 (9). <https://doi.org/10.1113/EP088654>
- Eaton, N. R., Keyes, K. M., Krueger, R. F., Balsis, S., Skodol, A. E., Markon, K. E., Grant, B. F., & Hasin, D. S. (2012). An invariant dimensional liability model of gender differences in mental disorder prevalence: Evidence

- from a national sample. *Journal of Abnormal Psychology*, 121(1).
<https://doi.org/10.1037/a0024780>
- Ekkekakis, P., & Biddle, S. J. H. (2023). Extraordinary claims in the literature on high-intensity interval training (HIIT): IV. Is HIIT associated with higher long-term exercise adherence? *Psychology of Sport and Exercise*, 64.
<https://doi.org/10.1016/j.psychsport.2022.102295>
- El Khoudary, S. R., Greendale, G., Crawford, S. L., Avis, N. E., Brooks, M. M., Thurston, R. C., Karvonen-Gutierrez, C., Waetjen, L. E., & Matthews, K. (2019). The menopause transition and women's health at midlife: A progress report from the Study of Women's Health across the Nation (SWAN). *Menopause*, 26 (10).
<https://doi.org/10.1097/GME.0000000000001424>
- Elhamalawy, A. (2024). Review of the pros and cons when comparing high-intensity interval training to moderate-intensity continuous training. *International Journal of Research in Medical Sciences*, 12(2).
<https://doi.org/10.18203/2320-6012.ijrms20240243>
- Emami, F., Ghorbani, M., Dostdar Rozbahani, A., & Rohani, A. (2022). Designing strategies for the development of health and physical activities of women in Iran. *Archives in Military Medicine*, 9(4).
<https://doi.org/10.5812/jamm.120275>
- Enjebab, B., Farajzadegan, Z., Taleghani, F., & Aflatoonian, A. (2014). Gender barriers to health promotion in middle-aged Iranian women. *Journal of Biosocial Science*, 46(6). <https://doi.org/10.1017/S0021932013000618>
- Eyre, H., & Baune, B. T. (2012). Neuroimmunological effects of physical exercise in depression. *Brain, Behavior, and Immunity*, 26 (2).
<https://doi.org/10.1016/j.bbi.2011.09.015>
- Faleschini, S., Tiemeier, H., Rifas-Shiman, S. L., Rich-Edwards, J., Joffe, H., Perng, W., Shifren, J., Chavarro, J. E., Hivert, M. F., & Oken, E. (2022). Longitudinal associations of psychosocial stressors with menopausal symptoms and well-being among women in midlife. *Menopause*, 29(11).
<https://doi.org/10.1097/GME.0000000000002056>
- Farzaneh, S., Ezabadi, R. R., Marandi, P. K., & Ranawat, V. (2021). Identifying barriers to women's participation in sports activities in both urban and

- rural communities. *International Journal of Human Movement and Sports Sciences*, 9(3). <https://doi.org/10.13189/saj.2021.090320>
- Freeman, M. P., Wosnitzer Smith, K., Freeman, S. A., McElroy, S. L., Kmetz, G. F., Wright, R., & Keck, P. E. (2002). The impact of reproductive events on the course of bipolar disorder in women. *Journal of Clinical Psychiatry*, 63(4). <https://doi.org/10.4088/JCP.v63n0403>
- Frimpong, E., Dafkin, C., Donaldson, J., Millen, A. M. E., & Meiring, R. M. (2019). The effect of home-based low-volume, high-intensity interval training on cardiorespiratory fitness, body composition and cardiometabolic health in women of normal body mass and those with overweight or obesity: Protocol for a randomized controlled trial. *BMC Sports Science, Medicine and Rehabilitation*, 11(1). <https://doi.org/10.1186/s13102-019-0152-6>
- Gastwirth, J. L., Gel, Y. R., & Miao, W. (2009). The impact of Levene's test of equality of variances on statistical theory and practice. *Statistical Science*, 24(3). <https://doi.org/10.1214/09-STS301>
- Ghanean, H., Nojomi, M., & Jacobsson, L. (2011). Internalized stigma of mental illness in Tehran, Iran. *Stigma Research and Action*, 1(1). <https://doi.org/10.5463/sra.v1i1.10>
- Ghanizadeh, A., Arkan, N., Mohammadi, M. R., Ghanizadeh-Zarchi, M. A., & Ahmadi, J. (2008). Frequency of and barriers to utilization of mental health services in an Iranian population. *Eastern Mediterranean Health Journal*, 14(2).
- Gharraee, B., Tajrishi, K. Z., Sheybani, F., Tahmasbi, N., Mirzaei, M., Naserbakht, M., & Farahani, H. (2019). Prevalence of major depressive disorder in the general population of Iran: A systematic review and meta-analysis. *Medical Journal of the Islamic Republic of Iran*, 33(1). <https://doi.org/10.47176/mjiri.33.151>
- Ghassemzadeh, H., Mojtabai, R., Karamghadiri, N., & Ebrahimkhani, N. (2005). Psychometric properties of a Persian-language version of the Beck Depression Inventory-second edition: BDI-II-Persian. *Depression and Anxiety*, 21(4). <https://doi.org/10.1002/da.20070>
- Ghazanfarpour, M., Mohammadzadeh, F., shokrollahi, P., Khadivzadeh, T., Najaf Najafi, M., Hajirezaee, H., & Afiat, M. (2018). Effect of *Foeniculum vulgare*

- (fennel) on symptoms of depression and anxiety in postmenopausal women: A double-blind randomized controlled trial. *Journal of Obstetrics and Gynaecology*, 38(1). <https://doi.org/10.1080/01443615.2017.1342229>
- Gibala, M. J., Little, J. P., Macdonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low-volume, high-intensity interval training in health and disease. *Journal of Physiology*, 590(5). <https://doi.org/10.1113/jphysiol.2011.224725>
- Gonçalves, C., Bravo, J., Abreu, A., Pais, J., & Raimundo, A. (2025). Comparing high-intensity versus moderate-intensity exercise training in coronary artery disease patients: A randomized controlled trial with 6- and 12-month follow-up. *Journal of Public Health (Germany)*, 33(12). <https://doi.org/10.1007/s10389-024-02224-z>
- Gong, C., Li, Y., & Chen, G. (2024). Relationship between physical exercise and risk of depression: An assessment of intermediate variables through self-assessed health status and life satisfaction in the Chinese Family Tracking Survey (CFPS) data. *Risk Management and Healthcare Policy*, 17. <https://doi.org/10.2147/RMHP.S499489>
- Graça, Á., Fonseca, H. S., Pina, F. L. C., Fiorillo, R. G., Mayhew, J. L., Gerage, A. M., Oliveira, D. V. de, & Nascimento, M. A. do. (2022). Effects of different order of combined training on functional capacity, blood pressure, and body composition in women from 53 to 79 years old. *Geriatrics Gerontology and Aging*, 16. <https://doi.org/10.53886/gga.e0220013>
- Groen, R. N., Ryan, O., Wigman, J. T. W., Riese, H., Penninx, B. W. J. H., Giltay, E. J., Wichers, M., & Hartman, C. A. (2020). Comorbidity between depression and anxiety: Assessing the role of bridge mental states in dynamic psychological networks. *BMC Medicine*, 18(1). <https://doi.org/10.1186/s12916-020-01738-z>
- Gulyaeva, V. v., Zinchenko, M. I., Uryumtsev, D. Y., Krivoschekov, S. G., & Aftanas, L. I. (2019). Exercise for depression treatment. Physiological mechanisms. *Zhurnal Nevrologii i Psikiatrii Imeni S.S. Korsakova*, 119(7). <https://doi.org/10.17116/jnevro2019119071112>
- Hajebi, A., Hajiabadi, I. Z., Fendereski, A., Ghodssighassemabadi, R., Zamani Hajiabadi, A., Hosseini, J., & Samadaee Gelehkolae, K. (2025). Prevalence

- of major depressive disorder in Iranian men from 2011 to 2022: A systematic review and meta-analysis. *BMC Psychiatry*, 25 (1). <https://doi.org/10.1186/s12888-025-06616-7>
- Handley, M. A., Lyles, C. R., McCulloch, C., & Cattamanchi, A. (2018). Selecting and improving quasi-experimental designs in effectiveness and implementation research. *Annual Review of Public Health*, 39. <https://doi.org/10.1146/annurev-publhealth-040617-014128>
- Hassan, J., Shannon, S., Tully, M. A., McCartan, C., Davidson, G., Bunn, R., & Breslin, G. (2022). Systematic review of physical activity interventions assessing physical and mental health outcomes in patients with severe mental illness within secure forensic settings. *Journal of Psychiatric and Mental Health Nursing*, 29 (5). <https://doi.org/10.1111/jpm.12832>
- Heisz, J. J., Marashi, M., Nicholson, E., & Ogrodnik, M. (2021). HIIT as a tool for improving mental health and cognition. *ACSM's Health and Fitness Journal*, 25(5). <https://doi.org/10.1249/FIT.0000000000000700>
- Heo, S. J., & Jee, Y. S. (2024). Intensity-effects of strengthening exercise on thigh muscle volume, pro- or anti-inflammatory cytokines, and immunocytes in the older adults: A randomized controlled trial. *Archives of Gerontology and Geriatrics*, 116. <https://doi.org/10.1016/j.archger.2023.105136>
- Herson, M., & Kulkarni, J. (2022). Hormonal agents for the treatment of depression associated with the menopause. *Drugs and Aging*, 39 (8). <https://doi.org/10.1007/s40266-022-00962-x>
- Hickey, M., Bryant, C., & Judd, F. (2012). Evaluation and management of depressive and anxiety symptoms in midlife. *Climacteric*, 15(1), 3–9. <https://doi.org/10.3109/13697137.2011.620188>
- Hofmann, S. G., & Gómez, A. F. (2017). Mindfulness-based interventions for anxiety and depression. *Psychiatric Clinics of North America*, 40 (4). <https://doi.org/10.1016/j.psc.2017.08.008>
- Hook, K., Ametaj, A., Cheng, Y., Serba, E. G., Henderson, D. C., Hanlon, C., & Ng, L. C. (2021). Psychotherapy in a resource-constrained setting: Understanding context for adapting and integrating a brief psychological

- intervention into primary care. *Psychotherapy*, 58(4).
<https://doi.org/10.1037/pst0000364>
- Hoseini, R., Hoseini, Z., Pourahmadi, D., & Kamangar, A. (2025). Demographic, cultural, and health correlates of physical activity and sports participation among adults in Kermanshah province, Iran. *BMC Public Health*, 25(1).
<https://doi.org/10.1186/s12889-025-23083-7>
- Hossain, M. N., Lee, J., Choi, H., Kwak, Y. S., & Kim, J. (2024). The impact of exercise on depression: How moving makes your brain and body feel better. *Physical Activity and Nutrition*, 28 (2).
<https://doi.org/10.20463/pan.2024.0015>
- Hsieh, S. S., Chueh, T. Y., Huang, C. J., Kao, S. C., Hillman, C. H., Chang, Y. K., & Hung, T. M. (2021). Systematic review of the acute and chronic effects of high-intensity interval training on executive function across the lifespan. *Journal of Sports Sciences*, 39(1).
<https://doi.org/10.1080/02640414.2020.1803630>
- Ionescu, D. F., Niciu, M. J., Mathews, D. C., Richards, E. M., & Zarate, C. A. (2013). Neurobiology of anxious depression: A review. *Depression and Anxiety*, 30 (4). <https://doi.org/10.1002/da.22095>
- Jabbour, G., & Iancu, H. D. (2024). Anaerobic and aerobic contributions to repeated supramaximal cycling exercises and their adaptation to high-intensity interval training in obese perimenopausal and postmenopausal women. *Menopause*, 31(1), 39–45.
<https://doi.org/10.1097/GME.0000000000002284>
- Jacob, K. S. (2011). Repackaging mental health programs in low-and middle-income countries. *Indian Journal of Psychiatry*, 53 (3).
<https://doi.org/10.4103/0019-5545.86798>
- Jannati, N., Farokhzadian, J., & Ahmadian, L. (2021). The experience of healthcare professionals providing mental health services to mothers with postpartum depression: A qualitative study. *Sultan Qaboos University Medical Journal*, 21(4), e532–e538.
<https://doi.org/10.18295/squmj.4.2021.031>
- Javed, A., Lee, C., Zakaria, H., Buenaventura, R. D., Cetkovich-Bakmas, M., Duailibi, K., Ng, B., Ramy, H., Saha, G., Arifeen, S., Elorza, P. M.,

- Ratnasingham, P., & Azeem, M. W. (2021). Reducing the stigma of mental health disorders with a focus on low- and middle-income countries. *Asian Journal of Psychiatry*, 58. <https://doi.org/10.1016/j.aip.2021.102601>
- Joffe, H., Chang, Y., Dhaliwal, S., Hess, R., Thurston, R., Gold, E., Matthews, K. A., & Bromberger, J. T. (2012). Lifetime history of depression and anxiety disorders as a predictor of quality of life in midlife women in the absence of current illness episodes. *Archives of General Psychiatry*, 69(5). <https://doi.org/10.1001/archgenpsychiatry.2011.1578>
- Johansson, L., Guo, X., Hällström, T., Norton, M. C., Waern, M., Östling, S., Bengtsson, C., & Skoog, I. (2013). Common psychosocial stressors in middle-aged women related to longstanding distress and increased risk of Alzheimer's disease: A 38-year longitudinal population study. *BMJ Open*, 3(9). <https://doi.org/10.1136/bmjopen-2013-003142>
- Jung, H., von Sternberg, K., & Davis, K. (2017). The impact of mental health literacy, stigma, and social support on attitudes toward mental health help-seeking. *International Journal of Mental Health Promotion*, 19(5), 252–267. <https://doi.org/10.1080/14623730.2017.1345687>
- Kamyab, F., & Hoseinzadeh, A. (2023). The psychological impact of social expectations on women's personal choices. *The Psychology of Woman Journal*, 4(2), 1-12. <https://doi.org/10.61838/kman.pwj.4.2.20>
- Kandola, A., Ashdown-Franks, G., Hendrikse, J., Sabiston, C. M., & Stubbs, B. (2019). Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity. *Neuroscience and Biobehavioral Reviews*, 107, 525-539. <https://doi.org/10.1016/j.neubiorev.2019.09.040>
- Kang, D. W., Fairey, A. S., Boulé, N. G., Field, C. J., Wharton, S. A., & Courneya, K. S. (2022). A randomized trial of the effects of exercise on anxiety, fear of cancer progression, and quality of life in prostate cancer patients on active surveillance. *Journal of Urology*, 207(4), 894–903. <https://doi.org/10.1097/JU.0000000000002334>

- Kaviani, H., & Mousavi, A. S. (2008). Psychometric properties of the Persian version of beck anxiety inventory (BAI). *Tehran University Medical Journal*, 66(2), 136–140.
- Kazemi Karyani, A., Karimi Matin, B., Soltani, S., Rezaei, S., Soofi, M., Salimi, Y., Moradinazar, M., Hajizadeh, M., Pasdar, Y., Hamzeh, B., Barzegar, L., Haghdooost, A. A., Malekzadeh, R., Poustchi, H., Mohammadi, Z., Faramarzi, E., Safarpour, A. R., Pourfarzi, F., Moosazadeh, M., Nejatizadeh, A., Farjam, M., Vahabzadeh, D., Ahmadi, A., Ghorat, F., Ahmadi, J., Mansour-Ghanaei, F., Mirjalili, M.R., Eslami, S., Maharlouei, N., Tabatabaei, S.M., Sarvandi, S., Najafi, F. (2019). Socioeconomic gradient in physical activity: Findings from the PERSIAN cohort study. *BMC Public Health*, 19(1), 1312. <https://doi.org/10.1186/s12889-019-7715-z>
- Khademi, A., Kamyab, P., Kouchaki, H., Kazemi, M., & Goharinia, M. (2025). Age of onset, sociodemographic, and clinical predictors of depression: A population-based study in rural southern Iran. *BMC Public Health*, 25(1). <https://doi.org/10.1186/s12889-025-22993-w>
- Khalafi, M., & Symonds, M. E. (2020). The impact of high-intensity interval training on inflammatory markers in metabolic disorders: A meta-analysis. *Scandinavian Journal of Medicine and Science in Sports*, 30 (11), 2020–2036. <https://doi.org/10.1111/sms.13754>
- Kheirikhah, M. T., Mokarrami, M., Kazemitabar, M., & Garcia, D. (2023). Inequalities in care for Iranian women suffering from the comorbidity of substance use and mental illness: The need for integrated treatment. *Health Promotion Perspectives*, 13(3), 222–229. <https://doi.org/10.34172/hpp.2023.24>
- Khosromanesh, R., Dzioban, K., Turkmani, E. M., & Asadolai, A. (2023). Middle-aged women's perceptions and experiences of physical activity: A grounded theory approach. *Physical Culture and Sport, Studies and Research*, 98(1). <https://doi.org/10.2478/pcssr-2023-0004>
- Kim, H. Y. (2020). Factors affecting aging anxiety in middle-aged women. *Journal of the Korea Academia-Industrial Cooperation Society*, 21(6), 563–573. <https://doi.org/10.5762/kais.2020.21.6.563>

- Ko, J. M., So, W. Y., & Park, S. E. (2025). Narrative review of high-intensity interval training: Positive impacts on cardiovascular health and disease prevention. *Journal of Cardiovascular Development and Disease*, 12 (4). <https://doi.org/10.3390/jcdd12040158>
- Kogan, C. S., Stein, D. J., Maj, M., First, M. B., Emmelkamp, P. M. G., & Reed, G. M. (2016). The classification of anxiety and fear-related disorders in the ICD-11. *Depression and Anxiety*, 33 (12). <https://doi.org/10.1002/da.22530>
- Korman, N., Armour, M., Chapman, J., Rosenbaum, S., Kisely, S., Suetani, S., Firth, J., & Siskind, D. (2020). High Intensity Interval training (HIIT) for people with severe mental illness: A systematic review and meta-analysis of intervention studies– considering diverse approaches for mental and physical recovery. *Psychiatry Research*, 284. <https://doi.org/10.1016/j.psychres.2019.112601>
- Kvam, S., Kleppe, C. L., Nordhus, I. H., & Hovland, A. (2016). Exercise as a treatment for depression: A meta-analysis. *Journal of Affective Disorders*, 202. <https://doi.org/10.1016/j.jad.2016.03.063>
- Laar, R., Zhang, J., Yu, T., Qi, H., & Ashraf, M. A. (2019). Constraints to women's participation in sports: a study of participation of Pakistani female students in physical activities. *International Journal of Sport Policy and Politics*, 11(3), 449–468. <https://doi.org/10.1080/19406940.2018.1481875>
- Lapointe, T., Houle, J., Sia, Y. T., Payette, M., & Trudeau, F. (2023). Addition of high-intensity interval training to a moderate intensity continuous training cardiovascular rehabilitation program after ischemic cerebrovascular disease: A randomized controlled trial. *Frontiers in Neurology*, 13. <https://doi.org/10.3389/fneur.2022.963950>
- Lee, S., Jeong, S., & Choi, Y. (2022). Effects of psychological well-being and depression on menopausal symptoms in middle-aged South Korean women and the necessity of exercise. *Journal of Environmental and Public Health*, 2022. <https://doi.org/10.1155/2022/6529393>
- Legrand, F. D., Chaouloff, F., Ginoux, C., Ninot, G., Polidori, G., Beaumont, F., Murer, S., Jeandet, P., & Pelissolo, A. (2023). L'exercice physique pour la santé mentale: Mécanismes, recommandations, recherches

- futures. *L'Encéphale*, 49(3), 296–303.
<https://doi.org/10.1016/j.encep.2023.03.004>
- Leichsenring, F., Steinert, C., Rabung, S., & Ioannidis, J. P. A. (2022). The efficacy of psychotherapies and pharmacotherapies for mental disorders in adults: an umbrella review and meta-analytic evaluation of recent meta-analyses. *World Psychiatry*, 21 (1), 133–145.
<https://doi.org/10.1002/wps.20941>
- Li, Y. T., & Zhou, Y. (2025). Experimental research of impact on psychological state for adolescents with high-intensity interval training intervention. *Frontiers in Psychology*, 16.
<https://doi.org/10.3389/fpsyg.2025.1567003>
- Liang, G., Kow, A. S. F., Yusof, R., Tham, C. L., Ho, Y. C., & Lee, M. T. (2024). Menopause-associated depression: Impact of oxidative stress and neuroinflammation on the central nervous system—A review. *Biomedicines*, 12 (1).
<https://doi.org/10.3390/biomedicines12010184>
- Lindwall, M., Larsman, P., & Hagger, M. S. (2011). The reciprocal relationship between physical activity and depression in older European adults: A prospective cross-lagged panel design using SHARE data. *Health Psychology*, 30(4). <https://doi.org/10.1037/a0023268>
- Lista, I., & Sorrentino, G. (2010). Biological mechanisms of physical activity in preventing cognitive decline. *Cellular and Molecular Neurobiology*, 30 (4), 453–462. <https://doi.org/10.1007/s10571-009-9488-x>
- Liu, J., Zhang, Y., Li, X., Wang, D., Shi, B., You, Y., Min, L., Luo, B., Li, Y., Di, Q., & Ma, X. (2022). Exercise improves mental health status of young adults via attenuating inflammation factors, but modalities matter. *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsyg.2022.1067890>
- Liu, K., Zhao, W., Li, C., Tian, Y., Wang, L., Zhong, J., Yan, X., Wang, Y., Wang, L., & Wang, H. (2024). The effects of high-intensity interval training on cognitive performance: a systematic review and meta-analysis. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-83802-9>

- Liu, N., Zhang, Y., Liu, S., Zhang, X., & Liu, H. (2021). Brain functional changes in perimenopausal women: an amplitude of low-frequency fluctuation study. *Menopause*, 28(4). <https://doi.org/10.1097/GME.0000000000001720>
- Liu, Q., He, H., Yang, J., Feng, X., Zhao, F., & Lyu, J. (2020). Changes in the global burden of depression from 1990 to 2017: Findings from the Global Burden of Disease study. *Journal of Psychiatric Research*, 126, 134–140. <https://doi.org/10.1016/j.jpsychires.2019.08.002>
- Loprinzi, P. D., & Lovorn, A. (2019). Exercise and cognitive function. *Journal of Clinical Medicine*, 8(10), 1707. <https://doi.org/10.3390/jcm8101707>
- Lu, S., McVeigh, J. A., Becerra, R., Bucks, R. S., Hunter, M., & Naragon-Gainey, K. (2024). Repetitive negative thinking and emotion regulation as mediators of the association between activity-related behaviours and depression. *Journal of Affective Disorders Reports*, 16. <https://doi.org/10.1016/j.jadr.2024.100748>
- Luo, L., Li, C., Deng, Y., Wang, Y., Meng, P., & Wang, Q. (2019). High-intensity interval training on neuroplasticity and the balance between brain-derived neurotrophic factor and precursor brain-derived neurotrophic factor in poststroke depression rats. *Journal of Stroke and Cerebrovascular Diseases*, 28(3), 672–681. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2018.11.009>
- Mahdaviani, B., Soleimani, Z., Selk-Ghaffari, M., Pourgharib shahi, M. H., Masoumi, S., & Kordi, R. (2024). Barriers to physical activity in the Iranian population: findings from the STEPwise surveillance 2021. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-024-20134-3>
- Mahindru, A., Patil, P., & Agrawal, V. (2023). Role of physical activity on mental health and well-being: A review. *Cureus*, 15(1). <https://doi.org/10.7759/cureus.33475>
- Maillard, F., Rousset, S., Pereira, B., Traore, A., de Pradel Del Amaze, P., Boirie, Y., Duclos, M., & Boisseau, N. (2016). High-intensity interval training reduces abdominal fat mass in postmenopausal women with type 2 diabetes. *Diabetes and Metabolism*, 42(6), 433–441. <https://doi.org/10.1016/j.diabet.2016.07.031>

- Maki, P. M., Kornstein, S. G., Joffe, H., Bromberger, J. T., Freeman, E. W., Athappilly, G., Bobo, W. v., Rubin, L. H., Koleva, H. K., Cohen, L. S., & Soares, C. N. (2019). Guidelines for the evaluation and treatment of perimenopausal depression: Summary and recommendations. *Journal of Women's Health*, 28(2). <https://doi.org/10.1089/jwh.2018.27099.mensocrec>
- Maleki, F. M., Massahikhaleghi, P., Tehrani-Banihashemi, A., Davoudi, F., & Nojomi, M. (2020). Community-based preventive interventions for depression and anxiety in women. *Archives of Iranian Medicine*, 23(3), 171–178. <https://doi.org/10.1089/jwh.2018.27099.mensocrec>
- Maroufizadeh, S., Pourshaikhian, M., Pourramzani, A., Sheikholeslami, F., Moghadamnia, M. T., & Alavi, S. A. (2020). Prevalence of anxiety and depression in general population of Iran during the COVID-19 pandemic: A web-based cross-sectional study. *Journal of Guilan University of Medical Sciences*, 29(2), 6–15.
- Marriott, C. F. S., Petrella, A. F. M., Marriott, E. C. S., Boa Sorte Silva, N. C., & Petrella, R. J. (2021). High-intensity interval training in older adults: A scoping review. *Sports Medicine – Open*, 7 (1). <https://doi.org/10.1186/s40798-021-00344-4>
- Marshe, V. S., Islam, F., Maciukiewicz, M., Bousman, C., Eyre, H. A., Lavretsky, H., Mulsant, B. H., Reynolds, C. F., Lenze, E. J., & Müller, D. J. (2020). Pharmacogenetic implications for antidepressant pharmacotherapy in late-life depression: A systematic review of the literature for response, pharmacokinetics and adverse drug reactions. *American Journal of Geriatric Psychiatry*, 28 (6). <https://doi.org/10.1016/j.jagp.2020.01.007>
- Martinez, N., Kilpatrick, M. W., Salomon, K., Jung, M. E., & Little, J. P. (2015). Affective and enjoyment responses to high-intensity interval training in overweight-to-obese and insufficiently active adults. *Journal of Sport and Exercise Psychology*, 37(2), 138–149. <https://doi.org/10.1123/jsep.2014-0212>
- Martland, R., Korman, N., Firth, J., Vancampfort, D., Thompson, T., & Stubbs, B. (2022). Can high-intensity interval training improve mental health outcomes in the general population and those with physical illnesses? A systematic review and meta-analysis. *British Journal of Sports Medicine*, 56 (5), 279–291. <https://doi.org/10.1136/bjsports-2021-103984>

- Martland, R., Mondelli, V., Gaughran, F., & Stubbs, B. (2020). Can high-intensity interval training improve physical and mental health outcomes? A meta-review of 33 systematic reviews across the lifespan. *Journal of Sports Sciences*, 38(4), 430–469. <https://doi.org/10.1080/02640414.2019.1706829>
- Masoomi, M., Hosseinikolbadi, S., Saeed, F., Sharifi, V., Jalali Nadoushan, A. H., & Shoib, S. (2023). Stigma as a barrier to suicide prevention efforts in Iran. *Frontiers in Public Health*, 10. <https://doi.org/10.3389/fpubh.2022.1026451>
- McArthur, D., Dumas, A., Woodend, K., Beach, S., & Stacey, D. (2014). Factors influencing adherence to regular exercise in middle-aged women: A qualitative study to inform clinical practice. *BMC Women's Health*, 14(1). <https://doi.org/10.1186/1472-6874-14-49>
- McGregor, G., Powell, R., Begg, B., Birkett, S. T., Nichols, S., Ennis, S., McGuire, S., Prosser, J., Fiassam, O., Hee, S. W., Hamborg, T., Banerjee, P., Hartfiel, N., Charles, J. M., Edwards, R. T., Drane, A., Ali, D., Osman, F., He, H., Lachlan, T., Haykowsky, M.J., Ingle, L., Shave, R. (2023). High-intensity interval training in cardiac rehabilitation: a multi-centre randomized controlled trial. *European Journal of Preventive Cardiology*, 30(9), 745–755. <https://doi.org/10.1093/eurjpc/zwad039>
- McIntyre, R. S., Alsuwaidan, M., Baune, B. T., Berk, M., Demyttenaere, K., Goldberg, J. F., Gorwood, P., Ho, R., Kasper, S., Kennedy, S. H., Ly-Uson, J., Mansur, R. B., McAllister-Williams, R. H., Murrough, J. W., Nemeroff, C. B., Nierenberg, A. A., Rosenblat, J. D., Sanacora, G., Schatzberg, A. F., Shelton, R., Stahl, S., Trivedi, M.H., Vieta, E., Vinberg, M., Williams, N., Young, A.H., Maj, M. (2023). Treatment-resistant depression: Definition, prevalence, detection, management, and investigational interventions. *World Psychiatry*, 22(3), 394–412. <https://doi.org/10.1002/wps.21120>
- McLean, C. P., Asnaani, A., Litz, B. T., & Hofmann, S. G. (2011). Gender differences in anxiety disorders: Prevalence, course of illness, comorbidity, and burden of illness. *Journal of Psychiatric Research*, 45(8), 1027–1035. <https://doi.org/10.1016/j.jpsychires.2011.03.006>

- MeAuley, E., & Courneya, K. S. (1994). The subjective exercise experiences scale (SEES): Development and preliminary validation. *Journal of Sport and Exercise Psychology*, 16(2), 163–177. <https://doi.org/10.1123/jsep.16.2.163>
- Michalak, R. T., & Ashkanasy, N. M. (2020). Working with monsters: Counting the costs of workplace psychopaths and other toxic employees. *Accounting and Finance*, 60(S1), 773–815. <https://doi.org/10.1111/acfi.12369>
- Mielniczek, M., & Aune, T. K. (2025). The effect of high-intensity interval training (HIIT) on brain-derived neurotrophic factor (BDNF) levels: A systematic review. *Brain Sciences*, 15(1). <https://doi.org/10.3390/brainsci15010034>
- Milanović, Z., Sporiš, G., & Weston, M. (2015). Effectiveness of high-intensity interval training (HIT) and continuous endurance training for VO₂max improvements: A systematic review and meta-analysis of controlled trials. *Sports Medicine*, 45(10), 1469–1481. <https://doi.org/10.1007/s40279-015-0365-0>
- Millan, M. J. (2013). An epigenetic framework for neurodevelopmental disorders: From pathogenesis to potential therapy. *Neuropharmacology*, 68, 2–82. <https://doi.org/10.1016/j.neuropharm.2012.11.015>
- Mirghafourvand, M., Baheiraei, A., Nedjat, S., Mohammadi, E., Charandabi, S. M. A., & Majdzadeh, R. (2015). A population-based study of health-promoting behaviors and their predictors in Iranian women of reproductive age. *Health Promotion International*, 30(3). <https://doi.org/10.1093/heapro/dat086>
- Mitchell, B. A., & Wister, A. v. (2015). Midlife challenge or welcome departure? Cultural and family-related expectations of empty nest transitions. *International Journal of Aging and Human Development*, 81(4), 260–280. <https://doi.org/10.1177/0091415015622790>
- Modarresi, M., & Arasti, Z. (2021). Cultural challenges of women entrepreneurs in Iran. In *The Emerald handbook of women and entrepreneurship in developing economies* (pp. 225–240). <https://doi.org/10.1108/978-1-80071-326-020211013>
- Mofrad, M. D., Siassi, F., Guilani, B., Bellissimo, N., & Azadbakht, L. (2019). Association of dietary phytochemical index and mental health in women:

- A cross-sectional study. *British Journal of Nutrition*, 121(9), 1049–1056.
<https://doi.org/10.1017/S0007114519000229>
- Mohamadi, E., Kraemer, A., Majdzadeh, R., Mohamadzade, M., Mohammadshahi, M., Kiani, M. M., Ebrahimi, F., Mostafavi, H., Olyaeemanesh, A., & Takian, A. (2024). Impacts of economic sanctions on population health and health system: A study at national and sub-national levels from 2000 to 2020 in Iran. *Globalization and Health*, 20(1).
<https://doi.org/10.1186/s12992-024-01084-2>
- Mojtabai, R., Evans-Lacko, S., Schomerus, G., & Thornicroft, G. (2016). Attitudes toward mental health help seeking as predictors of future help-seeking behavior and use of mental health treatments. *Psychiatric Services*, 67(6), 650–657. <https://doi.org/10.1176/appi.ps.201500164>
- Mollarahimi Maleki, F., Massahikhaleghi, P., Tehrani-Banihashemi, A., Davoudi, F., & Nojomi, M. (2020). Community-based preventive interventions for depression and anxiety in women. *Archives of Iranian Medicine*, 23(3), 197–206.
- Moreno-Llamas, A., García-Mayor, J., & de La Cruz-Sánchez, E. (2022). Gender inequality is associated with gender differences and women participation in physical activity. *Journal of Public Health*, 44(4).
<https://doi.org/10.1093/pubmed/fdab354>
- Murray, C. J. L., Aravkin, A. Y., Zheng, P., Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abegaz, K. H., Abolhassani, H., Aboyans, V., Abreu, L. G., Abrigo, M. R. M., Abualhasan, A., Abu-Raddad, L. J., Abushouk, A. I., Adabi, M., ... Lim, S. S. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, 396(10258), 1223–1249.
[https://doi.org/10.1016/S0140-6736\(20\)30752-2](https://doi.org/10.1016/S0140-6736(20)30752-2)
- Murri, M. B., Ekkekakis, P., Magagnoli, M., Zampogna, D., Cattedra, S., Capobianco, L., Serafini, G., Calcagno, P., Zanetidou, S., & Amore, M. (2019). Physical exercise in major depression: Reducing the mortality gap while improving clinical outcomes. *Frontiers in Psychiatry*, 9.
<https://doi.org/10.3389/fpsy.2018.00762>

- Myśliwiec, N., Ciesielska, A., Wojtczak, M., Sieradzka, A., Kot, A., Różycki, A., Pniak, M., Mawlichanów, M., Miklis, P., & Szerej, K. (2025). The impact of physical activity on mental health. *Quality in Sport*, 37. <https://doi.org/10.12775/qs.2025.37.57234>
- Nascimento, Y. D. B., & Santos, M. G. D. (2025). Physical exercise, nutrition, and mental health: A detailed look at the psychological and physiological benefits. *World Journal of Advanced Research and Reviews*, 25(30), 351–360. <https://doi.org/10.30574/wjarr.2025.25.3.0731>
- Naslund, J. A., & Deng, D. (2021). Addressing mental health stigma in low-income and middle-income countries: A new frontier for digital mental health. *Ethics, Medicine and Public Health*, 19. <https://doi.org/10.1016/j.jemep.2021.100719>
- Nawaz, A., Mamoon, B., Batool, T. E., Khattak, M. I., Amir, F., Akbar, A., & Khan, S. (2024). Advances in antidepressant therapy: Comparing the efficacy of selective serotonin reuptake inhibitors (SSRIs), serotonin–norepinephrine reuptake inhibitors (SNRIs), and novel agents. *Cureus*, 16. <https://doi.org/10.7759/cureus.76318>
- Nicolò, A., & Girardi, M. (2016). The physiology of interval training: a new target to HIIT. *Journal of Physiology*, 594(24), 7159–7160. <https://doi.org/10.1113/IP273466>
- Noorbala, F., Borjali, A., Ahmadian-Attari, M. M., & Noorbala, A. A. (2013). Effectiveness of compassionate mind training on depression, anxiety, and self-criticism in a group of Iranian depressed patients. *Iranian Journal of Psychiatry*, 8(3), 113–117.
- Olney, N., Wertz, T., Laporta, Z., Mora, A., Serbas, J., & Astorino, T. A. (2018). Comparison of acute physiological and psychological responses between moderate-intensity continuous exercise and three regimes of high-intensity interval training. *Journal of Strength and Conditioning Research*, 32(8), 2130–2138. <https://doi.org/10.1519/jsc.0000000000002154>
- Patel, V., Maj, M., Flisher, A. J., de Silva, M. J., Koschorke, M., Prince, M., Tempier, R., Riba, M., Sanchez, M., Campodonico, F. D., Risco, L., Gask, L., Wahlberg, H., Roca, M., Lecic-Tosevski, D., Soghoyan, A., Moussaoui, D., Baddoura, C., Adeyemi, J., Richardson, G. (2010). Reducing the treatment

- gap for mental disorders: A WPA survey. *World Psychiatry*, 9(3), 169–176. <https://doi.org/10.1002/j.2051-5545.2010.tb00305.x>
- Patten, R. K., McIlvenna, L. C., Moreno-Asso, A., Hiam, D., Stepto, N. K., Rosenbaum, S., & Parker, A. G. (2023). Efficacy of high-intensity interval training for improving mental health and health-related quality of life in women with polycystic ovary syndrome. *Scientific Reports*, 13(1). <https://doi.org/10.1038/s41598-023-29503-1>
- Penninx, B. W., Pine, D. S., Holmes, E. A., & Reif, A. (2021). Anxiety disorders. *The Lancet*, 397(10277), 914–927. [https://doi.org/10.1016/S0140-6736\(21\)00359-7](https://doi.org/10.1016/S0140-6736(21)00359-7)
- Perrin, P. B., Panyavin, I., Morlett Paredes, A., Aguayo, A., Macias, M. A., Rabago, B., Picot, S. J. F., & Arango-Lasprilla, J. C. (2015). A disproportionate burden of care: Gender differences in mental health, health-related quality of life, and social support in Mexican multiple sclerosis caregivers. *Behavioural Neurology*, 2015. <https://doi.org/10.1155/2015/283958>
- Petersen, I., Lund, C., & Stein, D. J. (2011). Optimizing mental health services in low- and middle-income countries. *Current Opinion in Psychiatry*, 24(4), 318–323. <https://doi.org/10.1097/YCO.0b013e3283477afb>
- Plag, J., Schmidt-Hellinger, P., Klippstein, T., Mumm, J. L. M., Wolfarth, B., Petzold, M. B., & Ströhle, A. (2020). Working out the worries: A randomized controlled trial of high-intensity interval training in generalized anxiety disorder. *Journal of Anxiety Disorders*, 76. <https://doi.org/10.1016/j.janxdis.2020.102311>
- Plizga, J., Jaworski, A., Grajnert, F., Gluszczyk, A., Surma, A., Cecot, J., Parfianowicz, A., Zarzecki, K., Mandryk, M., & Holdun, N. (2024). High-intensity interval training: Health benefits and risks—Literature review. *Quality in Sport*, 18. <https://doi.org/10.12775/qs.2024.18.53359>
- Poon, E. T. C., Li, H. Y., Kong, A. P. S., & Little, J. P. (2025). Efficacy of high-intensity interval training in individuals with type 2 diabetes mellitus: An umbrella review of systematic reviews and meta-analyses. *Diabetes, Obesity and Metabolism*, 27(4), 1234–1248. <https://doi.org/10.1111/dom.16220>

- Ramadan, W., Xirouchaki, C. E., & El-Gilany, A. H. (2025). The comparative effects of high-intensity interval training and traditional resistance training on hormonal responses in young women: A 10-week intervention study. *Sports*, 13(3). <https://doi.org/10.3390/sports13030067>
- Ramli, N. Z., Yahaya, M. F., Mohd Fahami, N. A., Abdul Manan, H., Singh, M., & Damanhuri, H. A. (2023). Brain volumetric changes in menopausal women and their association with cognitive function: A structured review. *Frontiers in Aging Neuroscience*, 15. <https://doi.org/10.3389/fnagi.2023.1158001>
- Rathod, S., Pinninti, N., Irfan, M., Gorczynski, P., Rathod, P., Gega, L., & Naeem, F. (2017). Mental health service provision in low- and middle-income countries. *Health Services Insights*, 10. <https://doi.org/10.1177/1178632917694350>
- Rauf, T. (2023). Mental health effects of income over the adult life course. *Socius*, 9. <https://doi.org/10.1177/23780231231186072>
- Rebar, A. L., Stanton, R., Geard, D., Short, C., Duncan, M. J., & Vandelandotte, C. (2015). A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychology Review*, 9(3), 366–378. <https://doi.org/10.1080/17437199.2015.1022901>
- Reljic, D., Lampe, D., Wolf, F., Zopf, Y., Herrmann, H. J., & Fischer, J. (2019). Prevalence and predictors of dropout from high-intensity interval training in sedentary individuals: A meta-analysis. *Scandinavian Journal of Medicine & Science in Sports*, 29(9), 1288–1304. <https://doi.org/10.1111/sms.13452>
- Ren, J., & Xiao, H. (2023). Exercise for mental well-being: Exploring neurobiological advances and intervention effects in depression. *Life*, 13(7). <https://doi.org/10.3390/life13071505>
- Rezaie, L., Heydari, S., Rezaei, F., & Khazaie, H. (2021). The challenges and opportunities for psychotherapy in Iran: a qualitative study. *Shenakht Journal of Psychology and Psychiatry*, 8(2). <https://doi.org/10.32598/shenakht.8.2.1>

- Rezaie, L., Shafaroodi, N., & Philips, D. (2017). The barriers to participation in leisure time physical activities among Iranian women with severe mental illness: A qualitative study. *Mental Health and Physical Activity*, 13, 171–178. <https://doi.org/10.1016/j.mhpa.2017.09.008>
- Rhoads, J. (2021). *Clinical consult to psychiatric mental health management for nurse practitioners* (2nd ed.). Springer Publishing Company. <https://doi.org/10.1891/9780826161840>
- Riazi, M. (2025). Unveiling the impacts of Islamic regulations and the limitations of Islamic feminism: Experiences of women from Iran. *Feminist Encounters*, 9(1). <https://doi.org/10.20897/femenc/16017>
- Ribeiro, J. A., Schuch, F. B., Vargas, K. F. M., Müller, P. T., & Boullosa, D. (2022). A rapid review of randomized trials assessing the effects of high-intensity interval training on depressive symptoms in people with mental illness. *International Journal of Environmental Research and Public Health*, 19(17). <https://doi.org/10.3390/ijerph191710581>
- Sabahat Ali Sheikh, Noor ul Ain, Dr. Anum Saleem, *Sadaf Ghayoor, & Dr. Sidra Shahid. (2025). Sports science approach to high-intensity interval training (HIIT): Cardiometabolic health benefits in university students. *Review Journal of Social Psychology & Social Works*, 3(3). <https://doi.org/10.71145/rjsp.v3i3.318>
- Saeidi, M., Ravanbod, R., Pourgharib-Shahi, M. H., Goosheh, B., Baradaran, A., & Torkaman, G. (2023). Validation study of the Persian version of the subjective exercise experiences scale (SEES) in Iranian adult individuals. *Journal of Bodywork and Movement Therapies*, 33, 225–232. <https://doi.org/10.1016/j.jbmt.2022.09.024>
- Salmeh, F., & Yaghobian, M. (2014). Women's attitudes towards obstacles of physical activity in Sari, Iran. *Journal of Nursing and Midwifery Sciences*, 1(1), 49–55. <https://doi.org/10.18869/acadpub.jnms.1.1.49>
- Santoro, N., Epperson, C. N., & Mathews, S. B. (2015). Menopausal symptoms and their management. *Endocrinology and Metabolism Clinics of North America*, 44(3), 497–515. <https://doi.org/10.1016/j.ecl.2015.05.001>

- Schleppenbach, L. N., Ezer, A. B., Gronemus, S. A., Widenski, K. R., Braun, S., & Janot, J. (2017). Speed- and circuit-based high-intensity interval training on recovery oxygen consumption. *International Journal of Exercise Science*, 10(7). <https://doi.org/10.70252/cazv3381>
- Schuch, F. B., Vancampfort, D., Rosenbaum, S., Richards, J., Ward, P. B., & Stubbs, B. (2016). Exercise improves physical and psychological quality of life in people with depression: A meta-analysis including the evaluation of control group response. *Psychiatry Research*, 241, 47–54. <https://doi.org/10.1016/j.psychres.2016.04.054>
- Schweizer-Schubert, S., Gordon, J. L., Eisenlohr-Moul, T. A., Meltzer-Brody, S., Schmalenberger, K. M., Slopian, R., Zietlow, A. L., Ehlert, U., & Ditzen, B. (2021). Steroid hormone sensitivity in reproductive mood disorders: On the role of the GABAA receptor complex and stress during hormonal transitions. *Frontiers in Medicine*, 7. <https://doi.org/10.3389/fmed.2020.479646>
- Sekhon, S., & Gupta, V. (2025). Mood disorder. In *StatPearls*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK558911/>
- Semrau, M., Alem, A., Ayuso-Mateos, J. L., Chisholm, D., Gureje, O., Hanlon, C., Jordans, M., Kigozi, F., Lund, C., Petersen, I., Shidhaye, R., & Thornicroft, G. (2019). Strengthening mental health systems in low- and middle-income countries: Recommendations from the Emerald programme. *BJPsych Open*, 5(5). <https://doi.org/10.1192/bjo.2018.90>
- Seyfi, S., Hall, C. M., & Vo-Thanh, T. (2022). The gendered effects of statecraft on women in tourism: Economic sanctions, women's disempowerment and sustainability? *Journal of Sustainable Tourism*, 30(7). <https://doi.org/10.1080/09669582.2020.1850749>
- Sharifi, K., Anoosheh, M., Foroughan, M., & Kazemnejad, A. (2014). Barriers to middle-aged women's mental health: A qualitative study. *Iranian Red Crescent Medical Journal*, 16(6). <https://doi.org/10.5812/ircmj.18882>
- Sharifi, V., Amin-Esmaeili, M., Hajebi, A., Motevalian, A., Radgoodarzi, R., Hefazi, M., & Rahimi-Movaghar, A. (2015). Twelve-month prevalence and correlates of psychiatric disorders in Iran: The Iranian mental health

- survey, 2011. *Archives of Iranian Medicine*, 18(2), 76–84.
<https://doi.org/015182/AIM.004>
- Shidhaye, R., Mendenhall, E., Sumathipala, K., Sumathipala, A., & Patel, V. (2013). Association of somatoform disorders with anxiety and depression in women in low- and middle-income countries: A systematic review. *International Review of Psychiatry*, 25(1), 65–76.
<https://doi.org/10.3109/09540261.2012.748651>
- Siebers, M., Biedermann, S. V., & Fuss, J. (2023). Do endocannabinoids cause the runner's high? Evidence and open questions. *The Neuroscientist*, 29(3).
<https://doi.org/10.1177/10738584211069981>
- Sieniawska, D., Sieniawska, J., & Proszowska, P. (2024). The impact of physical activity on depression treatment: A literature review. *Quality in Sport*, 16.
<https://doi.org/10.12775/qs.2024.16.52858>
- Simon, J. A., Davis, S. R., Althof, S. E., Chedraui, P., Clayton, A. H., Kingsberg, S. A., Nappi, R. E., Parish, S. J., & Wolfman, W. (2018). Sexual well-being after menopause: An International Menopause Society White Paper. *Climacteric*, 21(5). <https://doi.org/10.1080/13697137.2018.1482647>
- Singh, B., Olds, T., Curtis, R., Dumuid, D., Virgara, R., Watson, A., Szeto, K., O'Connor, E., Ferguson, T., Eglitis, E., Miatke, A., Simpson, C. E. M., & Maher, C. (2023). Effectiveness of physical activity interventions for improving depression, anxiety and distress: An overview of systematic reviews. *British Journal of Sports Medicine*, 57(18), 1203–1209.
<https://doi.org/10.1136/bjsports-2022-106195>
- Soares, C. N. (2014). Mood disorders in midlife women. *Menopause*, 21(2), 196–206.
<https://doi.org/10.1097/gme.0000000000000193>
- Spruit, A., Assink, M., van Vugt, E., van der Put, C., & Stams, G. J. (2016). The effects of physical activity interventions on psychosocial outcomes in adolescents: A meta-analytic review. *Clinical Psychology Review*, 45.
<https://doi.org/10.1016/j.cpr.2016.03.006>
- Steckling, F. M., Farinha, J. B., Santos, D. L. D., Bresciani, G., Mortari, J. A., Stefanello, S. T., Courtes, A. A., Duarte, T., Duarte, M. M. M. F., Moresco, R. N., Cardoso, M. S., & Soares, F. A. A. (2016) High intensity interval training reduces the levels of serum inflammatory cytokine in women

- with metabolic syndrome. *Experimental and Clinical Endocrinology & Diabetes*, 124(10). <https://doi.org/10.1055/s-0042-111044>
- Steckling, Flávia Mariel, Farinha, J. B., Figueiredo, F. da C., Santos, D. L. dos, Bresciani, G., Kretzmann, N. A., Stefanello, S. T., Courtes, A. A., Beck, M. de O., Sangoi Cardoso, M., Duarte, M. M. M. F., Moresco, R. N., & Soares, F. A. A. (2019). High-intensity interval training improves inflammatory and adipokine profiles in postmenopausal women with metabolic syndrome. *Archives of Physiology and Biochemistry*, 125(1), 38–45. <https://doi.org/10.1080/13813455.2018.1437750>
- Steinmo, S., Hagger-Johnson, G., & Shahab, L. (2014). Bidirectional association between mental health and physical activity in older adults: Whitehall II prospective cohort study. *Preventive Medicine*, 66. <https://doi.org/10.1016/j.ypmed.2014.06.005>
- Stillman, C. M., Esteban-Cornejo, I., Brown, B., Bender, C. M., & Erickson, K. I. (2020). Effects of exercise on brain and cognition across age groups and health states. *Trends in Neurosciences*, 43(7). <https://doi.org/10.1016/j.tins.2020.04.010>
- Stork, M. J., Gibala, M. J., & Martin Ginis, K. A. (2018). Psychological and behavioral responses to interval and continuous exercise. *Medicine & Science in Sports & Exercise*, 50(10). <https://doi.org/10.1249/MSS.0000000000001671>
- Stubbs, B., Vancampfort, D., Rosenbaum, S., Firth, J., Cosco, T., Veronese, N., Salum, G. A., & Schuch, F. B. (2017). An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. *Psychiatry Research*, 249, 102–108. <https://doi.org/10.1016/j.psychres.2016.12.020>
- Szuhany, K. L., Bugatti, M., & Otto, M. W. (2015). A meta-analytic review of the effects of exercise on brain-derived neurotrophic factor. *Journal of Psychiatric Research*, 60. <https://doi.org/10.1016/j.jpsychires.2014.10.003>
- Tabata, I. (2019). Tabata training: One of the most energetically effective high-intensity intermittent training methods. *Journal of Physiological Sciences*, 69(4), 559–572. <https://doi.org/10.1007/s12576-019-00676-7>

- Taghva, A., Farsi, Z., Javanmard, Y., Atashi, A., Hajebi, A., & Khademi, M. (2017). Stigma barriers of mental health in Iran: A qualitative study by stakeholders of mental health. *Iranian Journal of Psychiatry*, 12(3), 163-171.
- Tahan, M., Azari, F., & Saleem, T. (2024). The implications of sanctions on civilian mental health and quality of life in Iran: An overview. *Neuropsychopharmacologia Hungarica*, 26(3), 170-181.
- Taheri, E., & Guven Lisaniler, F. G. (2019). Gender aspect of economic sanctions: Case study of women's economic rights in Iran. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3303800>
- Talebi, M., Taghipour, A., Raouf-Rahmati, A., Farokhani, E. M., Ghaffariyan-Jam, S., Samarghandi, A., Nemati, M., & Nemati, A. (2024). Prevalence of mental disorders among middle-aged population of primary healthcare centers in Northeastern Iran. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-023-17598-0>
- Tao, Y., Lu, J., Lv, J., & Zhang, L. (2024). Effects of high-intensity interval training on depressive symptoms: A systematic review and meta-analysis. *Journal of Psychosomatic Research*, 180. <https://doi.org/10.1016/j.jpsychores.2024.111652>
- Thomas, A. J., Mitchell, E. S., & Woods, N. F. (2018). The challenges of midlife women: themes from the Seattle midlife Women's health study. *Women's Midlife Health*, 4(1). <https://doi.org/10.1186/s40695-018-0039-9>
- Trautmann, S., Rehm, J., & Wittchen, H. (2016). The economic costs of mental disorders. *EMBO Reports*, 17(9). <https://doi.org/10.15252/embr.201642951>
- Vaziri-harami, R., Kazemi, S. N., Vaziri-harami, S., Hazari, V., Farokh, P., & Valadbeigi, T. (2024). The prevalence of depression and anxiety in premenopausal and menopausal women: A cross-sectional study. *Health Science Reports*, 7(7). <https://doi.org/10.1002/hsr2.2267>
- Veale, D. (2008). Behavioural activation for depression. *Advances in Psychiatric Treatment*, 14(1). <https://doi.org/10.1192/apt.bp.107.004051>
- Vidović, S., Rakić, N., Kraštek, S., Pešikan, A., Degmečić, D., Zibar, L., Labak, I., Heffer, M., & Pogorelić, Z. (2025). Sleep quality and mental health among medical students: A cross-sectional study. *Journal of Clinical Medicine*, 14(7). <https://doi.org/10.3390/jcm14072274>

- Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abolhassani, H., Aboyans, V., Abrams, E. M., Abreu, L. G., Abrigo, M. R. M., Abu-Raddad, L. J., Abushouk, A. I., ... Murray, C. J. L. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, 396(10258), 1204–1222. [https://doi.org/10.1016/S0140-6736\(20\)30925-9](https://doi.org/10.1016/S0140-6736(20)30925-9)
- Wang, S.-M., Han, C., Bahk, W.-M., Lee, S.-J., Patkar, A. A., Masand, P. S., & Pae, C.-U. (2018). Addressing the side effects of contemporary antidepressant drugs: A comprehensive review. *Chonnam Medical Journal*, 54(2). <https://doi.org/10.4068/cmj.2018.54.2.101>
- Wang, Y., Zhang, X., Zhang, Y., & Zhang, H. (2025). The impact of high-intensity interval training on anxiety: A scoping review. *Frontiers in Psychiatry*, 16. <https://doi.org/10.3389/fpsy.2025.1515266>
- Weston, K. S., Wisløff, U., & Coombes, J. S. (2014). High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 48(16). <https://doi.org/10.1136/bjsports-2013-092576>
- Wewege, M., van den Berg, R., Ward, R. E., & Keech, A. (2017). The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: a systematic review and meta-analysis. *Obesity Reviews*, 18(6). <https://doi.org/10.1111/obr.12532>
- White, R. L., Vella, S., Biddle, S., Sutcliffe, J., Guagliano, J. M., Uddin, R., Burgin, A., Apostolopoulos, M., Nguyen, T., Young, C., Taylor, N., Lilley, S., & Teychenne, M. (2024). Physical activity and mental health: a systematic review and best-evidence synthesis of mediation and moderation studies. *International Journal of Behavioral Nutrition and Physical Activity*, 21(1). <https://doi.org/10.1186/s12966-024-01676-6>
- Wickramaratne, P. J., Yangchen, T., Lepow, L., Patra, B. G., Glicksburg, B., Talati, A., Adekanattu, P., Ryu, E., Biernacka, J. M., Charney, A., Mann, J. J., Pathak, J., Olfson, M., & Weissman, M. M. (2022). Social connectedness as

- a determinant of mental health: A scoping review. *PLOS ONE*, 17(10), e0275004. <https://doi.org/10.1371/journal.pone.0275004>
- Wilczyńska, D., Walczak-Kozłowska, T., Santos-Rocha, R., Laskowski, R., & Szumilewicz, A. (2023). Stress is not so bad—cortisol level and psychological functioning after 8-week HIIT program during pregnancy: a randomized controlled trial. *Frontiers in Public Health*, 11. <https://doi.org/10.3389/fpubh.2023.1307998>
- Wong, M. J., Santos, C., & Thomas Tobin, C. S. (2023). Racial/ethnic differences in social support and health among Asian American and non-Hispanic White midlife women: Results from the Study of Women's Health Across the Nation (SWAN). *Ethnicity and Health*, 28(2). <https://doi.org/10.1080/13557858.2022.2035691>
- World Health Organization. (2021). *Comprehensive mental health action plan 2013–2030*. <https://www.who.int/publications/i/item/9789240031029>
- World Health Organization. (2019). *Depression*. <https://www.who.int/health-topics/depression>
- World Health Organization. (2023). *Depressive disorder (depression)*. <https://www.who.int/news-room/fact-sheets/detail/depression>
- World Health Organization. (2024). *Physical activity*. <https://www.who.int/news-room/fact-sheets/detail/physical-activity>
- Woźniak, K., Woźniak, A., & Stasiak, M. (2024). The impact of physical activity on depressive and anxiety disorders: A literature review. *Quality in Sport*, 36. <https://doi.org/10.12775/qs.2024.36.56456>
- Wu, L. Y., Hsu, H. C., Ni, L. F., Yan, Y. J., & Hwang, R. J. (2024). Effect of physical exercise on executive functions using the emotional Stroop task in perimenopausal women: A pilot study. *Behavioral Sciences*, 14(4). <https://doi.org/10.3390/bs14040338>
- Xu, Y., Li, Y., Wang, C., Han, T., Wu, Y., Wang, S., & Wei, J. (2024). Clinical value and mechanistic analysis of HIIT on modulating risk and symptoms of depression: A systematic review. *International Journal of Clinical and Health Psychology*, 24(1). <https://doi.org/10.1016/j.ijchp.2023.100433>
- Yao, Y., Du, J., Wang, D., Li, N., Tao, Z., Wu, D., Peng, F., Shi, J., Zhou, W., Zhao, T., & Tang, Y. (2024). High-intensity interval training ameliorates

- postnatal immune activation-induced mood disorders through KDM6B-regulated glial activation. *Brain, Behavior, and Immunity*, 120. <https://doi.org/10.1016/j.bbi.2024.06.006>
- Yarmohammadi, S., Saadati, H. M., Ghaffari, M., & Ramezankhani, A. (2019). A systematic review of barriers and motivators to physical activity in elderly adults in Iran and worldwide. *Epidemiology and Health*, 41. <https://doi.org/10.4178/epih.e2019049>
- Zavareh, M. S. A., Shirzadi, F., Hoseiny-Rad, M., & Aivazi, A. A. (2023). A qualitative investigation of the determinants influencing physical activity among women in Ilam Town. *Journal of Education and Community Health*, 10(4). <https://doi.org/10.34172/jech.2230>

XI – APPENDIXES

APPENDIXES

APPENDIX 1: Research Instruments (Questionnaires)

A) Beck Depression Inventory-II (BDI-II)

BDI - II

Instructions: This questionnaire consists of 21 groups of statements.

1. Sadness

- 0. I do not feel sad.
- 1. I feel sad much of the time.
- 2. I am sad all the time.
- 3. I am so sad or unhappy that I can't stand it.

2. Pessimism

- 0. I am not discouraged about my future.
- 1. I feel more discouraged about my future than I used to.
- 2. I do not expect things to work out for me.
- 3. I feel my future is hopeless and will only get worse.

3. Past Failure

- 0. I do not feel like a failure.
- 1. I have failed more than I should have.
- 2. As I look back, I see a lot of failures.
- 3. I feel I am a total failure as a person.

4. Loss of Pleasure

- 0. I get as much pleasure as I ever did from the things I enjoy.

1. I don't enjoy things as much as I used to.
2. I get very little pleasure from the things I used to enjoy.
3. I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings

0. I don't feel particularly guilty.
1. I feel guilty over many things I have done or should have done.
2. I feel quite guilty most of the time.
3. I feel guilty all of the time.

6. Punishment Feelings

0. I don't feel I am being punished.
1. I feel I may be punished.
2. I expect to be punished.
3. I feel I am being punished.

7. Self-Dislike

0. I feel the same about myself as ever.
1. I have lost confidence in myself.
2. I am disappointed in myself.
3. I dislike myself.

8. Self-Criticalness

0. I don't criticize or blame myself more than usual.
1. I am more critical of myself than I used to be.
2. I criticize myself for all of my faults.
3. I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes

- 0. I don't have any thoughts of killing myself.
- 1. I have thoughts of killing myself, but I would not carry them out.
- 2. I would like to kill myself.
- 3. I would kill myself if I had the chance.

10. Crying

- 0. I don't cry anymore than I used to.
- 1. I cry more than I used to.
- 2. I cry over every little thing.
- 3. I feel like crying, but I can't.

11. Agitation

- 0. I am no more restless or wound up than usual.
- 1. I feel more restless or wound up than usual.
- 2. I am so restless or agitated, it's hard to stay still.
- 3. I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest

- 0. I have not lost interest in other people or activities.
- 1. I am less interested in other people or things than before.
- 2. I have lost most of my interest in other people or things.
- 3. It's hard to get interested in anything.

13. Indecisiveness

- 0. I make decisions about as well as ever.
- 1. I find it more difficult to make decisions than usual.
- 2. I have much greater difficulty in making decisions than I used to.
- 3. I have trouble making any decisions.

14. Worthlessness

- 0. I do not feel I am worthless.
- 1. I don't consider myself as worthwhile and useful as I used to.
- 2. I feel more worthless as compared to others.
- 3. I feel utterly worthless.

15. Loss of Energy

- 0. I have as much energy as ever.
- 1. I have less energy than I used to have.
- 2. I don't have enough energy to do very much.
- 3. I don't have enough energy to do anything.

16. Changes in Sleeping Pattern

- 0 I have not experienced any change in my sleeping pattern.
- 1 I sleep somewhat more than usual.
- 2 I sleep somewhat less than usual.
- 3 I sleep a lot more than usual.
- 4 I sleep a lot less than usual.
- 5 I sleep most of the day.
- 6 I wake up 1-2 hours early and can't get back to sleep.

17. Irritability

- 0. I am not more irritable than usual.
- 1. I am more irritable than usual.
- 2. I am much more irritable than usual.
- 3. I am irritable all the time.

18. Changes in Appetite

- 0 I have not experienced any changes in my appetite.
- 1 My appetite is somewhat less than usual.

- 2 My appetite is somewhat greater than usual.
- 3 My appetite is much less than before.
- 4 My appetite is much greater than usual.
- 5 I have no appetite at all.
- 6 I crave food all the time.

19. Concentration Difficulty

- 0. I can concentrate as well as ever.
- 1. I can't concentrate as well as usual.
- 2. It's hard to keep my mind on anything for very long.
- 3. I find I can't concentrate on anything.

20. Tiredness or Fatigue

- 0. I am no more tired or fatigued than usual.
- 1. I get more tired or fatigued more easily than usual.
- 2. I am too tired or fatigued to do a lot of the things I used to do.
- 3. I am too tired or fatigued to do most of the things I used to do.

21. Loss of Interest in Sex

- 0. I have not noticed any recent change in my interest in sex.
- 1. I am less interested in sex than I used to be.
- 2. I am much less interested in sex now.
- 3. I have lost interest in sex completely.

Total Score: _____

B) Beck Anxiety Inventory (BAI)

	Not At All	Mildly but it didn't bother me much	Moderately, it wasn't pleasant at times	Severely, it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Hear pounding / racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky / unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint / lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot / cold sweats	0	1	2	3
Column Sum				

Above is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

APPENDIX 2: Informed Consent Form**CONSENT FORM**

The participant must complete this form herself/himself

Title _____ of _____ Project _____

Protocol Number: _____

PLEASE TICK YOUR RESPONSE IN THE APPROPRIATE BOX

I have read and understood the attached Participant information leaflet

Yes ☐ No ☐

I have had the opportunity to ask questions and discuss the study

Yes ☐ No ☐

I have received satisfactory answers to all my questions Yes

☐ No ☐

I understand that I am free to withdraw from the study at any time without Yes ☐ No ☐

giving a reason and without this affecting my future medical care

I agree to take part in this study without prejudice to my legal or ethical rights Yes ☐ No ☐

Participant's Signature: _____

Date: _____

Participant's Name in Print: _____

Witness Signature:* _____

Date: _____

Witness' Name in Print: _____

Investigator's Signature: _____

Date: _____

Investigator's Name in Print: _____

Consent checklist for investigators

In order to document consent, investigators might wish to complete the following checklist for each participant who agrees to take part in the research study.

Research _____ project _____ name: _____
 _____ No.: _____

Date: _____ Participant name: _____
 Sex: M/F DOB: _____

Name _____ of _____ investigator _____ obtaining _____ consent: _____

1. Have you given the participant an oral explanation of the proposed research project? Yes/No

1. Have you told the participant that he/she will be kept informed of all relevant information that becomes available during the course of the study? Yes/No

2. Did your oral explanation to the participant include:

2.1 that this is a research project? Yes/No

2.2 that participation is voluntary? Yes/No

2.3 the aims of the project? Yes/No

2.4 the likely duration of the participant's involvement? Yes/No

2.5 the expected benefits to the participant and/or others? Yes/No

2.6 the procedures which will be involved in participation? Yes/No

2.7 what risks, inconvenience, discomfort or distress may reasonably be anticipated for this participant: the level and the likelihood? Yes/No

- 2.8 that there may be some unforeseen risks? Yes/No
- 2.9 that a refusal to participate may be given without reasons and will not affect the participant's rights or their right to care? Yes/No
- 2.10 that the participant may be withdrawn from the study if the study investigator considers this is necessary in the best interests of the participant? Yes/No
- 2.11 that information generated by the study may be published but that no details will be divulged from which the participant could be identified? Yes/No
- 2.12 that some such information will be retained for a period after the end of the trial? Yes/No
- 2.13 whom to contact in an emergency and how? Yes/No
- 3. Has the participant given authorisation to you to inform his/her GP of the participants involvement in this study? Yes/No
- 4. Is or has the participant been involved in any other research studies relevant to the present one? Yes/No
- 5. Have you allowed the participant sufficient time to consider the matter on his/her own, to discuss with others if wished, or ask you questions? Yes/No
- 6. In your opinion, has the participant understood and consented to take part in this research? Yes/No

APPENDIX 3: Training Protocol

□ General Information

- **Type of Program:** High-Intensity Interval Training (HIIT)
- **Target Group:** Middle-aged women (40–55 years old) with mild to moderate symptoms of depression and anxiety
- **Duration:** 10 months (40 weeks)
- **Frequency:** 3 sessions per week (total = 120 sessions)
- **Session Length:** ~60 minutes (10 min warm-up, 30–40 min HIIT, 10 min cool-down)
- **Location:** Women-only fitness facility
- **Supervision:** 3 certified female trainers, trained in international HIIT instruction and safety monitoring

□ Structure of Each Session

1. Warm-up (10 minutes)

- 2 minutes light walking/jogging in place
- 3 minutes dynamic mobility (arm circles, hip rotations, leg swings)
- 5 minutes functional activation (glute bridges, bodyweight squats, push-ups on wall or knees)

2. Main HIIT Phase (30–40 minutes)

- **Work interval:** 30–60 seconds at 75–90% HRmax
- **Rest interval:** 60–90 seconds active recovery (walking or slow movements)
- **Sets per session:** 3–5 (progressive)

□ Example Circuit (rotation every 2 weeks):

- **Lower Body:** Squat jumps, dumbbell lunges, kettlebell swings, step-ups
- **Upper Body:** Push-ups (modified as needed), TRX rows, overhead presses with dumbbells

- **Core:** Plank variations, Russian twists, TRX mountain climbers
- **Cardio / Full Body:** Burpees, medicine ball slams, high knees, jump rope

3. Cool-down (10 minutes)

- 3 minutes walking with controlled breathing
- 7 minutes static stretching (quadriceps, hamstrings, calves, shoulders, back)

Phase	Weeks	Structure	Intensity (RPE)	Equipment
Adaptation	1–4	3 sets × 30 sec work / 90 sec rest	6–7 (moderate)	Bodyweight only
Foundation	5–12	4 sets × 40 sec work / 80 sec rest	7–8	Resistance bands, light dumbbells (2–4 kg)
Development	13–24	4–5 sets × 45 sec work / 75 sec rest	7–8	Dumbbells (3–6 kg), kettlebells, medicine balls
Intensification	25–36	5 sets × 50 sec work / 70 sec rest	8–9	TRX, kettlebells, bodyweight plyometrics
Peak	37–40	5 sets × 60 sec work / 60 sec rest	8–9 (high)	Mixed modalities, combination circuits

APPENDIX 4: Subjective Exercise Experiences Scale (SEES)

Subjective Exercise Experience Scale

How Do You Feel?

This inventory contains a number of items designed to reflect how you feel at this particular moment in time

(i.e., Right Now). Please circle the number on each item that indicates HOW YOU FEEL RIGHT NOW.

I FEEL:

1. Great

1 2 3 4 5 6 7

not at all moderately very much so

2. Awful

1 2 3 4 5 6 7

not at all moderately very much so

3. Drained

1 2 3 4 5 6 7

not at all moderately very much so

4. Positive

1 2 3 4 5 6 7

not at all moderately very much so

5. Crummy

1 2 3 4 5 6 7

not at all moderately very much so

6. Exhausted

1 2 3 4 5 6 7

not at all moderately very much so

7. Strong

1 2 3 4 5 6 7

not at all moderately very much so

8. Discouraged

1 2 3 4 5 6 7

not at all moderately very much so

9. Fatigued

1 2 3 4 5 6 7

not at all moderately very much so

10. Terrific

1 2 3 4 5 6 7

not at all moderately very much so

Subjective Exercise Experience Scale

11. Miserable

1 2 3 4 5 6 7

not at all moderately very much so

12. Tired

1 2 3 4 5 6 7

not at all moderately very much so

