# The Association Between Physical Activity and Mental Health Indicators [1]

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## Abstract

Engaging in physical exercise is essential in enhancing one's mental and physical well-being. There have been several studies that have shown that participating in regular physical exercise leads to a reduction in stress, an improvement in mood, and a decreased incidence of psychological disorders such as anxiety and depression. Among a sample of 87 healthy volunteers, the purpose of this research was to investigate the association between the objectively measured amount of energy expenditure and the psychological consequences of depression, anxiety, and stress. Both personal information from the DASS-21 questionnaire and the usage of the SenseWear wristband were used in the research project to monitor the amount of energy expended over seven consecutive days.

The findings show a statistically significant inverse link between energy consumption and depression ($r$ = -0.238, $p$ = 0.026). This suggests that more significant energy expenditure is related to lower depression levels. On the other hand, no significant connections were discovered between the amount of energy used and either the anxiety ($r$ = -0.071, $p$ = 0.516) or stress ($r$ = -0.196, $p$ = 0.068). After correcting for the Body Mass Index (BMI) and age, multiple linear regression analysis indicated that energy expenditure significantly predicted reduced depression ratings ($B$ = -2.813, $p$ = 0.019). Additionally, BMI was shown to be significantly connected to more significant depression ($B$ = 0.215, $p$ = 0.041).

This study accomplishes with a summary of the accumulating indication for mental health benefits of physical activity, especially for depression. The strong correspondence of energy expenditure and lower depressive symptoms verifies the significance role of the physical activity

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component intervention in improving depression level. Although these data imply that physical exercise plays a substantial role in lowering depression, the effects of physical activity on psychological stress and anxiety may be more complex, perhaps dependent on other variables such as the intensity of the activity and the individual's degree of stress. Further study is required, especially in non-Western cultures, to investigate these linkages and provide information that may be used to design culturally adapted solutions.

Keywords: Physical Activity, Energy Expenditure, Depression, Anxiety, Mental Health

## Introduction

Physical activity is widely known to be an essential element in maintaining physical and mental well-being. There are plenty of studies out there that indicate that physical activity is indeed correlated with improved mood, less stress and decreased incidences of mental health conditions, such as depression and anxiety. Physical inactivity has been identified globally as a significant contributor to mental health disorders, and interventions of physical activity are being widely integrated into public health initiatives (World Health Organization, 2010). The notion exists that physical activity enhances mental health through several pathways, including the release of endorphins, a decrease in stress hormones, or improvement in sleep and self-esteem (Hamer & Chida, 2008).

Physical activity is increasingly used as a feasible behavioral intervention to reduce mental health disorders symptoms within the clinical psychology field. Physical activity is frequently utilized as a part of a larger behavioral intervention strategy, that is used in cognitive behavioural therapy (CBT), and the effort was designed to encourage the engagement of patients in rewarding and meaningful activities that can alleviate depressive symptoms (Martinsen, 2008). Even mild to moderate levels of physical activity can confer significant reductions in depression and anxiety symptoms and so can serve as an intervention for those with mild to moderate mental health problems (Schuch et al., 2016). In addition, physical activity has mental health benefits in clinical settings and real life, as evidenced by studies indicating that more active people tend to have better mental health outcomes than their more sedentary counterparts (Stubbs et al., 2016).

However, despite the enormous evidence supporting that physical activity benefits mental health, much of the early research depended on

subjective self-reported measures of physical activity, which is prone to bias and error (Prince et al., 2008). The use of wearable devices to objectively measure physical activity has grown in recent years and has enabled researchers to determine better how energy expenditure relates to mental health. However, data gathered from these devices contain objective data that can give insights into the intensity, frequency and duration of the activity as these form the crux of determining whether they impact mental health in an ideal way (Prince et al., 2008). Research with wearable devices has consistently found that more significant amounts of energy expenditure lead to fewer symptoms of depression and anxiety (Schuch et al., 2021).

Nevertheless, the relationship between physical activity and mental health is also influenced by another critical factor such as obesity. For example, physical activity is associated with decreased body mass index and decreased risk for mental health indicators. It has been shown that physical activity is considered as moderator of the obesity impacts such as body image and self-esteem (Atlantis et al., 2008). Additionally, physical activity also moderates the effects of age on mental health. In addition to their overall fitness benefits, physical activity is generally more beneficial for older adults in terms of maintaining cognitive function and lessening physiological stress (Hou et al., 2024).

Hence, most of the research in this area has been conducted in Western populations, with very little work done about the effects of physical activity on mental health in the non-Western context. The cultural and environmental factors of Saudi Arabia are unique, including high temperatures and differences in the social norm of physical activity, which may influence the level of physical activity engagement as well as physical activity's effects on mental health. The relationship between physical activity and mental health among individuals from Saudi Arabia is investigated in order to gain additional insights from which to develop culturally appropriate mental health interventions against a backdrop of a global understanding of these dynamics (Al-Eisa et al., 2016).

Due to previous research's limitations and the importance of accurate measurement, this study examined the associations between average energy expenditure and psychological outcomes, including depression, anxiety and stress, while controlling for obesity and age. This research aimed to clarify the role of physical activity as a behavioral intervention for health, specifically mental health, within the cultural context of Saudi Arabia by using wearable devices to obtain objective measurements of energy

expenditure.

## Method

This is a cross-sectional study in which 87 healthy respondents aged 18–60 were recruited from the public. Participants who did not show specific medical conditions associated with physical exercise, such as movement disabilities were included. Furthermore, the participants were instructed to wear physical activity devices for the next 7 days, as well as mental health indicators (Depression, Anxiety and Stress) was assessed using a validated questionnaire. Age, Body Mass Index (BMI), and educational level were included as demographic variables. Data was excluded from participants who did not complete seven days of physical activity device and did not complete the demographic and mental health assessment.

## Materials

### SenseWear Armband

Physical activity was objectively measured using the "energy expenditure" of the SenseWear armband over 7 consecutive days. BodyMedia was a wearable device created to track numerous movement sensors, skin temperature, heat flux, and galvanic skin response to provide accurate data about a person's physical activity level (Johannsen et al., 2010). The armband takes this data into an estimate of daily energy expenditure of kilocalories (kcal). Participants were asked to wear the armband at all waking hours except when in water, including swimming and bathing.

### Depression, Anxiety, and Stress Scales (DASS-21)

The DASS-21 is validated tool that is used to measure psychological outcomes in research and clinical setting, it is widely used self-report instrument for depression, anxiety, and stress (Lovibond & Lovibond, 1995). There is convergent validity between the DASS depression and anxiety subscales and the Beck depression and anxiety inventories (Ali et al. ,2017). The 21-item questionnaire is organized into three subscales of seven items each. Participants assessed the frequency of symptoms experienced in the preceding week using a 4-point Likert scale, with values ranging from 0 ("Did not apply to me at all") to 3 ("Applied to me very much or most of the time").

*Procedure*

Upon recruiting, participants done consent form and demographic and DASS-21 assessments. Subsequently, they were asked to wear with the SenseWear armband, which they used for 7 consecutive days. Participants were directed to continue their regular daily routines during this time. After the monitoring time concluded, participants returned the device to the study team, and the energy expenditure data were extracted.

**Statistical Analysis**

Data were analyzed with SPSS software (version [27]). Before the primary analysis, the dataset was examined for missing values and outliers, and Kolmogorov-Smirnov tests evaluated normality. All variables, including energy expenditure, depression, anxiety, stress, BMI, and age, were calculated using descriptive statistics: mean and standard deviation.

The primary analysis used Pearson's correlation coefficient to analyze relationships between energy expenditure and psychological outcomes, as energy expenditure data (Table 2) followed a normal distribution. The continuous variables, depression, anxiety, stress, and energy expenditure, were correlated in a parametric test that identified significant associations.

Additionally, a multiple linear regression was executed to determine how best depression, anxiety, and stress can be predicted by energy expenditure, controlling for BMI and age. The dependent variables in the analysis were depression, anxiety, and stress, and the independent variables included energy expenditure, BMI, and age. The regression model was assessed for the R squared, as a measure of variance on the psychological outcome variable predicted by the independent variable, and p values for the predictors.

**Results**

Table 1 consists of the descriptive statistics of the study sample comprising 87 participants. Average estimates of energy expenditure were mean = 6.45 kcal (SD = 0.947). The average BMI of the participants was 33.84 (standard deviation = 10.490), and their mean education level was 14.18 years (standard deviation = 3.704). The participants had a mean age of 42.13 years, with a standard deviation of 12.686 years. The subjects reported a mean rating of 12.09 (standard deviation = 10.497) for depressive disorders, 10.36 (standard deviation = 9.50) for anxiety, and 15.51 (standard deviation = 11.08) for

stress. This information pertains to psychological factors.

**Table 1:** Descriptive Statistics for Energy Expenditure, Psychological Measures, and Demographic Data.

| Variables | N | Mean | Std. Deviation |
|---|---|---|---|
| Average Energy Expenditure (kca) | 87 | 6.45 | 0.947 |
| Education | 87 | 14.18 | 3.704 |
| BMI | 87 | 33.84 | 10.490 |
| Age | 87 | 42.13 | 12.686 |
| Depression | 87 | 12.09 | 10.497 |
| Anxiety | 87 | 10.36 | 9.50 |
| Stress | 87 | 15.51 | 11.08 |
| **Gender (Male)** | 57 | | |
| **Gender (Female)** | 30 | | |

**kcal**: Kilocalories (unit for energy expenditure), **BMI**: Body Mass Index, **N**: Number of participants, **Mean**: Average value, **Std. Deviation**: Standard Deviation (a measure of variability), **Score**: Represents values from self-reported or measured psychological variables.

Correlation analysis was conducted to investigate the relationship between the average amount of energy expended and the psychological factors of depression, anxiety, and stress (see Table 2 for more information). The findings indicated a statistically significant inverse relationship between the average amount of the energy expenditure and the instances of depression ($r = -0.238$, $p = 0.026$). Taking into consideration this data, it seems that a greater degree of energy expenditure is connected with lower levels of depression.

On the other hand, no significant association was established between the average energy expenditure and anxiety ($r = -0.071$, $p = 0.516$), while the link with stress was only marginally non-significant ($r = -0.196$, $p = 0.068$). According to these findings, while there is a slight correlation between average energy expenditure and lower levels of depression, there is no conclusive evidence that it has a substantial link with either anxiety or stress.

**Table 2:** Person's Correlation Between Average Energy Expenditure and Psychological Variables (Depression, Anxiety, Stress)**.**

| Variables | Depression | Anxiety | Stress |
|---|---|---|---|
| Average Energy Expenditure (kca) | -.238* | -.071 | -.196 |
| | (0.026**) | (0.516) | (0.068) |

***=R-value**: Person's correlation coefficient, **=**p-value** < 0.05, **kcal**: Kilocalories (Energy Expenditure).

Table 3 indicated that the average energy expenditure was a significant predictor of reduced depression ratings (B = -2.813, β = -0.248, p = 0.019). In particular, depression ratings fell by around 2.81 points for every unit increase in energy expenditure while keeping the BMI and age unchanged within the same context. Furthermore, it was shown that body mass index BMI significantly predicts depression (B = 0.215, β = 0.218, p = 0.041). This implies that a higher BMI is connected with greater levels of depression. The statistical analysis revealed no significant link between age and depression (B = -0.159, β = -0.191, p = 0.071). However, the negative beta indicates that there may be a tendency for older individuals to report somewhat lower depression levels.

In general, these findings indicate that the average amount of energy expenditure plays a significant role in lowering levels of depression. This is the case even after adjusting for BMI and age.

**Table 3:** Linear Regression Analysis with Depression as the Dependent Variable and Energy Expenditure, BMI, and Age as Predictors**.**

| Variables | B | Std. Error | Beta | t | Sig | Lower Bound (95%) | Upper Bound (95%) |
|---|---|---|---|---|---|---|---|
| Average Energy Expenditure (kcal) | -2.813 | 1.178 | -0.248 | -2.389 | 0.019 | -5.156 | -0.471 |
| BMI | 0.215 | 0.103 | 0.218 | 2.080 | 0.041 | 0.009 | 0.420 |
| Age | -0.159 | 0.087 | -0.191 | -1.828 | 0.071 | -0.331 | 0.014 |

**BMI**: Body Mass Index, **kcal**: Kilocalories (Energy Expenditure), SD: Standard Deviation, **N**: Sample Size, **B**: Unstandardized Coefficient (for regression analysis), SE: Standard Error, **p-value**: Probability value (significance), **CI**: Confidence Interval, **t**: t-statistic, **Sig.**: Significance.

## Discussion

The study aimed to investigate the connection between the average amount of

physical activity using energy expenditure and psychological indictors. Current findings indicated a substantial correlation between the average amount of energy spent and lower levels of depression. This suggests that persons who expended more energy via physical exercise had fewer symptoms of depression. Nevertheless, no substantive correlations were identified between anxiety and/or stress and energy expenditure, suggesting that there might be other factors than BMI and age could moderate anxiety and stress.

In consistent with the earlier studies that demonstrated that physical activity is a protective factor towards depressive symptoms (Schuch et al., 2016), there was a strong negative correlation between energy expenditure and depression. It has been proven that physical activity stimulates the production of endorphins and serotonin, critical neurotransmitters linked to mood (Hamer & Chida, 2008). Further, physical activity is frequently linked with an increase in self-esteem and a decrease in social withdrawal, both typical of depression (Atlantis et al., 2008). This finding supports and extends the evidence that physical activity is an effective behavioral intervention for managing depressive symptoms, especially in clinical and nonclinical populations, and that increased energy expenditure is associated with decreased depression.

In contrast with the current study, several papers found that physical activity has decreased anxiety and stress (Hamer & Chida, 2008; Martinsen, 2008; Schuch et al., 2016; Stubbs et al., 2016; Liu et al., 2024). Variability of the type and intensity of participants' physical activity may explain the absence of significant findings. Higher energy expenditure, in general, is expected to have mental health benefits. However, there could be differences according to the intensity of the activity and other stressors in the participants' lives (Ming Liu et al., 2024). In addition, anxiety and stress are complex, multi-factor constructs, where other psychological and environmental factors may not be as amenable to physical activity alone as effects in depression.

Additionally, obesity and age, both known influences mental health outcomes, were also controlled n the current study. Relatively, BMI was found to be a predictor of depression, and depressive symptoms increased with higher BMI. This is consistent with epidemiological evidence that obesity is a significant risk factor for depression (Atlantis et al., 2008), presumably because of body dissatisfaction, social stigmatization, and physical function limitation. Improving body image and self-esteem through physical activity has been shown to cause adverse health and psychological

outcomes of obesity. However, physical activity may not wholly ameliorate the negative saliency of the weight body image (Shang et al., 2021).

While age proved to be a weak predictor in this study, its association with depression approached significance psychometrically, consistent with a marginal negative relationship with depression and with a slightly lower prevalence of depression among older participants. That is in line with research showing that physical activity in older adults often results in cognitive benefits and increased resilience to stress (Walker & Cooper, 2019). However, no causal effect was observed, and further work is needed to specify the role of age in better moderating the relationship between physical activity and mental health.

The findings of this study have important implications for clinical practice, specifically in the use of physical activity as a non-pharmacological intervention in depression. The relationship between energy expenditure reductions and lowered depression symptom scores suggests that physical activity may be integrated into therapy for individuals who are 5 depressed. It is possible to include physical exercise in cognitive-behavioural treatment as a component of a behavioural activation approach. This would involve encouraging patients to participate in regular physical activity in order to enhance their mood and break the cycle of depressed inactivity (Martinsen, 2008).

Even though it offers insightful information on the connection between physical activity (energy expenditure) and depression, it is essential to point out that this research has several limitations. First, making causal conclusions is hindered because the research used a cross-sectional methodology. Longitudinal studies are required to determine the directionality of the association between physical exercise and mental health outcomes. Secondly, while the SenseWear wristband offered objective measurements of energy expenditure, the research did not consider several other metrics of physical activity, which might have potentially impacted the results concerning anxiety and stress. In addition, findings for anxiety and stress fail to indicate strong associations with physical activity alone, which may not be adequate to address these psychological outcomes. In addition including physical activity with other therapeutic interventions, such as mindfulness-based stress reduction or anxiety-specific CBT could be beneficial.

This study concludes with a summary of the accumulating evidence for mental health benefits of physical activity, especially for depression. The strong correspondence of energy expenditure and lower depressive symptoms

verifies the significance role of the physical activity component intervention in improving depression level. Nevertheless, the modest findings in the anxiety and stress outcomes indicate that there are many links within these relationships and that physical activity may not be enough to address all mental health outcomes. Future research should attempt to shed light on these relationships and explore the likelihood of combining physical activity with other therapeutic approaches to enhance mental health.

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**الملخص**

إن ممارسة التمارين الرياضية أمر ضروري لتعزيز الصحة العقلية والجسدية. ومن المعروف أن ممارسة التمارين الرياضية أمر ضروري لتعزيز الصحة العقلية والجسدية. وقد أجريت العديد من الدراسات التي أظهرت أن المشاركة في التمارين الرياضية المنتظمة تؤدي إلى تقليل التوتر وتحسين الحالة المزاجية وانخفاض حدوث الاضطرابات النفسية مثل القلق والاكتئاب. ومن بين عينة من ٨٧ متطوعاً سليماً، كان الغرض من هذا البحث هو التحقيق في العلاقة بين النشاط الحركي المقاس بشكل موضوعي ومستوى الاكتئاب والقلق والتوتر. وقد تم استخدام كل من استبيان DASS-21 لقياس مستوى الاكتئاب، القلق> والتوتر واستخدام سوار SenseWear لقياس النشاط الحركي ( استهلاك الطاقة) على مدى سبعة أيام متتالية.

وتظهر النتائج وجود ارتباط عكسي ذي دلالة إحصائية بين استهلاك الطاقة والاكتئاب (r = -0.238، p = 0.026). وهذا يشير إلى أن الإنفاق الأكثر أهمية للطاقة يرتبط بانخفاض مستويات الاكتئاب. فمن ناحية أخرى، لم يتم اكتشاف أي ارتباطات مهمة بين كمية الطاقة المستخدمة والقلق (r = -0.071 ، p = 0.516) أو التوتر (r = -0.196 ، p = 0.068). بعد التصحيح لمؤشر كتلة الجسم (BMI) والعمر، أشار تحليل الانحدار الخطي المتعدد إلى أن إنفاق الطاقة تنبأ بشكل كبير بانخفاض معدلات الاكتئاب (B = -2.813 ، p = 0.019). بالإضافة إلى ذلك، تبين أن مؤشر كتلة الجسم مرتبط بشكل كبير بالاكتئاب الأكثر أهمية (B = 0.215 ، p = 0.041).

تنجز هذه الدراسة ملخصاً للمؤشر المتراكم لفوائد النشاط البدني على الصحة العقلية، وخاصة الاكتئاب. إن التوافق القوي بين النشاط الحركي وانخفاض أعراض الاكتئاب يؤكد

الدور المهم لتدخل مكون النشاط البدني في تحسين مستوى الاكتئاب. ورغم أن هذه البيانات تشير إلى أن التمارين الرياضية تلعب دوراً كبيراً في خفض الاكتئاب، فإن تأثيرات النشاط البدني على الضغوط النفسية والقلق قد تكون أكثر تعقيداً، وربما تعتمد على متغيرات أخرى مثل شدة النشاط ودرجة الضغوط التي يتعرض لها الفرد. وهناك حاجة إلى مزيد من الدراسة، وخاصة في الثقافات غير الغربية، للتحقيق في هذه الارتباطات وتوفير المعلومات التي يمكن استخدامها لتصميم حلول تتكيف مع الثقافات الأخرى.