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Original Article

# Mediating Role of Exercise Self-Efficacy in the Relationship between Physical Activity and Mental Health among Adolescents: An Accelerometer-Based Study

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## Abstract

**Introduction:** Research has extensively explored the link between physical activity (PA) and mental health (MH); however, the specific mechanisms that explain this relationship remain largely unclear.
**Objective:** This research aims to explore the connections between PA and MH among adolescents, while also examining how exercise self-efficacy (ESE) may mediate these relationships.
**Methods:** This study utilized a descriptive-correlational methodology, employing structural equation modeling to analyze the data. A total of 384 adolescents (192 girls) with mean age of 16.52 years were recruited through convenience sampling. PA was assessed using a contemporary accelerometer, while MH and ESE were evaluated with standardized measurement tools. Data analysis was conducted using Smart PLS statistical software version 4.
**Results:** The results reveal a significant structural relationship between MH and ESE in the context of PA for MH (P=0.000, t=-10.24, and b=0.68), and for ESE (P=0.000, t=8.41, and b=0.53). Furthermore, there is a significant structural relationship between ESE and MH, indicated by P=0.000, t=-7.73, and b=0.46. Finally, the findings demonstrate that ESE plays a crucial mediating role in the correlation between PA and MH. This is evidenced by a p-value of 0.000, a t-value of 5.86, and a b coefficient of 0.18, highlighting the statistical significance of this relationship.
**Conclusion:** The findings provide essential guidance for enhancing the mental well-being of adolescents. The findings of this research offer practical strategies for improving MH among adolescents.

*Keywords:* Adolescent, Mental Health, Exercise, Self-Efficacy, Schools

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## 1. Introduction

Currently, there are 1.3 billion adolescents globally, accounting for 16 percent of the world's population, a figure that has reached unprecedented levels (1). Despite this significant demographic, adolescents have often been neglected in global health and social policies, as this life stage is typically viewed as the healthiest (2). Consequently, the specific health challenges faced by adolescents have frequently been overlooked in favor of more urgent public health issues (3). The changing health profiles of adolescents in both developed and developing countries underscore the necessity for focused attention on their varied health needs (4). In 2016, the World Health Organization (WHO) reported that more than 1.1 million adolescents died, with the majority of these fatalities resulting from conditions that were either preventable or treatable (5). The significant advancements made through global investments in child and maternal health will have limited long-term impact unless there is also a dedicated emphasis on adolescent health (6).

The mental health (MH) challenges faced by young people have garnered significant attention from psychologists and educators due to their long-term impact on overall functioning and well-being (7). Globally, approximately one in seven individuals aged 10 to 19 experiences a mental disorder, with depression, anxiety, and behavioral issues being the most common indicators of distress among adolescents (8). Epidemiological studies indicate that the prevalence of psychiatric disorders in this age group ranges from 17.5% to 19.9%. Between 2009 and 2019, there was a marked increase in feelings of sadness and hopelessness, escalating from 26.1% to 36.7% (9). This period also saw a rise in suicide planning and attempts. Adolescence is a pivotal stage for developing health, cognitive, and emotional skills, with effects that can last a lifetime. From a socio-economic standpoint, MH issues originating in childhood incur higher costs than those arising in adulthood, affecting healthcare, education, the criminal justice system, and social welfare programs (10).

In addition, MH issues represent a significant global health challenge for adolescents, contributing substantially to the overall disease burden (11). WHO reported that in 2016, MH conditions represent 16% of the global disease and injury burden in this

demographic, with depression identified as a leading contributor to both illness and disability (12). Suicide is the second leading cause of death, with self-harm closely following as the third (13). UNICEF highlights that approximately half of all lifetime mental disorders begin during adolescence (14). The recent recognition of adolescents as a critical target group for global health interventions marks a pivotal advancement in efforts to alleviate MH burden and prevent avoidable deaths (15). Nevertheless, the historical neglect of MH as a public health priority presents numerous challenges in effectively addressing MH needs of adolescents.

Exercise and physical activity (PA) play a crucial role in enhancing fitness, boosting endurance, and increasing muscle strength, while also serving as a preventive measure against various diseases, particularly cardiovascular issues, hypertension, diabetes, and obesity (16). Furthermore, MH significantly influences societal dynamics and progress, with physical education and exercise acting as effective tools to address psychological needs (17). Engaging in healthy sports and recreational activities during leisure time not only promotes individual physical and mental well-being but also enhances overall productivity and efficiency, reduces the risk of numerous health conditions, and leads to substantial savings in healthcare costs (18). In all countries, the importance of sports participation is underscored by its contributions to improved physical health, mental wellness, and optimal recreation for individuals (19).

Moreover, self-efficacy (SE) is a crucial element of social cognitive theory that influences health behaviors, particularly PA (20). It refers to an individual's confidence in their ability to organize and engage in PA while addressing various challenges. Derived from Bandura's framework, exercise self-efficacy (ESE) specifically pertains to a person's belief in their capacity to participate in sports and maintain a regular exercise routine (21). This belief is instrumental in predicting adherence to PA. Higher SE allows individuals to assess the outcomes of their efforts, leading to increased PA when weight loss goals are achieved (22). Notably, SE is particularly beneficial for adolescent girls, as studies indicate that obese and overweight students exhibit lower levels of ESE compared to their peers with a normal body mass index (23). Furthermore, SE serves as a significant predictor of changes in PA and weight loss among overweight and obese individuals. Empowerment in exercise, coupled with supportive environmental influences, significantly shapes behavioral intentions (24). Research indicates that programs aimed at enhancing SE yield positive outcomes, encouraging adolescents to adopt healthier lifestyles and mitigate obesity risks (25,26).

The relationship between PA and MH has been extensively studied, yet the mechanisms that underpin this connection remain largely unclear. There is ongoing uncertainty about how regular PA influences an individual's MH and whether factors such as SE serve as mediators in this relationship. This gap highlights the necessity for further investigation, particularly among adolescents who face diverse stressors that significantly contribute to psychological challenges. Understanding the protective factors that affect adolescents' MH is crucial for developing effective interventions to promote their well-being. Therefore, this study aims to examine the links between PA, ESE, and MH in adolescents, while also exploring the potential mediating roles of ESE. Based on prior research, we propose a theoretical model (Figure 1) and present several hypotheses: (1) PA positively correlates with MH; (2) ESE positively correlates with MH; (3) ESE mediates the relationship between PA and MH.

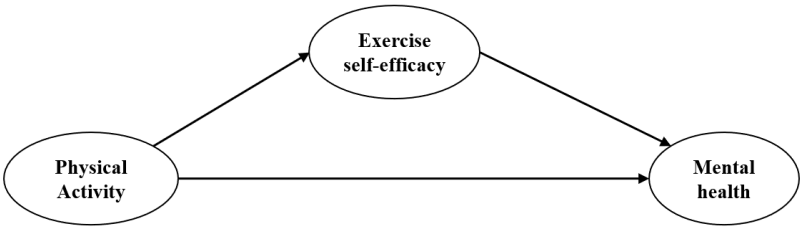


**Figure 1.** Theoretical Model of the Study

## 2. Methods

### *2.1. Design and Participants*

This study utilized a descriptive-correlational design with structural equation modeling to analyze data from a target population of female adolescents aged 15 to 18 years. The sample comprised 384 participants, evenly split between 192 boys and 192 girls, calculated based on parameters of $\alpha$=0.05, $\beta$=0.05, and r=0.20. The average age of participants was 16.52 years, with a standard deviation of 0.33. Recruitment was carried out through convenience sampling, and both participants and their parents were fully briefed on the research aims and methods prior to participation. Inclusion criteria were to be healthy adolescents without any physical or MH issues and not on special medication; those who did not meet these criteria or failed to complete the questionnaire were excluded from the analysis.

### *2.2. Measurements*

#### *2.2.1. Physical Activity*

The ActiGraph wGT3X-BT accelerometer, a highly validated device from ActiGraph LLC in Pensacola, FL, was employed to objectively assess the intensity and duration of PA as well as sedentary time among adolescents. Participants wore the accelerometer on their right hip for one week, and the accompanying software facilitated data analysis. The established cutoff points for categorizing PA intensity were defined as follows: light PA ranged from 101 to 2,799 counts per minute (CPM), moderate PA from 2,800 to 3,999 CPM, and vigorous PA was identified as any activity exceeding 4,000 CPM. In this study, moderate-to-vigorous PA (MVPA) was considered as PA score.

#### 2.2.2. Mental Health

The Depression, Anxiety, Stress Questionnaire (DASS-21) was employed to assess MH, focusing on three key areas: depression, which includes eight items; anxiety, with seven items; and stress, comprising six items (27). Participants responded using a 4-point Likert scale, where zero indicates "not applicable to me at all" and three signifies "entirely applicable to me." In this study, the validity of this instrument has been confirmed by eight experts, yielding a Content Validity Index (CVI) of 0.94 and a Content Validity Ratio (CVR) of 0.93. Moreover, the DASS-21 demonstrated a high reliability with a Cronbach's alpha of 0.93.

#### 2.2.3. Exercise Self-Efficacy

The Exercise Self-Efficacy Scale was employed to assess ESE (28), consisting of 12 items within a single dimension. Each item is rated on a three-point Likert scale, ranging from "1" (I can't do it) to "3" (I am sure I can do it). The total score is calculated by summing the individual item scores, with higher scores indicating greater ESE among college students. In this study, the scale's validity was established through evaluations by eight experts, resulting in a CVI of 0.90 and a CVR of 0.92. Additionally, the scale demonstrated strong internal consistency, evidenced by a Cronbach's alpha coefficient of 0.91.

### 2.3. Procedure

In the implementation phase, collaboration with the Education Department was initiated to obtain the necessary permissions. A visit to the school followed, during which the research objectives were presented, emphasizing the significance of the findings to ensure informed consent from both parents and students. Subsequently, a convenience sampling method was utilized to select a sample of 384 adolescents, who were then asked to complete accelerometer protocol and questionnaires. The completed accelerometer data and questionnaires were subsequently collected for analysis.

### 2.4. Statistical Analysis

For the data analysis, descriptive statistics were applied, concentrating on central tendency and variability measures, including mean, standard deviation, skewness, and kurtosis. In the subsequent phase of inferential statistics, structural equation modeling was utilized following the confirmation of requisite assumptions. The analysis was conducted using Smart PLS statistical software version 4, with a significance level established at 0.05.

## 3. Results

Table 1 presents the features of PA, MH, and ESE among adolescents. The skewness and kurtosis values for all variables fall within the range of -2 to +2, confirming that the data meets the criteria for normal distribution.

**Table 1.** Description of Research Variables.

| | Skewness | Kurtosis | Mean | SD | Maximum | Minimum |
|---|---|---|---|---|---|---|
| **Physical Activity** | 0.272 | 0.539 | 35.69 | 3.47 | 66.97 | 5.52 |
| **Mental Health** | 1.39 | 0.134 | 13.58 | 1.44 | 19 | 3 |
| **Exercise Self-Efficacy** | 1.26 | 0.123 | 15.52 | 1.47 | 28 | 4 |

Table 2 revealed that the Cronbach's alpha values for PA was 0.95, MH was 0.92, and ESE was 0.90. Additionally, the composite reliability for PA was 0.93, MH was 0.90, and ESE was 0.88. Finally, the average variance extracted (AVE) for PA was 0.641, for MH was 0.587, and for ESE was 0.553. These values exceed acceptable thresholds, indicating that the questionnaires utilized demonstrated satisfactory reliability and validity.

**Table 2.** Validity and Reliability.

| | Cronbach's Alpha | Composite Reliability | AVE |
|---|---|---|---|
| **Physical Activity** | 0.952 | 0.931 | 0.641 |
| **Mental Health** | 0.922 | 0.902 | 0.587 |
| **Exercise Self-Efficacy** | 0.901 | 0.884 | 0.553 |

The analysis conducted using Pearson's correlation coefficient indicated a strong negative correlation between PA and MH ($P < 0.001$, $r = -0.63$), as well as between ESE and MH ($P < 0.001$, $r = -0.52$). Furthermore, a significant positive relationship was identified between PA and ESE ($P < 0.001$, $r = 0.42$). These results lend support to the hypothesis of a linear relationship among the examined variables. Additionally, the variance inflation factor (VIF) values for all research variables were below the critical threshold of 10, suggesting that multicollinearity is not a concern in this study.

The results of the path analysis conducted using Smart PLS software, as shown in Table 3, reveal a significant structural relationship between MH and ESE in the context of PA, with values of P=0.000, t=-10.24, and b=0.68 for MH, and P=0.000, t=8.41, and b=0.53 for ESE. Furthermore, there is a significant structural relationship between ESE and MH, indicated by P=0.000, t=-7.73, and b=0.46.

**Table 3.** Structural Model Coefficients and Values for the Direct Path.

| Path | b | SE | t-Value | P-Value |
|---|---|---|---|---|
| **Physical Activity => Mental Health** | - 0.683 | 0.069 | -10.24 | 0.000 |
| **Physical Activity => Exercise Self-Efficacy** | 0.531 | 0.058 | 8.41 | 0.000 |
| **Exercise Self-Efficacy => Mental Health** | - 0.463 | 0.044 | -7.73 | 0.000 |

The findings in Table 4 demonstrate that ESE plays a crucial mediating role in the correlation between PA and MH. This is evidenced by a p-value of 0.000, a t-value of 5.86, and a b coefficient of 0.18, highlighting

the statistical significance of this relationship.

**Table 4.** Structural Model Coefficients and Values for the Indirect path.

| Indirect Path | b | SE | t-Value | P-Value |
|---|---|---|---|---|
| Physical Activity => Exercise Self-Efficacy => Mental Health | 0.18 | 0.041 | 5.86 | 0.000 |

The Stone-Geisler $Q^2$ index values shown in Table 5 and Figure 2 are all positive, indicating that the structural model is of high quality. The model demonstrates robust predictive capability for the endogenous latent variables, with an $R^2$ value of 0.43 for PA, signifying that it explains 43 percent of the variance in this variable. Furthermore, the SRMR value of 0.075 is below the acceptable limit of 0.08, and the goodness of fit index (GOF) for the overall model is 0.39, exceeding the minimum requirement of 0.36. Collectively, these findings indicate that the model exhibits a good fit.

**Table 5. Model Fit Indices.**

| | $Q^2$ | $R^2$ | SRMR | GOF |
|---|---|---|---|---|
| Physical Activity | 0.283 | 0.433 | 0.075 | 0.39 |
| Mental Health | 0.314 | 0.071 | | |
| Exercise Self-Efficacy | - | | | |
| Acceptable Value | Be positive | | <0.8 | >0.36 |

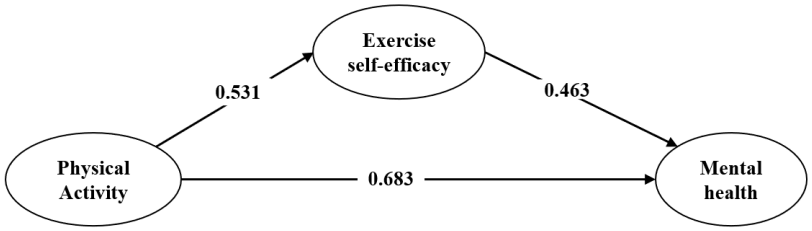


**Figure 2.** Standardized Coefficients of Paths

## 4. Discussion

This study seeks to investigate the relationships among PA, ESE, and MH in adolescents, while also assessing the mediating effects of ESE. The initial findings indicated that the adolescents participating in this study exhibited significantly lower levels of health-related PA, particularly in terms of MVPA, compared to established recommendations. International guidelines advocate for at least 60 minutes of MVPA daily for youth, yet our participants averaged only 35.69 minutes per day, a figure that falls well short of these benchmarks. This trend aligns with previous research, underscoring a concerning lack of engagement in health-related PA among youth (29,30). Given the numerous benefits of regular PA for adolescents' health, it is crucial for health practitioners to focus on PA patterns of adolescents. Therefore, developing targeted interventions and strategies to enhance MVPA levels in this population is of paramount importance.

In addition, the main findings of this study indicate a significant structural relationship between MH and ESE within the framework of PA. Additionally, a significant structural relationship exists between ESE and MH. Importantly, the results highlight that ESE serves as a significant mediator in the relationship between PA and MH. These findings revealed that PA initially appeared to predict MH outcomes without considering mediating factors. However, once ESE was included as mediators, it significantly influenced the relationship between PA and MH. This indicates that PA may act as a more distant factor affecting MH, likely due to its inherent characteristics. Engaging in PA is a deliberate behavior driven by personal intentions and motivations, while also being influenced by external environmental factors that can either support personal growth or provide external rewards (31,32). Positive experiences derived from PA, especially when they align with individual goals, are more likely to enhance MH. Conversely, if adolescents do not have fulfilling experiences or fail to achieve their motivations through PA, it may not positively impact their MH (31,33). The effects of PA can differ among individuals, and improvements in MH often require sustained engagement and are influenced by various factors, with PA being just one component. The delayed nature of observing the benefits of PA on MH can result in its effects being obscured by other life stressors and unforeseen events. Therefore, increasing adolescents' awareness of the MH benefits of PA is crucial for promoting their overall health.

The results reinforce the idea that PA positively affects MH through the mediation of ESE, highlighting the importance of enhanced ESE as key pathway through which PA impacts MH. In recent years, the Resilience Portfolio Model has become an essential framework for understanding the comprehensive array of protective factors and MH processes that individuals experience in the face of adversity (34-36). This model categorizes protective factors into three main areas: regulation, meaning-making, and interpersonal relationships, emphasizing the critical importance of boosting self-esteem, improving self-regulation, and nurturing positive social connections as vital mechanisms for supporting MH. Prior research has also demonstrated the mediating role of resilience in linking PA to MH outcomes.

The mediating role of ESE can be understood through primary perspectives that emphasize the intrinsic value of PA. From this angle, SE is shaped by individual perceptions of the benefits and experiences associated with engaging in PA (21,22). Such activities are linked to numerous positive outcomes, including improved physical fitness, enhanced body image, increased subjective heath, elevated self-esteem, and

greater overall life satisfaction. This collection of benefits serves as a cognitive resource that supports MH and promotes heath. Individuals who experience these positive effects are more likely to maintain their engagement in PA, which in turn enhances their self-perception and boosts SE (24,25). As adolescents develop greater SE, they tend to experience a reduction in negative emotions and adopt a more positive outlook when facing life's challenges. Research has shown that MH is closely tied to both positive and negative memory biases, with positive interpretation biases being particularly significant (21,26). Therefore, those who enjoy favorable experiences from PA are likely to exhibit increased SE, equipping them to tackle stressors with optimism and fostering a more resilient psychological state.

Furthermore, clinical research has identified several mechanisms that elucidate the beneficial effects of PA on depression. These studies suggest that engaging in PA leads to elevated levels of serotonin, dopamine, and norepinephrine, which are often termed "feel-good" hormones (37). This biochemical response not only alleviates stress but also contributes to an overall enhancement of heath. In addition, the beneficial impact of PA on MH can be linked to enhancements in self-confidence, self-esteem, and overall physical fitness (38). Engaging in regular PA helps sustain physical fitness by promoting healthy weight management, improving bone density, increasing muscle strength, and enhancing joint mobility. These factors contribute to overall physiological heath and subsequent psychological heath (39).

This study faced several limitations that warrant consideration. Its focus on adolescents may limit the generalizability of the findings to other age groups, such as children, highlighting the necessity for future research to include younger populations. Furthermore, the reliance on questionnaires to assess research variables introduces the possibility of self-reporting bias. The study also overlooks potential confounding factors, including age, type of sport, years of athletic experience, and socioeconomic status, all of which could affect levels of anxiety and mindfulness. Lastly, while structural equation modeling was employed, the cross-sectional correlational design restricts the ability to draw causal inferences. On a positive note, this research highlighted significant strengths, particularly in its exploration of ESE among adolescents, a relatively under-researched area in existing literature.

### *4.1. Conclusion*

This study is significant on several levels. Theoretically, it develops a mediation model that elucidates the mechanisms by which PA impacts MH, offering important insights into the complex factors influencing MH outcomes. Additionally, it is the first investigation into the relationships among PA, ESE, and MH specifically in adolescents, thereby broadening the application of The Resilience Portfolio Model. Practically, the findings provide essential guidance for enhancing the mental well-being of adolescents. The findings of this research offer practical strategies for improving MH among adolescents. It is essential for educational institutions, schools, and parents to focus on raising awareness and promoting habits related to PA among young people. This focus can significantly alleviate negative emotions through exercise, fostering better MH. Additionally, physical education programs should emphasize goal-setting for PA, as regular assessments of these goals, coupled with timely support, can enhance adolescents' SE. By expanding the variety of PA available to students, schools can cater to adolescents' physical needs and preferences, supporting ongoing MH development.

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## Footnotes

**Authors' Contribution:** This study was carried out solely by the corresponding author.

**Conflicts of Interest**

Non to declare.

**Data Availability:** The data that support the findings of this study are openly available upon request from the corresponding author.

**Ethical Approval:** The author confirms that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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**Informed Consent:** Informed written consent was obtained from all participants

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