

Physical Exercise and Meaning in Life among Male Adolescents: The Mediating Role of Attachment

Qiangyan Hou, Haiqing Wang*

School of Psychology, Northwest Normal University, Lanzhou, Gansu, 730070, China

*Corresponding author: Haiqing Wang, 1871229497@qq.com

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Abstract: Background: A sense of meaning in life can enhance an individual's well-being, reduce anxiety and depression, strengthen the ability to cope with stress, promote positive and healthy behaviors, and improve physical and mental health. How to improve the sense of meaning in life is a very important issue. This study explored the relationship between physical exercise and the sense of meaning in life among male adolescents, as well as the mediating role of attachment. **Methods:** The "Physical Activity Rating Scale", the "Experiences in Close Relationships Scale", and the "Sense of Meaning in Life Scale" were used to conduct a survey among male students in a middle school in Gansu Province. A total of 304 questionnaires were collected online. After organizing the data, SPSS and its plug-in PROCESS were used for analysis. **Results:** Physical exercise can directly and positively predict the score of the sense of meaning in life ($\beta = 0.133$, $t = 2.326$, $p = 0.021 < 0.05$). Attachment anxiety plays a partial mediating role between physical exercise and the sense of meaning in life (Effect = 0.021, $SE = 0.014$, 95% CI [0.001, 0.055]). **Conclusions:** Higher levels of exercise can improve the sense of meaning in life among male adolescents. It can also reduce attachment anxiety, thereby promoting the enhancement of the sense of meaning in life, and then having a positive impact on the physical and mental health of male adolescents.

Keywords: Physical Exercise; Attachment Anxiety; Attachment Avoidance; Sense of Meaning in Life

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1. Introduction

Sense of Meaning in Life (SML) is not merely a cognitive experience regarding the value of one's existence and life goals, but also an intrinsic driving force that motivates individuals to take positive actions and cope with challenges. As Frankl^[1] emphasized in "Man's Search for Meaning", even in the most difficult circumstances, individuals can maintain hope and dignity by finding meaning in life. SML is the cornerstone of individual psychological well-being and a vital source of happiness. It not only enhances individuals' life satisfaction but also strengthens their ability to cope with stress and promotes positive social behaviors^[2-4]. Conversely, a lack of SML can lead to intense feelings of emptiness, confusion, and a perception that life lacks purpose and value, subsequently triggering negative emotions such as anxiety and depression, and even increasing the risk of suicide. This absence of SML not only affects individuals' mental health but also negatively impacts their social functioning and interpersonal relationships^[5-7].

For male adolescents, SML is particularly important. On one hand, this period is a crucial stage for self-awareness development and value formation, where individuals face multiple challenges related to identity, academic pressure, and

interpersonal relationships^[8–10]. On the other hand, gender differences in mental health often emerge during late childhood and adolescence, with males exhibiting higher rates of physical and mental health issues, and behavioral health problems. Globally, the male suicide rate is two to four times higher than that of females, and males underperform in indices related to substance abuse, risk-related injuries, behavioral problems, violence, aggression, and subsequent incarceration^[11, 12]. Therefore, it is significant to focus on the SML of male adolescents, providing them with support and guidance, and helping them establish a clear SML and cultivate correct values.

Existing research indicates that SML is influenced by various factors. Positive social support, good interpersonal relationships, participation in meaningful activities, and having clear personal goals all contribute to enhancing individuals' SML. Social support provides emotional comfort and practical assistance, enhancing their sense of security and belonging^[13, 14]. Good interpersonal relationships promote interaction and communication, strengthen the sense of belonging, and help them better understand their value and social responsibilities^[15, 16]. Participating in meaningful activities allows individuals to feel their value and contribution, thereby enhancing SML^[17, 18].

In recent years, studies have found that Physical Exercise (PE) has a positive effect on enhancing SML^[19]. The relationship between PE and SML in male adolescents can be viewed from the perspective of self-determination theory. PE can satisfy individuals' needs for autonomy, competence, and relatedness, thereby promoting intrinsic motivation and further enhancing SML^[20]. Research shows that PE not only improves physical function but also helps individuals better understand their value and life goals by promoting mental health, enhancing social interaction, and cultivating a positive mindset^[21–24]. Based on this, we hypothesize that PE positively predicts SML in male adolescents (Hypothesis 1).

An individual's initial SML is formed in the establishment of attachment relationships with parents. Attachment refers to a special emotional connection between a child and their primary caregiver (usually the parents)^[25]. An individual's judgment of the meaning of life is not based on social value but on reflections of "me and others" in the attachment relationship^[26]. According to the framework of attachment theory, attachment patterns affect an individual's social relationships and mental health throughout life^[27, 28]. Secure attachment provides individuals with a sense of security and confidence, enabling them to dare to explore the world, establish good interpersonal relationships, and helps them explore life goals and pursue their value. Insecure attachment leads individuals to lack security and trust, making it difficult to establish intimate relationships, and may affect their perception of their value and their expectations for future life^[29–32]. Therefore, individuals with secure attachment seek help from attachment figures, thereby buffering the panic caused by the lack of SML. Individuals with insecure attachment are more likely to be skeptical about life, have a lack of knowledge about the world, and thus ignore life^[33]. Therefore, reducing an individual's level of insecure attachment should be conducive to the development of their SML^[34].

On the other hand, PE can provide individuals with positive interactive experiences, enhancing their adaptability and sense of belonging^[14, 35]. Research suggests a positive relationship between physical activity and attachment to parents and peers^[36, 37]. Among them, boys' peer attachment scores are significantly lower than girls', and their scores in terms of parental estrangement are also significantly lower than girls'^[38, 39]. Brennan et al.^[40] divided attachment styles into two dimensions: attachment anxiety and attachment avoidance. Attachment avoidance is the fear of dependence and intimacy, causing individuals to give up the pursuit of closeness. Attachment anxiety is the fear of being abandoned by a partner, driving individuals to seek closeness, kindness, and attention from other important figures. Individuals with high levels of avoidance or/and anxiety can be classified as having insecure attachment styles. This study focuses on the positive effects of PE on insecure attachment.

In summary, this study proposes the following hypotheses:

PE negatively predicts attachment anxiety (Hypothesis 2);

PE negatively predicts attachment avoidance (Hypothesis 3);

Attachment anxiety negatively predicts SML (Hypothesis 4);

Attachment avoidance negatively predicts SML (Hypothesis 5);

Attachment anxiety mediates the relationship between PE and SML (Hypothesis 6);

Attachment avoidance mediates the relationship between PE and SML (Hypothesis 7).

2. Materials and Methods

2.1 Participants

Participants were male students (ages 12-16) from a middle school in Lanzhou, Gansu, recruited online between October 23rd and 31st, 2023. Questionnaires were distributed online. Before filling out the questionnaires, all participants were required to read the informed consent form and then voluntarily participate in the survey. All participants answered anonymously. A total of 304 questionnaires were collected, comprising 228 urban (75.000%), 76 rural (25.000%); 164 students (53.947%) were only-children and 140 students (46.053%) had siblings; 91 students (29.934%) were in Grade 7, 137 students (45.066%) were in Grade 8, and 76 students (25.000%) were in Grade 9.

2.2 Research Tools

2.2.1 General Demographic Questionnaire

Participants provided demographic data via a self-compiled questionnaire, which included questions about their place of origin, whether they were an only child, and their grade level.

2.2.2 Physical Activity Rating Scale (PARS)

Physical exercise was measured using the Physical Activity Rating Scale, revised by Liang ^[41]. This widely-used scale assesses physical activity volume based on three items: intensity, duration, and frequency. A 5-level scoring system is used, with intensity and frequency scored from 1 to 5, and duration from 0 to 4. Physical activity volume is calculated as: intensity $\times$ duration $\times$ frequency.

2.2.3 Experiences in Close Relationships Scale (ECRS)

Close relationships were measured using the Experiences in Close Relationships Scale, compiled by Brennan et al. ^[40] and translated by Li and Kato ^[42]. This 36-item questionnaire, initially developed for adult attachment styles and later adapted for adolescents, comprises two 18-item sub-scales: attachment anxiety and attachment avoidance. Odd-numbered items assess attachment avoidance, while even-numbered items assess attachment anxiety. A 7-point scale (1 = “very inconsistent” to 7 = “very consistent”) was used. The internal consistency coefficient ($\alpha = 0.899$) indicated good reliability.

2.2.4 Meaning in Life Questionnaire (MLQ)

The Meaning in Life Questionnaire was used to assess meaning in life ^[43]. This 10-item instrument utilizes a 7-point Likert scale (1 = “completely inconsistent”, 7 = “completely consistent”) and comprises two sub-scales: Presence of Meaning (items 1, 4, 5, 6, 9) and Search for Meaning (items 2, 3, 7, 8, 10). Item 2 is reverse-scored, and higher scores indicate a greater SML. The internal consistency coefficient (α) for the MLQ in this study was 0.877.

2.3 Statistical Methods

Data were analyzed using SPSS 26.0 with the PROCESS macro. Analyses included descriptive statistics, independent-samples t-tests, analysis of variance, Pearson correlations, and PROCESS model 4 for mediation.

3. Results

3.1 Common Method Bias

Due to the use of self-report questionnaires for data collection, this study may be susceptible to common method bias. To mitigate its potential influence, Harman’s single-factor test was employed for assessment. The results indicated that the first factor accounted for 22.243% of the variance without rotation, which is below the 40% threshold, suggesting a low risk of common method bias in this study.

3.2 Difference Analysis

As shown in Table 1, independent samples t-test and analysis of variance were used to examine the demographic differences of each variable. The results showed that there were no significant differences in each variable in terms of whether being an only-child, place of origin and grade ($ps > 0.05$).

Table 1 Analysis of demographic differences among variables (N = 304)

Variable	Variable	N	Physical Exercise	Attachment Anxiety	Attachment Avoidance	Sense of Meaning in Life
Variable	Variable	N	M±SD	M±SD	M±SD	M±SD
Family structure	only child	164	27.366±23.494	47.842±16.645	61.689±14.771	54.092±11.832
Family structure	non-only children	140	27.100±22.311	50.786±19.132	61.129±17.015	53.836±11.918
Family structure	<i>t</i>		0.101	-1.435	0.307	0.187
Family structure	<i>p</i>		0.920	0.152	0.759	0.852
Place of origin	urban	228	26.706±22.036	49.351±17.324	62.311±14.487	53.930±11.326
Place of origin	rural	76	28.855±25.475	48.137±19.508	58.790±19.140	54.105±13.389
Place of origin	<i>t</i>		-0.707	0.259	1.686	-0.112
Place of origin	<i>p</i>		0.480	0.796	0.093	0.911
Grade	Grade 7	91	24.385±19.933	50.198±17.782	61.385±15.416	53.407±10.958
Grade	Grade 8	137	29.102±24.261	48.701±16.907	61.620±15.287	54.183±11.584
Grade	Grade 9	76	27.316±23.704	48.895±19.741	61.145±17.376	54.276±13.399
Grade	<i>F</i>		1.160	0.205	0.023	0.149
Grade	<i>p</i>		0.301	0.814	0.978	0.864

3.3 Correlation Analysis

Through Pearson correlation analysis (see Table 2), it was found that there was a significant negative correlation between PE and attachment anxiety ($r = -0.152$, $p = 0.008 < 0.01$), and there was no significant correlation between PE and attachment avoidance ($r = -0.093$, $p = 0.105 > 0.05$). There was a significant positive correlation between PE and the SML ($r = 0.153$, $p = 0.007 < 0.01$). There was a significant positive correlation between attachment anxiety and attachment avoidance ($r = 0.672$, $p = 0.000 < 0.001$), and there was a significant negative correlation between attachment anxiety and the SML ($r = -0.156$, $p = 0.007 < 0.01$). There was no significant correlation between attachment avoidance and the SML ($r = 0.029$, $p = 0.612 > 0.05$). Since there is no significant correlation between attachment avoidance and the independent variable (PE) as well as the dependent variable (SML), the mediating role of attachment avoidance between PE and SML will not be further analyzed.

Table 2 Correlation analysis of each variable (N = 304)

	1	2	3	4
1. Physical Exercise	1			
2. Attachment Anxiety	-0.152**	1		
3. Attachment Avoidance	-0.093	0.672***	1	
4. Sense of Meaning in Life	0.153**	-0.156**	0.029	1

Note: ** $p < 0.01$, *** $p < 0.001$; “p” = probability.

3.4 Analysis and Effect Test of the Mediating Role of Attachment Anxiety

The SPSS macro program PROCESS developed by Hayes was used, model 4 was selected, the sampling was repeated 5000 times, the 95% CI was calculated, and the chain mediating effects of exercise volume and SML between attachment avoidance and school bullying behavior were tested. The results are shown in Table 3. PE can negatively predict attachment anxiety ($\beta = -0.152$, $t = -2.668$, $p = 0.008 < 0.01$). PE can positively predict the SML ($\beta = 0.133$, $t = 2.326$, $p = 0.021 < 0.05$). Attachment anxiety can negatively predict the SML ($\beta = -0.135$, $t = -2.371$, $p = 0.018 < 0.05$).

Table 3. The mediating role of attachment anxiety between physical exercise and sense of meaning in life ($N = 304$)

Dependent variable	Independent variable	R^2	F	p	β	t	p
Attachment Anxiety	Physical Exercise	0.023	7.120	0.008	-0.152	-2.668	0.008
Sense of Meaning in Life	Physical Exercise	0.041	6.502	0.002	0.133	2.326	0.021
	Attachment Anxiety				-0.135	-2.371	0.018

The mediation model's diagram is presented in Figure 1.

Fig. 1. A mediation model diagram of attachment anxiety between physical exercise and sense of meaning in life. (A) The specific values marked are the predictive effect values of variables. (B) The dotted line indicates a non-significant path, and the solid line indicates a significant path. (C) * $p < 0.05$, ** $p < 0.01$; "p" = probability.

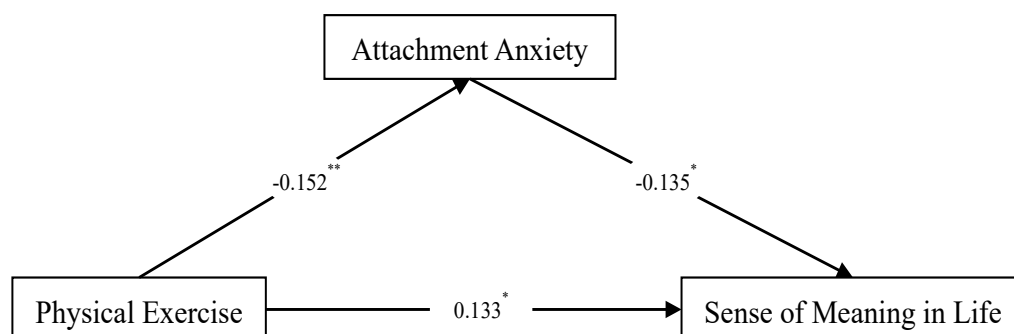


Table 4 presents the results of the mediation analysis, showing a significant total effect (Effect = 0.153, SE = 0.057, 95% CI [0.042, 0.265]). The direct effect of PE on the SML is significant (Effect = 0.133, SE = 0.057, 95% CI [0.021, 0.245]). The mediating effect of attachment anxiety between PE and the SML is significant (Effect = 0.021, SE = 0.014, 95% CI [0.001, 0.055]). Attachment anxiety plays a partial mediating role between PE and the SML.

Table 4. Test of the mediating effect of attachment anxiety between physical exercise and sense of meaning in life ($N = 304$)

	Effect	Bootstrap SE	Bootstrap 95% CI	Bootstrap 95% CI
	Effect	Bootstrap SE	Low	High
Total Effect	0.153	0.057	0.042	0.265
Direct Effect: Physical Exercise → Sense of Meaning in Life	0.133	0.057	0.021	0.245
Indirect Effect: Physical Exercise → Attachment Anxiety → Sense of Meaning in Life	0.021	0.014	0.001	0.055

4. Discussion

This study aimed to explore the impact of PE on the SML among male adolescents, as well as the mediating roles of attachment anxiety and avoidance. The results indicated that PE significantly enhances the SML for male adolescents, and attachment anxiety plays a partial mediating role between PE and the SML. Specifically, increased PE can reduce an individual's attachment anxiety, thereby enhancing their SML. However, no significant mediating effect of attachment avoidance was found in this study.

Previous research has shown that insecure attachment is associated with lower levels of mental health^[28], and Yen's study directly pointed out that insecure attachment significantly reduces an individual's SML^[26]. Attachment anxiety, as a manifestation of insecure attachment, further confirms this view. Attachment anxiety negatively predicts the SML, which is consistent with the findings of previous studies. PE may alleviate attachment anxiety caused by fear of rejection and abandonment, thereby enabling individuals to experience the meaning of life more fully and establish healthier connections with others^[14]. The sense of belonging brought about by positive peer interactions and teamwork may also play a role.

However, attachment avoidance did not show a significant mediating effect in this study. The reasons for this may be: First, attachment avoidance is mainly manifested as detachment and distrust in close relationships. Individuals tend to maintain emotional distance and pursue independence ^[44], which may have a relatively weak direct association with the SML. Individuals with attachment avoidance may participate in PE more for personal interest or health purposes rather than seeking emotional support. Second, individuals with attachment avoidance may be more inclined to suppress their emotional needs and deal with problems more cognitively than emotionally ^[45]. Although the SML includes emotional experiences, it also involves rational thinking about life goals and values ^[46]. Therefore, individuals with attachment avoidance may seek meaning in life more through rational analysis than emotional experience, and the emotional impact of PE on them may not directly translate into an enhanced SML. In addition, the sample in this study was male adolescents, and their expression of attachment avoidance may differ from that of women or adults ^[47]. They may be more inclined to establish a sense of self-worth and meaning in life through other means (such as pursuing achievements and developing hobbies) rather than relying on close relationships.

The findings of this study have important practical significance. It emphasizes the importance of PE in promoting the mental health of male adolescents. Schools and families should encourage male adolescents to actively participate in physical activities to reduce their attachment anxiety, enhance their SML, and promote their physical and mental health development. This study also has certain limitations. The cross-sectional design makes it difficult to determine the causal relationship between variables. Future studies can use a longitudinal design to track adolescents' PE and SML levels at different periods to more accurately assess the relationship between variables. This study only focused on the amount of PE and did not pay attention to the types of PE, which may be an important factor (for example, team cooperation projects in the process of PE may be more effective for emotions and relationships). Future studies can explore the impact of different types of PE on adolescents' attachment levels, SML, and physical and mental health. In addition, future studies can also explore other possible mediating variables, such as social support and self-efficacy, to more comprehensively understand the mechanism of PE's impact on the SML.

5. Conclusions

- (1) PE can significantly enhance the SML among male adolescents.
- (2) Attachment anxiety plays a mediating role between PE and the SML, meaning that PE may enhance the SML by alleviating attachment anxiety.
- (3) The results of this study emphasize the importance of PE for the mental health of male adolescents and suggest that attention should be paid to the attachment patterns of male adolescents and corresponding support should be provided.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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