Applied Mathematics, Modeling and Computer Simulation
C.-H. Chen et al. (Eds.)

doi:10.3233/ATDE230936

A Systematic Review and Meta-Analysis on the Relationship Between Physical Exercise and Body-Esteem: With the Sample from Mainland China

Tao XU[a,b], Wancheng LIU[c], Hongyu ZHANG[b], Huiyong FAN[a,1] and Qin LAI[d]
[a] *College of Physical Education, Bohai University, No. 19 Keji Road, Jinzhou (121013), Liaoning, China*
[b] *Faculty of Education, Languages & Psychology, Segi University, Kota Damansara, PJU 5, Petaling Jaya (47810), Selangor, Malaysia*
[c] *College of Physical Education, Anhui Polytechnic University, No. 8 Beijing Middle Road, Wuhu (241000), Anhui, China*
[d] *Division of Kinesiology, Health & Sport Studies, Wayne State University, Detroit (48202), Michigan, USA*

Abstract. Objective: Body-esteem is an important indicator of the psychological benefits of physical exercise. To integrate inconsistent findings from previous literature, this study aimed to explore the reasons for the inconsistency. Methods: A meta-analysis was conducted to analyze 90 original studies published between 2008 and 2022, involving 98 independent samples and 29,251 participants. Results: (1) There was a significant positive correlation between physical exercise and body-esteem (r = 0.421, 95%CI [0.368, 0.472]), with a moderate effect size. (2) There were also significant positive correlations, with moderate effect sizes, between exercise duration (r = 0.386, 95%CI [0.235, 0.520]), exercise intensity (r = 0.355, 95%CI [0.227, 0.470]), exercise frequency (r = 0.405, 95%CI [0.291, 0.507]), and body-esteem. (3) Group type effects moderated the relationship between physical exercise and body-esteem (Qb = 8.088). (4) Exercise type effects partially moderated the relationship between physical exercise and body-esteem (Qb = 10.057), physical self-worth (Qb = 10.015), and physical attractiveness (Qb = 7.823). (5) Publication type effects were not significant (Qb = 2.795). (6) Exercise measurement type effects moderated the relationship between physical exercise and body-esteem (Qb = 10.304). Conclusion: (1) There is a moderate positive correlation between physical exercise and body-esteem. (2) Research characteristics, such as group type, exercise type, and exercise measurement type, can affect the relationship between physical exercise and body-esteem, with small to moderate moderation effects.

Keywords. Physical exercise; body-esteem; self-worth; meta-analysis; moderation effects.

[1] Corresponding Author, Huiyong FAN, College of Physical Education, Bohai University, No. 19 Keji Road, Jinzhou (121013), Liaoning, China; E-mail: taoxu1977@foxmail.com.

1. Introduction

Body-esteem is the counterpart of self-esteem, which refers to an individual's self-evaluation of one's body or appearance[1-3]. Increased body-esteem is significant in reducing depressive symptoms in children, adolescents, and elderly, enhancing individuals' sense of self-worth[4]; contributing to individuals' mental health (Zhang, 2015) and stimulating positive social behaviour (Hartson, Gance-Cleveland, Amura, & Schmiege, 2018). Physical exercise is a type of sports activities of a certain intensity, frequency and duration to improve health[5-7]. As an economical and convenient means of promoting overall health, physical exercise has become increasingly important in the field of mental health intervention and promotion[8-12].

Research on the impact of exercise on self-esteem and body-esteem has yielded inconsistent results. Calfas and Taylor (1994) found a small effect size in their review of 20 studies. Lindahl et al. (2015) reported mixed findings in eight articles. Zhu and Chen (2009) and Huang and Guo (2008) found a wide range of effect sizes in their reviews. This study aims to synthesize these findings using a meta-analytic approach to understand the relationship between physical exercise and body-esteem, particularly focusing on studies published in mainland China..

This study uses articles from mainland China to examine the link between physical exercise and body-esteem, determine the effect size, and understand the psychological mechanisms involved.

1.1. Body-Esteem Measurement

The main instruments of body-Esteem (McPhie, et al., 2011) used in this study were the Physical Self-Perception Profile-PSPP (Fox,1989) and the Body Esteem Scale -BES (Franzo & Shields, 1984).

1.2. Physical Exercise Measurement

Physical exercise (Editorial Board of Encyclopedia of China, 1982) was measured in this study in two main ways, the Physical Activity Rating Scale-3 -PARS-3 (Liang, 1992) and Physical Activity Inventory Form-PAI (Shi, 2013).

1.3. Research Related to Physical Exercise and Body-Esteem

Recent studies in China show varied correlation coefficients between physical exercise and body-esteem, ranging from -0.157 (Tao, Yin, & Xiao, 2015) to 0.800 (Wang, 2013). Some found a low to moderate positive correlation (Zhang, Dou, & Gao, 2015; Xu & Mao, 2013), others reported no significant correlation (Gao & Wang, 2016), and a few even suggested a negative correlation (Tao, Yin, & Xiao, 2015) .

1.4. Research Questions and Hypotheses

1.4.1. Overall Correlation between Physical Activity and Body-Esteem

This study primarily investigates the correlation between physical exercise and body-esteem. The theory is that physical exercise improves physical condition, thereby

enhancing body-esteem. This is backed by experimental studies like Liu, Wu, and Ming (2015), who found that physical exercise increased self-concept and self-worth in children and adolescents through a meta-analysis of 25 randomised controlled trials.

H1: Exercise overall score and dimensions are significantly and positively related to body-esteem.

1.4.2. Moderating Effects of Study Characteristics

The second question was about which study characteristics contributed to the variance between the original study effect sizes in this study. Based on the dose-response model (Dishman, 1986, 1995) and related meta-analyses (Brown, 2013), we conducted meta-regression analyses to examine several potential moderators, including characteristics of participants' group type, type of exercise, publication type, and type of measurement of physical exercise, which are important sources of variation in effect sizes and may lead to variation in effect sizes of the original studies (Card, 2015).

H2: Group type moderates the relationship between physical exercise and body-esteem.

H3: Exercise type moderates the relationship between physical exercise and body-esteem.

H4: Publication type moderates the relationship between physical exercise and body-esteem.

H5: Exercise measurement type moderates the relationship between physical exercise and body-esteem. Finally, we test our model on three independent test set and realize a wonderful result.

2. Materials and Methods

2.1. Literature Search

2.1.1. Search Strategy

First, search the China National Knowledge Infrastructure (CNKI) full-text database of journals, the CNKI database of doctoral dissertations, and the CNKI database of outstanding master's dissertations. Then, conduct searches on the VIP Journal Database and Wanfang Data to fill in any gaps. The search criteria should be set to the topic, with no restrictions on other criteria. The search terms are (physical activity) AND (self-esteem) OR (body self-worth) OR (Attractive Body) OR (Physical Strength) OR (Sport Competence) OR (Physical Condition). The search time frame should be set from January 1, 2008 to June 30, 2022. In addition to conducting searches in the databases, the authors also checked the references of already published articles to supplement any potentially missed literature. A preliminary search yielded 779 articles.

2.1.2. Criteria for Study Selection

To maximize the number of literature sources, the following criteria will be followed: (1) The literature reports a correlation coefficient between the dimensions or total scores of the self-esteem scale and the dimensions or total scores of the physical exercise scale, or other information that can be converted into a correlation coefficient. (2) The survey was targeted on Chinese people with a clear sample size. (3) Only one data source will be used if the data is duplicated. If a thesis is converted into a journal

article and reports related data, the data from the published journal article will be used; otherwise, the data from the thesis will be used. (4) For experimental studies, only the post-test scores of the experimental group and control group will be considered, and literature sources without a control group or with only pre-test scores for the control group will be excluded.

2.1.3. Search Results

After carefully reading the entire text, excluding articles without data, duplicate publications, and articles without explicit data, a total of 90 articles that meet the aforementioned criteria were selected, comprising 98 independent samples and a total sample size of 29,251. Among them, 15 articles were published in core journals (based on the inclusion criteria of Peking University Core Journals and Nanjing University Core Journals), 27 were published in general journals, 45 were master's or doctoral theses, and 3 were published in English. The subjects included different age groups such as primary school students, middle school students, college students, middle-aged and elderly people, from 19 provinces and cities including Shaanxi, Fujian, Jiangsu, Henan, Jiangxi, Guangxi, Tianjin, Zhejiang, Anhui, Guangdong, Sichuan, Yunnan, Liaoning, Shanxi, Hunan, Xinjiang, Shanghai, Shandong, and Hong Kong, with a relatively wide geographical representation.

2.1.4. Literature Code

Coding refers to extracting useful information from the original studies included in the analysis, which mainly includes participant characteristics, sample size, publication type, publication date, geographical region, research methods, and effect sizes (ES).

The extraction of ES follows the following principles: (1) the correlations between the total scores and dimensions of physical exercise and self-esteem are included in the coding; (2) each independent sample is coded once, and if an article reports multiple independent samples, they are coded separately; (3) when calculating the effect sizes for each category, the data used do not overlap, that is, each original data appears only once in each category, to ensure the independence of the effect size calculation.

2.2. Effect Sizes

As some studies reported the correlation between the total score or dimensions of physical exercise and body-esteem, the correlation coefficient with effect size (ES) as the index is calculated using Fisher's Z transformation to normalize the correlation coefficient and meet the requirements of correlation analysis.

For other non-correlation analyses that met the inclusion criteria, Cohen's d was first calculated, and then the following formula was used to convert it to r:

$$r = \frac{d}{\sqrt{d^2 + \frac{4(N-2)}{N}}} \quad (1)$$

where d = Cohen's d and N = the combined sample size. Cohen suggested that effect sizes ≤0.2 are small, effect sizes between 0.21 and 0.79 are moderate, and effect sizes ≥0.80 are large (Cohen & Syme, 1985).

2.3. Heterogeneity Test

In order to determine whether an analysis of effect modification is needed, a heterogeneity test is conducted. The Q-test is a commonly used heterogeneity test, and the coefficient Q follows a chi-squared distribution with df = K-1. The formula for calculating Q is as follows:

$$Q = \sum w_i r_i^2 - \frac{\Sigma(w_i r_i)^2}{\Sigma w_i} \tag{2}$$

where Wi = n-3, and K is the number of original studies.

Because Q can be easily influenced by sample size and can reach the critical value of significance test, researchers proposed I^2, which is less susceptible to sample size effects (Borenstein, Hedges, Higgins, & Rothstein, 2021).

$$I^2 = \frac{Q - df}{Q} \tag{3}$$

Higgins et al. suggested that 25%, 50%, and 75% can be considered as critical values for small, moderate, and large differences (Borenstein, Hedges, Higgins, & Rothstein, 2021). That is, if I2 > 75%, the effect size is considered heterogeneous, indicating the possibility of potential effect modification variables.

3. Result

3.1. Heterogeneity Test Results

Tables 1 and 2 show that the Q values for the physical activity overall score and dimensions are between 170 and 1210, much larger than the critical value of $\chi^2(93) = 116.511$ at a significance level of 0.05. The I2 values are all above 0.75, indicating significant differences between the data, and suggesting the presence of a moderator effect (Card, 2015).

3.2. Publication Bias Check Results

FSR values of the total score and dimension level are between 2 and 49, all of which are greater than 1, indicating no publication bias. The funnel plot after trim and fill analysis shows little change in effect size, proving the absence of publication bias.

3.3. The Relationship between Physical Exercise Overall Score, Dimensions and Body-Esteem

In estimating the correlation coefficients between exercise overall score, dimensions and body-esteem overall score only the body-esteem overall score was used without its sub-dimensions. Table 1 shows the results of the meta-analysis estimation. Under the fixed model condition, the correlation between overall and dimension of physical exercise and body-esteem ranged from 0.277 to 0.346, with a medium effect size (ES). Under the

random model condition, the correlation ranged from 0.355 to 0.421, also with a medium effect size. The difference in estimation results between the two models was not significant. The 95% confidence intervals of the effect sizes did not include 0, indicating that the possibility of the correlation coefficient being caused by chance factors was small. Overall, the correlation coefficient between overall and dimension of physical exercise and body-esteem was medium and relatively stable.

Table 1. A meta-analysis of the correlation coefficient between the total score and dimension of physical exercise and body-esteem (Random model).

Body self-esteem	Exercise	*K*	Sample size	Effect value random	95%CI	Heterogeneity test[b]		Fail-safe ratio[b]
						Q	I^2	
PSPP	Duration	12	6432	0.386	0.235-0.520	479.376	97.705	31.743
	Frequency	15	8211	0.405	0.291-0.507	468.598	97.012	49.941
	Intensity	13	7139	0.355	0.227-0.470	405.551	97.041	28.640
	Total score	53	14469	0.421	0.368-0.472	675.249	92.299	10.127

Notes: **a.** Heterogeneity test $Qs > \chi^2(51)\alpha = 0.01 = 77.386$, all I^2 are greater than 0.75, so the sample is heterogeneous. Same below. **b.**All FSRs are greater than 1, the implication is that the sample is representative. Same below.

3.4. The Relationship between Physical Exercise Overall Score, Dimensions and Body-Esteem Dimensions

The meta-analysis results of the correlation between each dimension of body-esteem and exercise overall score and dimensions are presented in table 2. Under the fixed-effect model, the overall effect size ranged from 0.190 to 0.469, with ES being small to medium; under the random-effect model, the overall effect size ranged from 0.191 to 0.370, with ES being small to medium as well. There was no significant difference in the estimation results between the two models. The 95% confidence intervals of the effect sizes did not include 0, indicating that the possibility of the correlation coefficients being caused by chance factors was small. Overall, the correlation coefficients between each dimension of body-esteem and PE overall score and dimensions were moderate and relatively stable.

Table 2. A meta-analysis of the correlation coefficient between body-esteem dimension and physical exercise score and dimension (Random model).

Body-esteem	Physical exercise	*K*	Sample size	Effect value	95%CI	Heterogeneity test[a]		Fail-safe ratio[b]
						Q	I^2	
PSW	Duration	8	6116	0.304	0.124-0.465	380.834	98.162	21.020
	Frequency	10	6895	0.229	0.097-0.352	278.858	96.773	13.100
	Intensity	8	5798	0.346	0.013-0.610	1210.110	99.422	40.240
	Total score	63	13104	0.346	0.292-0.398	655.923	90.548	19.622
SC	Duration	9	6313	0.304	0.162-0.434	279.136	97.134	23.273

PC	Frequency	11	7092	0.282	0.130-0.421	439.720	97.726	24.631
	Intensity	8	5798	0.254	0.104-0.393	241.338	97.100	14.560
	Total score	63	12628	0.370	0.311-0.426	778.946	92.041	29.191
	Duration	8	5295	0.346	0.190-0.485	251.779	97.220	26.340
	Frequency	10	6074	0.272	0.087-0.438	486.482	98.150	21.367
	Intensity	7	4780	0.250	0.097-0.391	170.545	96.482	10.689
	Total score	61	12458	0.354	0.295-0.410	720.065	91.667	20.324
	Duration	8	5855	0.291	0.140-0.429	249.692	97.197	19.620
AB	Frequency	10	6634	0.191	0.071-0.305	215.528	95.824	9.750
	Intensity	7	5340	0.234	0.062-0.392	241.541	97.516	10.622
	Total score	67	13781	0.329	0.227-0.379	659.965	89.999	16.968
	Duration	7	4634	0.249	0.003-0.467	413.866	98.550	11.889
PS	Frequency	9	5413	0.237	0.016-0.435	524.006	98.473	11.945
	Intensity	6	4119	0.211	-0.032-0.430	291.918	98.287	7.275
	Total score	60	11829	0.296	0.247-0.343	405.623	85.454	2.752

3.5. Moderating Effects of Study Characteristics

Due to the high correlation between the total score and each dimension of the questionnaire, this section only analyzes the correlation between exercise total score and body-esteem total score and each dimension. The moderating effects of four study characteristics, namely group type, exercise type, study design, publication type, and exercise measurement type, are referred to as group type effect, exercise type effect, publication type effect, and exercise measurement type effect, respectively.

3.5.1. Group Type Effect

Participants were divided into two groups, students and adults, based on their similarity to each other. The group type had a significant moderating effect on the correlation between PE×PSPP, with a Qb of 8.088. The correlation coefficient was 0.217 for primary school students, 0.337 for secondary school students, 0.467 for college students, and 0.375 for adults. The effect size ranged from moderate to high, with values between 0.217 and 0.467. The results of the comparison of differences (Q_b) showed no significant differences in all dimensions except for the total score dimension.

3.5.2. Exercise Type Effects

According to the characteristics of exercise types, they can be classified into ball games, dance, and martial arts. The exercise type has a significant moderating effect on E×PSPP, E×PSW, and E×AB, with Q_b values of 10.057, 10.015, and 7.832, respectively. For E×PSPP, the correlation coefficient is 0.314 for ball games, 0.508 for dance, 0.315 for martial arts, and 0.347 for comprehensive sports. For E×PSW, the correlation coefficient

is 0.176 for ball games, 0.396 for dance, 0.160 for martial arts, and 0.359 for comprehensive sports. For E×AB, the correlation coefficient is 0.319 for ball games, 0.378 for dance, 0.156 for martial arts, and 0.319 for comprehensive sports. Q_b shows significant differences in the total score, PSW, and AB dimensions.

3.5.3. Publication Type Effects

According to different types of publications, they were divided into core journals, general journals, and dissertations. Publication type had a significant moderating effect on E×PSW, E×SC, and PE×AB, with Qb values of 11.892, 7.754, and 7.925, respectively. For E×PSW, the correlation coefficient was 0.257 for core journals, 0.211 for general journals, and 0.319 for dissertations. For E×SC, the correlation coefficient was 0.404 for core journals, 0.268 for general journals, and 0.426 for dissertations. For E×AB, the correlation coefficient was 0.302 for core journals, 0.238 for general journals, and 0.389 for dissertations. Qb indicated that there were significant differences in the PSW, SC, and AB dimensions.

3.5.4. Exercise Measurement Type Effect

According to the different types of exercise measurement, the main measurement tools used are the Physical Activity Rating Scale (PARS-3), the Physical Activity Inventory (PAI), RPE, PIP, and fixed values. Exercise measurement type has a significant moderating effect on E×PSPP, with a Q_b of 10.304 and effect sizes ranging from 0.251 to 0.485, indicating a moderate effect. Q_b indicates a significant difference between exercise and body-esteem.

4. Discussion

4.1. Moderate Correlation between Physical Exercise and Body-Esteem

The meta-analysis found a moderate correlation between physical exercise and body-esteem ($r = 0.421$), supporting Hypothesis 1. This result is consistent with the results of previous English-language meta-analyses (Calfas & Taylor, 1994), which reported that exercise can improve body self-concept or body-esteem scores, with effect sizes ranging from small to moderate ($d=0.23$-0.42), corresponding to correlation coefficients of $r = 0.125$-0.205.

Furthermore, the meta-analysis results showed that the correlation between exercise duration, intensity, frequency, and body-esteem overall scores ranged from 0.305 to 0.370, and the correlation between exercise and body-esteem dimensions ranged from 0.156 to 0.405, indicating small to moderate positive correlations and supporting hypotheses H1. These results are consistent with those of Wang (2016), which reported that body-esteem increases with the exercise frequency, exercise duration, and exercise intensity.

The original studies' zero correlations and negative correlations may be due to sampling errors. Most of the studies included in the analysis had small sample sizes, making sampling bias more likely. By contrast, a key advantage of meta-analysis is that it aggregates data from many different studies, which significantly improves the stability and generalizability of the results. This meta-analysis included 27,992 participants from 18 provinces and cities across China, which greatly improved its representativeness and overcame the problem of small sample sizes. The study results were not significantly

biased, and there was no significant publication bias. Therefore, the results of this study are more reliable.

4.2. Moderator Effects

This study found significant effects of exercise type, group type, publication type, and physical exercise measurement type, supporting hypotheses H2 to H5. This aligns with the heterogeneity test results. The Q test identified significant differences among effect sizes, with moderator analysis pinpointing specific sources. However, the number of studies included in the moderator analysis was small.

First, the study found a significant difference between university students and other groups, partially supporting hypothesis H2. This aligns with Sun (2020), who found a positive correlation between physical exercise and body-esteem in students across various academic stages, but noted that physical exercise didn't predict overall self-esteem in junior high and high school stages. Future research could explore the impact of high BMI values from adolescence to adulthood on body-esteem.

Second, the study found a significant difference in exercise type, partially supporting hypothesis H3. Yan et al. (2022) found that different combinations of exercise significantly improved body-esteem in senior primary school students. However, this contradicts Roark (1999) and Forster (1977), who found that the form and type of exercise didn't significantly impact self-esteem or body-esteem levels. This discrepancy may be due to the variety of exercise types and different controls over exercise duration and intensity in various studies. Future research should delve deeper into this topic.

Finally, Significant differences were found in physical exercise measurement types, confirming hypothesis H5. Given the varied measurement methods in the original studies, future meta-analyses should focus on articles using the same measurement tool to effectively distinguish different effect sizes..

5. Conclusions

Under the conditions of this study, the following conclusions were obtained:

(1) There is a moderate positive correlation between physical exercise and body-esteem.

(2) Study characteristics such as group type, exercise type, and exercise measurement type can influence the correlation between physical exercise and body-esteem, with small to moderate moderation effects.

References

[1].Pokhrel, P., B.L. Bennett and C.J. Boushey, Body esteem, weight-control outcome expectancies, and e-cigarette use among young adults. Nicotine Tob Res, 2021. 23(3): p. 454-461.

[2].Pop, L.M., M. Iorga and R. Iurcov, Body-Esteem, Self-Esteem and Loneliness among Social Media Young Users. Int J Environ Res Public Health, 2022. 19(9).

[3].Boursier, V. and F. Gioia, Which are the Effects of Body-Objectification and Instagram-Related Practices on Male Body Esteem? A Cross-Sectional Study. Clin Neuropsychiatry, 2022. 19(1): p. 8-19.

[4].Kindred, M.M., B.M. Pinto and S.I. Dunsiger, Association of Body Esteem with Fitness and Body Fat Among Colorectal Cancer Survivors: Secondary Analyses from a Randomized Trial. Int J Behav Med, 2019. 26(6): p. 619-628.
[5].Lopez-Torres, H.J., Effectiveness of physical exercise in the treatment of depression in older adults as an alternative to antidepressant drugs in primary care. BMC Psychiatry, 2019. 19(1): p. 21.
[6].Celik, O. and B.O. Yildiz, Obesity and physical exercise. Minerva Endocrinol (Torino), 2021. 46(2): p. 131-144.
[7].Ribeiro, M.M., A. Andrade and I. Nunes, Physical exercise in pregnancy: benefits, risks and prescription. J Perinat Med, 2022. 50(1): p. 4-17.
[8].Fossati, C., et al., Physical Exercise and Mental Health: The Routes of a Reciprocal Relation. Int J Environ Res Public Health, 2021. 18(23).
[9].Grasdalsmoen, M., et al., Physical exercise, mental health problems, and suicide attempts in university students. BMC Psychiatry, 2020. 20(1): p. 175.
[10].Hosker, D.K., R.M. Elkins and M.P. Potter, Promoting Mental Health and Wellness in Youth Through Physical Activity, Nutrition, and Sleep. Child Adolesc Psychiatr Clin N Am, 2019. 28(2): p. 171-193.
[11].Caponnetto, P., et al., The Effects of Physical Exercise on Mental Health: From Cognitive Improvements to Risk of Addiction. Int J Environ Res Public Health, 2021. 18(24).
[12].Herbert, C., Enhancing Mental Health, Well-Being and Active Lifestyles of University Students by Means of Physical Activity and Exercise Research Programs. Front Public Health, 2022. 10: p. 849093.