Effects of physical exercise on self-concept of college students based on meta-analysis model

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Abstract

Meta-analysis is a scientific quantitative comprehensive analytical method. With respect to individual research, meta-analysis is characterized by high effectiveness and extensive and accurate quantification. This thesis uses meta-analysis to conduct quantitative analysis of the effects of physical exercise on the self-concept of college students. The relationship between physical exercise and self-concept is also determined. Therefore, average effect size of intervention of physical exercise in effects on the self-concept of college students is 0.45. This value is classified under medium intervention level. In addition, results of deviation indicate that the effects of physical exercise are relatively stable and have no evident deviation. The results also present a reliable scientific basis for psychological education that colleges provide to their students and intervention methods in mental health.

Keywords: Self-concept, Meta-analysis, Physical exercise, Offset, Intervention effect

1 Introduction

Meta-analysis is a scientific quantitative comprehensive analytical method that is also called assembly analysis, summary analysis, comprehensive analysis, and secondary analysis [1]. Meta-analysis performs comprehensive quantitative analysis of many independent analysis results and in-depth analysis of difference. Meta-analysis usually involves the following steps: raising questions, searching studies, selecting references, analyzing materials comprehensively, and reporting results [2]. With respect to individual research, meta-analysis is characterized by high effectiveness as well as extensive and accurate quantification [3]. In recent years, meta-analysis has been extensively applied to quantitative analysis in pedagogy, psychology, and other fields. Meta-analysis considers several research facts as analytic targets to establish analytical models. Then, general conclusions are drawn by performing analysis and evaluation based on the model. Pure theory of the method has been introduced, whereas the application of meta-analysis is not common [4]. Researchers believed that economic management is superior to traditional narrative literature review and that the method is applied extensively to economic management [5]. Meta-analysis has been commonly applied to research in all fields.

Self-concept was proposed first by James. Later, Rogers refined self-concept in the middle of the 20th century, considering that self-concept should include ideal ego and realistic ego [6]. The ideal ego refers to the self-status that people hope to reach, whereas the realistic ego involves people's evaluation of themselves in reality and acts as the objective consciousness of people with regard to their existence [7]. When the ideal ego exceeds the realistic ego, the happiness of individuals is enhanced and they are satisfied with their living conditions. Meanwhile, some sociologists have considered this sense of happiness to be an important factor that has influenced social stability in recent years [8]. On the contrary, individuals suffer psychological problems when the ideal ego exceeds the realistic ego. The wider the gap between the ideal ego and realistic ego is, the happier individuals are. College students who stay at a critical period when their self-concept is differentiated encounter mental problems easily [9]. Considering the situation that primary and secondary school education beautifies college education excessively, colleges face a severe situation in the psychological education of students [10]. Therefore, colleges must devote themselves to classroom education of students in the area of mental health and some simple and easy methods should be continually recommended for students [11]. Meanwhile, other forms of teaching methods may be used to balance the difference between the realistic and ideal ego of students.

As an effective way to solve mental health problems, physical exercise is commonly applied to the field of mental adjustment. Health should not only involve physical health but also include mental health and social morality. Given that high employment pressure and various complicated social environments exist, the self-concept of college students should achieve significant breakthrough nowadays instead of being limited to similar ranges; for instance, that they are unusually lucky people [12]. In detail, various methods for adjustment exist. However, result analysis of influence factors usually stays at a qualitative stage. Questionnaire surveys and creating scales of the degree of satisfaction are commonly used methods. Nevertheless, obtained results are often biased. Thus, a breakthrough that combines several research results with quantitative analysis and establishes analytical models is needed.

The scope of studies that are conducted in social fields such as medicine and psychology usually suffers from

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localization wherein contradicting conclusions from different researchers appear. Disadvantages of individual research, i.e., localization and limitation, are observed. Random error caused by this kind of analytical result is large and cannot easily reflect the overall level of research objects. Therefore, different research achievements must be integrated. Previous literature review has many qualitative factors because they are strongly affected by subjective judgment of researchers. Meta-analysis can efficiently overcome this shortage. This thesis applies meta-analysis to discuss the effects of physical exercise on the self-concept of college students. Analytical models are established by performing meta-analysis with strong logicality. Various parameters are used to explain obtained results by analyzing the relationship between physical exercise and self-concept. Meta-analysis focuses on quantification and can efficiently combine quantitative analysis with qualitative analysis.

2 Meta-analysis statistical method

Many statistical methods and models are feasible for meta-analysis. In addition, different statistical methods are used for different research objects. Thus, researchers should choose corresponding statistical methods according to statistical objects. Commonly used statistical methods in meta-analysis include the following types.

2.1 FIXED EFFECT MODEL

Core of fixed effect model converts all research objects and calculates weighted average. First, correlation size is converted into a *Z* fraction.

$$Z_{r_i} = \frac{1}{2}\log_e\left(\frac{1+r_i}{1-r_i}\right);\ \ r_i = \frac{e^{(2Z_i)}-1}{e^{(2Z_i)}+1} \tag{1}$$

Then, the Z fraction obtained by Formula (1) is used to calculate and obtain a weighted average.

$$\overline{Z}_i = \frac{\sum_{i=1}^{k} w_i z_{r_i}}{\sum_{i=1}^{k} w_i} \tag{2}$$

The following processing must be performed for parameters in Formula (2) to reflect accuracy of study on large samples.

$$w_i = \frac{1}{v_i};\ v_i = \frac{1}{n_i - 3}. \tag{3}$$

Similarly, Formula (2) also needs modification in the following form according to transformation of Formula (3).

$$\overline{Z}_r = \frac{\sum_{i=1}^{k}(n_i-3)\, z_{r_i}}{\sum_{i=1}^{k}(n_i-3)}. \tag{4}$$

Standard error can be provided by the following formula and obtained by removing square root of sample variance. We may obtain the following equation by using Formula (4):

$$SE\left(\overline{Z}_r\right) = \sqrt{\frac{1}{\sum_{i=1}^{k} w_i}} \tag{5}$$

Meanwhile, the results of homogeneity among all sizes are obtained after converting the coefficient of individual functions to test the reliability of results. In combination with variance among all terms, *Q* equation for each party's distribution is obtained.

$$Q = \sum_{i=1}^{k}(n_i-3)\left(Z_{r_i} - \overline{Z}_r\right)^2 \tag{6}$$

Thus far, the fixed effect model has completed the entire analysis. In particular, selection or rejection of specific parameters must be confirmed according to analytical objects. This model is mainly applied to conditional deduction (i.e., conditions must be provided before deduction, and the obtained results and the region where the extension of these results stays are within the set of meta-analysis results). The fixed effect model is usually applied to research on social management. Meanwhile, other statistical models also exist. For instance, the model used for non-conditional deduction is a random effect model. The authors of the present study will not provide unnecessary details about random effect models because of the limited length of this article. Readers who are interested in the random effect model may consult related studies.

2.2 STANDARDIZATION MEAN DIFFERENCE MODEL

This model evaluates research objects by calculating standardization mean difference (SMD). Moreover, the evaluated objects are coefficients and mean difference. The calculation of the method is simpler and the process standardization mean difference model is considerably quicker than those of the fixed effect model. Thus, the standardization mean difference (SMD) model is usually applied to research on pedagogy. Many kinds of computing methods in SMD are mentioned in this paper. We introduce d-value computing method presented by Hedges as follows:

$$d = \left(M_e - M_c\right)\Big/ S \tag{7}$$

In Formula (7), M_e and M_c are mean numbers that belong to the experimental group and control group, respectively, whereas S refers to standard deviation. Joint standard deviation of the experimental group and control group should be used to reduce deviation. The formula to compute standard deviation is provided as follows:

$$S = \sqrt{\frac{\left(N_e-1\right)S_e^2 + \left(N_c-1\right)S_c^2}{N_e + N_c - 2}} \tag{8}$$

Square of standard deviation is just variance. The variance of d is shown as follows:

$$S_d^2 = \frac{N_e - N_c}{N_e N_c} + \frac{d^2}{2(N_e + N_c)} \tag{9}$$

Where d stands for effect size, whereas N_c and N_e are the sample size of the control group and the experimental group, respectively. Then, homogeneity analysis for obtained results must be performed, which is also called heterogeneity analysis in some studies. Many kinds of methods are used for the homogeneity test; these include graphical, chi-square, and Q test methods. The Q test method is common. Q-value computing method is shown as follows:

$$Q = \sum_{i=1}^{k} W_i \cdot \left(Y_i - \overline{Y}\right)^2 \tag{10}$$

Where k refers to the assumed quantity of research, whereas $\overline{Y}$ and Y_i respectively represent the mean number of all research quantity and effect values of the ith research object. The specific computing formula for $\overline{Y}$ is shown as follows:

$$\overline{Y} = \frac{\sum W_i \cdot Y_i}{\sum W_i} \tag{11}$$

The distribution of Q value with degree of freedom is evaluated by computing Q value. Then, evaluation results are also obtained. The computing process of the method is simple. Thus, many researchers use this method for analysis. According to existing studies, the model is usually applied to research on pedagogy and psychology. Calculation in this thesis also adopts this method.

3 Meta-analysis model of effects of physical exercise on college students

Self-concept of college students is classified simply by using the meta-analysis model. Additionally, this model starts from different aspects of the self-concept of college students and studies the influence of physical exercise on the students.

3.1 RESEARCH OBJECTS

Search keys of the meta-analysis include college students, physical exercise, self-concept, and self-esteem. Moreover, the search period is from 2000 to 2014. The number of meta-analysis studies that are appropriate for this thesis is 16. Research methods and objects in the foregoing studies are coded. Specific information about research objects is presented in Table 1.

TABLE 1 Main information on objects of meta-analysis

No.	Author	Year	Main research method
1	Wang Kun	2011	Questionnaire survey and creating scales
2	Chen Jin	2013	Literature review and questionnaire survey
3	Li Dan	2006	Questionnaire survey
4	Li Shan and Yu Xinxin	2002	Questionnaire survey
5	Xiao Linxia	2014	Questionnaire survey
6	Gu Yuanyao	2007	Questionnaire survey and organizational exercise
7	Liu Yuxin	2012	WAI survey
8	Liu Peng	2010	Questionnaire survey and mathematical statistics
9	Bian Zenghui	2012	Questionnaire survey
10	Zhang Wenxian	2012	Questionnaire survey
11	Wang Lina	2013	Questionnaire survey and mathematical statistics
12	Xie Jing	2013	Questionnaire survey
13	Chen Hang	2014	Questionnaire survey
14	Ren Ruopeng	2008	Literature and questionnaire surveys
15	Tang Wenjie, Guo Yi	2009	Questionnaire survey and making scales
16	Liu Xiaoling and Zhang Jinfu	2000	Questionnaire survey

3.2 CALCULATION OF EFFECT SIZE

First, effect size d is calculated by using Formula (7). Then, variance is computed by using Formula (8). Calculation is performed by using Office Excel 2007 and CMD2.0 software. Deviation of minor samples in the process of calculation increases while the calculation proceeds. Computing results of minor samples must be corrected while the sample size increases. The correction formula used is shown as follows:

$$J = 1 - \frac{3}{4(N_1 + N_2 - 2) - 9} \tag{12}$$

In this study, g value is used as an effect size. Variance of the experimental group and the control group is solved based on effect size d. The value obtained by using the correction coefficient is considered based on the variance of the experimental and control groups. The commonly used operation method involves multiplying the correction coefficient. Although studies on the present subject have been screened, researchers use different methods. According to research on exercise, research factors are divided into exercise time, frequency of exercise, amount of exercise, and exercise intensity. The research objects are divided into male and female students. Statistical calculation of all data is important because the research factors are complicated. If the g value is used for analysis, then this problem can be efficiently solved. The results of calculation are reported in Table 2.

TABLE 2 Computed results of meta-analysis effect size

Author	Research sample size	Weight of sample size	*g* value	P	Standard residual error
Wang Kun	500	9.123	0.32(0.19,0.49)	0.00	−0.31
Chen Jin	700	15.241	0.15(0.09,0.27)	0.00	0.11
Li Dan	80	1.358	0.65(0.54,0.87)	0.00	−0.03
Li Shan and Yu Xinxin	120	2.023	0.14(0.03,0.29)	0.11	0.26

Xiao Linxia	135	2.124	0.63(0.51,0.81)	0.25	0.36
Gu Yuanyao	533	9.614	0.14(0.06,0.28)	0.00	0.14
Liu Yuxin	200	5.147	0.25(0.14,0.38)	0.00	−0.12
Liu Peng	352	7.687	0.36(0.24,0.54)	0.56	0.18
Bian Zenghui	124	2.059	0.42(0.35,0.59)	0.00	0.01
Zhang Wenxian	90	1.974	0.35(0.19,0.54)	0.09	0.33
Wang Lina	250	5.568	0.36(0.13,0.49)	0.00	0.05
Xie Jing	470	7.987	0.14(0.01,0.28)	0.03	0.12
Chen Hang	60	1.652	0.25(0.10,0.40)	0.00	−0.14
Ren Ruopeng	120	2.545	0.35(0.15,0.50)	0.00	0.35
Tang Wenjie and Guo Yi	100	4.546	0.15(0.08,0.34)	0.01	0.06
Liu Xiaoling, Zhang Jinfu	150	2.865	0.37(0.21,0.49)	0.00	0.13
Comprehensive result	4484	100	0.45	0.00	0.08

According to the results in Table 2, the sample size and weight ratio of each research object are appropriate and none of them is excessively large or excessively small. Even if the research is on a relatively small sample size, the weight of the sample size also exceeds 1%. Thus, literature screening at the initial stage increases the reliability of results. With respect to the computed g value, the left column involves correction and the right column shows the range in which the g value may encounter offset. Numerical results of standard deviation indicate that abnormal value does not exist.

3.3 ANALYSIS OF RESULTS

3.3.1 Sensitivity analysis

According to the results presented in Table 2, the sensitivity analysis is conducted for all studies. Therefore, the results of all studies after separation based on research levels and the ones without separation are the same. This finding implies that the research data are reliable and the stability of the research results is dependable.

3.3.2 Heterogeneity analysis

The SMD model is used to implement heterogeneity analysis for all data, the results of which are significant. Therefore, selection or rejection of data is appropriate and meta-analysis can combine with each group of computed results well. End value is removed in data and Q value is calculated based on Formula (10). The results are shown in Table 3.

TABLE 3 Computed results of meta-analysis after removing end value

Total sample size *n*	K	k	$\overline{r_w}$	P	s_e^2 / s_r^2	Q
4484	20	124	0.3214	0.00	35.124%	101.74

Table 3 indicates that P value is 0 and Q value is 101.74. These values indicate that the effect is significant. Thus, the SMD model can efficiently reflect the behavior of research objects. Significant heterogeneity also means that the results have popular sense rather than represent only a certain range.

3.3.3 Analysis of effect size

Based on the research experience of our predecessors, a small effect size is observed when the g value is less than 0.2; a medium effect size is observed when the g value is between 0.2 and 0.8; and a large effect size is observed when the g value is larger than 0.8. Based on the data in Table 1, we observed that the effect size of the g value is affected, to a certain extent, by the research sample size. The smaller the sample size is, the larger the fluctuation of the computed g value is. This result shows that the effects of physical exercise on the self-concept of college students fluctuate significantly. Nevertheless, this fluctuation may have resulted from the fact that the researchers used different sample size ranges. When the total number of research samples is larger than 300, the fluctuation of the g value is small, which indicates that the deviation of the samples reduces gradually as the research groups expand. However, the deviation can only be reduced, not eliminated, because no ideal sample group can represent all college students.

4 Conclusions

After long-term psychological research, physical exercise is considered as a good means to reduce pressure. Therefore, in this thesis, we apply meta-analysis to evaluate the effects of physical exercise on the self-concept of college students. Meta-analysis selects appropriate statistical models and establishes the relationship between two models. Using meta-analysis, we observed that the average effect size of physical exercise on the self-concept of college students is 0.45, which is associated with a medium intervention level. This result shows that physical exercise can have certain effects but not a decisive effect on the self-concept of college students. Therefore, based on this result, other factors that affect the self-concept of college students can be predicted, such as employment rate, emotion, and inner demand.

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