Iran J Public Health, Vol. 51, No.11, Nov 2022, pp.2425-2434

Review Article

Physical Fitness for Depression in Adolescents and Adults: A Meta-Analysis

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(Received 09 Apr 2022; accepted 05 Jun 2022)

Abstract

Background: Depression has been recognized as one of the most significant factors affecting mental health status. For this reason, several efforts to prevent and reduce depression in all ages have been made in various domains to identify the relevant factors as well as the causes of depression. The objective of this meta-analysis was to examine the effect size between physical fitness and depression in adolescents and adults.

Methods: A systematic search for meta-analysis (2009-2020) was performed using PubMed, Scopus, Web of Science, and RISS, with key terms such as depression, depressive illness, and physical fitness or fitness. Overall, 19 out of 448 articles were included in the meta-analysis with strict inclusion criteria.

Results: The effect size is a medium between physical fitness and depression in adolescents and adults. Two fitness factors, namely cardiovascular endurance and muscle strength, are more relevant for alleviating depression in adolescents and adults, whereas agility was not related to depression. In particular, the cardiovascular fitness factor has an impact on almost all ages; however, muscular strength has less impact on depression in young adolescents, but has a great impact on older adults' depression.

Conclusion: The effect size in this study is a medium between physical fitness and depression in adolescents and adults. Thus, more longitudinal and clinical studies with larger sample sizes are needed to clarify the relationship between physical fitness and depression.

Keywords: Depression; Physical fitness; Meta-analysis; Cardiovascular endurance; Muscular strength

Introduction

Physical fitness plays a significant role in health promotion and the well-being of the population. Depression is a common mental and emotional disorder in the global society and consequently interrupts the quality of life of affected individuals (1-4). In fact, physical fitness has beneficial effects on the prevention and reduction of depression in all people, regardless of sex, age, and diseases (5-13).

To date, several studies have examined the effects of depression on physical fitness elements, such as depression and cardiorespiratory fitness (4, 11, 14-20), depression and muscular strength (2, 21-29), depression and balance (30, 31), depression and flexibility (32), and depression and coordination (33). These previous studies have primarily examined the effects of two fitness: the cardiorespiratory endurance and strength, not other factors, such as flexibility, agility, and balance (26). Taking into account the research trend, two meta-analyses (9, 18) were recently conducted to provide a comprehensive overview about the effects of cardiorespiratory fitness and muscular strength on depression, based on synthesizing existing data.

According to most of the reviews listed above, individuals with higher levels of certain fitness elements are less likely to have symptoms of depression. In particular, Jeong (26) found that strength, endurance, and the body fat of fitness elements could be the most important predictors of depression. However, the role of the three fitness factors as predictors of depression (26) is less certain, due to a lack of sufficient evidence. Little is known about which fitness element of all the fitness elements is the most important determinant of the depression prevention and/or improvement. Thus, a meta-analysis is needed to provide people with sufficient evidence of priorities in deciding how to participate in physical activity, including information about the scope and sequence of fitness promotion. A meta-analysis rather than individual and separate studies could obviously provide more practical knowledge of the relationship between physical fitness and depression for individuals with or without depression.

There is no doubt that regular physical activity increases physical fitness, which can help manage depression for people of all ages (34, 35). If we know the priority ranking among all fitness elements related to depression, it would be more helpful to save time, money, and/or efforts of all individuals who exercise regularly. This information makes it possible for individuals with or without depression to design, provide, or join tailored physical activity programs. Therefore, the objective of this meta-analysis was to determine the effect size between physical fitness and depression in adolescents and adults.

Methods

Search strategy and inclusion criteria

In this study, papers in academic journals that revealed the relationship between depression and physical fitness were analyzed without limiting the time of publication of the research papers. The studies(2009-2020) were obtained from a systematic search of PubMed, Scopus, Web of Science, and RISS, using the following search terms (“depression” OR “depressive illness” OR “depressed”) AND (“physical fitness” OR “fitness”). In addition, references from the analyzed studies were examined to search for other relevant studies. The criteria for the selection of literature for a systematic literature review and meta-analysis were set as follows: a) an empirical study that used a sample of humans, b) assessment of the depressive symptoms using validated instruments, c) inclusion of a measure of physical fitness by a test, and d) a study that tested the cross-sectional association between physical fitness and depressive symptoms, presenting the r-value of the correlation.

Inclusion of eligible studies

Overall, 448 papers were collected through a literature search process. After excluding 98 overlapping papers by checking the thesis titles, a review of abstracts was conducted on 350 papers. Through the abstract review, three non-empirical studies on human subjects and 105 non-quantitative studies were excluded. A full-text review of 242 articles was then conducted. Of these, 36 papers that did not assess depressive symptoms using validated instruments, 21 papers containing physical fitness information not assessed by a test, and 166 papers that did not present the r-value of the correlation were excluded. Through the systematic review process shown in (Fig. 1), this study finally used 19 papers for the meta-analysis.

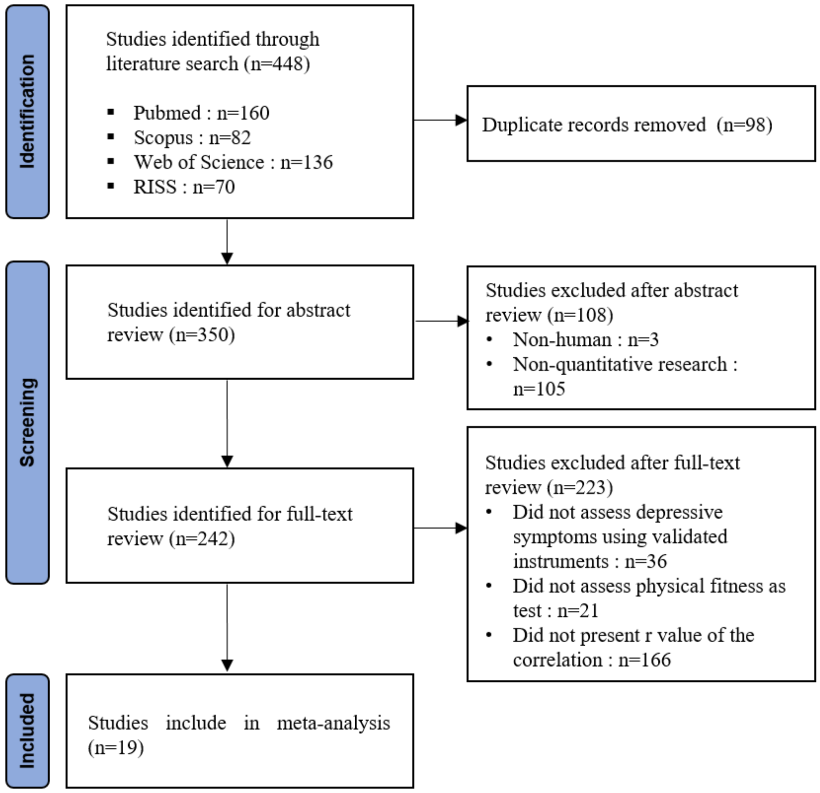

Fig. 1: Flowchart of record search and selection process

Data coding

The coding items included the author's name, publication year, gender, age group, physical fitness test data, depressive symptom instruments used, sample size, and correlation coefficient. Two researchers conducted the data input, and all data entered after coding were compared with the original text. The inconsistencies were corrected after cross-checking and sufficient agreement.

Data processing and analysis

In this study, the effect size calculation, homogeneity verification, subgroup analysis, and publication bias verification were performed using the Comprehensive Meta-Analysis program, version 3.0. First, to calculate the effect size, the correlation coefficient (r-values) was converted into Fisher's z-value and used for analysis (36). Second, for the homogeneity test between each paper, the Q-test and the I^2 values were used for the homogeneity test between each paper. If heterogeneity was confirmed, it was analyzed using a random effect model and subgroup analysis was performed. Third, the publication bias was assessed using the funnel plot and Egger's regression. Finally, the calculated effect sizes were interpreted as weak (r =0.10–0.29), medium (r=0.30–0.50), or strong (r>0.50) (37).

Results

Overall analysis

In the homogeneity test (Table 1), the effect sizes of the primary studies were heterogeneous (Q = 81.982, P<.05, I^2=78.04%). Therefore, we calculated the overall effect size using a random-effects model. The result of analysis with the random effects model, is shown in Table 2. The overall effect size had medium effect size (37).

Table 1: Results of the homogeneity test

k	*Q*	*P-Value*	I^2	*ES*	*95% CI*
19	81.982	.000	78.044	0.141	0.128~0.153

k=Number of the effect size; ES=Effect size

Table 2: Overall Result of Meta-analysis using a Random Effects Model

k	*ES*	*95% CI*
19	0.160	0.129~0.190

k=Number of the effect size; ES=Effect size

Nineteen studies yielding 83 effect sizes were included in the meta-analysis. The effect size of the selected papers was found to be statistically significant. The total number of subjects in the included study was 5109 (men: 613, women: 1951, women·men: 2545). Most of the studies were conducted with adults (73.7%), and 79% of the 19 studies used GDS (36.8%), CES-D (21.1%), BDI (21.1%), as the tools to measure depression. In addition, aerobic capacity (27.5%), strength (29.5%), balance (11.8%), and flexibility (11.8%) were measured as major physical fitness variables of the thesis to be analyzed (Table 3).

Table 3: Descriptive Characteristics of the Collected Studies and their Effect Size

Study	*ES*	*Lower limit*	*Upper Limit*	*Sample size*	*Gender*	*Age*	*Depression measure*	*Fitness measure*
Song et al (2011) (42)	0.064	0.019	0.108	321	Female	Adult	GDS	Strength, Aerobic capacity Flexibility, Balance
Kim et al (2019) (43)	0.194	0.145	0.242	107	Male	Adult	GDS	Strength, Aerobic capacity Flexibility, Balance Coordination
Chun et al (2019) (39)	0.150	0.119	0.181	385	Female, Male	Adult	GDS	Strength, Aerobic capacity Agility
Jung & Hyun (2011) (44)	0.570	0.341	0.735	48	Female	Minors	CES-D	Aerobic capacity
Jang et al (2012) (45)	0.088	0.028	0.147	269	Female,Male	Minors	POMS	Strength, Aerobic capacity Flexibility, Explosive strength
Lee et al (2014) (2)	0.327	0.252	0.398	117	Female,Male	Adult	GDS	Strength, Aerobic capacity Flexibility, Balance Coordination
Staples et al (2020) (46)	0.192	0.061	0.316	111	Female,Male	Adult	GDS	Strength, Balance
Sener et al (2016) (47)	0.262	0.079	0.428	39	Female	Adult	BDI	Strength
Galiano-Castillo et al (2014) (6)	0.150	0.068	0.231	187	Female	Adult	POMS	Strength, Explosive strength

Jeoung (2020) (26)	0.129	0.066	0.191	160	Female,Male	Adult	GDS	Strength, Aerobic capacity Agility, Explosive strength
Yeatts et al (2017) (13)	0.101	0.073	0.128	789	Male	Minors	CES-D	Strength, Aerobic capacity
Tonello et al (2019) (19)	0.446	0.132	0.678	35	Female	Adult	BDI	Aerobic capacity
Farren et al (2018) (7)	0.216	0.155	0.274	249	Female,Male	Minors	CES-D	Strength, Aerobic capacity Flexibility
Esmaeilzadeh (2015) (22)	0.112	0.077	0.146	456	Male	Minors	CDI	Strength, Aerobic capacity Agility, Explosive strength
Johnson et al (2020) (8)	0.178	0.147	0.209	1248	Female,Male	Adult	NEO, SCL, MMPI	Aerobic capacity
You & Ko (2014) (48)	0.132	0.068	0.196	305	Female	Adult	BDI	Strength, Flexibility Explosive strength
Lee & Lim (2014) (49)	0.102	0.089	0.287	29	Female	Adult	GDS	Strength, Aerobic capacity Balance
Scopaz et al (2009) (50)	0.125	0.021	0.266	182	Female,Male	Adult	CES-D	Balance
Zhang et al (2014) (51)	0.149	0.017	0.307	72	Female,Male	Adult	BDI	Strength, Aerobic capacity

Sub-group analysis

In this study, since heterogeneity was confirmed as a result of the homogeneity test, a subgroup analysis was performed by applying a random effect model.

Outcome

The results of the effect sizes by outcome are presented in Table 4. As a result of analyzing the effect size according to the sub-factors of physical fitness, a medium correlation coefficient effect size was found for all factors except agility and flexibility, and this difference was statistically significant (Q=15.165, *P*<.05).

Table 4: The Effect Sizes by Outcome

Outcomes	*Sub-outcomes*	*k*	*ES*	*95% CI*	*Q*	*P-value*
Fitness	Strength	34	0.145	0.115~0.174	15.165	0.019
	Agility	4	0.098	0.015~0.179		
	Explosive strength	6	0.106	0.061~0.152		
	Aerobic capacity	19	0.190	0.143~0.236		
	Flexibility	10	0.092	0.041~0.142		
	Balance	7	0.182	0.084~0.277		
	Coordination	3	0.271	0.130~0.402		

k=Number of the effect size; ES=Effect size

Sub-outcome

From analyzing the effect sizes according to the age group, there was a medium effect size in the order of adults (ES=0.166) and minors (ES=0.145). However, there was no significant difference (Q=0.364, *P*=0.546). By analyzing the effect size according to the gender, the medium effect size was found to be men (ES=0.135) and women (ES=0.125). There was no difference in the effect size according to sex (Q=0.120, *P*=0.729) (Table 5).

Table 5: Effect Sizes by Subgroup: Age and Gender

Subgroup	*Categories*	*k*	*ES*	*95% CI*	*Q*	*P-value*
Age*****	adult	14	0.166	0.130~0.202	0.364	0.546
	minor	15	0.145	0.087~0.203		
Gender	male	16	0.135	0.091~0.178	0.120	0.729
	female	30	0.125	0.095~0.156		

k=Number of the effect size; ES=Effect size

Assessment of publication bias

Two major tests were conducted to confirm the publication bias. By examining the funnel plot, there were a few outliers; however, it is difficult to say that there is a publication bias because the left and right sides of the funnel plot are generally symmetrical. The Egger's regression test was performed to verify this in a more objective manner. Based on the regression intercept (regression intercept=1.634, standard error=.837, *P*=.080), there was no statistical significance; hence, there was no publication bias (Fig. 2).

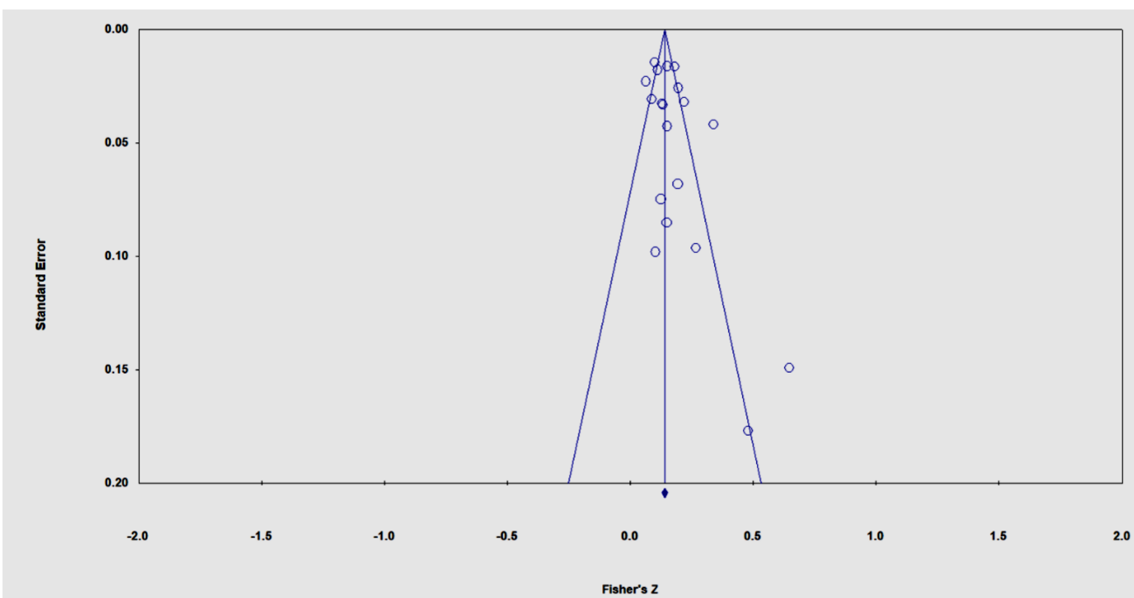

Fig. 2: Funnel plot

Discussion

The purpose of this meta-analysis was to determine the effect size between physical fitness and depression in adolescents and adults. To do this, 19 papers were analyzed to calculate the effect sizes that demonstrated the correlation between depression and physical fitness. This study also conducted a homogeneity test and a sub-group analysis, and check for publication bias. In this study, depression was mainly measured using the GDS, CES-D, and BDI tests, and physical fitness was measured using the aerobic capacity, muscle strength, balance, and flexibility. The analysis results for the correlation effect size between depression and physical fitness are as follows.

According to the overall analysis, there was a statistically significant association between depression and physical fitness, and the effect size of the correlation was moderate, at 0.160. According to Kandola et al (38), using a sample size of 152,978 adults aged 40–69 yr, the lowest-ranked group was twice as likely as the highest ranked group to suffer from depression seven years later, and 1.6 times more likely to suffer from an anxiety disorder. This explains how improving mental health is related to increased blood flow to the brain when exercise increases.

According to the sub-factors of physical fitness in this study, effect size revealed an intermediate correlation with all physical fitness factors, except agility. Agility was found to have little relationship to depression in this study; this has also been reported by the two studies (22,39), determining that agility does not affect depression. However, other fitness factors, such as muscular strength, endurance, and cardiovascular endurance significantly affect depression. In general, agility, coordination, and power are the representative physical fitness factors that contribute to improving motor functions, and cardiopulmonary endurance, muscle endurance, and flexibility are known to contribute to health. The meta-analysis of this study demonstrated that the variables of physical fitness factors contributing to health are related to mental health, such as depression. Both depression and physical fitness factors are mutually related, focusing on cardiovascular endurance and muscle strength as major variables of depression.

For adolescents, increased cardiovascular endurance, particularly in middle-school adolescents, reduces depression and body fat in adolescents (17). This result was also observed in both boys and girls. The elementary school students aged 7–11 yr were studied, concluded that strength is not significantly related to the significant negative relationship between the cardiovascular endurance and depression (22). On the other hand, for adults, low muscle strength, particularly low grip strength, was associated with depression in adults aged between 45 and 79 yr old (23). The grip strength in adults is negatively associated with depression, especially in women than men (24). Similar findings reported that gripping power in older adults is strongly associated with depression (25). Muscle strength, especially grip strength, can be an indicator of depression in older individuals (3). In summary, cardiovascular endurance has a negative correlation with depression in both elementary students and the elderly. Muscle strength as a fitness factor is strongly associated with depression, especially after adulthood (17, 22-25). The correlation of the effect size between physical fitness and depression for both adolescents and adults was found to be moderate; however, there were no statistically significant differences between the age groups. On the other hand, Lee et al (40) with a large sample size reported that adults with low muscle strength are more prone to depression as age increases. These results appear in certain sub-strength factors, such as the muscle strength.

In general, women are more likely to experience depression than men. According to this study, the gender-based effect size was medium for men and women. Additionally, the gender difference in the effect size on the relationship between physical fitness and depression was not statistically significant in this study. This finding is supported already (41) who reported a similar ratio of depression between men and women using large sample sizes. Meanwhile, recent studies (3, 38) have reported the relationship between depression and physical fitness based on gender. The higher the muscle strength in people over 60 yr of age, the lower the spread of depression in both men and women (3). On the other hand, low muscle strength in men and women was a possible risk factor in a 7-year cohort study of large samples aged 40–69 yr (38).

Conclusion

The present meta-analysis study was conducted to determine the effect size between physical fitness and depression in adolescents and adults. The effect size is medium between physical fitness and depression in adolescents and adults. Moreover, physical fitness is significantly and negatively related to depression among adolescents and adults. In general, cardiovascular endurance and muscle strength could function to alleviate depression in adolescents and adults, whereas agility was not related to depression. The cardiovascular fitness factor had an impact on almost all ages; however, the effect of the muscular strength on depression was not the same. That is, the muscular strength has lesser effect on depression in young adolescents; however, it greatly affects depression in older adults. The effect size of muscular strength, especially the grip strength, increases with age, but there was no significant difference in the effect size between men and women. This does not support the hypothesis that women are at a higher risk of depression, compared to men. Thus, more longitudinal and clinical studies with large sample sizes of all ages are needed to clarify the relationship between physical fitness and depression.

Journalism Ethical considerations

Ethical issues(Including plagiarism, informed consent, misconduct, data fabrication, and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

No financial support was received for this study. .

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Jin Y, Kim D, Hong H, et al (2019). A long-term exercise intervention reduces depression symptoms in older Korean women. *J Sports Sci Med*, 18: 399-404.
2. Lee I, Jin Y, Cho J, et al (2014). Association between depression and physical fitness, body fatness and serum vitamin D in elderly population. *Korean J Obes*, 23(2): 125-130.
3. Lee J, Ryan E (2020). The relationship between muscular strength and depression in older adults with chronic disease comorbidity. *Int J Environ Res Public Health*, 17(18): 6830.
4. Rethorst C, Leonard D, Barlow C, et al (2017). Effects of depression, metabolic syndrome, and cardiorespiratory fitness on mortality: results from the Cooper Center longitudinal study. *Psychol Med*, 47(14): 2414-2420.
5. Axelsdottir B, Biedilae S, Sagatun A, et al (2020). Exercise for depression in children and adolescents–a systematic review and meta-analysis. *Child Adolesc Ment Health*, 26(4):347-356.
6. Galiano-Castillo N, Ariza-Garcia A, Cantarero-Villanueva I, et al (2014). Depressed mood in breast cancer survivors: associations with physical activity, cancer-related fatigue, quality of life, and fitness level. *Eur J Oncol Nurs*, 18(2): 206-210.
7. Farren G, Zhang T, Gu X, et al (2018). Sedentary behavior and physical activity predicting depressive symptoms in adolescents beyond attributes of health-related physical fitness. *J Sport Health Sci*, 7(4): 489-496.
8. Johnson W, Mortensen E, Kyvik K (2020). Gene–environment interplay between physical exercise and fitness and depression symptomatology. *Behav Genet*, 50(5): 346-362.
9. Marques A, Gomez-Baya D, Peralta M, et al (2020). The effect of muscular strength on depression symptoms in adults: a systematic review and meta-analysis. *Int J Environ Res Public Health*, 17(16): 5674.
10. Perez-Cruzado D, Cuesta-Vargas A, Vera-Garcia E, et al (2018). The relationship between quality of life and physical fitness in people with severe mental illness. *Health Qual Life Outcomes*, 16(1): 82.

11. Rahman M, Helgadottir B, Hallgren M, et al (2018). Cardiorespiratory fitness and response to exercise treatment in depression. *BJPsych Open*, 4(5): 346-351.
12. Rica R, Shimojo G, Gomes M, et al (2020). Effects of a kinect-based physical training program on body composition, functional fitness and depression in institutionalized older adults. *Geriatr Gerontol Int*, 20(3): 195-200.
13. Yeatts P, Martin S, Petrie T (2017). Physical fitness as a moderator of neuroticism and depression in adolescent boys and girls. *Pers Individ Differ*, 114: 30-35.
14. Dangi A, Aurangabadkar S, Deo M (2018). Effect of a structured yoga program on fatigue, depression, cardiorespiratory fitness, and quality of life in a postmenopausal breast cancer survivor. *Int J Yoga*, 11(3): 255-257.
15. Hallgren M, Kandola A, Stubbs B, et al (2020). Associations of exercise frequency and cardiorespiratory fitness with symptoms of depression and anxiety-a cross-sectional study of 36,595 adults. *Ment Heath Phys Act*, 19: 100351.
16. Nikolakaros G, Vahlberg T, Sillanmaki L, et al (2020). Recurrent depression in childhood and adolescence and low childhood socioeconomic status predict low cardiorespiratory fitness in early adulthood. *J Affect Disord*, 266: 782-792.
17. Ruggero C, Petrie T, Sheinbein S, et al (2015). Cardiorespiratory fitness may help in protecting against depression among middle school adolescents. *J Adolesc Health*, 57(1): 60-65.
18. Stubbs B, Rosenbaum S, Vancampfort D, et al (2016). Exercise improves cardiorespiratory fitness in people with depression: a meta-analysis of randomized control trials. *J Affect Disord*, 190: 249-253.
19. Tonello L, Oliveira-Silva L, Medeiros A, et al (2019). Prediction of depression scores from aerobic fitness, body fatness, physical activity, and vagal indices in non-exercising, female workers. *Front Psychiatry*, 10: 192.
20. Yamagata E, Yamada Y, Sugihara Y, et al (2013). Physical fitness and depression symptoms in community-dwelling elderly women. *Nihon Koshu Eisei Zasshi*, 60(4): 231-240.
21. Ren Z, Cao J, Li Y, et al (2020). Association between muscle strength and depressive symptoms among Chinese female college freshmen: a cross-sectional study. *BMC Musculoskelet Disord*, 21(1):510.
22. Esmaeilzadeh S (2015). The association between depressive symptoms and physical status including physical activity, aerobic and muscular fitness tests in children. *Environ Health Prev Med*, 20(6): 434-440.
23. Fukumori N, Yamamoto Y, Takegami M, et al (2015). Association between hand-grip strength and depressive symptoms: Locomotive syndrome and health outcomes in Aizu cohort study (LOHAS). *Age Ageing*, 44(4): 592-598.
24. Gu Y, Li X, Zhang Q, et al (2021). Grip strength and depressive symptoms in a large-scale adult population: the TCLSIH cohort study. *J Affect Disord*, 279: 222-228.
25. Han K, Chang J, Yoon H, et al (2019). Relationships between hand-grip strength, socioeconomic status, and depressive symptoms in community-dwelling older adults. *J Affect Disord*, 252: 263-270.
26. Jeong B (2020). Correlation of physical fitness with psychological well-being, stress, and depression in Korean adults. *J Exerc Rehabil*, 16(4): 351-355.
27. McDowell C, Gordon B, Herring M (2018). Sex-related differences in the association between grip strength and depression: Results from the Irish Longitudinal Study on Ageing. *Exp Gerontol*, 104: 147-152.
28. Park S, Cho J, Kim D, et al (2019). Handgrip strength, depression, and all-cause mortality in Korean older adults. *BMC Geriatr*, 19(1): 127.
29. Smith L, Firth J, Grabovac I, et al (2019). The association of grip strength with depressive symptoms and cortisol in hair: A cross-sectional study of older adults. *Scand J Med Sci Sports,* 29(10): 1604-1609.
30. Alghwiri A, Khalil H, Al-Sharman A, El-Salem K (2018). Depression is a predictor for balance in people with multiple sclerosis. *Mult Scler Relat Disord*, 24:28-31.
31. Dutta A, Kumar R, Malhotra S, et al (2013). A low-cost point-of-care testing system for psychomotor symptoms of depression affecting standing balance: a preliminary study in India. *Depress Res Treat*, 2013:640861.
32. Byeon H (2019). Relationship between physical activity level and depression of elderly people

living alone. *Int J Environ Res Public Health*, 16(20): 4051.
33. Hocherman S, Dimant A, Schwartz M (2003). Visuo-motor coordination is normal in patients with major depression. *Parkinsonism Relat Disord*, 9(6): 361-366.
34. Choi M, Sohng K (2018). The effects of floor-seated exercise program on physical fitness, depression, and sleep in older adults: A cluster randomized controlled trial. *Int J Gerontol,* 12(2): 116-121.
35. Garber C, Blissmer B, Deschenes M, et al (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*, 43(7): 1334-1359.
36. Borenstein M, Cooper H, Hedges L, et al (2009). Effect sizes for continuous data. *The Handbook of Research Synthesis and Meta-analysis*, 2: 221-235.
37. Cohen J (2013). *Statistical power analysis for the behavioral sciences*. New York: Routledge.
38. Kandola A, Osborn D, Stubbs B, et al (2020). Individual and combined associations between cardiorespiratory fitness and grip strength with common mental disorders: a prospective cohort study in the UK Biobank. *BMC Med*, 18: 303.
39. Chun M, Choi J, Kang S, et al (2019). The relationship between health related physical fitness, depression, and quality of life of the elderly. *Journal of the Korea Convergence Society*, 10(12): 387-397.
40. Lee M, Jung S, Bang H, et al (2018). The association between muscular strength and depression in Korean adults: a cross-sectional analysis of the sixth Korea National Health and Nutrition Examination Survey (KNHANES VI) 2014. *BMC Public Health*, 18(1): 1123.
41. Martin L, Neighbors H, Griffin D (2013). The experience of symptoms of depression in men vs. women: Analysis of the national comorbidity survey replication. *JAMA Psychiatry*, 70(10): 1100-1106.
42. Song MS, Kim SK, Kim NC (2011). A study on the correlation between elderly women's depression and physical fitness. *J Korean Biol Nurs Sci,* 13(1): 37-43.
43. Kim TH, Han TY, Choi YC (2019). Relationship between Physical Fitness, Obesity and Depression Index in Male and Female Elderly. *Korean Journal of Sports Science,* 28(6): 1187-1196.
44. Jung HS, Hyun MS (2011). Cardiorespiratory Fitness is Associated with Depression Symptom, Blood BDNF, and Cardiovascular Disease Risk Factor in Female Obese Adolescents. *Korean Journal of Measurement and Evaluation in Physical Education and Sports Science*, 13(2): 105-113.
45. Jang SW, Jung KI, Ko JG (2012). The relationship between the physical fitness and the mental health, academic achievement of elementary school students. *Korean Journal of Elementary Physical Education*, 18(2): 211-221.
46. Staples WH, Kays A, Richman R (2020). Examination of the correlation between physical and psychological measures in community-dwelling older adults. *Clin Interv Aging*, 15: 293-300.
47. Sener U, Ucok K, Ulasli AM, et al (2016). Evaluation of health-related physical fitness parameters and association analysis with depression, anxiety, and quality of life in patients with fibromyalgia. *Int J Rheum Dis*, 19(8): 763-772.
48. You SE, Ko YS (2014). Evaluation on mediation model of physical fitness depending on Sasang constitution in relation with obesity and depression. *Korean Journal of Measurement and Evaluation in Physical Education and Sports Science*, 16: 67-82.
49. Lee SJ, Lim CG (2014). The effect of geriatric depression level on senior fitness, balance, and falls efficacy scale in elderly women. *Korean Journal of Sports Science*, 23(3): 1291-1300.
50. Scopaz KA, Piva SR, Wisniewski S, et al (2009). Relationships of fear, anxiety, and depression with physical function in patients with knee osteoarthritis. *Arch Phys Med Rehabil*, 90(11): 1866-1873.
51. Zhang M, Kim JC, Li Y, et al (2014). Relation between anxiety, depression, and physical activity and performance in maintenance hemodialysis patients. *J Ren Nutr*, 24(4): 252-260.