



# The Effect of Taekwondo on Depression: A Meta-Analysis

Yujie Gao <sup>1</sup>, Zhengfa Han <sup>2</sup>, \*Bo Dai <sup>3</sup>

1. School of Physical Education, Xi'an Shiyou University, Xi'an 710065, China

2. School of Physical Education, Guangdong University of Education, Guangzhou 510800, China

3. School of Physical Education, Shangrao Normal University, Shangrao 334001, China

\*Corresponding Author: Email: d18070325026@163.com

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## Abstract

**Background:** Depression is a prevalent mental health disorder with adverse effects on both physical and psychological health. Taekwondo is posited to exert a positive influence on depression, yet its efficacy warrants further verification.

**Methods:** This study employed meta-analysis to quantify the intervention effect of Taekwondo on depression. Concurrently, based on subgroup analysis results, an optimal intervention program was suggested. Multiple databases were searched, including English (Web of Science, PubMed), Chinese (CNKI, WANFANG DATA), and Korean (RISS, KISS, DBPIA), to retrieve randomized controlled trials (RCTs) studying Taekwondo's impact on depression, published up to Jan 2024. The Cochrane bias risk tool version 2 (RoB 2.0) was utilized for literature bias risk assessment. Comprehensive Meta-Analysis software facilitated the meta-analysis, subgroup analysis, and publication bias evaluation.

**Results:** Fifteen articles, encompassing 1945 participants, were included in the study. The primary findings indicated a significant reduction in depression risk due to Taekwondo intervention (Effect Size [ES]=-0.635,  $P<0.001$ ). Subgroup analysis revealed the most substantial intervention effects in elderly individuals (ES=-1.025,  $P=0.004$ ) and women (ES=-1.114,  $P=0.009$ ). Taekwondo exercises, when conducted over 12 wk (ES=-0.922,  $P<0.001$ ), three times per week (ES=-0.729,  $P<0.001$ ), for 60 min per session (ES=-0.980,  $P=0.003$ ), and at low intensity (ES=-1.777,  $P=0.024$ ), yielded the greatest depression mitigation effects.

**Conclusion:** Taekwondo is an effective means to alleviate depression, particularly in older women. The study recommends a low-intensity Taekwondo exercise regimen, consisting of 60-minute sessions, three times weekly for 12 wk, as an optimal exercise prescription for best outcomes.

**Keywords:** Taekwondo; Depression; Meta-analysis; Intervention protocol

## Introduction

Depression, a prevalent mental health disorder, adversely affects both physical and mental well-being (1). Its principal symptoms include persistent sadness, diminished or absent interest, commonly

accompanied by reduced appetite, fatigue, and impaired attention (2). More gravely, severe depression escalates the risk of suicide (3). As reported by the WHO, an estimated 280 million individuals



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worldwide are affected by depression (4), highlighting its status as a significant global mental health concern.

Currently, pharmacotherapy and psychotherapy are the primary treatments for depression (4). However, these approaches are often costly and inaccessible for a majority of patients (5). WHO reports that over 75% of individuals in low- and middle-income countries lack access to these treatments (4). Physical exercise, being affordable, low-risk, and free of side effects, is an effective alternative for treating depression (6,7). Additionally, WHO emphasizes the significant role of regular physical activity in managing depression and enhancing overall health (4).

Since its inception as an official Olympic event, Taekwondo has gained widespread global popularity, establishing itself as an internationally recognized sport (8,9). Taekwondo training not only encompasses physical and technical exercises but also places significant emphasis on mental strength training, such as focus, meditation, and breathing control exercises. These components are highly beneficial in alleviating psychological issues such as stress and anxiety. Moreover, Taekwondo training substantially benefits mental health (10). Several studies have indicated a beneficial impact of Taekwondo interventions on depression (11–13). However, contrasting research suggests no significant improvement in depression through Taekwondo intervention (14–16). The efficacy of Taekwondo in treating depression thus remains a topic of debate. Additionally, the potential influence of variables such as participant characteristics, intervention duration, and exercise intensity on the effectiveness of Taekwondo interventions is yet to be conclusively determined.

To address this, the present study employed a meta-analytic approach to quantitatively synthesize existing research on Taekwondo's impact on depression. This aimed to verify the efficacy of Taekwondo interventions in treating depression and to quantify the effect. Moreover, through subgroup analysis, this study aimed to identify the optimal intervention protocol for Taekwondo in the context of depression. The findings of this study were intended to inform exercise-based therapy

for depression and provide a theoretical foundation for the use of Taekwondo in mitigating depression.

## Methods

We conducted this meta-analysis based on the PRISMA 2020 Checklist and have registered it in PROSPERO (Registration No.: CRD42023495827).

### *Literature search*

To enhance the comprehensive coverage of relevant literature, searches were conducted in databases of three languages: English, Korean, and Chinese. The English literature was sourced from Web of Science and PubMed, while Chinese studies were retrieved from CNKI and WANFANG DATA. Korean literature was extracted from RISS, KISS, and DBPIA databases. The search strategy employed the combination of two keywords, focusing on articles published prior to Jan 2024. Acknowledging the potential variations in the terminology across different countries, 'taekwondo' was designated as subject keyword 1, with 'depression' and 'Depressive Disorder' as subject keyword 2. This approach yielded 208 articles, distributed as follows: 32 from the English databases, 118 from Korean, and 58 from Chinese sources.

### *Inclusion and exclusion criteria of the literature*

The selection criteria for the literature in this meta-analysis adhered to the PICOS framework. 1) Participants: The study population included males and females of all age groups. 2) Intervention: Studies focusing solely on taekwondo interventions were considered. Research involving drug therapy, dietary modifications, or other auxiliary interventions was excluded. 3) Control: The control group consisted of individuals engaged in routine physical activities based on their daily living habits. 4) Outcome: The primary outcome measured was depression. 5) Study Design: Only Randomized Controlled Trials (RCTs) were included.

Additionally, studies were excluded if the reported data were insufficient for calculating the effect size. Ultimately, 15 articles were included in this study.

#### ***Data extraction***

Data extraction was independently conducted by two researchers, with a subsequent verification upon completion. Discrepancies were resolved through discussion and consensus among all researchers. For this study, all retrieved literature was imported into Zotero software for management. The process involved several steps: firstly, duplicate entries were removed. Secondly, literature that did not meet the inclusion criteria was excluded based on the evaluation of titles and abstracts. Thirdly, inaccessible literature was eliminated. Fourthly, studies from which effect size data could not be extracted were also excluded. Finally, the remaining literature was compiled into the Meta-analysis database. To facilitate efficient data analysis, pertinent information such as the first author's name, year of publication, article title, sample size, gender, age group, duration of the intervention, frequency per week, session length, and exercise intensity, was systematically extracted.

#### ***Risk of literature bias and publication bias assessment***

In this research, the Cochrane Risk of Bias Tool version 2 (RoB 2.0) was employed to evaluate the bias risk in the included literature. The RoB 2.0 categorizes bias risk into five domains: Randomization Process, Deviations from Intended Interventions, Missing Outcome Data, Measurement of the Outcome, and Selection of the Reported Result. The risk level of bias in each study is classified into three categories: Low Risk, Some Concerns, and High Risk. Additionally, to assess publication bias, this study utilized funnel plots and Egger's test within the Comprehensive Meta-Analysis software.

#### ***Statistical analysis***

In this study, the Risk of Bias was assessed using the RoB 2.0 tool, and data analysis was conducted utilizing the Comprehensive Meta-Analysis software. For the selection of the combined effect size in Meta-analysis, the standardized mean difference (SMD) generally adopts Cohen's *d* value for continuous variables. Cohen's *d* estimation can exhibit a positive bias with small sample sizes. To correct this, the Hedges' *g* value is derived by applying a correction factor *J* (Hedges'  $g = d \times J$ ) (17). Consequently, this study selected the Hedges' *g* value as the combined effect size. According to Cohen's guidelines, an effect size of 0.2 is considered small, 0.5 medium, and 0.8 large (18). Moreover, the choice of the statistical model is based on the  $I^2$  value and *p*-value from the heterogeneity test. Typically, a random effects model is employed when  $I^2 \geq 50\%$  and  $P < 0.05$ , whereas a fixed effects model is used when  $I^2 < 50\%$  and  $P > 0.05$ . However, heterogeneity should not be solely determined by  $I^2$  and *P*-values, and potential heterogeneity between studies must be considered (19).

### ***Results***

#### ***Overview of the included literature***

Following a thorough screening process, this study ultimately included 15 articles for meta-analysis. These comprised 8 Chinese studies (13,14,16,20–24), 5 Korean publications (12,25–28), and 2 articles from English-language sources (11,29). The literature screening process is depicted in Fig. 1. Notably, one study reported data separately for male and female participants (28), and another included three intervention groups (16), bringing the total number of studies to 18, with an aggregate of 1945 participants. The studies were systematically catalogued based on the following attributes: First Author, Year of Publication, Number of Subjects, Gender, Age Group, and Intervention Program (Table 1).

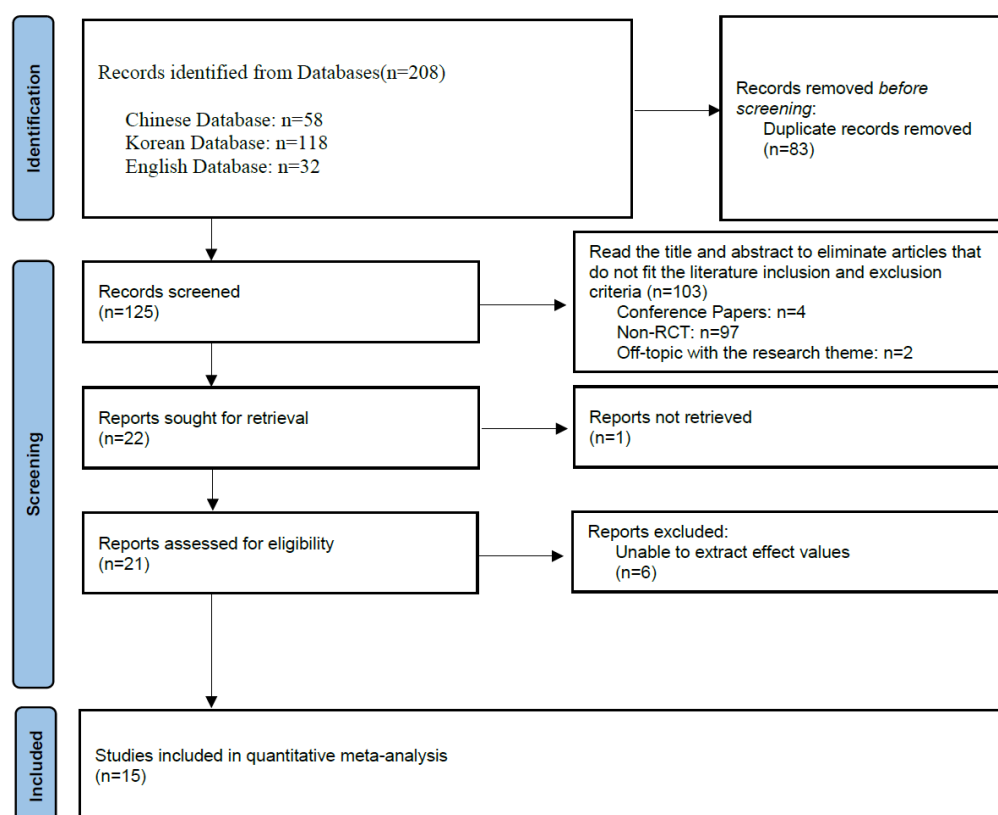


Fig. 1: PRISMA 2020 flow chart

Table 1: Basic characteristics of included articles

The first author (Published year)	Number of research subjects	Sex	Age group	Intervention Program			
				Period	Times per week	Minutes per time	Intensity
Xu(2015)	120	Unrestricted	Underage	12	5	90min	Small
Jiang(2007)	325	Unrestricted	Underage	24	2-3		
Wang(2020)	50	Unrestricted	Underage	12	7	40min	Moderate
Lin(2017)	300	Unrestricted	young adults	16	3	60min	Moderate
Li(2021)	104	Unrestricted	Underage	16	2	40min	High
Zhang(2016)	120	Unrestricted	Underage	12	5	90min	
Chen(2013)	120	Unrestricted	Underage	8	14	90min	Moderate
Zhang(2012)a	255	Unrestricted	young adults	15	2	40min	
Zhang(2012)b	66	Unrestricted	young adults	15	2	40min	
Zhang(2012)c	55	Unrestricted	young adults	15	2	40min	
Roh(2018)	30	Unrestricted	Underage	16	1	60min	Moderate
Baek(2021)	20	Female	Elderly	12	3	60min	Small
Park(2022)	18	Female	quinquagenarian	12	3	60min	Moderate
Kim(2022)	23	Female	Elderly	24	3	60min	Moderate
Kim(2014)	28	Unrestricted	Elderly	12	1-2	40min	Small
Jeong(2020)	18	Female	Elderly	16	3	60min	Moderate
Nam(2009)a	43	Male	Elderly	12	3	50min	
Nam(2009)b	250	Female	Elderly	12	3	50min	

Blank cells: Not reported in the priginal article.

### Bias risk assessment

The assessment outcomes for the risk of bias in the included studies are illustrated in Figs 2 and 3. Concerning the Randomization Process, one study was classified as high risk, while 14 studies

exhibited some concerns. The remaining bias risk categories predominantly demonstrated low risk. In terms of Overall Bias, one study was identified as having a high risk, with the remainder presenting some concerns.

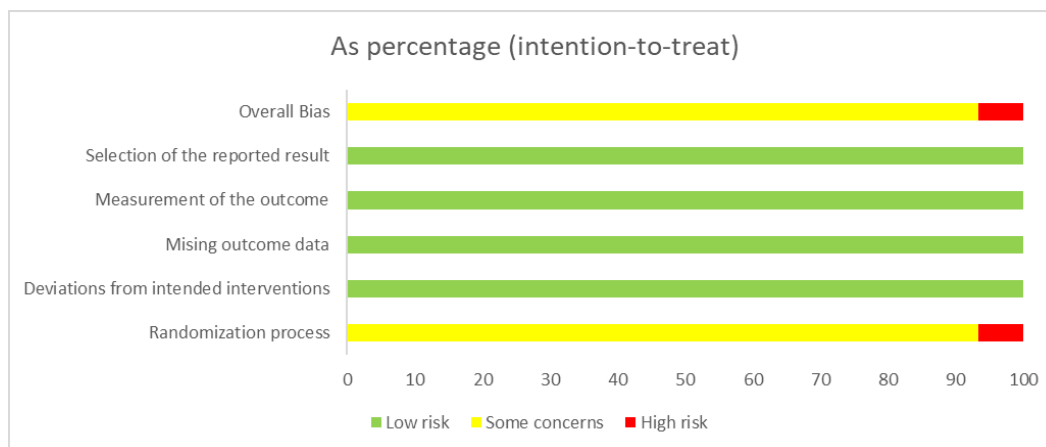


Fig. 2: Results of the risk of bias Judgments about each risk of bias item presented across all included trials

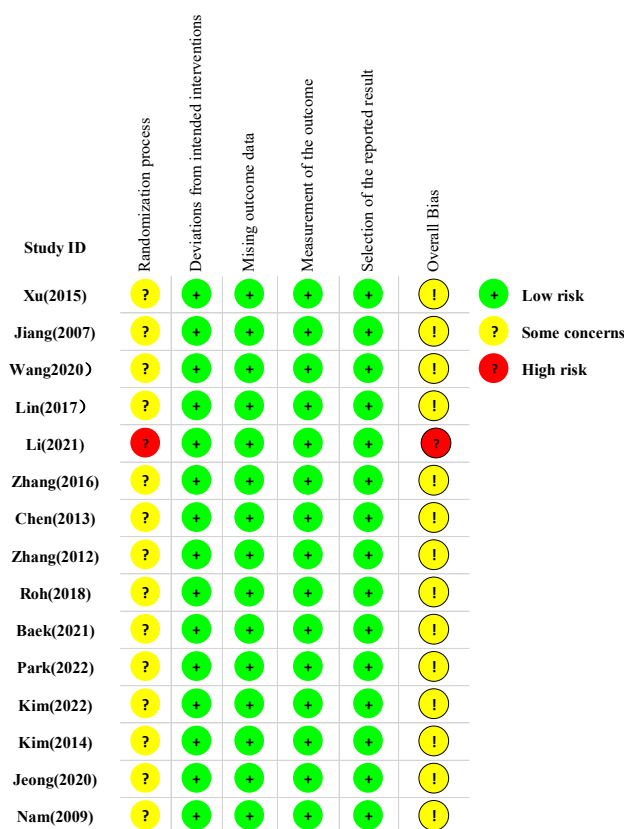


Fig. 3: Results of the risk of bias Judgments about each risk of bias item for each included trail

### Heterogeneity test and quantitative synthesis of main effect

The findings, presented in Table 2, reveal high heterogeneity among the studies ( $I^2=85.888$ ,  $P$

$<0.001$ ). Consequently, this meta-analysis employed a random effects model to combine the effect sizes. Taekwondo intervention significantly alleviates depression (Effect Size [ES] =  $-0.635$ ,  $P<0.001$ ).

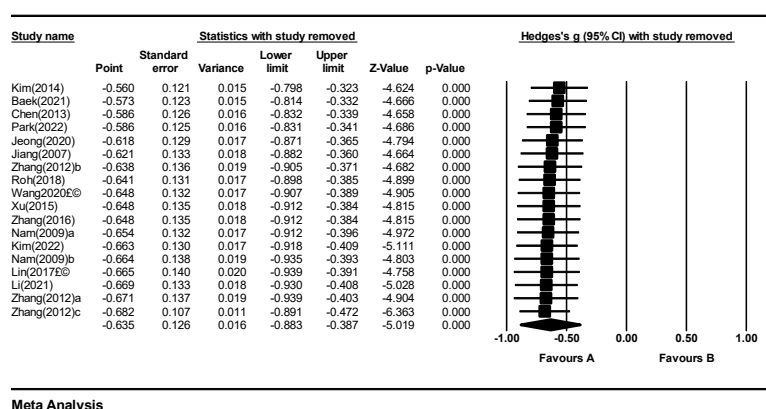
**Table 2:** Quantitative synthesis of main effects

Number studies	Number of research subjects	ES	Test of null(2-Tail)		95%CI		Heterogeneity test	
			z	P	lower limit	upper limit	$I^2$	P
18	1945	-0.635	-5.019	<0.001	-0.883	-0.387	85.888	<0.001

### Sensitivity analysis

To ascertain the robustness of the meta-analysis outcomes, a sensitivity analysis was performed. Fig. 4 illustrates the results of this analysis. The ef-

fect size interval  $[-0.560, -0.682]$ , obtained by sequentially excluding each study, falls within the 95% Confidence Interval (CI)  $[-0.387, -0.883]$  of the main effect's quantitative synthesis. Thus, the meta-analysis results are considered robust.

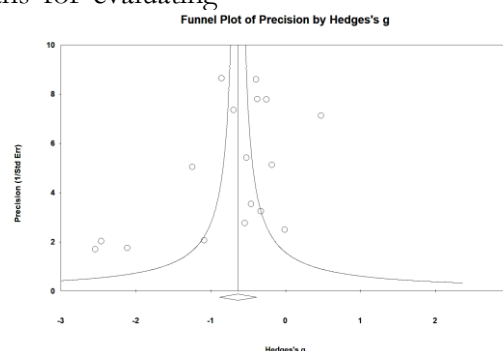


**Fig. 4:** Results of the sensitivity analysis

### Publication bias test

Given the limited number of studies, solely relying on the funnel plot for symmetry assessment is challenging. Therefore, in addition to utilizing the funnel plot as an auxiliary means for evaluating

publication bias, Egger's test was also conducted. The results of Egger's test ( $P=0.107$ ) suggest the absence of significant publication bias in the included studies (Fig. 5).



**Fig. 5:** Funnel plot



### Subgroup analysis

To investigate the optimal Taekwondo intervention for alleviating depression, this study identified several moderating variables: sex, age group, intervention duration, frequency per week, duration per session, and intensity. For the subgroup analysis to yield representative results, a minimum of three studies per subgroup is generally recommended (30). The characteristics of the included studies dictated the subgroup divisions. Sex was categorized into two subgroups: Unrestricted and Female. Age was divided into three subgroups: Underage, Young Adults, and Elderly. The intervention period was split into three subgroups: 12 wk, 15 wk, and 16 wk. Intensity was categorized into two subgroups: Low and Moderate. Additionally, to incorporate as many studies as possible into the analysis, subgroups with similar frequencies and session durations were amalgamated. The revised frequency per week was divided into three subgroups: 1-2 times, 3 times, and 5-7 times, while session duration was split into three subgroups: 40-50 min, 60 min, and 90 min. Subgroups with fewer than three studies were excluded from the subgroup analysis due to insufficient data.

The results of the subgroup analysis are presented in Table 3. Regarding sex, the intervention effect of Taekwondo on women (Effect Size [ES]=-1.114,

$P=0.009$ ) was found to be greater than the effect in the sex-unrestricted subgroup (ES=-0.562,  $P<0.001$ ). Age-wise, Taekwondo exhibited the most significant impact on the elderly (ES=-1.025,  $P=0.004$ ), followed by minors (ES=-0.673,  $P<0.001$ ), while the effect on young adults was not statistically significant ( $P=0.345$ ). For intervention duration, the 12-week Taekwondo program showed the highest effectiveness (ES=-0.922,  $P<0.001$ ), succeeded by the 16-week intervention (ES=-0.385,  $P<0.001$ ), and the 15-week intervention did not achieve statistical significance ( $P=0.629$ ). Concerning frequency, Taekwondo intervention thrice weekly demonstrated the most substantial effect (ES = -0.729,  $P<0.001$ ), followed by 5-7 times per week (ES=-0.511,  $P<0.001$ ), while the effect of 1-2 times per week was not statistically significant ( $P=0.062$ ). Regarding session duration, 60-minute sessions of Taekwondo intervention had the most pronounced effect (ES=-0.980,  $P=0.003$ ), followed by 90-minute sessions (ES=-0.757,  $P=0.001$ ), and the 40-50-minute sessions exhibited the least effect (ES=-0.418,  $P=0.025$ ). In terms of intensity, low-intensity Taekwondo intervention (ES=-1.777,  $P=0.024$ ) had a greater impact than moderate-intensity intervention (ES=-0.756,  $P<0.001$ ).

**Table 3:** Results of subgroup analysis

Moderating variable	Subgroup	Number of articles	Heterogeneity test		ES	Test of null(2-Tail)	
			I <sup>2</sup>	P		Z	P
Sex	Female	5	83.201	<0.001	-1.114	-2.629	0.009
	Unrestricted	12	88.554	<0.001	-0.562	-3.814	<0.001
	Male	1					
Age group	Underage	7	68.635	0.004	-0.673	-4.751	<0.001
	Young adults	4	92.261	<0.001	-0.220	-0.943	0.345
	Elderly	6	84.319	<0.001	-1.025	-2.870	0.004
	Quinquagenarian	1					
Period	12week	8	80.804	<0.001	-0.922	-4.306	<0.001
	15week	3	94.494	<0.001	-0.160	-0.428	0.629
	16week	4	11.087	0.337	-0.385	-3.517	<0.001
	8week	1					
	24week	2					
Times per week	1-2	6	91.397	<0.001	-0.485	-1.863	0.062
	3	7	75.769	<0.001	-0.729	-3.499	<0.001
	5-7	3	<0.001	0.982	-0.511	-4.311	<0.001
	2-3	1					
	14	1					
Minutes per time	40-50min	8	88.129	<0.001	-0.418	-2.242	0.025
	60min	6	78.924	<0.001	-0.980	-3.001	0.003
	90min	3	78.496	0.010	-0.757	-3.218	0.001
Intensity	Small	3	90.935	<0.001	-1.777	-2.249	0.024
	Moderate	7	75.109	<0.001	-0.756	-3.500	<0.001
	High	1					

## Discussion

### *Sources of heterogeneity*

This study sought to identify the source of statistical heterogeneity by examining differences across subgroups. If the heterogeneity within all subgroups of a moderating variable becomes non-significant, it suggests that the variable may be the source of inter-study heterogeneity. However, based on the subgroup heterogeneity results presented in Table 3, no moderating variable was identified where all subgroups exhibited insignificant heterogeneity, thus the source of statistical heterogeneity remains undetermined. Moreover, in the bias risk assessment of this study, one study was categorized as high risk, while the others showed some concerns, indicating potential methodological heterogeneity among the included studies. Nevertheless, the sensitivity analysis revealed no significant variation between the effect size after excluding any study and the original effect size. Therefore, the findings of this meta-analysis are considered reliable.

### *Main results*

The primary findings of this study indicate that Taekwondo has a significant positive impact on depression (Effect Size [ES]=-0.635,  $P<0.001$ ). To our knowledge, this is the first meta-analysis to assess the effect of Taekwondo on depression, and as such, there is no existing meta-analysis for direct comparison. However, previous meta-analyses have confirmed the beneficial effects of physical exercise on depression (31–33). Additionally, other meta-analyses have shown that practices like Tai Chi and Health Qigong effectively alleviate depression (34,35). Early research has also noted Taekwondo's positive impact on negative emotions, including anxiety, tension, and depression (36,37). These prior studies lend indirect support to our findings. This result can be explained from both psychological and social perspectives. Psychologically, the discipline and confidence gained from Taekwondo training enhance self-efficacy, which is the belief in one's ability to succeed in

specific situations or accomplish tasks (38). The focus, meditation, and breathing control exercises involved in Taekwondo help reduce stress and anxiety, providing mental relaxation (39). Socially, Taekwondo training often involves group activities that foster a sense of community and social support, which are crucial factors in alleviating depressive symptoms (40).

Along with most preceding research, is based on data collected during the experimental period without extensive follow-up. For example, a study on elderly participants revealed that a 12-week Taekwondo intervention significantly reduced depression symptoms. However, a one-month post-intervention follow-up showed a notable increase in depression scores compared to the end of the intervention, indicating symptom relapse (26). Therefore, while the meta-analysis confirms Taekwondo's positive effect on depression, the magnitude of this impact should be interpreted cautiously.

Additionally, while this study focused on the chronic effects of Taekwondo on depression, examining the acute effects of Taekwondo could provide further insights. Acute exercise effects are known to have immediate psychological benefits, such as reducing stress and improving mood (41). Investigating how a single session of Taekwondo impacts depressive symptoms could help in understanding the short-term mechanisms of its mental health benefits. Future research should consider exploring both the acute and chronic effects of Taekwondo on depression to develop a more comprehensive understanding of its therapeutic potential.

### *Subgroup analysis*

In this study, we examined the sex differences in the effects of Taekwondo on depression. Due to the absence of sufficient studies (fewer than three) for the male subgroup, it was excluded from the subgroup analysis. However, in the female subgroup, Taekwondo intervention demonstrated a significant improvement in depression (Effect Size [ES]=-1.114,  $P=0.009$ ), which was notably more effective than the results observed in the



sex-neutral subgroup ( $ES = -0.562$ ,  $P < 0.001$ ). Women may respond more positively to Taekwondo as a means to alleviate depression compared to men. This aligns with a study on physical exercise interventions for depression, which reported greater therapeutic effects in females than in males, regardless of the severity of depression or the presence of symptoms (42). This outcome may be attributed to women's heightened concern for their image, potentially increasing their willingness to participate in physical exercise. Consequently, this could result in a more pronounced exercise effect in women compared to men in regular physical activities (19). Furthermore, depression is more prevalent among women than men, leading to a higher baseline level of depression in females. This difference makes women more likely to experience therapeutic benefits from physical exercise (43–45). Therefore, the role of sex differences should be thoroughly considered in future research.

This study also examined the effects of Taekwondo on depression across different age groups. Taekwondo's intervention effect was significantly more pronounced in the elderly (Effect Size  $[ES] = -1.025$ ,  $P = 0.004$ ) compared to minors ( $ES = -0.673$ ,  $P < 0.001$ ), while its impact on young adults was not statistically significant ( $P = 0.345$ ). This outcome might be attributed to the enhanced psychological resilience physical exercise provides the elderly. Resilience can assist in better managing life's challenges and pressures, thereby reducing depressive symptoms (46). Furthermore, retirement often results in a reduced social circle for many elderly individuals, potentially leading to loneliness, a common precursor to depression. Older adults who engage in frequent social activities are significantly less likely to exhibit depressive symptoms (47). Participating in Taekwondo is more than just physical exercise; it involves group activities, providing social interaction that can mitigate loneliness and, consequently, depressive symptoms. Hence, this social aspect of Taekwondo may explain why its intervention effect is more evident in the elderly than in young adults and minors.

Additionally, this study aimed to identify the optimal intervention program by analyzing the effects of Taekwondo on depression across different program durations. Initially focusing on the 'period' of intervention, the study found that a 12-week intervention (Effect Size  $[ES] = -0.992$ ,  $P < 0.001$ ) was significantly more effective than a 16-week intervention ( $ES = -0.385$ ,  $P < 0.001$ ), while the effectiveness of a 15-week intervention was not statistically significant ( $P = 0.629$ ). This suggests that a longer intervention period does not necessarily yield better outcomes. Similar findings were reported in prior studies; for instance, a systematic review and meta-analysis on exercise's effects on adolescent depression indicated that a 6-week intervention had a greater impact than longer intervention cycles (48). However, this should not be interpreted as shorter-duration interventions consistently having a more substantial effect on depression than longer-duration ones. It is crucial to consider not just the duration but also the frequency, single session length, and intensity of the intervention. Current research limitations and insufficient data preclude a more detailed subgroup analysis; thus, future studies covering a broader range of durations are needed. Current data analysis suggests that a 12-week Taekwondo intervention may be most effective in alleviating depression. Furthermore, studies have shown that a three-month regular exercise intervention can effectively remodel the central nervous system in depression patients (49). Another study revealed an inverted U-shaped relationship between exercise duration and mental health symptom relief, indicating an optimal duration beyond which the effect diminishes (50). Consequently, a 12-week period may represent the optimal duration for Taekwondo interventions targeting depression. Secondly, regarding 'frequency', Taekwondo sessions three times a week yielded the greatest intervention effect (Effect Size  $[ES] = -0.729$ ,  $P < 0.001$ ). In terms of 'single duration', sessions lasting 60 min each had the most substantial impact ( $ES = -0.980$ ,  $P = 0.003$ ). This aligns with the WHO guidelines for physical exercise, recommending adults to engage in at least 150 min of aerobic activity weekly (51). Generally, a positive

dose-response relationship exists between the frequency and duration of exercise and the alleviation of depression (52). For instance, a study on depressed rats found that a single 30-minute wheel run was more effective in reducing serum corticosterone concentrations than a 20-minute run (53). However, excessively frequent or prolonged exercise sessions may diminish exercise enthusiasm, consequently impacting the effectiveness of the intervention. A meta-analysis on exercise duration reported that the effect of single interventions lasting less than 45 min was greater than those exceeding 45 min (54). Therefore, it is crucial to find a balance in exercise frequency and duration to maximize intervention effects. Practicing Taekwondo three times a week, for 60 min each session, may be the most effective approach to improving depression.

Finally, regarding 'exercise intensity', this study found that low-intensity Taekwondo (Effect Size [ES]=-1.777,  $P=0.024$ ) had a greater intervention effect than moderate-intensity ( $ES = -0.756$ ,  $P<0.001$ ). Higher exercise intensity may not always yield better outcomes, a finding that diverges from some previous research. A prior study indicated a positive correlation between exercise intensity and plasma endorphins (55). The American College of Sports Medicine recommends moderate-intensity exercise for treating depression (56). Furthermore, low, medium, and high-intensity exercises can effectively alleviate depressive symptoms (57). However, it is not sufficiently objective to judge the intervention's effectiveness by intensity alone without considering exercise duration and frequency. Additionally, the intensity metrics in the included studies varied, leading to potential errors in intensity conversion. Therefore, the interpretation of these findings necessitates further research to bolster the credibility of this study's results. Taekwondo, being a martial art with combative elements, can be challenging for beginners. Low-intensity training in Taekwondo may reduce the psychological pressure associated with the exercise and require shorter recovery time, fostering long-term and continuous participation. While these findings should be interpreted cautiously,

the current data analysis suggests that low-intensity Taekwondo may be more effective for alleviating depressive symptoms. Moreover, the optimal exercise intensity may vary across different age groups. Since this study includes minors, adults, and the elderly, future research should delve into how varying intensities of Taekwondo influence depressive symptoms across these diverse age groups.

### *Limitations of the study*

This meta-analysis is subject to several limitations.

1) All included studies rely on self-reported data, lacking objective diagnostic methods such as clinical interviews or biomarker analysis. 2) The intensity units reported in the included studies are inconsistent, potentially leading to errors in conversion. 3) Multiple subgroups in the subgroup analysis have an insufficient number of studies (less than three), limiting the subgroup analysis's conclusions. 4) To maximize the inclusion of studies in the subgroup analysis, we merged subgroups with similar frequencies and durations. This approach may have compromised the accuracy of the results. 5) Despite utilizing subgroup and sensitivity analyses, we were unable to pinpoint specific factors contributing to the high heterogeneity observed in the meta-analysis. This heterogeneity might stem from methodological differences, variations in sample characteristics, or discrepancies in measurement methods. Consequently, while our analysis uncovers intriguing trends, these findings should be interpreted cautiously.

### *Conclusion*

Taekwondo has a beneficial impact on depression, particularly for older women. We recommend a regimen of low-intensity Taekwondo training, consisting of 60-minute sessions three times a week for a duration of 12 wk, to achieve optimal relief from depression. However, given the limitations of this study, future research should be more rigorous and detailed to further validate these findings and enhance the quality of such research.

**Journalism Ethics 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.

## Conflict of interest

The authors declare that there is no conflict of interests.

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