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REVIEW

Influencing Factors of Women's Sports Participation Based on Self-Determination Theory: A Systematic Review and Meta-Analysis

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Introduction: The lack of physical exercise is a global health concern, particularly affecting women. However, there is limited research on factors influencing women's sports participation. Recent studies on increasing women's physical activity levels differ in methodologies and conclusions. Motivation, as the cornerstone of most human behaviors, has important effects on female motor participation. Self-Determination Theory (SDT) is an important method to study human behavioral motivation and supported by empirical evidence. In the field of women's sports, the SDT is also widely used. This review explores the impact of SDT-related factors on women's sports participation, considering age variations. It aims to guide future empirical research and promote PA across demographics.

Methods: This review, by searching the existing empirical literature in Web of Science, Google Scholar, Elsevier ScienceDirect, CNKI, obtained 32 independent studies, conducted a meta-analysis after coding them, considering 11 influencing factors from the integration of SDT and Basic Psychological Needs Theory.

Results/Conclusion: The study found a significant positive correlation between autonomous motivation and women's sports participation, with identified regulation having the strongest influence. Controlled motivation showed no significant impact on women's exercise, while amotivation had an inhibitory effect. Enhancing women's perception of autonomy, competence, and relatedness significantly promotes sports participation. Age differences were observed in the relationship between autonomous motivation, basic psychological needs, and sports participation, with the strongest effects on women aged 25–40, while the impact was relatively weaker in older women. The correlation between basic psychological needs and female sports participation also has a significant age difference. Thus, different measures should be taken to improve exercise participation in women of different age groups.

Keywords: sports participation, self-determination theory, women, meta-analysis

Introduction

In 2018, the World Health Assembly introduced the "Global Action Plan on Physical Activity 2018–2030" (GAPPA), aiming to reduce the prevalence of insufficient PA among adults and adolescents by 15% by 2030.[1] Currently, 81% of adolescents and 27.5% of adults fail to meet the recommended physical activity levels,[2] leading to a rise in non-communicable diseases and making sedentary lifestyles the fourth leading cause of premature death globally.[3–5]

The relationship between women and PA is complex and influenced by various factors. Sport is an important part of physical activity.[1] However, the competitive and strength-oriented nature of sports often clashes with traditional gender expectations for women to be gentle and conform to certain beauty standards.[6,7] Women also face limitations in terms of time and opportunities for sports due to unpaid domestic work and sedentary occupations.[6] Gender inequality in sports governance, representation, and fan support further hinders women's participation in sports.[8,9] These factors contribute to the significant issue of insufficient PA among women, with studies showing that globally, 31.7% of women are insufficiently active, making women 47% more likely than men to lead a sedentary lifestyle.[2,8,10]

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Sports participation involves various dimensions, such as the type of sport, intensity, duration, frequency, and persistence.[11] It is not only essential for physical fitness and overall health but also plays a crucial role in enhancing social interaction and well-being. Most research categorizes sports participation into four dimensions: sport type, intensity, duration, and frequency,[12] with some including persistence as a measurement indicator. In today's context, where PA is more driven by individual needs rather than societal demands, psychological factors have an increasing influence on sports participation. Therefore, promoting active sports involvement has become a primary goal in public health.[13] Identifying the motivations behind different groups' sports participation is vital for increasing physical activity levels and promoting individual engagement in sports.[14]

Researchers typically use various dimensions to design PA behavior questionnaires. The most commonly used tool for measuring PA levels is the Leisure Time Exercise Questionnaire (LTEQ), created by Godin and Shephard.[15] This questionnaire assesses PA volume according to the World Health Organization's definitions of different intensity levels.[15] It records the time spent on vigorous, moderate, and light physical activities over a week and calculates it using the formula (9 × vigorous) + (5 × moderate) + (3 × light). In China, researchers often employ the Physical Activity Rating Scale-3 (PARS-3), developed by Liang.[16] PARS-3 evaluates exercise intensity, duration, and frequency, and calculates exercise volume using the formula: exercise volume = exercise intensity × exercise duration × exercise frequency. The resulting exercise volume score is then categorized for further analysis.[16]

Motivation is the cornerstone of most human behaviors, representing a goal-oriented force that guides and stimulates individual activities.[17] Scholars have identified a lack of motivation as a significant reason for sedentary behavior.[18–20] Various theories address exercise motivation, including the Health Belief Model (HBM), Cognitive Evaluation Theory, Achievement Motivation Theory (AMT), Self-Determination Theory (SDT), and Self-Efficacy Theory (SET). Currently, the primary focus in exercise motivation research centers on SDT, introduced by Deci and Ryan.[3] SDT is based on the Basic Psychological Needs Theory, proposing that human behavior is driven by three core psychological needs: autonomy, competence, and relatedness. Autonomy pertains to an individual's control over their actions and their desire for their behavior to result from their own choices. Competence, or the need for mastery, involves the desire to control outcomes, acquire experience, and develop skills. Relatedness relates to the need for social connection and support, fostering a safe interpersonal atmosphere.[21] Many scholars have applied the Basic Psychological Needs Theory to the field of sports. The most widely utilized tool for measuring these basic psychological needs in sports is the Psychological Need Satisfaction in Exercise (PNSE) scale developed by Wilson. This scale assesses needs for competence, relatedness, and autonomy and has been revised and adopted by researchers in various countries.[22]

Deci and Ryan[21] expanded on the Basic Psychological Needs Theory, proposing the Organismic Integration Theory, categorizing motivation into three types based on self-determination: amotivation, extrinsic motivation, and intrinsic motivation.[23] Deci and Ryan[21] further divided extrinsic and intrinsic motivation into autonomous motivation and controlled motivation. Autonomous motivation reflects fully self-determined and voluntary engagement in activities, while controlled motivation indicates activities influenced by external conditions or internal psychological control. This internalization of motivation occurs once basic psychological needs are met.[24,25]

Numerous studies have highlighted gender and age differences in sports motivation. From a gender perspective, women are primarily motivated by external factors such as appearance and weight management, while men are driven by challenges, strength and endurance enhancement, competition, and social recognition.[26–28] Gender differences also exist in the impact of family environment on sports participation. Women from lower socio-economic status (SES) backgrounds tend to exhibit more sedentary behavior compared to those from higher SES backgrounds, whereas family influences on men's sports participation are predominantly related to whether they come from single or dual-parent families.[29]

From an age perspective, young people are more likely to increase sports participation based on the goal of physical health, while older individuals have lower self-efficacy and fewer expectations of benefits from participating in sports.[30,31] Therefore, studying the motivations of young people for engaging in sports activities appears to have a more significant impact on enhancing overall societal sports participation. Research on sports motivation, based on SDT, has progressively moved to-wards examining individual differences. However, the existence of gender differences in sports motivation within the purview of SDT remains a subject of debate. Some studies suggest negligible differences

between men and women, while others found variations in identified regulation, external regulation, and introjected regulation affecting men's and women's participation in sports.[32–35] Regarding age differences in sports motivation according to SDT, the results are relatively consistent, with older individuals being more internally motivated and external motivation being more effective for young people's participation in sports activities.[36,37]

Despite women's increasing presence in competitive sports, gender inequality persists in general sports activities.[38] Research on women's roles in sports and their motivations for exercise is limited, often focusing on comparative studies of gender differences rather than dedicated research. While there are existing meta-analyses on sports participation or sports motivation, there has been no utilization of meta-analysis methods to study the motivations affecting sports participation.[6,39,40] Therefore, this review aims to use meta-analysis to quantitatively analyze and verify the factors influencing women's participation in sports exercise, offering theoretical guidance for enhancing women's sports participation. The available literature and empirical studies on sports motivation and participation provide a suitable sample size for meta-analysis research. Based on this literature review, limited group-level analysis under SDT has been conducted, and no unified conclusion has been reached regarding gender and age differences in sports motivation. This meta-analysis of women's sports motivation may contribute to subsequent research on group differences in sports motivation.

Materials and Methods

Literature Search and Selection

The system review adheres to the protocol registered on PROSPERO (CRD42023478660). After determining the research theme, the next step involves the search and selection of relevant literature. In this review, databases Web of Science, Google Scholar, Elsevier ScienceDirect, and CNKI were utilized for literature retrieval. The language of the search literature is the national literature covered in all databases, which can reflect the Women's Sports Participation Based on Self-Determination Theory worldwide. The main search keywords included: motivation; physical activity, sport, exercise; female, women. SDT, BREQ; frequency, strength, time. Literature searches were conducted using combinations of these keywords. A total of 556 papers were identified initially, following the removal of duplicates.

The subsequent step involved reviewing the titles and abstracts of these papers to exclude those that did not align with the objectives of this review. Papers focused on special populations like patients or athletes were also excluded. This filtering process resulted in 192 papers for a full-text review. During the full-text review, 18 papers that did not conduct quantitative analysis and 93 that did not specifically address the exercise motivation and participation of women were further excluded, leaving 81 papers.

The essence of meta-analysis is analyzing the effect sizes reported in various empirical studies to synthesize past research findings. Therefore, papers that reported effect sizes for women's exercise motivation and participation or confirmed no gender differences in these areas and reported overall effect sizes were selected. Out of the remaining quantitative studies, 29 papers met these criteria. However, two papers had identical samples, so only one was included. Additionally, 4 more papers that met the analysis criteria were included from other sources such as references of the retrieved articles. Ultimately, 32 papers were incorporated into the meta-analysis.

The meta-analysis involved aggregating information reported in the literature, such as sample sizes, average ages, Cronbach's alpha coefficients for scales, and correlation coefficients. This process is illustrated in a detailed selection flowchart, as shown in Figure 1.

Literature Coding and Processing

To enhance the accuracy of the research and reduce bias, this review independently coded the selected literature. Key coding elements included the title, author names, publication year, sample size, participant status, average age of participants along with the standard deviation, motivation measurement scales used in the study, metrics for measuring the level of sports participation, effect sizes, and reliability. Appendix A lists the descriptive information of the studies included in the meta-analysis.

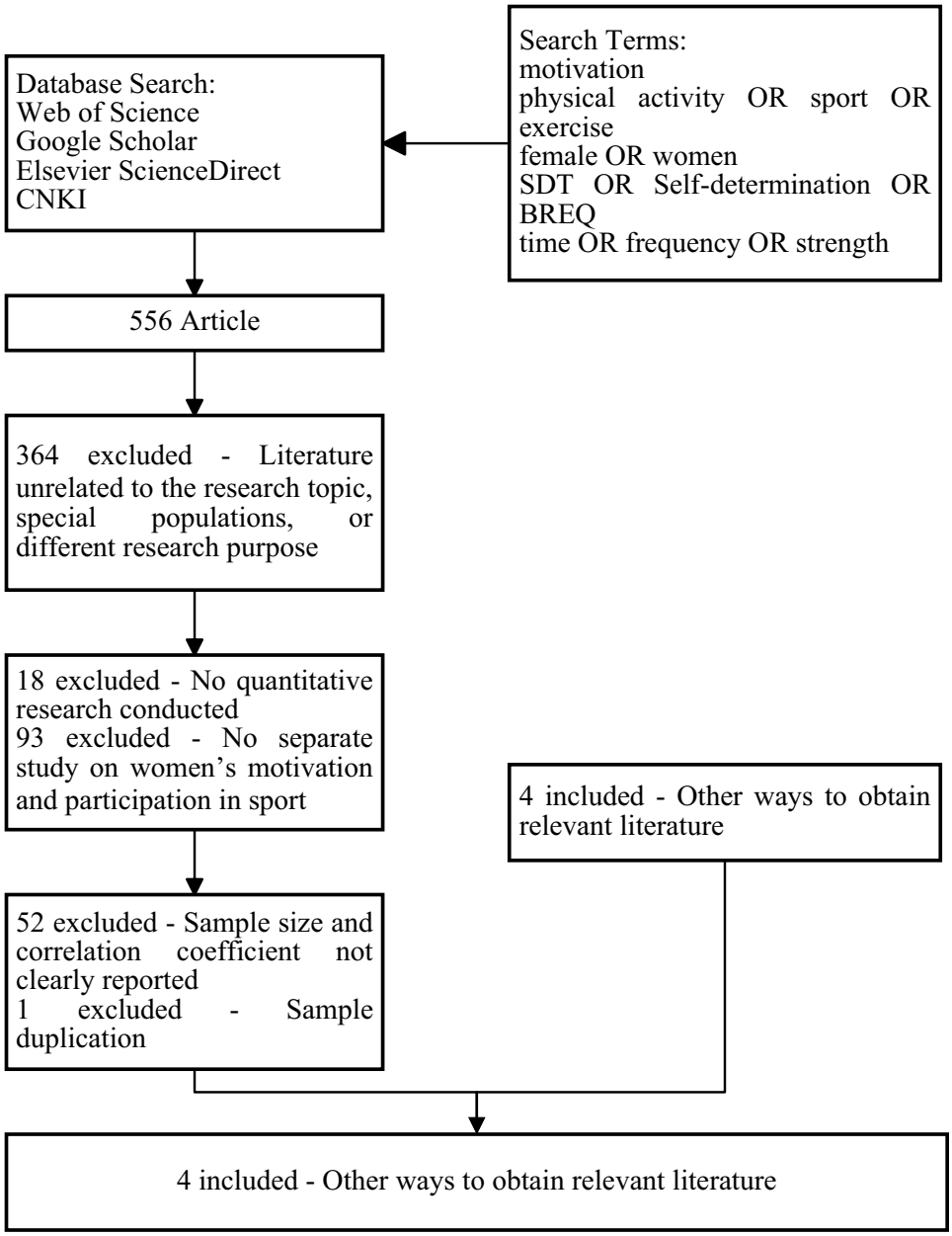

Figure 1 Literature Selection Process.

This review used the correlation coefficient (r) as the measure of effect size. For articles that only reported significance t-values or path coefficients (β) without reporting correlation coefficients (r), formula (1) was used to convert these values into r for coding purposes.

In cases where studies conducted correlation analyses on different elements of the same group, such as various dimensions of exercise volume, the average values were used to measure overall correlation. The meta-analysis included studies on sports motivation within the framework of SDT, involving Basic Psychological Needs Theory, Organismic Integration Theory, and studies integrating both theories. This research analyzed the relationship between these influencing factors and sports participation.

$$r = \sqrt{\frac{t^2}{t^2 + df}}\, r = \frac{\beta\ sd\ (x)}{sd\ (y)} \tag{1}$$

Table 1 Coding Information for Factors Influencing Sports Participation

Influence factor	k	n	r_{min}	r_{max}
Amotivation	12	5437	−0.60	0.40
External Regulation	20	8095	−0.30	0.33
Introjected Regulation	15	4991	−0.05	0.48
Identified Regulation	18	7766	0.00	0.94
Integrated Regulation	5	2133	0.16	0.71
Intrinsic Regulation	21	8660	0.01	0.81
Autonomous Motivation	7	1933	0.16	0.51
Controlled Motivation	4	1111	0.01	0.25
Competence	4	3218	0.20	0.60
Autonomy	5	3435	0.16	0.46
Relatedness	4	3218	0.20	0.64

Note: k- number of studies combined for effect size; n cumulative sample size across k studies.

Table 1 presents a summary of the coding information for factors influencing sports participation under the perspective of SDT.

Model Selection

In meta-analysis, there are two basic models for estimating the overall effect size of the sample: the fixed-effect model and the random-effects model. The fixed-effect model assumes that the samples from each study belong to the same population and that the effect sizes are theoretically homogeneous. Differences in study results are at-tributed to random errors. The random-effects model, however, assumes that the studies in a meta-analysis reflect different populations. These are considered part of a larger overall population, yielding heterogeneous effect sizes. Besides random errors, differences may also arise from variations in sample characteristics.

Based on these principles, this review employed the random-effects model for the meta-analysis. The meta-analysis software CMA 3.7 was used for heterogeneity analysis, publication bias testing, overall effect analysis, and moderator effect testing. Moderator effect testing was conducted using subgroup analysis for significance testing based on the type of data. This review aimed to test the moderating effect of age on the relationship between various influencing factors and sports participation, providing an analysis of the age differences in sports motivation.

Results

Reliability Analysis

In this meta-analysis, questionnaires were predominantly used to study the impact of sports motivation on participation. Therefore, it was necessary to test the consistency and robustness of the results obtained from these questionnaires, typically reflected through reliability analysis. This review used Cronbach's alpha (Cronbach's α) coefficients in the reliability analysis to verify the reliability of the variable measurements. A Cronbach's alpha coefficient greater than 0.7 indicates good reliability of the variable measurement and high research reliability. Of the 32 articles included in the analysis, 4 did not report questionnaire reliability data. Therefore, reliability analysis was con-ducted on the remaining 28 articles. For articles that did not measure the reliability of individual variables, Composite Reliability (CR) values were used as substitutes. For those that only listed the range of Cronbach's alpha coefficients for all variables, the minimum value was used for statistical inclusion. The reliability analysis values for each variable are shown in Table 2.

Table 2 Reliability Analysis

Influence factor	Number of Samples	Average Reliability	Maximum Value	Minimum Value	Variance
Amotivation	11	0.779	0.93	0.54	0.015
External Regulation	18	0.805	0.90	0.66	0.005
Introjected Regulation	14	0.814	0.93	0.73	0.002
Identified Regulation	16	0.807	0.95	0.71	0.004
Integrated Regulation	4	0.890	0.94	0.81	0.003
Intrinsic Motivation	19	0.859	0.96	0.71	0.005
Autonomous Motivation	6	0.835	0.91	0.69	0.008
Controlled Motivation	4	0.770	0.82	0.72	0.003
Competence	3	0.937	0.95	0.93	0.000
Autonomy	4	0.930	0.96	0.91	0.000
Relatedness	3	0.927	0.96	0.89	0.001

From the results in the above table, it can be observed that the minimum average reliability of the variables is 0.770, which is above the 0.7 threshold. Moreover, the average reliability of most variables is above 0.8, with relatively small variances. This indicates that the measurement results of these variables are credible, stable, and consistent.

Heterogeneity Testing

Theoretically, this review should employ a random-effects model. To further verify the appropriateness of the random-effects model, heterogeneity testing was con-ducted using Q-test, I^2 values, and Tau-squared values. When Q is significant, or $I^2 \geq 75\%$, it implies that the effect sizes may be influenced by potential moderating variables and that there is a high degree of heterogeneity in the research, making the random-effects model more suitable The closer the Tau-squared value is to zero, the lower the heterogeneity. Heterogeneity testing was conducted on the effect sizes included in this review, and the results are presented in Table 3.

According to the results in the table, the Q-tests for all variables, except controlled motivation, reached the 95% confidence level in their correlation with sports participation. The Q-test for controlled motivation was significant at the 10% level. The Tau Squared values were not zero, and I^2 values were mostly above 75%. This suggests that over 75% of the variance in the models for almost all variables is due to differences between study results, and less than 25% is due to random error. There is a high level of heterogeneity among the study results of each variable, which validates the use of a random-effects model for the analysis.

Publication Bias Testing

When conducting a meta-analysis, it is also necessary to test for publication bias in the effect sizes of the variables to avoid bias in the meta-analysis results due to re-searchers not having complete access to all relevant data in the field. The study first used funnel plots for qualitative analysis. Generally, if the scatter points are concentrated at the top of the funnel and symmetrically distributed, it indicates a lower likelihood of publication bias. After subjective visual assessment with funnel plots, Egger's linear regression and Fail-Safe N tests were used for quantitative analysis of publication bias. Typically, an Egger's test p-value greater than 0.05 indicates a low probability of publication bias. Table 4 shows that the regression results for identified regulation and integrated regulation in Egger's test was significant, indicating the existence of publication bias in studies on the correlation between these forms of regulation and sports participation, requiring further analysis. The Fail-Safe N test re-quires a Z-value greater than 1.96 and a p-value less than 0.05, indicating a low likelihood that publication bias affected the meta-analysis results. Both identified regulation and

Table 3 Heterogeneity Analysis

Influence factor	Heterogeneity			Tau-squared	
	Q-value	P-value	I2(%)	Tau Squared	Tau
Amotivation	155.917	0.000	92.945	0.035	0.188
External Regulation	108.581	0.000	82.502	0.013	0.113
Introjected Regulation	121.560	0.000	88.483	0.024	0.156
Identified Regulation	1084.064	0.000	98.432	0.160	0.400
Integrated Regulation	55.223	0.000	92.757	0.033	0.182
Intrinsic Motivation	508.437	0.000	96.066	0.064	0.253
Autonomous Motivation	36.695	0.000	83.649	0.020	0.142
Controlled Motivation	6.373	0.095	52.928	0.005	0.072
Competence	45.967	0.000	93.474	0.043	0.208
Autonomy	14.659	0.005	72.713	0.008	0.090
Relatedness	21.251	0.000	85.883	0.018	0.136

Table 4 Analysis of Publication Bias Results

Influence factor	K	Egger's regression			Fail-safe N	
		Intercept	t-value	P-value	Z-value	P-value
Amotivation	12	−1.206	0.569	0.582	−6.746	0.000
External Regulation	20	1.188	1.028	0.318	3.036	0.002
Introjected Regulation	15	2.524	1.239	0.237	10.984	0.000
Identified Regulation	18	8.895	2.501	0.024	28.238	0.000
Integrated Regulation	5	9.617	3.267	0.047	14.529	0.000
Intrinsic Motivation	21	4.325	1.871	0.077	23.995	0.000
Autonomous Motivation	7	5.011	2.238	0.075	14.528	0.000
Controlled Motivation	4	3.049	2.757	0.110	2.378	0.017
Competence	4	2.823	0.798	0.509	13.342	0.000
Autonomy	5	−0.490	0.294	0.788	14.590	0.000
Relatedness	4	0.929	0.346	0.762	14.633	0.000

integrated regulation passed the Fail-Safe N test, suggesting that although there is publication bias, it is unlikely to have impacted the analysis results significantly. It was found that amotivation did not pass the Fail-Safe N test but passed Egger's test, indicating that the analysis results for amotivation might be prone to publication bias, but are unlikely to be biased, suggesting that any publication bias is mild.

To further investigate the publication bias for integrated regulation, Figures 2 and 3 illustrate the funnel plots for identified regulation and integrated regulation. It can be observed that both identified and integrated regulation show fewer effect size distributions on the right side.

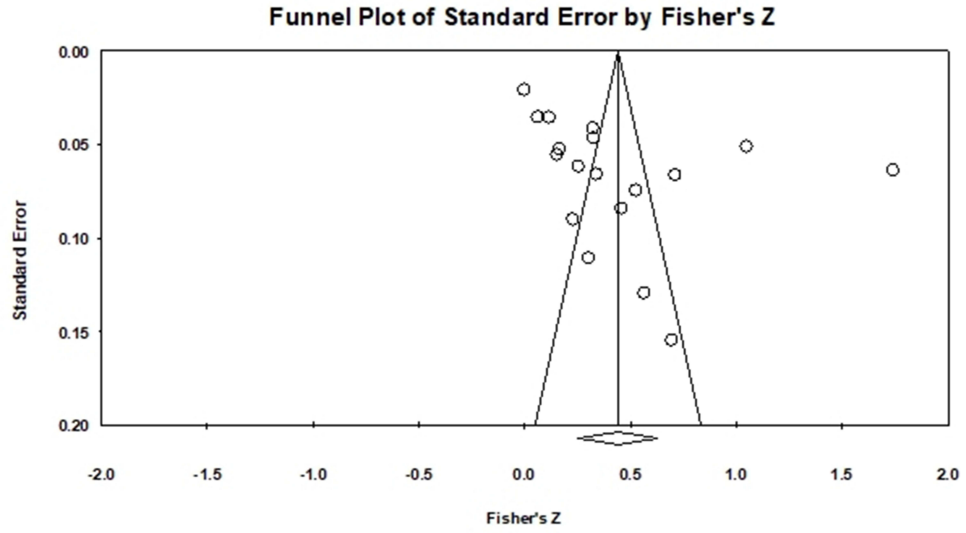

Figure 2 Funnel Plot of Publication Bias for Effect Values of Identified Regulation.

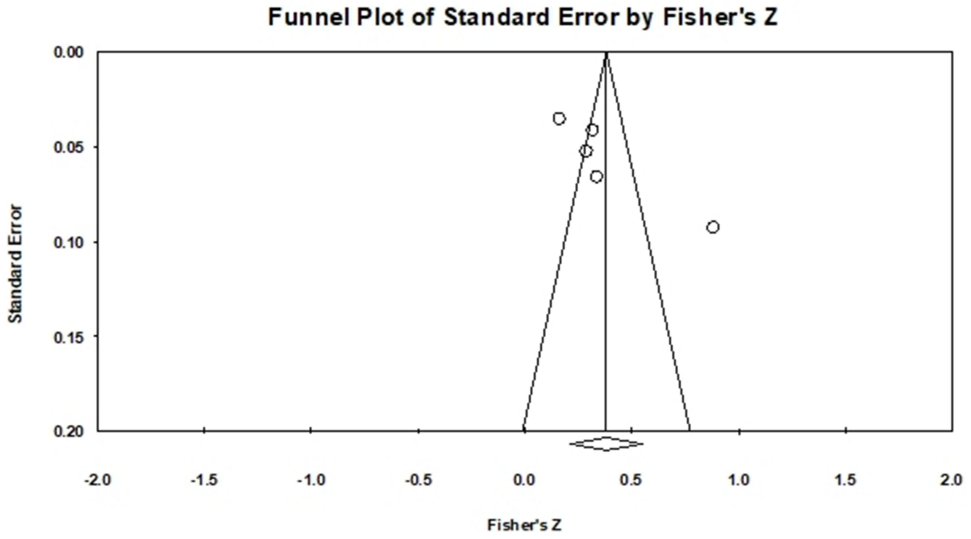

Figure 3 Funnel Plot of Publication Bias for Effect Values of Integrated Regulation.

The trim and fill test was used for identification and correction. If the effect size changes significantly after trimming and filling, but the final result does not undergo a fundamental change, it can be considered that the publication bias error is still within a reasonable range. For identified regulation, after trimming and filling five studies to the right, the point estimate changed from 0.253 to 0.520. For integrated regulation, after trimming and filling one study to the right, the point estimate changed from 0.278 to 0.386. The corrected point estimates show significant changes, indicating that the publication bias is minor and does not significantly impact the results. Thus, combining various methods, it can be concluded that the publication bias in the included studies for each variable is moderate and acceptable

Overall Effect Test

This review used a random-effects model for the meta-analysis of each variable to test the significance of the average effect size. The results are presented in Table 5.

From the results in the table, it is evident that the average effect values of most variables reached a significant level, while external regulation and controlled motivation were not significant. This indicates that there is no significant

Table 5 Statistical Results of Overall Effect Analysis

Influence factor	k	n	r	95% Confidence Interval		Z-value	P-value
				LL	UL		
Amotivation	12	5437	−0.120	−0.232	−0.006	−2.057	0.040
External Regulation	20	8095	0.046	−0.012	0.104	1.557	0.120
Introjected Regulation	15	4991	0.180	0.094	0.262	4.096	0.000
Identified Regulation	18	7766	0.414	0.247	0.557	4.853	0.000
Integrated Regulation	5	2133	0.364	0.210	0.500	4.452	0.000
Intrinsic Motivation	21	8660	0.318	0.214	0.416	5.734	0.000
Autonomous Motivation	7	1933	0.356	0.249	0.455	6.179	0.000
Controlled Motivation	4	1111	0.080	−0.019	0.177	1.588	0.112
Competence	4	3218	0.321	0.117	0.499	3.027	0.002
Autonomy	5	3435	0.293	0.203	0.379	6.129	0.000
Relatedness	4	3218	0.330	0.192	0.455	4.524	0.000

Table 6 Moderator Effect Analysis Results

Influence Factor	Moderator Variable	K	R	Two-tailed Test		Subgroup Difference Test	
				Z-value	P-value	Q-value	P-value
Amotivation	Adolescents	1	0.037	0.601	0.548	14.757	0.001
	Youth	9	−0.116	−7.587	0.000		
	Middle-aged	2	0.002	0.072	0.943		
	Elderly	0	-				
External Regulation	Adolescents	3	0.138	5.269	0.000	32.015	0.000
	Youth	11	−0.024	−1.623	0.105		
	Middle-aged	5	0.042	1.705	0.088		
	Elderly	1	0.100	1.820	0.069		
Introjected Regulation	Adolescents	2	0.132	4.567	0.000	2.710	0.439
	Youth	8	0.155	6.971	0.000		
	Middle-aged	4	0.130	4.985	0.000		
	Elderly	1	0.220	4.057	0.000		
Identified Regulation	Adolescents	3	0.120	4.596	0.000	70.598	0.000
	Youth	10	0.252	17.287	0.000		
	Middle-aged	4	0.400	16.136	0.000		
	Elderly	1	0.150	2.741	0.006		

(*Continued*)

Table 6 (Continued).

Influence Factor	Moderator Variable	K	R	Two-tailed Test		Subgroup Difference Test	
				Z-value	P-value	Q-value	P-value
Integrated Regulation	Adolescents	2	0.198	6.890	0.000	19.197	0.000
	Youth	3	0.373	12.029	0.000		
	Middle-aged	0					
	Elderly	0					
Intrinsic Motivation	Adolescents	3	0.226	8.729	0.000	17.296	0.001
	Youth	12	0.217	15.853	0.000		
	Middle-aged	5	0.319	13.459	0.000		
	Elderly	1	0.170	3.114	0.002		
Autonomous Motivation	Adolescents	1	0.490	8.577	0.000	28.159	0.000
	Youth	2	0.181	5.023	0.000		
	Middle-aged	1	0.360	6.018	0.000		
	Elderly	3	0.349	9.275	0.000		
Controlled Motivation	Adolescents	0	-			5.635	0.060
	Youth	1	0.010	0.252	0.801		
	Middle-aged	1	0.030	0.479	0.632		
	Elderly	2	0.194	2.850	0.004		
Competence	Adolescents	1	0.210	3.464	0.001	0.571	0.752
	Youth	2	0.248	13.555	0.000		
	Middle-aged	1	0.200	1.836	0.066		
	Elderly	0	-				
Autonomy	Adolescents	2	0.298	6.730	0.000	0.046	0.977
	Youth	2	0.307	16.956	0.000		
	Middle-aged	1	0.295	2.753	0.006		
	Elderly	0	-				
Relatedness	Adolescents	1	0.195	3.209	0.001	19.772	0.000
	Youth	2	0.294	16.204	0.000		
	Middle-aged	1	0.639	6.850	0.000		
	Elderly	0	-				

correlation between these two variables and the level of sports participation; changes in external regulation and controlled motivation do not significantly affect the level of sports participation. According to the evaluation criteria proposed by Gignac and Szodorai,[41] an absolute value of the average effect size less than 0.3 indicates a weak correlation, between 0.3 and 0.5 indicates a moderate correlation, and greater than 0.5 indicates a strong correlation.[41]

First, the study examined the relationship between the elements of Organismic Integration Theory and the level of sports participation. Among the subtypes, the correlation coefficient for amotivation with sports participation level was −0.120, with a 95% confidence interval of [−0.232, −0.006], not including 0, indicating a weak negative correlation between amotivation and sports participation level. The test result for external regulation within external motivation was not significant, indicating it does not significantly affect the level of sports participation. The correlation coefficient for introjected regulation with exercise volume was 0.180, with a 95% confidence interval of [0.094, 0.262], not including 0, indicating a weak positive correlation between introjected regulation and women's sports participation level. The correlation coefficient for identified regulation with sports participation level was 0.414, with a 95% confidence interval of [0.247, 0.557], not including 0; for integrated regulation, the correlation coefficient was 0.364, with a 95% confidence interval of [0.210, 0.500], not including 0; and for intrinsic motivation, the correlation coefficient was 0.318, with a 95% confidence interval of [0.214, 0.416], not including 0, indicating a moderate positive correlation between identified regulation, integrated regulation, and intrinsic motivation with sports participation level. Among them, identified regulation had the strongest effect, followed by integrated motivation. In the two categories divided based on the degree of motivational autonomy, the correlation coefficient for autonomous motivation with sports participation level was 0.356, with a 95% confidence interval of [0.249, 0.455], not including 0, indicating a moderate correlation. The p-value for controlled motivation was greater than 0.05, indicating no significant correlation with sports participation.

Subsequently, the study analyzed the correlation between the elements of Basic Psychological Needs Theory under SDT and the level of sports participation and found that all three basic needs were significantly positively correlated with sports participation. The correlation coefficient for autonomy need with sports participation level was 0.293, with a 95% confidence interval of [0.203, 0.379], not including 0, indicating a weak correlation between autonomy need and women's sports participation level. The correlation coefficient for competence need with sports participation level was 0.321, with a 95% confidence interval of [0.117, 0.499], not including 0; for relatedness need, the correlation coefficient was 0.330, with a 95% confidence interval of [0.192, 0.455], not including 0. This indicates a moderate correlation between competence need, relatedness need, and sports participation level, with the correlation strength for relatedness need with women's sports participation level slightly greater than that for competence need.

Moderator Effect Testing

The heterogeneity testing previously showed strong heterogeneity among the study samples, suggesting the existence of significant moderating variables that could account for differences in the impact of various factors on women's sports participation. To scientifically explain the causes of heterogeneity, moderator effect testing was necessary. This review used age as a moderating variable and conducted subgroup analysis to test whether the correlation between each variable and the level of sports participation was significantly influenced by the moderating variable. The included samples showed a wide age range, with the lowest average age being 14.34 years and the highest being 70.88 years. There were also large age discrepancies within the samples. Therefore, the study roughly divided the samples into four age groups: adolescents (14–18 years), youth (19–25 years), middle-aged (26–50 years), and elderly (>50 years). This review only focused on whether there are age differences in the correlation between each variable under SDT and women's sports participation level, without further introducing sampling error, hence a fixed-effect model was chosen for sub-group analysis.

In the subgroup analysis, significant results in the group Q-test ($p < 0.5$) indicate that there are significant differences in the effect values under that moderating variable. From the results in table 6, it can be seen that age significantly influences the relationship between various motivational factors (such as amotivation, external regulation, identified regulation, integrated regulation, and intrinsic motivation) and women's sports participation. However, age does not significantly affect the relationship between introjected regulation and sports participation. From an overall perspective of motivation, age significantly moderates the impact of autonomous motivation on sports participation, while the effect of controlled motivation on women's sports participation is not significant at the 95% confidence level. Regarding the satisfaction of psychological needs, the impact of relatedness need on women's sports participation is moderated by age differences; however, competence need and autonomy need do not show significant age-related effects on sports participation.

Discussion

Influencing Factors and Their Intensity

In this review, a meta-analysis of 32 research articles was conducted, focusing on the factors influencing women's sports participation within the SDT framework. The results show that factors from both sub-theories of SDT influence women's sports participation. Within the Basic Psychological Needs Theory, autonomy, competence, and relatedness needs all show significant positive correlations with women's sports participation.[42,43] Among these, relatedness need has the strongest impact on women's sports participation levels, followed by competence need, with autonomy need having the weakest impact. However, the overall differences are relatively small, and all three factors have a strong influence on women's sports participation levels.[44] In the Organismic Integration Theory, amotivation tends to suppress women's sports participation; influenced by amotivation, women's participation levels may slightly decrease.[45,46] External regulation within external motivation does not significantly impact women's sports participation, suggesting that changes in the strength of external motivation do not significantly affect women's sports participation levels.[34,47] Within external motivation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation all positively impact women's sports participation levels,[45–47] with introjected regulation having a relatively weaker effect compared to the other three motivations.[32,48] These three variables are also components of autonomous motivation, and in the effect analysis of studies examining the influence of autonomous motivation on sports participation (excluding amotivation), it was found that autonomous motivation has a significant positive effect,[49,50] with a correlation similar to that between identified regulation, integrated regulation, intrinsic motivation, and sports participation. The study also found no significant relationship between controlled motivation and sports participation,[50,51] consistent with the analysis of external regulation and introjected regulation, components of controlled motivation. These corroborating results validate the scientific and reasonable nature of the meta-analysis findings in this review. The correlation coefficients between each factor and women's sports participation levels are illustrated in Figure 4.

The meta-analysis results indicate that autonomous motivation is the primary factor influencing women's sports participation.[50,52] The stronger the autonomous motivation, the more it encourages women to engage in physical exercise. This conclusion matches most empirical studies and is consistent with the perspectives of SDT, suggesting that autonomy in the motivational process plays an active role in better motivating and maintaining individual behavior.[24]

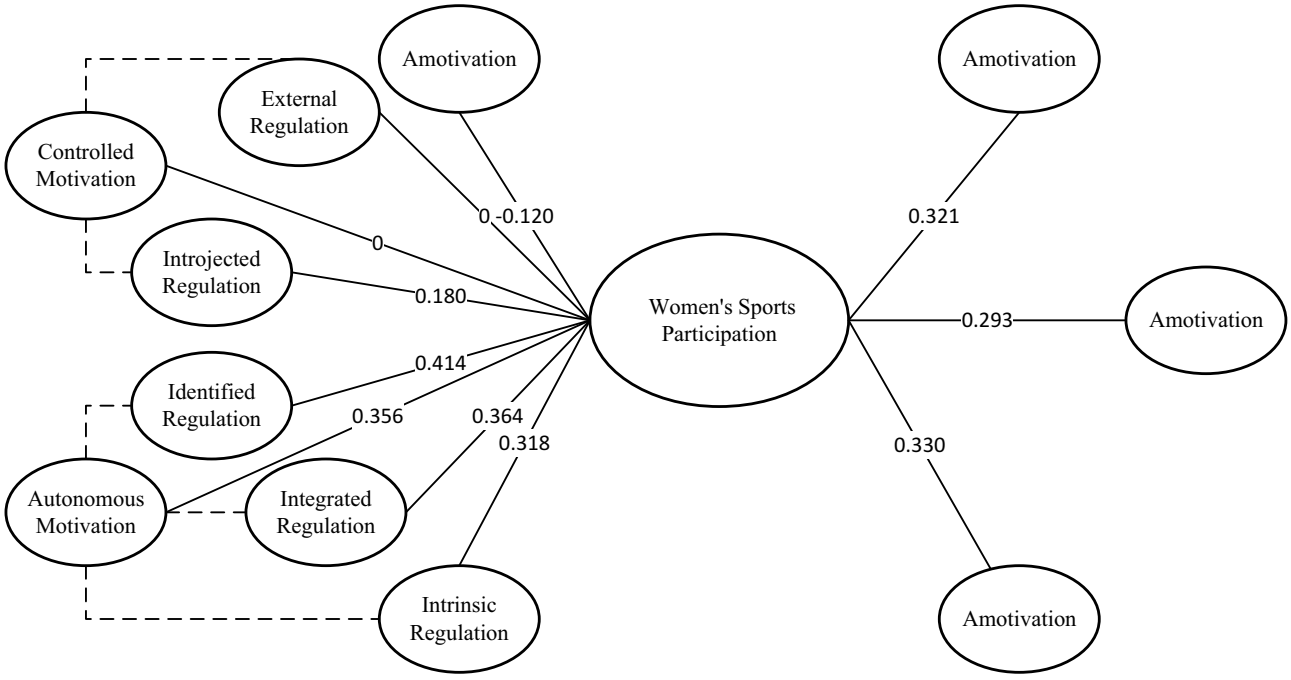

Figure 4 Factors Influencing Women's Sports Participation.

Autonomous motivation, encompassing identified regulation, integrated regulation, and intrinsic motivation, significantly impacts women's sports participation. Research findings indicate that identified regulation has the strongest effect on women's sports participation,[34] high-lighting the importance of making women recognize the value of physical exercise in enhancing their participation levels.[53] Enhancing women's identified regulation levels can effectively increase their exercise volume. Additionally, enabling women to enjoy physical exercise (intrinsic motivation) and fully identify with exercise to form a habit (integrated motivation) can also effectively promote their participation in physical exercise.[43] Controlled motivation, typically hard to impact women's sports participation, suggests that external motivations do not significantly enhance women's physical exercise. While introjected regulation (motivating exercise through internal pressure) has some positive effect, its overall impact is relatively weak.[32,35] Using amotivation to encourage women's sports participation not only fails to promote activity but may also have negative effects, suppressing their activity levels.[51]

Thus, it is evident that promoting the internalization of motivation can effectively enhance women's participation in sports.[54] The fulfillment of basic psychological needs can strengthen internal motivation and facilitate the internalization of external motivation.[55] SDT posits that when an individual's psychological needs are met, they exhibit stronger intrinsic motivation and perform better in activities.[24] The meta-analysis also confirms that satisfying basic psychological needs can increase the extent of women's participation in sports. Test results show that autonomy, competence, and relatedness needs are significantly positively correlated with sports participation levels, indicating that enhancing women's sense of autonomy, competence, and relatedness can promote their physical exercise behaviors.

Moderator Effect Analysis

The subgroup analysis reveals significant age differences in the factors affecting women's sports participation. Age as a moderating variable influences the strength of the relationship between certain variables and women's sports participation. Age significantly moderates the relationship between autonomous motivation, amotivation, and sports participation, but does not have a significant effect on controlled motivation. The positive effect of autonomous motivation on sports participation is most pronounced in adolescent females, followed by middle-aged and elderly women, and is least in young women. Amotivation does not always negatively affect sports participation; it significantly inhibits the participation of young women, but does not significantly impact adolescent and middle-aged women. Controlled motivation does not show age differences overall, but has a relatively weak positive impact in older women. Overall, adolescent, middle-aged, and elderly women show a notable increase in sports participation levels under the influence of motivation; young women's autonomous motivation has a mild positive effect on sports participation, while amotivation has a negative impact, suggesting that enhancing both internal and external sports motivation can have a significant positive impact on young women's sports participation. However, due to sample limitations, the performance of amotivation in elderly women and controlled motivation in adolescents remains uncertain, which may be a limitation of the conclusions.

In terms of specific subcategories, age differences significantly moderate the impact of identified regulation, integrated regulation, and intrinsic motivation within autonomous motivation, as well as external motivation within controlled motivation on sports participation, while having no significant effect on introjected regulation. These findings are generally consistent with the previous analysis of autonomous and controlled motivations, indicating that the overall argument is valid. In the subcategories of autonomous motivation, identified regulation has a much stronger impact on sports participation in young and middle-aged women compared to adolescents and elderly women; integrated regulation has a stronger correlation with sports participation in young women than in adolescents, with a lack of data for middle-aged and elderly women; intrinsic motivation has the strongest positive effect on sports participation in middle-aged women, followed by adolescents and young women, and the weakest in elderly women. There are some differences in the age moderation effects between the overall category of autonomous motivation and its subcategories, likely due to the combined effects of both categories or differences in samples and sample sizes. Overall, enhancing autonomous motivation in middle-aged women has the strongest effect on increasing sports participation levels, followed by young women, and then adolescents and elderly women. In the subcategories of controlled motivation, external motivation has a mild positive impact on sports participation in adolescents, but no significant impact in young, middle-aged, and elderly women; introjected motivation has a mild effect on sports

participation in women of all ages. Overall, controlled motivation does not vary much with age differences and has a weak or even negative impact on women's sports participation.

The impact of satisfying basic psychological needs on sports participation also shows some age differences. The correlation between relatedness needs and women's sports participation is moderated by age, while autonomy and competence needs do not show significant age differences. Enhancing the sense of relatedness in middle-aged women compared to adolescents and young women can have a more significant impact on overall sports participation. Due to sample limitations, there is a lack of research on the correlation between basic psychological needs and sports participation in elderly women, precluding effective conclusions and requiring further investigation by scholars.

Implications

This review utilized meta-analysis to explore how various motivations and psychological needs within the SDT framework influence women's sports participation. It quantified previous research findings to establish clear relationships and intensities between various motivations, psychological needs, and women's sports participation. Moderator analysis revealed age-related differences in the factors influencing women's sports participation within the SDT framework. The study found that women significantly increase their exercise levels under the influence of autonomous motivation. Controlled motivation does not have a noticeable effect on sports participation, while amotivation can suppress women's sports participation. The motivational levels with-in autonomous motivation are all moderately correlated with women's sports participation, with the intensity of impact in the order of identified regulation > integrated regulation > intrinsic motivation. Enhancing women's perception of autonomy, competence, and relatedness significantly promotes sports participation, with the impact strength in the order of relatedness need > competence need > autonomy need, with small differences in impact intensity.

Since autonomous motivation significantly influences women's sports participation, it is important to focus on whether age moderates the relationship between women's autonomous motivation and sports participation. The study finds that age significantly affects the impact of women's autonomous motivation on sports participation, with young women showing a relatively weaker correlation. Due to limited samples for overall analysis of autonomous motivation, the study relies on subcategory results for qualitative conclusions. The overall strength of the relationship between autonomous motivation and women's sports participation appears to follow the order: middle-aged women > young women > adolescent women > elderly women. This suggests a potential parabolic relationship with age, which requires further research. The correlation between basic psychological needs and women's sports participation also shows clear age differentiation. Overall, the perception of basic psychological needs and its correlation with sports participation increases from adolescents to young women to middle-aged women, with a lack of data for elderly women, necessitating further research.

Therefore, to increase sports participation in adolescent females, it is essential to enhance their autonomous motivation, particularly intrinsic motivation and integrated regulation, as well as their perception of autonomy, competence, and relatedness, especially autonomy perception. For young women, internalizing controlled motivation, reducing amotivation, and focusing on identified regulation and integrated regulation are vital. Autonomous, competence, and relatedness needs also effectively promote young women's sports participation, with autonomy perception being most effective. For middle-aged women, emphasizing identified regulation and intrinsic motivation within autonomous motivation, and enhancing relatedness and autonomy perception can have a significant positive impact, particularly relatedness perception. For elderly women, actively internalizing motivation and enhancing autonomous motivation is crucial to promote physical exercise.

Conclusions

This review's results highlight areas for further research on factors influencing women's sports participation within the SDT framework and provide a more detailed reference for subsequent quantitative analysis. The study confirms that enhancing women's autonomous motivation and actively promoting the internalization of their sports motivation have a significant positive effect on improving women's PA levels. Identified regulation within external motivation is the most

effective in increasing women's sports participation levels, so it is necessary to strengthen sports promotion and guide women to realize the importance of increasing sports participation. The study finds that the impact of various factors on women's sports participation varies with age. The study offers targeted recommendations for improving sports participation levels among women of different ages, which are significantly valuable for promoting nationwide fitness.

However, the study has limitations. Firstly, the meta-analysis results only demonstrate linear correlations between SDT factors and women's sports participation levels and do not reveal causality. Future research could further explore the dynamic patterns between these variables and sports participation within the SDT framework. Secondly, the study includes only 32 articles, with uneven distribution across different groups. The samples primarily focus on student populations, ie, adolescents and young people, with a relative lack of data for elderly women, which may affect the accuracy of the results. Future research should strengthen the study of factors influencing sports participation among elderly women. At the same time, compared with SDT studies in other fields, the study of women's sports participation needs to be refined, and future studies can classify more carefully the motivation of women's sports participation under the self-determination theory.[56] Lastly, studies suggest inherent connections between SDT and theories like TPB and SCM, jointly influencing exercise levels. Some studies also indicate potential mechanisms of SDT motivations in regulating PA and diet. Further meta-analysis research could be conducted by integrating these studies.

Data Sharing Statement

All data related to this manuscript is accessible. Should you require it, please reach out to the corresponding author.

Consent for Publication

All authors have agreed to the publication of this manuscript. The corresponding author is submitting it on behalf of everyone involved.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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