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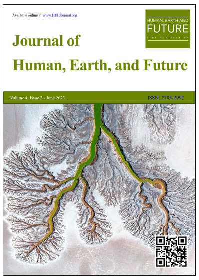

Review Article

Assessment of Self-Determined Motivation in Exercise: A Systematic Review and Meta-analysis

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Abstract

Self-determined motivation is measured on numerous scales as a predictor of long-term exercise. Our study applied a systematic review and meta-analysis to assess associations between types of self-determined motivation in exercise with selected parameters of studies using Behavioral Regulation in Exercise Questionnaires (BREQs). Following PRISMA 2020 guidelines, we screened 244 studies from PubMed, ScienceDirect, and Scopus against criteria and selected 43 articles for qualitative synthesis. Of those, 40 studies reporting mean scores and standard deviations of six regulations of BREQs, representing self-determined motivation types, were selected for meta-analysis. The pooled mean scores were the highest in intrinsic regulation at 4.00 (95%CI: 2.92–5.09), followed by identified, integrated, introjected, external, and motivation regulations at 3.65 (95%CI: 3.06–4.24), 3.11 (95%CI: 2.68–3.55), 2.21 (95%CI: 1.88–2.53), 1.42 (95%CI: 0.93–1.92), and 0.94 (95%CI: 0.67–1.12), respectively. Findings indicated significant associations between longer exercise duration and introjected ($\beta = 0.014$, $p = 0.027$) and identified ($\beta = 0.014$, $p = 0.021$) regulations. An inverse relationship was found with a higher female participation rate (β=-0.047, p=0.042), while exercise settings in sports and fitness centers exhibited a stronger association with intrinsic motivations (β=2.700, p=0.039). No significant differences were observed among the versions of BREQs in measuring self-determined motivation. This investigation of context invariance utilizing the particular validated scale contributes to furthering comprehension of the instrument in sports and fitness settings. Additionally, it is essential to take into account sex and the exercise environment concerning self-determined motivation when predicting long-term exercise adherence.

Keywords: Exercise; Self-determined Motivation; BREQ; Systematic Review; Meta-analysis.

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1. Introduction

Self-determined motivation is defined as "the process whereby goal-directed activities are instigated and sustained" [1]. This definition highlights the integral role of motivation in initiating and maintaining activity to achieve a specific objective, with a particular emphasis on goal-oriented behavior [2]. As exercise predictors, three main types of motivation from the self-determination theory, including extrinsic motivation, intrinsic motivation, and amotivation, were adapted to examine relationships with exercise maintenance via indirect or direct mechanisms [3].

The Behavioral Regulation in Exercise Questionnaires (BREQs) and recent amendments have emerged as the prevailing instruments in psychological research for self-determined exercise motivation measurement [4–6]. Over the years, the BREQs have been restructured in various iterations, featuring four to six constructs, including amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation. Besides, the number of items within each construct has fluctuated, typically from three to four, consolidated into a single scale [7-9]. Various participant response formats have been applied in exercise motivation research, predominantly using a 5-point Likert scale to gauge the varying degree of agreement with the endorsement of specific statements [10–12]. Nevertheless, more scale points may result in greater distinction between questions, leading to higher variability [13]. Furthermore, previous studies focused on the validation of the BREQs to measure motivation across a spectrum of exercise settings, including public settings [9, 14, 15], educational institutions [16, 17], healthcare settings [18, 19], and sports and fitness centers [20–22]. Various research methodologies, including cross-sectional design [9, 15], longitudinal studies [23, 24], randomized controlled trials [18, 25], or mixed-method approaches [11, 26], have been applied in different investigations. The existing versions of the BREQs demonstrated satisfactory reliability and validity across diverse participant groups, such as the elderly [27, 28], students [16, 17], middle-aged adults [10, 12], and company workers [15]. In addition, previous studies overlooked the full spectrum of constructs within the regulatory continuum of motivation. For example, the original BREQ and the BREQ-2 removed the amotivation or integrated regulation subscales. The absence of these constructs in exercise suggests their little importance when individuals decide about exercise participation. The exclusion of integrated regulation can be attributed to the difficulty in proving discriminant validity between this construct, identified regulation, and intrinsic motivation [29]. Additionally, there is a lack of research examining the psychometric properties of the BREQ-3 on a 7-point scale [22].

As a part of behavioral regulations, intrinsic motivation, emerging as an important predictor, demonstrated a significant association with exercise habits. In contrast, factors related to extrinsic motivation, such as engagement in exercise-related social media activities and online social support, did not yield a significant effect [30]. However, these external motivators may act to adopt better exercise behavior and to sustain these habits over an extended period. In this context, long-term exercisers are characterized by an adherence to exercise at least three times per week, with each exercise session lasting a minimum of thirty minutes and sustaining this routine exceeding six months [31–33]. Furthermore, a positive correlation was observed between exercise behavior and autonomous types of self-determined motivation. Among these, intrinsic motivation exhibited a stronger association with long-term exercise adherence than identified regulation and integrated regulation. The identified regulation, on the other hand, demonstrated a more substantial influence on initial adoption and short-term adherence [3]. Conversely, controlled motivation, including external regulation and introjected regulation, appeared to exert an adverse impact, as evidenced by higher rates of exercise discontinuation [3]. For those who primarily work out due to external pressure, although this may bring about temporary changes in exercise habits, it frequently hinders the development of long-lasting exercise behaviors. Given the multifaceted nature of self-determined motivation underlying exercise maintenance, it is crucial to identify and advocate a variety of motivational styles [32].

Previous studies showed non-invariance between groups of athletes, gym users, and exercisers, which explained why participants' views of each motivation varied according to the characteristics of each environment [22, 34]. Sports competitors, for instance, were accustomed to training plans and aspects of competition that drove them to extreme exercise behaviors [34]. Contrarily, habitual exercisers arrange their own flexible schedule of workouts with interest and enjoyment, without being influenced by rewards for achieving expected outcomes from managers or fitness professionals [22]. These studies applied various measurements, not only the BREQs, that may lead to differences in terms of exercise behaviors such as frequency of exercise sessions, length of exercise for each session, and exercise commitment. These findings offered the first concrete proof of the distinctiveness of exercise domain measurements.

As far as the authors know, no study has yet compared exercisers' motivational types measured by the BREQs and other relevant characteristics that influence their long-term commitment to exercise [13, 35, 36]. The results of the present study, therefore, advance current knowledge by filling a gap in the literature. On the assumption that exercise motivation differs among individuals, this systematic review and meta-analysis aims to evaluate whether disparities exist in self-determined exercise motivation when employing various versions of the BREQs, contingent upon factors such as the exerciser's age, sex, duration of exercise adherence, and different exercise settings. The main findings of this study are presented through associations between regulations of BREQ versions, length of exercise, and study settings. Multivariate meta-regressions of included studies are shown using selected characteristics of participants. This study is expected to contribute insights into the most appropriate application of the BREQs scale for a specific exercise context.

2. Research Methodology

2.1. Study Protocol

According to the PRISMA 2020 guidelines [37], a systematic review was conducted, addressing all 27 items on the checklist.

2.2. Literature Review

The following databases were used to find research articles: PubMed, ScienceDirect, and Scopus. Boolean logic tools featuring the operators "AND" and "OR," as well as the asterisk (*) wildcard, were utilized during the search process. In PubMed, the advanced search employed the following keywords: ("exercise" AND "motiv*" AND (“BREQ” OR “Behavioral regulation”) AND “self-determin*”). Meanwhile, the search query consisted of "exercise" AND "motivation" AND (“BREQ” OR “Behavioral regulation”) AND “self-determination” in ScienceDirect. Additional efforts were made by manually searching through Google Scholar and ResearchGate to expand the scope and encompass a broader range of eligible publications.

2.3. Study Selection

Initially, we applied the filtering functions provided by PubMed and ScienceDirect to select eligible articles. We excluded review articles, book chapters, conference abstracts, or letters, as well as those not written in English. Furthermore, only full-text articles published from 2003 to September 2023 were considered for inclusion. The search results were exported, and duplicates were removed using the Endnote reference manager program. Following the initial filtering, the title and abstract of each article were meticulously scrutinized to identify at least one aspect related to the regulations of the BREQs, which include amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation. After this preliminary screening, the full-text of the eligible articles was retrieved for comprehensive assessment and review. The systematic review included only those articles that contained the BREQs, utilized a Likert-pointing scale, and provided scores (mean and standard deviation) for each domain, encompassing amotivation, external regulation, introjection, identified regulation, integrated regulation, and intrinsic motivation. The Critical Appraisal Skills Programme (CASP) criteria for reporting quantitative data were applied to ensure the quality of the included articles and reduce the selection bias [38]. This involved a detailed evaluation of eligible studies based on a set of standardized questions - 12 questions for the CASP observational studies checklist and 11 questions for the CASP randomized controlled trial standard checklist—aligned with CASP guidelines. Each question elicited one of four responses: "yes," "no," "cannot tell," and "not applicable". Only studies that received a “yes” for every question were included. In cases of discrepancy, a consensus of "yes" from two out of three independent reviewers (T.T.N, D.H.P, and C.N.L) was required for the study inclusion. This approach ensured a rigorous and impartial evaluation of the selected studies.

2.4. Data Extraction

Each retrieved publication's data underwent a meticulous examination, and the following details were systematically extracted and documented within a Microsoft Excel 2019 spreadsheet: (1) author(s); (2) year of publication; (3) country; (4) study settings categorized into four groups, including educational institutions (students), healthcare settings (patients), sports and fitness centers (athletes, gym members), and public settings (general exercisers); (5) study design (observational studies/randomized control trials, mixed-methods); (6) sample size; (7) type of participants (adults/ adolescents and children); (8) participant's gender - female rate; (9) length of exercise (months); (10) versions of the BREQs, (11) type of Likert-pointing scale; (12) amotivation (mean score, SD); (13) external regulation (mean score, SD), (14) introjection (mean score, SD); (15) identified regulation (mean score, SD); (16) integrated regulation (mean score, SD); and (17) intrinsic motivation (mean score, SD). Two independent reviewers (T.T.N and D.H.P) were responsible for retrieving data from the included studies to minimize the potential for information bias. Subsequently, a third reviewer (C.N.L) conducted a meticulous cross-verification of the extracted data. Any disparities or inconsistencies were diligently resolved through consensus among all reviewers, ensuring the integrity and accuracy of the data before proceeding with the analysis.

2.5. Data Analysis

The synthesis and evaluation of the extracted data from the selected studies were conducted through descriptive analyses, encompassing proportions, medians, interquartile ranges (IQR), means, and standard deviation [39]. Furthermore, Spearman's correlation coefficient was employed to explore the association between all domains of BREQ and long-term exercise. Non-parametric statistical methods and Kruskal-Wallis tests were applied to examine the associations between the scores of all BREQ domains and various study settings, including four groups representing healthcare settings (patients), educational institutions (students), public settings (general exercisers), and sports and fitness centers (athletes, gym members).

Given that the data collected from the retrieved studies included mean scores and standard deviations for each BREQ domain, we conducted a meta-analysis of means utilizing the generic inverse variance approach following the guidelines proposed by Harrer et al. (2021) [40]. The meta-analysis parameters encompassed the number of observations (i.e., participants) (n), the mean score for each BREQ domain (mean), the standard deviation of the mean [39], and the type of summary measure for raw means that were pooled (sm). A random-effects model was utilized to estimate the within-study (V_{Yi}) and between-studies (τ^2) variance. Heterogeneity among the selected studies for meta-analysis was assessed using the inverse variance index (I^2), where an index exceeding 75.0% and a p-value <0.05 indicated significant heterogeneity, as described by previous studies [41, 42].

Factors associated with each BREQ domain were identified utilizing multiple meta-regression models. The explanatory variables considered included age (in years), duration of exercise (in months), the percentage of females, the type of BREQ version (e.g., BREQ-2, BREQ-3, BREQ-4), study settings (e.g., educational institutions, healthcare settings, sports and fitness centers, public settings), and geographic regions (e.g., Asia, Americas, Europe, Oceania). Initially, univariable meta-regression was employed to screen potential variables associated with each BREQ domain, selecting only those with a p-value <0.2. A stepwise approach was then applied to explore potential pairs of variables and build multivariable meta-regression models, with a p-value <0.05 indicating a significant association with the BREQ domain. The outcomes of the meta-analysis were visualized using forest plots.

Two methods were applied to evaluate publication bias in the meta-analysis. Contour-enhanced funnel plots were used to visualize any asymmetrical patterns that could indicate publication bias. In addition to assessing funnel plot asymmetry, Egger's regression test was employed based on a linear regression model to quantitatively determine publication bias by testing for asymmetry in the funnel plots. If the intercept (β_o) significantly deviated from zero, it indicated funnel plot asymmetry, suggesting the presence of publication bias.

All statistical analyses were conducted using R software, with the 'meta' and 'metafor' packages utilized for meta-analysis and multiple meta-regression, respectively. The 'metamean' function was employed for data pooling of means, while the 'tidyverse' package facilitated the assessment of publication bias. Figures depicting the study results were generated using the 'ggplot2' package.

3. Results and Discussion

3.1. Characteristics of the Selected Studies

A total of 448 articles were initially retrieved from all databases. After eliminating duplicate entries (n = 199) and excluding non-research papers (n = 5), 244 studies remained. The title and abstract of each article were carefully assessed, leading to the exclusion of articles that were not available in full-text (n=25), those written in languages other than English (n=12), and those lacking sufficient information concerning the regulatory characteristics of the BREQs (n=164). This screening process yielded 43 full-text studies, with a total of 27,421 participants, for the systematic review. However, upon reviewing these full texts, three more papers were excluded since they did not provide the mean scores and SD for measuring Behavioral BREQ regulations required to perform the meta-analysis [18, 27, 43]. Figure 1 presents the PRISMA flow diagram of study selection.

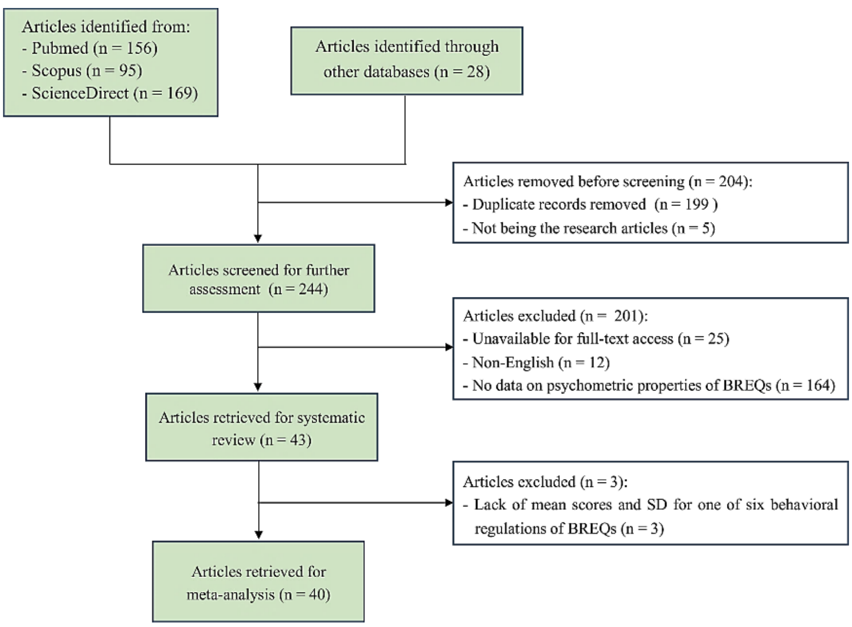


Figure 1. PRISMA flow diagram for systematic review and meta-analysis

Table 1 characterizes the selected studies for quantitative synthesis. Among 43 selected studies for systematic review, three versions of BREQs were applied to measure self-determined motivation in exercise among study participants. The majority of studies applied a version of BREQ-2 (53.5%), followed by BREQ-3 (44.2%), and only one study used a version of BREQ-4 (2.3%). The median number of respondents across the selected studies was 550 (inter-quartile range (IQR): 199 - 1,000 participants). Females had a higher proportion in these studies than males, with the median female rate of 56% [IQR: 48% - 71%]. Almost all studies were conducted on the adult populations, with median age of 34 (IQR 23 – 40). While all selected studies were published between 2004 and 2023, the majority were from the most recent years (from 2019 to 2023) (65.0%). Most studies were conducted in Europe (65.0%), followed by Americas (21.0%), and only four (9.3%) and two (4.7%) studies were from Asia and Oceania, respectively. Thirty-nine studies employed the observational design (90.7%), two randomized controlled trials (4.7%), and two mixed-method designs (4.7%). The studies were carried out in diverse settings and populations, including sports and fitness centers (30.2%), public settings (27.9%), educational institutions (25.6%), and healthcare settings (16.3%).

Table 1. Characteristics of selected studies for systematic review (n=43); by type of BREQ

Characteristics	BREQ-2 (n=23) (53.5)	BREQ-3 (n=19) (44.2)	BREQ-4 (n=1) (2.3)	Total (n=43) (100.0)
No. participants (median, IQR)	552 [168 - 908]	403 [210 - 1,128]	700 [nc]	550 [199 - 1,000]
Female rate (median, IQR)	60 [54 - 74]	53 [45 - 66]	43 [nc]	56 [48 - 71]
Age (years) (median, IQR)	34 [28 - 41]	34 [30 - 37]	29 [nc]	34 [23 - 40]
Types of participants [44]				
Adults	20 (46.5)	19 (44.2)	1 (2.3)	40 (93.0)
Adolescents and children	3 (7.0)	0 (0)	0 (0)	3 (7.0)
Publication years				
2019 – 2023	12 (30.2)	15 (34.9)	1 (2.3)	28 (65.0)
2014 – 2018	5 (11.6)	1 (2.3)	0 (0)	6 (14.0)
2009 – 2013	5 (11.6)	1 (2.3)	0 (0)	6 (14.0)
2004 – 2008	1 (2.3)	2 (4.7)	0 (0)	3 (7.0)
Country region*				
Europe	15 (34.9)	12 (30.2)	1 (2.3)	28 (65.0)
Americas	2 (4.7)	7 (16.3)	0 (0)	9 (21.0)
Asia	4 (9.3)	0 (0)	0 (0)	4 (9.3)
Oceania	2 (4.7)	0 (0)	0 (0)	2 (4.7)
Study settings				
Sports and fitness centers	4 (9.3)	8 (18.6)	1 (2.3)	12 (30.2)
Healthcare settings	5 (11.6)	2 (4.7)	0 (0)	7 (16.3)
Educational institutions	8 (18.6)	3 (7.0)	0 (0)	11 (25.6)
Public settings	6 (14.0)	6 (14.0)	0 (0)	12 (27.9)
Study design				
Observational studies	21 (48.8)	17 (39.5)	1 (2.3)	39 (90.7)
Randomized control trials	1 (2.3)	1 (2.3)	0 (0)	2 (4.7)
Mixed-methods	1 (2.3)	1 (2.3)	0 (0)	2 (4.7)

*Europe, BREQ-2 (15): Portugal, Greece, Spain, UK, Belgium, Denmark, Romania, Italy, Luxembourg [8, 12, 19, 24, 25, 27, 45-51]. Europe, BREQ-3 (12): Spain, Portugal, UK, Italy, Turkey [9, 15, 16, 22, 52-58]. Europe, BREQ-4 (1): Turkey [59]. The Americas, BREQ-2 (2): Canada [60, 61]. The Americas, BREQ-3 (7): Brazil, Canada, USA [10, 11, 18, 23, 62-64]. Asia, BREQ-2 (4): China, Singapore [28, 65-67]. Oceania, BREQ-2 (2): New Zealand, Australia [68, 69]. nc: not calculated.

3.2. Correlations Between the Regulations of BREQ Versions and Long-Term Exercise

Spearman's correlation coefficients were employed to investigate the relationship between the duration of exercise commitment among study participants and the six regulations characteristics assessed by the BREQs (Figure 2). A positive correlation was observed between exercise duration and integrated regulation ($R = 0.27$), followed by amotivation and intrinsic motivation (all $R = 0.21$), external ($R = 0.17$), introjected ($R = 0.12$), and identified ($R = 0.08$) regulations. However, none of these correlations reached statistical significance.

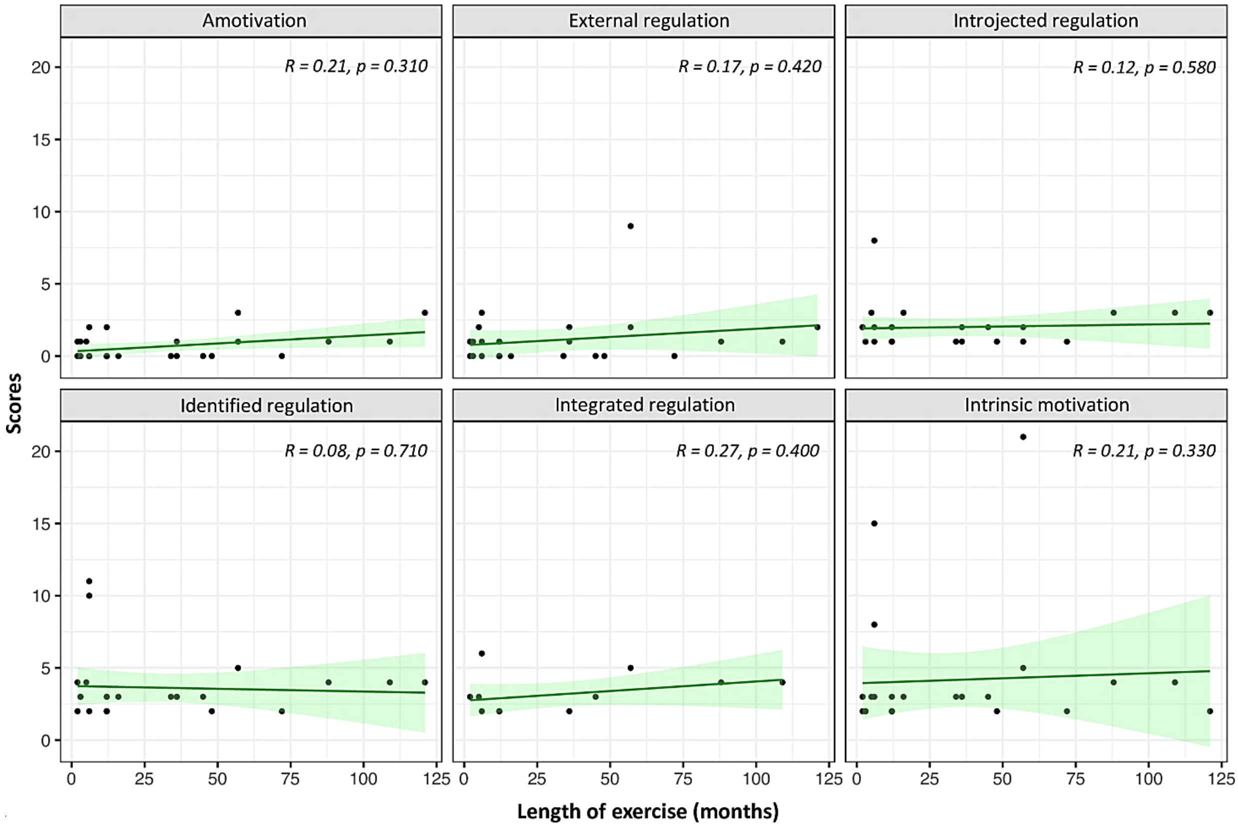


Figure 2. The correlation of regulations of BREQ domains and long-term exercise

3.3. Associations between the Regulations of BREQ Versions and Study Settings

Among the selected studies, the domain of identified regulation had the highest median score, at 3.32 (IQR 2.92–4.22), closely followed by intrinsic motivation, with a median score of 3.20 (IQR 2.79–4.13), and then integrated regulation, introjected regulation, external regulation, and amotivation at 2.77 (IQR 2.43–3.71), 2.02 (IQR 1.43–2.83), 1.12 (IQR 0.57–1.93), and 0.60 (IQR 0.31–1.40), respectively. We explored the connections between the scores of the BREQ domains and various study settings, including four distinct categories representing healthcare settings, educational institutions, public settings, and sports and fitness centers. Although there were no significant associations between most BREQ domains and study settings, a significant difference was found in intrinsic motivation across different study settings ($p = 0.010$). The highest scores were observed in the sports and fitness groups, with a median score of 3.50 (IQR 3.31–4.93), which was higher than the median scores of other groups, including educational institutions, healthcare settings, and public settings at 2.65 (IQR 2.50–3.31), 3.10 (IQR 2.89–6.07), and 2.93 (IQR 2.82–3.37), respectively. The boxplots in Figure 3 provide an overview of the mean scores across all BREQ domains and their distribution among the different study settings.

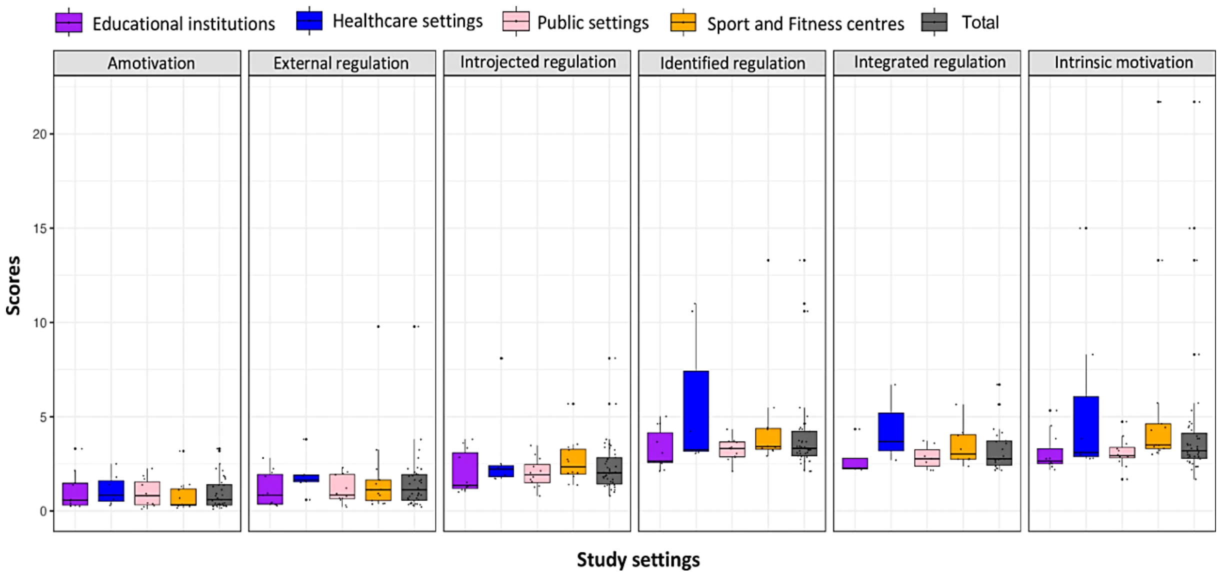
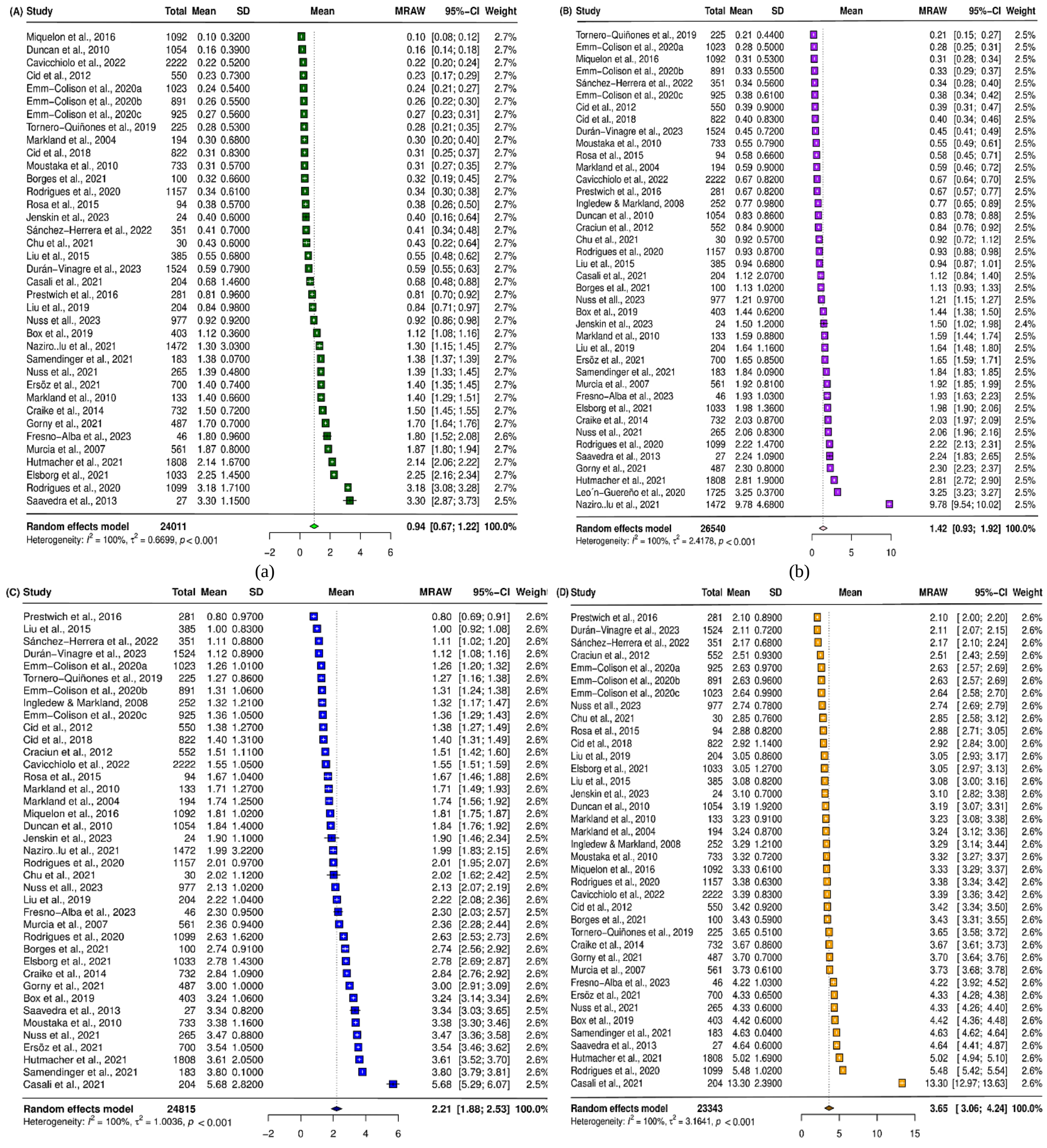


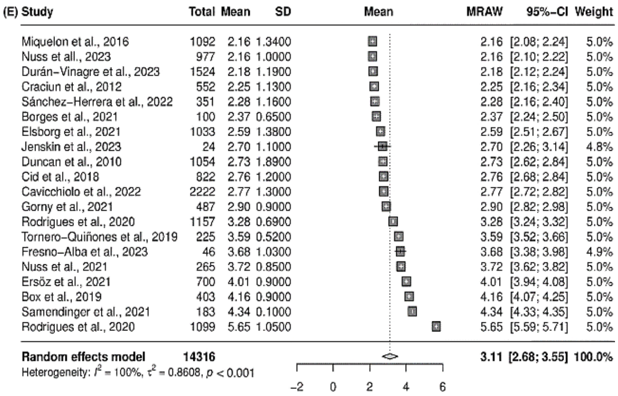
Figure 3. The scores of regulations measured by BREQs in comparison among study settings

3.4. Meta-analysis of the Selected Studies

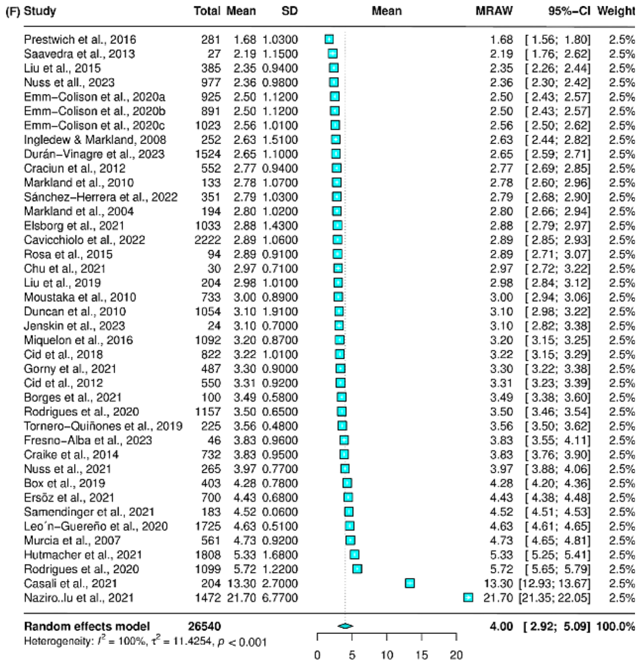
Among the 40 studies selected for meta-analysis, thirty-seven provided data on mean scores and standard deviations related to amotivation. These mean scores ranged from 0.1 to 3.3, with an unadjusted mean (crude mean) of 0.95 (SD ± 0.83). The findings from the meta-analyses revealed a pooled mean of 0.94 (95% CI: 0.67–1.12) (Figure 4-a). Regarding external regulation, all 40 selected studies reported mean scores ranging from 0.21 to 9.78, with a crude mean of 1.43 (SD ± 1.56). The pooled mean of 1.42 (95% CI: 0.93–1.92) was obtained after conducting meta-analyses (Figure 4-b). Thirty-nine studies provided mean scores for introjected regulation, ranging from 0.8 to 5.68, with a crude mean of 2.21 (SD ± 2.21). The pooled mean remained consistent at 2.21 (95% CI: 1.88–2.53) (Figure 4-c). Regarding identified regulation, 38 studies reported mean scores, varying from 2.1 to 13.3. The crude mean was calculated at 3.65 (SD ± 1.79). The meta-analysis yielded a pooled mean of 3.65 (95% CI: 3.06–4.24) (Figure 4-d). Twenty studies provided data on integrated regulation, with scores ranging from 2.16 to 5.65 and a crude mean of 3.11 (SD ± 0.93). The pooled mean closely mirrored the crude mean, measuring 3.11 (95% CI 2.68–3.55) (Figure 4-e). All forty selected studies reported data on intrinsic motivation, with results at a range of 1.68 to 21.70. The crude mean was determined to be 4.01 (SD ± 3.39), and the means of all studies' pooled intrinsic motivation converged at 4.00 (95% CI 2.92–5.09) (Figure 4-f). Moreover, findings from random effect models of meta-analysis revealed that the absolute heterogeneity of the selected studies with the inverse variance index was almost 100.0% ($p < 0.001$).



(a) (b) (c) (d)



(e)



(f)

Figure 4. a &b) Forest plot for scores attributing to amotivation (in dark green) and external regulation (in purple), c & d) Forest plot for scores attributing to introjected regulation (in dark blue) and identified regulation (in orange), e & f) Forest plot for scores attributing to integrated regulation (in gray) and intrinsic motivation (in cyan).

The disparity among the articles selected for the meta-analysis was discovered during analyses for publication bias. Each scatter of contour-enhanced funnel plots illustrates for each article in our meta-analysis that scatters are unevenly distributed, distant from the pooled effect size (vertical line), and mostly plotted on the darkened regions of $p < 0.05$ and $p < 0.01$. The results of Egger's regression tests support the conclusions. The papers selected for meta-analyses of amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation demonstrated that the intercept (βo) was different from zero value (all $\beta o < -0.41$), revealing publication bias. Figure 5 displays each contour-enhanced funnel plot, highlighting the asymmetry between the selected studies and the results of Egger's regression tests.

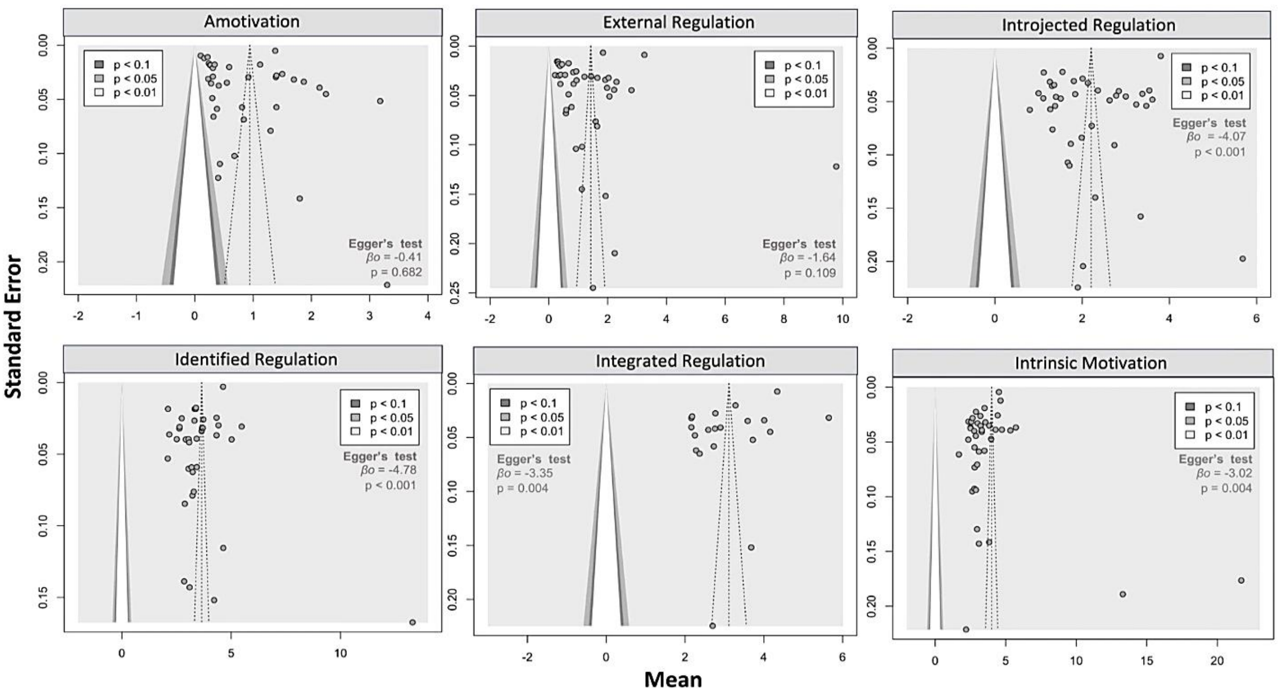


Figure 5. The contour-enhanced funnel plots highlight the asymmetries between particular researches. The dotted vertical lines display the average effect sizes, each scatter displays the selected papers, and the colored areas highlight the statistical significance.

3.5. Multivariate Meta-regressions of the Selected Studies

Six independent variables, including (1) types of the BREQs, (2) study region, (3) study setting, (4) length of exercise by month, (5) age by year, and (6) sex, in univariable models were selected as prospective inputs for multivariable meta-regression models. Univariable models indicated no significant associations between the tested independent variables with domains of amotivation, external regulation, and integrated regulation. Therefore, multivariable meta-regression models could not be performed for modelling these domains. The remaining domains included introjected regulation, identified regulation, and intrinsic motivation, with several potential variables selected in multivariable models. As shown, the longer length of exercise had a slightly significant association with introjected regulation (β = 0.014, p = 0.027) and identified regulation (β = 0.014, p = 0.021). Regarding intrinsic motivation, the higher female rate of participants had a slightly reverse association with self-determined motivation in exercise (β = -0.047, p = 0.042). In contrast, the study setting of those workouts in sports and fitness centers had a higher association with intrinsic motivations (β = 2.700, p = 0.039). Table 2 shows meta-regression models to examine the variables associated with the pooled mean scores of six Behavioral regulations.

Table 2. Multivariable meta-regression analyses of factors associated with all domains

Factors	Univariable models			Multivariable model*		
	β	95% CI	p-value	β	95% CI	p-value
Amotivation						
Scale (baseline = BREQ-3)						
BREQ-2	0.184	-0.38 - 0.76	0.521			
BREQ-4	0.576	-1.18 - 2.33	0.511			
Region (baseline = Americas)						
Asia	0.160	-0.90 - 1.22	0.761			
Europe	0.310	-0.40 - 1.02	0.382			
Oceania	0.234	-1.14 - 1.61	0.731			
Study setting (baseline = Sports and Fitness centers)						
Educational institutions	0.200	-0.56 - 0.96	0.597			
Healthcare settings	0.096	-0.85 - 1.04	0.837			
Public settings	0.092	-0.65 - 0.84	0.803			
Length of exercise (month)	0.011	-0.00 - 0.02	0.058			
Age (year)	-0.015	-0.04 - 0.01	0.147			
Female rate	-0.005	-0.02 - 0.01	0.368			
External regulation						
Scale (baseline = BREQ-2)						
BREQ-3	0.387	-0.65 - 1.43	0.455			
BREQ-4	0.401	-2.89 - 3.69	0.247			
Region (baseline = Americas)						
Asia	0.275	-1.73 - 2.28	0.782			
Europe	0.295	-1.03 - 1.61	0.654			
Oceania	0.593	-2.01 - 3.19	0.647			
Study setting (baseline = Educational institutions)						
Sports and Fitness centers	0.837	-0.49 - 2.17	0.210			
Healthcare settings	0.316	-1.41 - 2.04	0.712			
Public settings	0.001	-1.33 - 1.33	0.999			
Length of exercise (month)	0.013	-0.01 - 0.04	0.287			
Age (year)	-0.006	-0.03 - 0.01	0.545			
Female rate	-0.031	-0.05 - -0.01	0.003			
Introjected regulation						
Scale (baseline = BREQ-3)						
BREQ-2	0.168	-0.50 - 0.84	0.615			
BREQ-4	0.147	-0.63 - 3.57	0.166			
Region (baseline = Asia)						
Americas	0.528	-0.75 - 1.81	0.408			
Europe	0.033	-1.09 - 1.60	0.953			
Oceania	0.321	-1.50 - 2.14	0.723			

Study setting (baseline = Healthcare settings)						
Educational institutions	0.047	-0.56 - 0.96	0.931	-1.092	-2.23 - 0.04	0.058
Sports and Fitness centers	0.728	-0.85 - 1.04	0.186	-0.632	-0.17 – 0.43	0.221
Public settings	0.041	-0.65 - 0.84	0.939	-0.002	-1.00 - 0.99	0.997
Length of exercise (month)	0.009	-0.00 - 0.02	0.057	0.014	0.00 - 0.03	0.027
Age (year)	-0.017	-0.04 - 0.01	0.177	-0.028	-0.06 - 0.01	0.129
Female rate	-0.008	-0.02 - 0.01	0.253			
Identified regulation						
Scale (baseline = BREQ-3)						
BREQ-2	0.216	-1.03 - 1.46	0.727			
BREQ-4	0.826	-3.01 - 4.66	0.664			
Region (baseline = Asia)						
Americas	0.449	-1.86 - 2.75	0.695			
Europe	0.593	- 1.44 - 2.63	0.557			
Oceania	0.215	- 3.05 - 3.48	0.894			
Study setting (baseline = Educational institutions)						
Healthcare settings	0.120	-1.79 - 2.02	0.899	0.834	-0.25 - 1.92	0.123
Sports and Fitness centers	1.464	-0.08 - 3.01	0.062	0.749	-0.08 - 1.58	0.073
Public settings	0.006	-1.47 - 1.48	0.994	0.614	-0.39 - 1.62	0.216
Length of exercise (month)	0.011	0.00 - 0.12	0.021	0.014	0.00 - 0.02	0.021
Age (year)	-0.025	-0.07 - 0.02	0.282			
Female rate	-0.011	-0.04 - 0.02	0.435			
Integrated regulation						
Scale (baseline = BREQ-2)						
BREQ-3	0.600	-0.28 - 1.49	0.171			
BREQ-4	1.292	-0.73 - 3.31	0.195			
Region (baseline = Oceania)						
Americas	0.392	-1.93 - 2.71	0.725			
Europe	0.485	-1.78 - 2.75	0.656			
Asia	0.200	-2.84 - 3.24	0.891			
Study setting (baseline = Educational institutions)						
Healthcare settings	0.434	-1.30 - 2.17	0.603			
Sports and Fitness centers	0.803	-0.43 - 2.04	0.188			
Public settings	0.078	-1.16 - 1.32	0.896			
Length of exercise (month)	0.016	-0.00 - 0.03	0.077			
Age (year)	0.010	-0.04 - 0.06	0.674			
Female rate	-0.004	-0.02 - 0.01	0.640			
Intrinsic motivation						
Scale (baseline = BREQ-2)						
BREQ-3	1.019	-1.23 - 3.27	0.364			
BREQ-4	0.881	-6.23 - 7.99	0.803			
Region (baseline = Asia)						
Americas	0.576	-3.74 - 4.90	0.788			
Europe	1.478	-2.31 - 5.27	0.434			
Oceania	0.565	-5.54 - 6.67	0.852			
Study setting (baseline = Public settings)						
Educational institutions	0.002	-2.71 - 2.71	0.999	0.223	-2.37 - 2.83	0.856
Sports and Fitness centers	3.046	0.40 - 5.70	0.026	2.700	0.15 - 5.26	0.039
Healthcare settings	0.009	-3.45 - 3.46	0.996	0.669	-2.70 - 4.03	0.689
Length of exercise (month)	0.020	-0.03 - 0.07	0.414			
Age (year)	-0.024	-0.07 - 0.02	0.311			
Female rate	-0.057	-0.10 - -0.01	0.013	-0.047	-0.09 - -0.00	0.042

* Model intercept (Introjected regulation): 3.140, SE = 0.930;

* Model intercept (Identified regulation): 2.461, SE = 0.426;

* Model intercept (Intrinsic motivation): 5.687, SE = 1.514.

This study aimed to systematically assess relevant studies and illustrate the variations in the relationships among the six behavioral regulations assessed by the BREQs in diverse contexts. A meta-analytical method was applied to compute the overall mean scores of self-determined motivations as measured by different versions of the BREQs. Furthermore, potential biases were considered carefully in our review, striving to minimize their impact. Our review revealed several key findings from analyzing the selected studies. First, autonomous forms of motivation, such as intrinsic motivation, identified regulation, and integrated regulation, exhibited the highest mean scores of self-determined motivations, while controlled motivations, encompassing external regulation and introjected regulation, received intermediate scores, and amotivation garnered the lowest score. Second, our analysis found no significant differences among the various versions of the BREQs in measuring self-determined motivation. Third, autonomous forms of motivation, including identified regulation and intrinsic motivation, exhibited significant associations with factors such as sex, longer exercise duration, and the study settings of participants, whereas controlled regulation, specifically introjected regulation, was linked to longer-term exercise commitment.

In our review, intrinsic motivation exhibited the highest mean score, followed by extrinsic motivation. This suggests that most self-determined behaviors are primarily driven by intrinsic motivation, while extrinsic motivation plays a secondary role. These findings align with previous studies applying the BREQs to assess self-determined exercise motivation [22, 51, 62]. Individuals who score higher on intrinsic regulation and lower on amotivation tend to perceive exercise as socially acceptable and enjoyable [70]. Consequently, having a solid sense of control in situations where decisions about exercising are made becomes pivotal [70]. In addition, our review revealed a factor contributing to the higher scores in intrinsic regulation. Specifically, a limited number of studies reported mean scores, representing unexpected outliers in the overall mean scores [18, 27, 49]. Notably, among these studies, the participants were either athletes in sports and fitness centers or older cancer patients in hospitals, often exhibiting higher intrinsic motivation levels due to a passion for fitness competition or the need to overcome critical health challenges, including psychological issues.

Various versions of BREQs were performed in diverse populations and study settings without disparities, given that the reviewed studies were validated and adapted to regional contexts and cultural situations regarding exercise behaviors [20, 21, 45, 46, 51]. However, the BREQ-2 lacked integrated regulation in most studies, and several others had modified the scale to add this domain [20, 45, 60, 61]. Both the BREQ-3 and BREQ-4 measure six self-determined motivational styles, but only one study applied the updated BREQ-4 version [43]. In general, the numbers of domains and items for each domain were not considerably different among the included studies using the BREQs.

Regarding exercise duration, our findings revealed that individuals engaged in longer exercise sessions exhibited higher mean scores in both identified and introjected regulation. These findings have practical implications, suggesting that exercisers who maintain longer and autonomous exercise commitments, perceiving exercise as personally significant, are more likely to sustain regular exercise over an extended period. Such individuals aim to attain desired health benefits and enhance their physical appearance, which are primary motivations for long-term exercise adherence [71]. Specific motivations such as "weight loss," "health," "aesthetics," and "hypertrophy" are also significantly linked to participants' commitment to ongoing exercise at fitness centers [72]. This finding was in line with prior research in sports and fitness settings, where the most influential motivation for exercise participation is the perceived benefits in terms of health, physical function, and appearance. Factors such as experiencing physical changes and feeling in control further enhance commitment [73]. Our review also found a significant association between introjected regulation and extended exercise duration. However, previous studies have shown that individuals with less controlled exercise motivations, such as introjected regulation oriented toward sport or exercise practice, are more susceptible to regressive tendencies, increasing the likelihood of exercise termination [3]. Additionally, while this review did not find a significant association between intrinsic motivation scores and exercise duration, other studies have shown that regular, long-term exercisers experience higher levels of enjoyment and challenge, particularly during the first year of their membership in sports and fitness settings [74].

Concerning age and sex, the findings of this review did not reveal any significant age-related differences in self-determined motivation in most domains, except for the inverse association between female gender and intrinsic motivation. Another study implied that females engaged in exercise not primarily out of interest or enjoyment but tended to place more emphasis on appearance-related concerns, which was particularly prominent among young and middle-aged individuals, with women showing more concern than men [73]. Regarding study settings in our analyses, the results of this study align with previous empirical research, indicating that higher levels of intrinsic motivation are typically associated with individuals who exercise at sports and fitness centers [21]. These individuals also tend to experience greater enjoyment, hold more favorable perceptions of their exercise behavior [75], exhibit higher persistence rates [76], and report greater life satisfaction [77].

Our study acknowledges several limitations. First, the vast majority of BREQ studies employed the two versions (BREQ-2 and BREQ-3), while research using the BREQ-4 version was methodologically necessary. Second, there were too few studies with BREQ estimations in samples representing children and adolescents, necessitating further investigations of BREQs in these age groups to enable the exploration of age as a potential moderator of the impact of exercise maintenance. Third, in terms of representativeness, although the included studies were from countries across 4 continents, most were from Europe and the Americas, highlighting the need for further studies in Asia and Africa to ensure better generalizability of BREQs. Finally, our analysis encompassed global research, spanning various geographical regions and study settings. Motivational styles can substantially differ due to exercise culture and behavioral patterns, which contribute to the notable heterogeneity observed in our meta-analysis results. This heterogeneity may be attributed to publication bias from including studies with limited sample sizes. Consequently, we recommend conducting additional studies to unearth novel motivational styles specific to particular populations, such as those in sports and fitness centers, where individuals demonstrate significantly higher levels of autonomous motivation.

4. Conclusion

Our investigation indicated the diverse measurements provided by BREQ modifications in assessing self-determined motivation among individuals engaged in exercise across various study settings. Our review highlighted the importance of employing context-specific measures to consistently evaluate how individuals regulate their behavior within a particular setting. Although both intrinsic and extrinsic motivation exhibited significant correlations with long-term exercise outcomes, intrinsic motivation emerged as the more crucial factor in self-determined motivation. We observed that the sports and fitness study setting displayed notably higher levels of intrinsic motivation than other groups. However, the current BREQs have limitations in fully and accurately capturing this form of motivation. Thus, the development of new instruments is warranted to comprehensively assess the motivation of individuals in fitness centers, allowing for a precise understanding of the reasons for maintaining their exercise routines.

5. Declarations

5.1. Author Contributions

Conceptualization, T.T.N., C.S., C.N.L., and O.D.; methodology, T.T.N., C.S., C.N.L., O.D., S.I., and S.S.; formal analysis, T.T.N., D.H.P., and C.N.L.; resources, C.S.; data curation, T.T.N., D.H.P., and C.N.L.; writing—original draft preparation, T.T.N., D.H.P., O.D., and M.H.S.; writing—review and editing, T.T.N. and C.S.; visualization, T.T.N. and D.H.P.; project administration, C.S. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in the study are available in the article.

5.3. Funding

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5.5. Institutional Review Board Statement

Not applicable.

5.6. Informed Consent Statement

Not applicable.

5.7. Declaration of Competing Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

6. References

[1] Ng, J. Y. Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. Perspectives on Psychological Science, 7(4), 325–340. doi:10.1177/1745691612447309.

[2] Cook, D. A., & Artino, A. R. (2016). Motivation to learn: an overview of contemporary theories. Medical Education, 50(10), 997–1014. doi:10.1111/medu.13074.

[3] Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. International Journal of Behavioral Nutrition and Physical Activity, 9, 78. doi:10.1186/1479-5868-9-78.

[4] Mullan, E., Markland, D., & Ingledew, D. K. (1997). A graded Conceptualisation of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analytic procedures. Personality and Individual Differences, 23(5), 745–752. doi:10.1016/S0191-8869(97)00107-4.

[5] Markland, D., & Tobin, V. (2004). A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. Journal of Sport and Exercise Psychology, 26(2), 191–196. doi:10.1123/jsep.26.2.191.

[6] Wilson, P. M., Rodgers, W. M., Loitz, C. C., & Scime, G. (2007). "It's Who I Am … Really!' The Importance of Integrated Regulation in Exercise Contexts1. Journal of Applied Biobehavioral Research, 11(2), 79–104. doi:10.1111/j.1751-9861.2006.tb00021.x.

[7] Ingledew, D. K., Markland, D., & Strömmer, S. T. (2014). Elucidating the roles of motives and gains in exercise participation. Sport, Exercise, and Performance Psychology, 3(2), 116–131. doi:10.1037/spy0000004.

[8] Elsborg, P., Heinze, C., Melby, P. S., Nielsen, G., Bentsen, P., & Ryom, K. (2021). Associations between previous sport and exercise experience and physical literacy elements among physically inactive Danes. BMC Public Health, 21(1), 1248. doi:10.1186/s12889-021-11299-2.

[9] Cavicchiolo, E., Sibilio, M., Lucidi, F., Cozzolino, M., Chirico, A., Girelli, L., Manganelli, S., Giancamilli, F., Galli, F., Diotaiuti, P., Zelli, A., Mallia, L., Palombi, T., Fegatelli, D., Albarello, F., & Alivernini, F. (2022). The Psychometric Properties of the Behavioural Regulation in Exercise Questionnaire (BREQ-3): Factorial Structure, Invariance and Validity in the Italian Context. International Journal of Environmental Research and Public Health, 19(4), 1937. doi:10.3390/ijerph19041937.

[10] Nuss, K., Sui, W., Rhodes, R., & Liu, S. (2023). Motivational Profiles and Associations with Physical Activity Before, During, and After the COVID-19 Pandemic: Retrospective Study. JMIR Formative Research, 7(e43411), 1-10. doi:10.2196/43411.

[11] Nuss, K., & Li, K. (2021). Motivation for physical activity and physcial activity engagement in current and former wearable fitness tracker users: A mixed-methods examination. Computers in Human Behavior, 121, 106798. doi:10.1016/j.chb.2021.106798.

[12] Emm-Collison, L. G., Sebire, S. J., Salway, R., Thompson, J. L., & Jago, R. (2020). Multidimensional motivation for exercise: A latent profile and transition analysis. Psychology of Sport and Exercise, 47, 101619. doi:10.1016/j.psychsport.2019.101619.

[13] Clancy, R. B., Herring, M. P., & Campbell, M. J. (2017). Motivation Measures in Sport: A Critical Review and Bibliometric Analysis. Frontiers in Psychology, 8. doi:10.3389/fpsyg.2017.00348.

[14] Ingledew, D. K., Markland, D., & Sheppard, K. E. (2004). Personality and self-determination of exercise behaviour. Personality and Individual Differences, 36(8), 1921–1932. doi:10.1016/j.paid.2003.08.021.

[15] Ingledew, D. K., & Markland, D. (2008). The role of motives in exercise participation†. Psychology & Health, 23(7), 807–828. doi:10.1080/08870440701405704.

[16] Durán-Vinagre, M. Á., Ibáñez, S. J., Feu, S., & Sánchez-Herrera, S. (2023). Analysis of the motivational processes involved in university physical activity. Frontiers in Psychology, 13(1080162), 1-10. doi:10.3389/fpsyg.2022.1080162.

[17] Sánchez-Herrera, S., Cubero, J., Feu, S., & Durán-Vinagre, M. Á. (2022). Motivation Regarding Physical Exercise among Health Science University Students. International Journal of Environmental Research and Public Health, 19(11), 6524. doi:10.3390/ijerph19116524.

[18] Keadle, S. K., Meuter, L., Phelan, S., & Phillips, S. M. (2021). Charity-based incentives motivate young adult cancer survivors to increase physical activity: a pilot randomized clinical trial. Journal of Behavioral Medicine, 44(5), 682–693. doi:10.1007/s10865-021-00218-w.

[19] Fresno-Alba, S., Leyton-Román, M., Mesquita da Silva, S., & Jiménez-Castuera, R. (2023). Predicting Quality of Life in Women with Breast Cancer Who Engage in Physical Exercise: The Role of Psychological Variables. Healthcare (Switzerland), 11(14), 2088. doi:10.3390/healthcare11142088.

[20] Cid, L., Monteiro, D., Teixeira, D., Teques, P., Alves, S., Moutão, J., Silva, M., & Palmeira, A. (2018). The Behavioral Regulation in Exercise Questionnaire (BREQ-3) Portuguese-version: Evidence of reliability, validity and invariance across gender. Frontiers in Psychology, 9(OCT), 1940. doi:10.3389/fpsyg.2018.01940.

[21] Moustaka, F. C., Vlachopoulos, S. P., Vazou, S., Kaperoni, M., & Markland, D. A. (2010). Initial validity evidence for the Behavioral Regulation in Exercise Questionnaire-2 among Greek exercise participants. European Journal of Psychological Assessment, 26(4), 269–276. doi:10.1027/1015-5759/a000036.

[22] Rodrigues, F., Macedo, R., Teixeira, D., Cid, L., & Monteiro, D. (2020). Motivation in sport and exercise: a comparison between the BRSQ and BREQ. Quality and Quantity, 54(4), 1335–1350. doi:10.1007/s11135-020-00988-6.

[23] Rosa, J. P. P., de Souza, A. A. L., de Lima, G. H. O., Rodrigues, D. F., de Aquino Lemos, V., da Silva Alves, E., Tufik, S., & de Mello, M. T. (2015). Motivational and evolutionary aspects of a physical exercise training program: a longitudinal study. Frontiers in Psychology, 6. doi:10.3389/fpsyg.2015.00648.

[24] Saavedra, J. M., García-Hermoso, A., Escalante, Y., & Domínguez, A. M. (2014). Self-determined motivation, physical exercise and diet in obese children: A three-year follow-up study. International Journal of Clinical and Health Psychology, 14(3), 195–201. doi:10.1016/j.ijchp.2013.12.001.

[25] Prestwich, A., Conner, M., Morris, B., Finlayson, G., Sykes-Muskett, B., & Hurling, R. (2017). Do web-based competitions promote physical activity? Randomized controlled trial. Psychology of Sport and Exercise, 29, 1–9. doi:10.1016/j.psychsport.2016.11.003.

[26] Fuentes-García, J. P., Alonso-Rivas, L., Gómez-Barrado, J. J., Abello-Giraldo, V. M., Jiménez-Castuera, R., & Díaz-Casasola, C. (2021). Modification of the forms of self-determined regulation and quality of life after a cardiac rehabilitation programme: Tennis-based vs. bicycle ergometer-based. International Journal of Environmental Research and Public Health, 18(17), 9207. doi:10.3390/ijerph18179207.

[27] Charles, A., Girard, A., Buckinx, F., Mouton, A., Reginster, J. Y., & Bruyère, O. (2020). Senior physical activity contests in nursing homes: a feasibility study. Aging Clinical and Experimental Research, 32(5), 869–876. doi:10.1007/s40520-020-01529-9.

[28] Liu, J. D., Chung, P. K., Zhang, C. Q., & Si, G. (2015). Chinese-translated Behavioral Regulation in Exercise Questionnaire-2: Evidence from university students in the Mainland and Hong Kong of China. Journal of Sport and Health Science, 4(3), 228–234. doi:10.1016/j.jshs.2014.03.017.

[29] McLachlan, S., Spray, C., & Hagger, M. S. (2011). The development of a scale measuring integrated regulation in exercise. British Journal of Health Psychology, 16(4), 722–743. doi:10.1348/2044-8287.002009.

[30] Zhou, X., & Krishnan, A. (2019). What Predicts Exercise Maintenance and Well-Being? Examining the Influence of Health-Related Psychographic Factors and Social Media Communication. Health Communication, 34(6), 589–597. doi:10.1080/10410236.2018.1428851.

[31] Matsumoto, H., & Takenaka, K. (2004). Motivational Profiles and Stages of Exercise Behavior Change. International Journal of Sport and Health Science, 2, 89–96. doi:10.5432/ijshs.2.89.

[32] Wininger, S. R. (2007). Self-determination theory and exercise behavior: An examination of the psychometric properties of the exercise motivation scale. Journal of Applied Sport Psychology, 19(4), 471–486. doi:10.1080/10413200701601466.

[33] Rhodes, R. E., Martin, A. D., & Taunton, J. E. (2001). Temporal Relationships of Self-Efficacy and Social Support as Predictors of Adherence in a 6-Month Strength-Training Program for Older Women. Perceptual and Motor Skills, 93(3), 693–703. doi:10.2466/pms.2001.93.3.693.

[34] Howley, E. T. (2001). Type of activity: Resistance, aerobic and leisure versus occupational physical activity. Medicine and Science in Sports and Exercise, 33(6 SUPPL.), 364–369. doi:10.1097/00005768-200106001-00005.

[35] Owen, K. B., Smith, J., Lubans, D. R., Ng, J. Y. Y., & Lonsdale, C. (2014). Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis. Preventive Medicine, 67, 270–279. doi:10.1016/j.ypmed.2014.07.033.

[36] Manninen, M., Dishman, R., Hwang, Y., Magrum, E., Deng, Y., & Yli-Piipari, S. (2022). Self-determination theory based instructional interventions and motivational regulations in organized physical activity: A systematic review and multivariate meta-analysis. Psychology of Sport and Exercise, 62, 102248. doi:10.1016/j.psychsport.2022.102248.

[37] Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, n71. doi:10.1136/bmj.n71.

[38] CASP (2023). Checklists-Critical appraisal skills. Critical Appraisal Skills Programme, Oxford, United Kingdom. Available online: https://casp-uk.net/casp-tools-checklists/ (accessed on May 2023).

[39] Benzing, V., Nosrat, S., Aghababa, A., Barkoukis, V., Bondarev, D., Chang, Y. K., Cheval, B., Çiftçi, M. C., Elsangedy, H. M., Guinto, M. L. M., Huang, Z., Kopp, M., Kristjánsdóttir, H., Kuan, G., Mallia, L., Rafnsson, D., Oliveira, G. T. A., Pesola, A. J., Pesce, C., … Brand, R. (2021). Staying active under restrictions: Changes in type of physical exercise during the initial COVID-19 lockdown. International Journal of Environmental Research and Public Health, 18(22), 12015. doi:10.3390/ijerph182212015.

[40] Harrer, M., Cuijpers, P., Furukawa, T., & Ebert, D. (2021). Doing meta-analysis with R: A hands-on guide. Chapman and Hall/CRC, New York, United States. doi:10.1201/9781003107347.

[41] Lin, L., & Xu, C. (2020). Arcsine-based transformations for meta-analysis of proportions: Pros, cons, and alternatives. Health Science Reports, 3(3), 07 27. doi:10.1002/hsr2.178.

[42] Phu, D. H., Wongtawan, T., Truong, D. B., Van Cuong, N., Carrique-Mas, J., & Thomrongsuwannakij, T. (2022). A systematic review and meta-analysis of integrated studies on antimicrobial resistance in Vietnam, with a focus on Enterobacteriaceae, from a One Health perspective. One Health, 15, 100465. doi:10.1016/j.onehlt.2022.100465.

[43] Teixeira, D. S., Rodrigues, F., Monteiro, D., & Cid, L. (2022). The Behavioral Regulation in Exercise Questionnaire (BREQ-4): Psychometric evidence of introjected approach regulation in Portuguese health club exercisers. Psychology of Sport and Exercise, 63, 102286. doi:10.1016/j.psychsport.2022.102286.

[44] Teixeira, P., & Hagger, M. (2016). Motivation and behaviour change techniques based on self-determination theory: a consensus analysis. European Health Psychologist, 389-389.

[45] Hoang, C. K., Pham, D. T. T., Do, T., Pham, T. T., Nguyen, M. N. T., Vu, Q. C., ... & Nguyen, T. C. (2022). Exploiting Idioms and Proverbs of Vietnamese Regions in Teaching Mathematics in Primary Schools. Emerging Science Journal, 6, 209-224. doi:10.28991/ESJ-2022-SIED-015.

[46] Vlachopoulos, S. P. (2012). Measurement equivalence of the behavioral regulation in exercise questionnaire-2 across Greek men and women exercise participants. Hellenic Journal of Psychology, 9(1), 1-17.

[47] Markland, D., & Tobin, V. J. (2010). Need support and behavioural regulations for exercise among exercise referral scheme clients: The mediating role of psychological need satisfaction. Psychology of Sport and Exercise, 11(2), 91–99. doi:10.1016/j.psychsport.2009.07.001.

[48] Crăciun, M. T., & Rus, C. L. (2012). Factorial validity and reliability evidence for the modified Behavioral Regulation in Exercise Questionnaire – 2 among Romanian adolescents. Procedia - Social and Behavioral Sciences, 33, 528–532. doi:10.1016/j.sbspro.2012.01.177.

[49] Casali, N., Cerea, S., Moro, T., Paoli, A., & Ghisi, M. (2021). Just Do It: High Intensity Physical Activity Preserves Mental and Physical Health in Elite and Non-elite Athletes During COVID-19. Frontiers in Psychology, 12, 757150. doi:10.3389/fpsyg.2021.757150.

[50] Hutmacher, D., Eckelt, M., Bund, A., & Steffgen, G. (2021). Lifting the Curtain on Motivation in Exercise: Validation of Two Questionnaires for Physical Education and Leisure Time in French and German. Journal of Psychoeducational Assessment, 39(5), 623–639. doi:10.1177/07342829211005571.

[51] Murcia, J., Gimeno, E. C., & Camacho, A. M. (2007). Measuring self-determination motivation in a physical fitness setting: validation of the Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) in a Spanish sample. The Journal of Sport Medicine and Physical Fitness, 47(3), 366-378.

[52] León-Guereño, P., Tapia-Serrano, M. A., & Sánchez-Miguel, P. A. (2020). The relationship of recreational runners' motivation and resilience levels to the incidence of injury: A mediation model. PLoS ONE, 15(5), 1-11. doi:10.1371/journal.pone.0231628.

[53] Cid, L., Moutão, J., Leitão, J., & Alves, J. (2012). Behavioral Regulation Assessment in Exercise: Exploring an Autonomous and Controlled Motivation Index. The Spanish Journal of Psychology, 15(3), 1520–1528. doi:10.5209/rev_sjop.2012.v15.n3.39436.

[54] Blom, V., Drake, E., Kallings, L. V., Ekblom, M. M., & Nooijen, C. F. (2021). The effects on self-efficacy, motivation and perceived barriers of an intervention targeting physical activity and sedentary behaviours in office workers: a cluster randomized control trial. BMC public health, 21(1), 1-9. doi:10.1186/s12889-021-11083-2.

[55] Markland, D., & Ingledew, D. K. (2007). The relationships between body mass and body image and relative autonomy for exercise among adolescent males and females. Psychology of Sport and Exercise, 8(5), 836–853. doi:10.1016/j.psychsport.2006.11.002.

[56] Tornero-Quiñones, I., Sáez-Padilla, J., Viera, E. C., Ferrete, J. J. G., & Robles, Á. S. (2019). Risk of dependence on sport in relation to body dissatisfaction and motivation. Sustainability (Switzerland), 11(19), 5299. doi:10.3390/su11195299.

[57] Naziroğlu, M., Demiral, Ş., & Özbar, N. (2023). Investigation of Motivation Levels of National Team Athletes Competing During the COVID-19 Pandemic Crisis (Judo, Wrestling and Taekwondo Example): Descriptive Research. Turkiye Klinikleri Journal of Sports Sciences, 15(2), 258–263. doi:10.5336/sportsci.2023-96086.

[58] Farholm, A., & Sørensen, M. (2016). Motivation for physical activity and exercise in severe mental illness: A systematic review of cross-sectional studies. International Journal of Mental Health Nursing, 25(2), 116-126. doi:10.1111/inm.12217.

[59] Ersöz, G., Elmas, A. G., & Aşçi, F. H. (2021). Psychometric properties of Turkish version of the Behavioural Regulation in Exercise Questionnaire (BREQ-3). International Journal of Sport Psychology, 52(6), 527–542. doi:10.7352/IJSP.2021.52.527.

[60] Duncan, L. R., Hall, C. R., Wilson, P. M., & Jenny, O. (2010). Exercise motivation: A cross-sectional analysis examining its relationships with frequency, intensity, and duration of exercise. International Journal of Behavioral Nutrition and Physical Activity, 7(1), 7. doi:10.1186/1479-5868-7-7.

[61] Miquelon, P., & Castonguay, A. (2016). Motives for Participation in Physical Activity and Observance of Physical Activity Recommendations among Adults with Type 2 Diabetes. Canadian Journal of Diabetes, 40(5), 399–405. doi:10.1016/j.jcjd.2016.02.009.

[62] Borges, J. C., de Oliveira Filho, G. G., de Lira, C. A. B., da Silva, R. A. D., Alves, E. da S., Benvenutti, M. J., & Rosa, J. P. P. (2021). Motivation Levels and Goals for the Practice of Physical Exercise in Five Different Modalities: A Correspondence Analysis. Frontiers in Psychology, 12(793238). doi:10.3389/fpsyg.2021.793238.

[63] Box, A. G., Feito, Y., Brown, C., & Petruzzello, S. J. (2019). Individual differences influence exercise behavior: how personality, motivation, and behavioral regulation vary among exercise mode preferences. Heliyon, 5(4). doi:10.1016/j.heliyon.2019.e01459.

[64] Samendinger, S., & Hill, C. R. (2021). Exercise schema and motivational regulation of college students: A person-centered analysis. Psychology of Sport and Exercise, 54, 101921. doi:10.1016/j.psychsport.2021.101921.

[65] Liu, L., Xiang, M., Guo, H., Sun, Z., Wu, T., & Liu, H. (2020). Reliability and Validity of the Behavioral Regulation in Exercise Questionnaire-2 for Nursing Home Residents in China. Asian Nursing Research, 14(1), 11–16. doi:10.1016/j.anr.2019.12.002.

[66] Chu, I. H., Chen, Y. L., Wu, P. T., Wu, W. L., & Guo, L. Y. (2021). The associations between self-determined motivation, multidimensional self-efficacy, and device-measured physical activity. International Journal of Environmental Research and Public Health, 18(15). doi:10.3390/ijerph18158002.

[67] Gorny, A. W., Low, M. C., Sayampanathan, A. A., Shiraz, F., & Müller-Riemenschneider, F. (2021). Motivations to exercise in young men following a residential weight loss programme conducted in National Service - a mixed methods study. BMC Public Health, 21(1). doi:10.1186/s12889-021-10373-z.

[68] Jenkins, M., Wilson, O. W., Richards, J., Huthwaite, M., Skirrow, P., Grant, E., & Every-Palmer, S. (2023). The association between motivation and physical activity among forensic and rehabilitation inpatients in Aotearoa New Zealand. The Journal of Sport and Exercise Science, 7(2), 9–17. doi:10.36905/jses.2023.02.02.

[69] Craike, M. J., Polman, R., Eime, R., Symons, C., Harvey, J., & Payne, W. (2014). Associations between behavior regulation, competence, physical activity, and health for adolescent females. Journal of Physical Activity and Health, 11(2), 410–418. doi:10.1123/jpah.2012-0070.

[70] Moreno-Murcia, J. A., Gimeno, E. C., Hernández, E. H., Belan-do Pedreño, N., & Marín, J. J. R. (2013). Motivational profiles in physical education and their relation to the Theory of Planned Behavior. Journal of sports science & medicine, 12(3), 551.

[71] Riseth, L., Nøst, T. H., Nilsen, T. I. L., & Steinsbekk, A. (2019). Long-term members' use of fitness centers: A qualitative study. BMC Sports Science, Medicine and Rehabilitation, 11(1), 9. doi:10.1186/s13102-019-0114-z.

[72] Sperandei, S., Vieira, M. C., & Reis, A. C. (2016). Adherence to physical activity in an unsupervised setting: Explanatory variables for high attrition rates among fitness center members. Journal of Science and Medicine in Sport, 19(11), 916–920. doi:10.1016/j.jsams.2015.12.522.

[73] Mullen, S. P., & Whaley, D. E. (2010). Age, gender, and fitness club membership: Factors related to initial involvement and sustained participation. International Journal of Sport and Exercise Psychology, 8(1), 24–35. doi:10.1080/1612197X.2010.9671931.

[74] Gjestvang, C., Abrahamsen, F., Stensrud, T., & Haakstad, L. A. H. (2020). Motives and barriers to initiation and sustained exercise adherence in a fitness club setting—A one-year follow-up study. Scandinavian Journal of Medicine and Science in Sports, 30(9), 1796–1805. doi:10.1111/sms.13736.

[75] Gardner, L. A., Magee, C. A., & Vella, S. A. (2017). Enjoyment and behavioral intention predict organized youth sport participation and dropout. Journal of Physical Activity and Health, 14(11), 861–865. doi:10.1123/jpah.2016-0572.

[76] Teixeira, D. S., Pelletier, L. G., Monteiro, D., Rodrigues, F., Moutão, J., Marinho, D. A., & Cid, L. (2020). Motivational patterns in persistent swimmers: A serial mediation analysis. European Journal of Sport Science, 20(5), 660–669. doi:10.1080/17461391.2019.1675768.

[77] Moreno-Murcia, J. A., Belando, N., Huéscar, E., & Torres, M. D. (2017). Social support, physical exercise and life satisfaction in women. Revista Latinoamericana de Psicología, 49(3), 194–202. doi:10.1016/j.rlp.2016.08.002.