Systematic Review

Motivation and recovery in sports: systematic review

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Abstract - Aim Adequate levels of motivation and recovery seem to be associated aspects in the sports context and could contribute to sports participation. Thus, how can athletes' motivation and recovery be associated in the sport context? The aim was to conduct a systematic review to identify studies investigating a possible relationship between motivation and recovery. **Method:** Searches were performed between 12/18/2020 and 01/04/2021 and were done in Embase, Portal BVS, PsycNET, PubMed/Medline, SciElo, and SPORTDiscus databases with terms that are specific to each database in three languages. Studies that included athletes in their samples and investigated motivational regulations and recovery states were included. Review studies and those that investigated recovery between sets of exercises or motivation as an incentive to exercise were excluded. Descriptive and analytical data were extracted using a previously prepared form. The synthesis of the relationships between motivational regulations and recovery states were allocated into analytical categories. **Results:** From the 4,051 studies identified in the databases, 7 met the inclusion criteria and were assessed and analysed. The extraction and summary of analytical data allowed the identification of categories where motivation and recovery were associated with a) psychophysiological outcomes and sports participation and b) readiness to perform the sports task. **Conclusion:** The studies included in this review suggest that motivational regulation and recovery could be critical in the sports context and could be related to psychophysiological outcomes and sport participation.

Keywords: motivation, recovery, self-determination, sports.

Introduction

Recovery states and motivational regulations have been reported as variables that could influence sports participation and performance[1,2]. Recovery is the regime for restoring an individual's functional capacity after a strenuous effort[3] and in the sporting context, it can be defined as the totality of psychophysiological processes (depending on time and personal resources) that occur in the body after a given training load[1,4,5]. Although the physiological perspective of recovery involves dietary, rest, and sleep strategies to restore biological resources, it is important to note that changes in training load are also reflected in athletes' behavioural states and mood[6]. In this sense, psychological and social aspects should be considered as facets of the same process[1,7,8].

Therefore, the psychological perspective of recovery is related to identifying the fatigue state and action oriented towards detachment from the stressor agent (physical and psychological stress from training and competition loads) aiming at adequate conditions for recovery[1,3,9]. Detachment from the stressor can occur through recovery strategies, guided by coaches or voluntarily (proactive strategies), aimed at organic recovery or through involvement in social and leisure activities aimed at mitigating psychological stress[7,9,10]. In both circumstances, the objective is to achieve physical and mental readiness to perform the next sport task[9].

In this sense, it is suggested that positive psychological states can support the biological processes of recovery through relaxation, good mood, and well-being[8,9,11]. In a recent consensus on the subject, Kellmann et al.[1] highlight that the implementation of proactive recovery strategies demands a high level of motivation, as they signal autonomous actions based on choices of strategies tailored to individual needs and preferences. Athletes with knowledge and perception of competence in implementing recovery strategies tend to use them more frequently[12].

In addition to motivational regulations facilitating engagement in sports activities, it is possible that interest, identification and pleasure in the activities performed may reduce stressors (cognitive and affective), benefiting the recovery process through positive psychological states. More specifically, high-quality motivation, good mood levels, and pleasant social contacts can benefit the process through detachment from exposure to the stressor agent[7,11]. This process could contribute to the psychophysiological restoration and experiencing positive emotional states, which are positively associated with well-being and inversely associated with stress, and can consequently amplify the perception of recovery[7].

Motivation could be defined as an intentional process, aimed at a determined objective, and mediated by the interaction between the direction and intensity of efforts involving personal and contextual factors, which, in turn, could change due to actual needs and opportunities, impacting the individual's volition to practice sport[13]. Regarding the literature on sports psychology, among the various theories supporting the investigations of motivation, the Self-Determination Theory (SDT) is highlighted by its contribution as theoretical background to understanding motivational phenomena in sports environments[2].

Motivational regulation is a key component to entering sports and maintaining successful sportive participation as, in general, autonomous behaviours are associated with desirable results such as psychological well-being, improvement of capabilities, and persistence in the sports practice, in addition to decreased feelings of helplessness and lack of control[2]. Thus, intrinsic regulation is high-quality motivational regulation, related to activities that athletes do for their own interest and enjoyment[14]. Nevertheless, some behaviours have been done for reasons other than fun and enjoyment. Although sports activities are associated with pleasure, participating in training involves controlled behaviours, like acknowledgement, surpassing a colleague, or winning a competition[2]. On the other hand, controlled forms of motivation and amotivation, in general, are related to negative consequences, like fatigue or dropout, as individuals with these regulations can show difficulties in performing tasks, anxiety, and low levels of self-efficacy[15].

In this sense, considering the potential influence of motivation in the training environment, as well as the psychophysiological demands the athletes face in various situations inside and outside the training context, it could be an influencing factor not just for recovery but for the decrease in psychological problems like burnout and dropout[1]. Thus, how can athletes' motivation and recovery be associated in the sports context? Therefore, the objective of this study was to carry out a systematic survey of the literature aiming to sum up research associating measures to regulate motivation and recovery states in the sports context.

Method

Choice was made for an investigation method used relied on summarizing the research through a systematic review of literature, adopting the procedures proposed by Boland et al.[16], aiming to find, assess and summarize the pieces of evidence about motivation and recovery in the sport context. We previously performed a scope search to establish the review protocol. The studied question is observational and was built using the **PICo** (**P**opulation, **I**nterest Phenomenon, and **Co**ntext) strategy[17].

Criteria for studies election

The inclusion and exclusion criteria were related to the PICo strategy[17]. Studies that investigated the following were included in our investigation:

(1) Athletes or practitioners of sports modalities;
(2) Motivation in the sport context;
(3) Recovery in the sport context.

The inclusion of studies investigating the sport context whose samples included athletes and practitioners of sports modalities is key, as in this context there is a need for adequate motivation and recovery to deal with the demands of stressor agents that are internal and external to the environment of the sport[1]. The following studies were excluded:

(1) Recovery between exercises series;
(2) Motivation as an incentive to exercise practice;
(3) Reviews.

As the subject of the study is recovery as a training phase to increase conditioning, excluding studies on recovery between series is justified because this type of recovery refers to a prescription to enhance metabolic aspects during the exercise[18].

The exclusion of studies about motivation as an incentive (use of music or other strategies to encourage task completion) is justified because these strategies stimulate affective and cognitive processes for the purpose to reduce the perceived effort, minimizing fatigue and increasing the quantity of exercises done[19-21]. However, they do not promote regulatory and motivational processes that allow the initiative and persistence of a determined behaviour[9,22]. Finally, review studies were excluded because their results are available in the original studies.

Search and Screening Strategy

Searches were performed between 12/18/2020 and 01/04/2021 in Embase, Portal BVS, PsycNET, *PubMed/ Medline,* SciElo, and SPORTDiscus databases considering studies in English, Spanish and Portuguese, with no filter and restrictors for the publishing date.

An additional search was conducted in secondary sources to recover non-indexed references (grey literature)[23]. The key words were in English and, when possible, in Spanish and Portuguese, according to the terms of each base[23]. The research syntaxes can be accessed on supplementary material (file 1). The results of each database were exported and stored using the *EndNote*® X9 software. Screening was performed with a previously prepared form to identify compliance with the inclusion and exclusion criteria. Two reviewers independently conducted the screening in two stages: a) reading of titles and summaries; and b) reading the document in full[24]. After this, a manual search was conducted in the reference list of the studies included, repeating stages 1 and 2 of the screening[24].

Assessment of the methodological quality

JBI Critical Appraisal Tools was chosen considering its applications and diversity of methodological designs[25]. They consist of Critical Appraisal Checklists (CAC) for each type of outline and allow answers "*Yes*", "*No*", "*Unclear*", and "*Not applicable*". Two reviewers conducted the assessment independently, and the concordance coefficient of inter-reviewers was substantial ($kappa$ = 0,805) and significant ($p < 0{,}001$)[26]. Studies not meeting the criteria were not excluded, although biases and limitations that could affect the results were identified and indicated in the summary of the findings[27].

Extraction of descriptive and analytical data

Only one reviewer extracted descriptive and analytical data using a previously prepared form[28]. The descriptive data were related to the sample's characteristics and information about the outline of the studies. On the other hand, the analytical data were the main subject of interest of this investigation and are related to the results of the studies corresponding to the measures of motivation and recovery, which were identified, extracted, tabulated, and presented in a written summary.

Analysis and summary of data

As the studies included were heterogeneous, the summary of results was analysed qualitatively, with an integrated synthesis via textual narrative, as proposed by Cherry et al.[29] and Lucas et al.[30]. The authors synthesized each study by combining analytical data and their respective methodological quality assessments to perform the analysis. In the sequence, we identified the synthesis sharing common factors and conditions in which motivation and recovery could be associated with the sports context. These syntheses were allocated into analytical categories, the comments on main aspects and results were used to conclude and, where possible, develop a synthesis of the subgroup.

Results

Searches resulted in 4051 studies in the databases (Embase [160], SciElo [11], Portal BVS [638], PsycNET [92], Pubmed [2028], and SportDiscus [1122]) and one study in the additional search. Before using inclusion and exclusion criteria, 718 duplicated studies were eliminated. After the screening stage, seven studies from the additional database searches were included. The manual search from reference lists of studies included resulted in 227 studies being consulted, but none were considered eligible. The number of identified registers in each screening stage is presented in the flowchart (Figure 1). The included studies were, in their majority, published in the last six years, 71% from 2018.

Bias assessment

Considering the studies' characteristics, we used three types of Critical Appraisal Checklists (CAC), as proposed by Moola et al.[25]:

- CAC for Quasi-Experimental Studies (non-randomized experimental studies);
- CAC for Case Series Studies;
- CAC for Transversal Studies.

The quality assessment result is shown in Table 1. The absence of strategies that favour the reliability of exposure measurements was observed in three studies[31-33]. The lack of inclusion and exclusion criteria to make the sample was observed in only one study[34]. One study had no control group[33]. The rest of the studies[35-37] met the criteria.

Descriptive data, analytic data, and synthesis

The descriptive data related to samples can be conferred on supplementary material (file 2). The sample of the studies included amounted to 389 participants (♂: 76% [n = 294]; ♀: 24% [n = 95]) from following sportive modalities: Cycling, Football, Table Tennis, Swimming and Wrestling. The sample consisted mostly of adolescent participants (80% [n = 313]).

The descriptive data related to the outline information are shown in Table 2. Descriptive correlational (n = 3), cross-sectional (n = 2), and quasi-experimental outlines were observed (n = 2) with monitoring periods between 4 weeks and six years. The majority of the studies[32-37] investigated motivation as a primary outcome, except Borges et al.[31] that investigated the recovery dynamic considering age. Borges et al.[31] and Rosa et al.[32] were the only ones that combined physiological and psychological measures. In general, the studies conclude the importance of monitoring psychophysiological variables and performance for training management and understanding the main outcomes in the sports context. Self-Determination Theory (SDT) was broadly utilized to understand the motivational regulation associations with other psychological constructs[32,35-37]. Selmi et al.[33] investigated motivation, entertainment, and physical pleasure through the physical enjoyment construct. Only Borges et al.[31] did not mention a motivational theory as theoretical background; they simply used a perceptual measure of motivation.

Analytical data and their respective syntheses are shown in Table 3. The extraction of analytical data

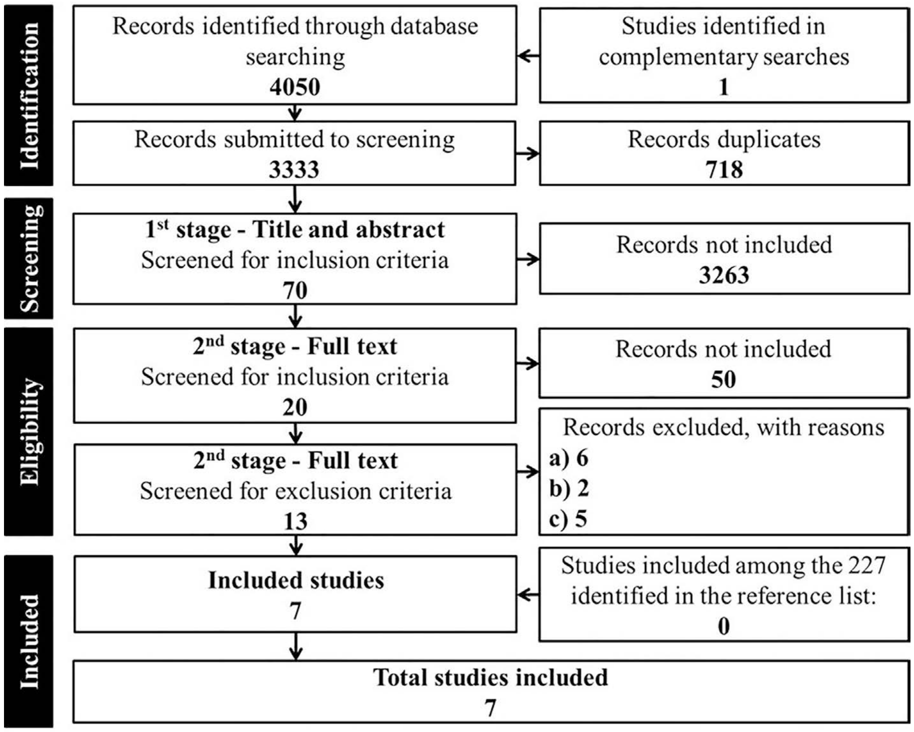

Figure 1 - Systematic review fluxogram. Note: a) = Studies that investigated and analysed recovery among exercises series; b) = Studies that investigated motivation through strategies to encourage or stimulate exercise; c) = Review Studies. Adapted from Liberati, et al.[49].

Table 1 - Bias assessment.

Study	JBI CAC* fulfilment									
	1	2	3	4	5	6	7	8	9	10
Borges et al. (2018)	Y	Y	Y	Y	Y	Y	Y	U	Y	–
Fagundes et al. (2019)	Y	Y	Y	NA	NA	Y	U	Y	Y	Y
Martinent and Decret (2015)	Y	Y	Y	NA	Y	Y	NA	Y	Y	Y
Martinent et al. (2018)	Y	Y	Y	NA	Y	Y	Y	Y	Y	Y
Martins and Pedro (2017)	U	Y	Y	NA	Y	Y	Y	Y	–	–
Rosa et al. (2020)	Y	Y	Y	NA	Y	Y	Y	Y	–	–
Selmi et al. (2018)	Y	Y	N	N	N	Y	Y	U	Y	–

Note: * = Quasi-Experimental Studies (9 criteria); Case Series Studies; (10 criteria); Transversal Studies Quasi-Experimental (8 criteria); Y = Yes; N = No; U = Unclear; NA = Not Applicable.

allowed to answer the research's question and identify two categories expressing conditions in which motivation and recovery could be associated in the sports context: a) psychophysiological outcomes and sportive participation; b) readiness to perform the sportive task. The association of motivation and recovery measures with psychophysiological variables and sportive participation could forecast information on maladaptive physiological outcomes (overtraining and burnout)[35] and, finally, information about sportive participation (dropout/maintenance of sports practice and performance)[36]. In turn, the category "readiness to perform a sports task" refers to the condition in which motivational regulation could impact the perception of recovery[34,37] or how the relation of these variables influences performing a particular sports task, without prejudice to fatigue and maintaining adequate volume and intensity[31,33]. However, in this category, the results of the studies are divergent.

Martins and Pedro[34] highlight the psychological and social dimensions of recovery, suggesting that distinct motivational regulations impact the athletes' recovery process differently. Martinent and Decret[37] indicate that high levels of autonomous motivation and low levels of controlled motivation were associated with better use of personal strategies allowing for adequate recovery situations. In the other studies, the association between motivation and recovery was not evident[33], or was not a variable that could explain the recovery dynamics[31].

Discussion

Considering the psychophysiological demands in internal and external contexts to training, understanding the relationship between the motivational aspects and recovery states could contribute to planning higher quality sessions and reducing psychological problems like burnout and dropout[1]. Therefore, the objective of this review was to conduct a systematic study of the literature to synthesize studies that link motivation and recovery in the sports context.

Table 2 - Descriptive data of the included studies' outline.

Study	Objective	Duration	MT	Intervention	MA	RA	Conclusion of the study
Borges et al. (2018)	Compare the recovery dynamics of athletes of two different ages after a HIIT session.	NR	NR	Recovery assessment after 1, 24, and 48 h after a HIIT session	Subjective assessment through a Likert-type scale (LS)	LS, CK, TT, SV e MIC	Older and younger cyclists had similar recovery rates after training, but the older ones showed a delay in the perception of recovery.
Fagundes et al. (2019)	Determine if motivation and overtraining can predict burnout.	1 Season	SDT	Usage of psychometric instruments during the season.	SMS using SDI	RESTQ-Sport 76	Amotivation´s dimensions and emotional and physical exhaustion were efficient to predict burnout.
Martinent and Decret (2015)	Investigate motivational profiles´ changes and their relationship with psychological aspects and recovery.	2 months	SDT	Usage of psychometric instruments during the season.	SMS using clusters approach	RESTQ-Sport 76	Changes in motivational profiles were observed and athletes with self-determined profile presented better adjustment to the daily demands.
Martinent et al. (2018)	Verify the relationship between motivation, coping, burnout and recovery in performance and abandonment of the sports practice.	6 years	SDT	Usage of psychometric instruments before and after six years.	SMS	RESTQ-Sport 76	Monitoring psychological aspects during adolescence could offer forecast information about performance and risk of sports abandonment.
Martins and Pedro (2017)	Explore the relationship between motivational regulations and recovery perception with wrestling athletes	NR	SDT	Athletes answered to psychometric instruments.	Continuum of Self-Determination	RESTQ-Sport 76	Results emphasise the relationship between motivational regulations and the recovery process, suggesting that different motivational regulations have distinct impacts in the athletes recovery process.
Rosa et al. (2020)	Analyse the association between hormonal status and psychobiological processes of paralympic swimmers in a competitive season.	8 months	SDT	Athletes answered to psychometric instruments and were subjected to salivary cortisol and testosterone concentrations collection in three moments of the preparation for the Olympic games.	SMS	RESTQ-Sport 76	Associations between hormonal state and stress related variables, recovery and motivation demonstrate interactions and potential influence of these biomarkers in the psychobiological domains.
Selmi et al. (2018)	Evaluate the relationship between well-being perception and PE during reduced games.	4 weeks	PE	Usage of psychometric instruments before and after reduced games sessions.	PACES	TQR	PE and RPE were not affected by the variability of well-being and recovery dimensions in reduced games.

Note: MT = Motivational Theory addressed; MA = Motivation assessment; RA = Recovery assessment; HIIT = High intensity interval training; NM = Not mentioned; LS = Subjective assessment through a Likert-type scale; CK = creatine kinase; TT = Time test; SV = Sprint velocity; MIC = Maximum isometric contraction; SDT = Self-Determination Theory; SMS = Sport Motivation Scale; SDI = index of self-determined sport motivation; PACES = Physical Activity Enjoyment Scale; PE = Physical Enjoyment; RPE = Rate Perceived Exertion; RESTQ-Sport 76 = Recovery-Stress Questionnaire for Athletes; TQR = Total Quality Recovery.

As a result, the studies suggested that motivational regulations and recovery states should be considered in psychophysiological outcomes and participation in sports. Also, it is noted that to understand the motivational regulations, STD was the theoretical construct used in 71% of these studies. Indeed, STD has been broadly used and has contributed to understanding the motivational phenomena in sport[2]. The association between motivation and recovery with psychophysiological outcomes and sport participation allowed us to notice that amotivation, combined with low levels of perceived recovery, could imply maladaptive outcomes, e.g., burnout[35], risk of dropout, and negative impacts in performance[36]. The results reported by Martinent et al.[36] show that after six years of monitoring, those who continued to practice reported less amotivation and external regulation at the beginning of the study, in addition to noticing greater recovery than those who stopped practicing. Additionally, not only was performance correlated with a more significant perception of recovery, but international and national level athletes showed less amotivation than regional athletes did at the beginning of the study. Nevertheless, the sport context can

Table 3 - Analytical data and synthesis.

Study	Results related to motivation and recovery	Synthesis
Borges et al. (2018)	Significant differences were not observed in the age comparison during post-HIIT recovery. After 48h, older cyclists reported less motivation, more fatigue, and more pain.	Although the recovery has similar measures between the groups, the reduced perception of motivation, as well as the higher perception of fatigue and pain could influence the recovery. It is important to mention that there was no mention to prior training of assessors in exposure measurement procedures.
Fagundes et al. (2019)	Amotivation presented high and negative correlation with general recovery and specific recovery. Amotivation also presented high correlation with physical exhaustion and burnout.	Amotivation levels are associated with low recovery and may trigger psychophysiological and emotional unbalance, resulting in low performance and burnout. Although the study met the participants' criteria of inclusion, collection procedures and analysis of data, it did not clarify the status of the athletes before the beginning of the study.
Martinent and Decret (2015)	Athletes with self-determined motivation profiles experienced a higher recovery level than the other motivation profiles.	Compared with athletes with other motivational profiles, self-determined athletes seem to deal better with stressors and daily demands, probably using more strategies to guarantee adequate recovery and adjustment to their daily lives. It is important to note that this study met the criteria of methodological quality assessment.
Martinent et al. (2018)	Compared with athletes who abandoned the practice, the ones that stayed in the sport reported at the beginning of the research smaller amotivation scores and external regulation, and higher recovery in general.	Although the weak association with performance, measures of motivation, and recovery of athletes in the beginning of the sports career can forecast information about the risk of sport abandonment. It is important to mention that the study met the criteria of methodological quality assessment
Martins and Pedro (2017)	There were observed correlations among the dimensions of motivational regulations and the recovery dimensions.	The results highlight that recovery is an intra and interindividual process dependent on psychological, physiological, and social factors, and it is possible to suggest that different motivations regulations have different impacts in the athletes´ recovery process. Nevertheless, this study has limitations concerning the inclusion criteria and sample size.
Rosa et al. (2020)	There were associations between cortisol concentration and subscales of perception of stress. Testosterone concentration was associated with dimensions of motivation, and conversely with "Amotivation". Testosterone was also correlated with perceptions of recovery.	The associations between hormonal states and variables related to recovery and motivation show interactions and influence of these biomarkers in the Paralympics swimmers' psychobiological domains. However, the lack of intra- and inter-observer reliability of self-reported measurements may impair reproducibility and repeatability.
Selmi et al. (2018)	No significative correlations were observed among the perceptions of recovery, sleep quality, stress, fatigue, muscular pain and well-being index with the PAE and RPE during the reduced games.	Although PE is a factor in the athlete's commitment and performance, it only reflects the motivation during the training and not the perception of recovery before the training session. Indeed, it is a motivation to the exercise modality, and it is not associated with the training load or fatigue. Additionally, the absence of a control group, previous training of the evaluators, and pre-evaluation measures may compromise the cause-effect relationship.

Notes: HIIT = High intensity interval training; PAE = Physical Activity Enjoyment; PE = Physical Enjoyment; RPE = Rated Perceived Exertion.

present stressor variables that influence the athlete's perception, resulting in inappropriate expectations and pressures and making for psychophysiological manifestations that impact athletic performance[32,38]. In this sense, Fagundes et al.[35] reported that amotivation and inappropriate recovery in the preparatory stage were responsible for 56% of physical exhaustion and 53% of burnout in the competitive phase. In addition to burnout, these psychophysiological and emotional imbalances can contribute to injuries, illnesses, and decreased performance.

Confirming the above mentioned, Lemyre et al.[39] suggest that athletes with low-quality motivation (controlled motivation) tend to show signs of exhaustion and report burnout symptoms at the end of the season. Furthermore, inappropriate recovery could negatively impact the athlete's cognitive and affective structures and impact psychological aspects, performance, and continuity in practice[34]. In this context, the motivational climate offered by coaches is a key factor to influence the training process and adaptive outcomes, as athletes without fostered autonomy may not relate to the reasons for the training and controlled motivation, which could impair the recovery process and increase the likelihood of maladaptive outcomes, like burnout, overtraining and dropout[2,39]. Typically, autonomous forms of motivation are related to psychological well-being or persistence, while controlled forms of motivation and amotivation are related to negative consequences, like physical attrition or dropout[14].

Motivational regulations and recovery perception can reflect psychophysiological outcomes associated with training adaptations. In this sense, Rosa et al.[32] reported that the association between a smaller perception of recovery and high cortisol levels in the preparatory stage could be explained by high training demands and social stressor factors. In turn, higher testosterone concentrations and recovery perception during Tapering, in which the training volume is reduced, could favour an increase in the performance. Similarly, positive correlations between testosterone concentration and intrinsic motivation dimensions, and inversely with amotivation, indicate that hormonal states could result in interactions in the athlete's psychophysiological domains, impacting behaviour and decision making. The authors also highlight that for this population, the competition involves intrinsic and extrinsic incentives compelling them to be motivated and recovered to train at maximum capacity to excel[32].

Corroborating with these data, two studies[34,37] categorized as "readiness for performing a sports task" emphasized the association between intrinsic and extrinsic regulations with recovery, allowing us to understand recovery as a complex multidimensional process, which is also influenced by psychological aspects. In this sense, Martins and Pedro[34] results suggest that different motivational regulations impact differently in the recovery process. Athletes with intrinsic motivational regulation who participate voluntarily and enjoy sports activities may present reductions in the feeling of powerlessness and a greater perception of well-being, which consequently may influence the perception of recovery.

Conversely, the association between extrinsic regulation of motivation and recovery observed by Martins and Pedro[34] suggests that, in some cases, recovery-related behaviours are not an end in themselves. Yet, they are carried out to reach an objective: athletes use recovery strategies to be able to participate in the next training session or competition. However, as it is not an autonomous behaviour, controlled forms of motivation and amotivation are generally related to negative consequences, such as exhaustion, difficulties in performing tasks, anxiety in situations of evaluation, and giving up[14]. Finally, it is important to note that self-determined behaviours, alone, are not always sufficient to explain recovery[40]. It is observed that although athletes with high levels of autonomous and controlled motivation present high-performance index, they also present high levels of physical and emotional exhaustion and a higher risk of developing burnout[41].

On the other hand, Martinent and Decret[37] noted that the athletes identified with high levels of autonomous motivation and low levels of controlled motivation experienced higher recovery levels and used more strategies to deal with stressors than other motivational profiles. Thus, this study suggests that athletes with an autonomous motivation profile can make better adjustments in their daily demands and personal strategies (proactive), which probably allow for adequate recovery. The recovery process tends to occur far away from the actual sport environment and from the training and competition demands in which the athlete implements strategies to minimize fatigue[9]. Additionally, it is important to highlight that those coping strategies are factors that influence the recovery process, as they can help athletes deal with the demands of sport[42]. Ultimately, adequate recovery and consequent maintenance of training load variables (volume and intensity) can maximize training adaptations[4,32].

The majority of the studies of this systematic review agree with the recent consensus about recovery in the sport context, in which Kellmann et al.[1] highlight the role of autonomous behaviour in promoting recovery. Among the possible strategies for recovery, the proactive implies a high level of motivation, as it signals activity choices according to individuals' needs and preferences[1,38]. When we consider that perspective during the recovery, the practitioner must be able to regulate behaviours to deal with fatigue and promote actions that favour the recovery[9]. Additionally, Beckmann and Kellmann[22] suggest that autonomous behaviours, observed when the individual voluntarily participates and enjoys the activities, are fundamental; hence, motivation interacts with cognitive and emotional self-regulated aspects.

Furthermore, it is possible that fulfilment Basic Psychological Needs (BPN) is also relevant for experiencing positive emotional states and recovery, as noted by van Hooff et al.[7]. This condition, positively associated with well-being and inversely associated with stress, the perception of fatigue, mood disorders, and anxiety, facilitates the individuals' interaction with the environment (daily personal and work context), broadening the recovery and vigour perceptions. Consequently, this can facilitate the possibilities for individuals to better interact with the environment in their personal and work context[43]. In sport, athletes who have their BPN frustrated can also trigger adverse outcomes related to emotional and physical exhaustion. Thus, it is possible that the motivational climate conferred by coach influences, as athletes who do not have fostered autonomy may lack personal ownership of the reasons for training, consequently lower motivation and ultimately hindering the recovery process and increasing the probability of occurrence of exhaustion[39].

However, in the studies of Borges et al.[31] and Selmi et al.[33], the association between motivation and recovery was not observed. Although physical enjoyment corresponds to entertainment and joy in the practice of the activity, with impact on task commitment and performance, Selmi et al.[33] did not link this fact to recovery, fatigue, stress, and effort perceived. In addition, the authors suggest that physical activity motivation in this population can be related to the exercise modality and not to the training load or fatigue.

The absence of a relationship between motivation and recovery was also observed in the investigation of Borges et al.[31] that identified age influence in the recovery dynamics: older athletes perceived lower motivation levels and higher levels of fatigue and muscular pain than the younger athletes, although without impact in the recovery. Thus, despite the possibility that impairments in recovery perceptions may negatively influence readiness to perform the sports task, the results observed in this study suggest that greater perceptions of fatigue, muscle soreness, and reduced motivation did not affect the recovery's physiological and physical parameters.

Only two studies combined psychological and physiological measures[31,32]; the rest of the studies included in this review used psychometric instruments to measure subjective recovery experiences. These authors may have chosen this option because of the viability and applicability of psychometric tools that, besides the low cost, can provide results in less time[44]. Although psychologic state disorders coincide with the increasing load, and these tools, if adequately validated, are sensitive to identify these answers[45], it is essential that the monitoring involves psychophysiological measures that allow efficient feedbacks. In this sense, the quality of data from subjective measures of recovery may be impaired if athletes enter values that do not correspond to their real condition[4,38].

Regardless of the results obtained in this review, one should consider the impact of the methodological quality of the studies included in the review, as they may influence the analytical data's interpretations. It is essential to notice the limitations in the study proposed by Selmi et al.[33], as the absence of comparison with a control group may undermine the plausibility of cause and effect as results can be attributed to the occurrence of events beyond the intervention of interest[46]. Additionally, in three studies[31-33], strategies favouring reliability were not observed, which may compromise the precision and exposition measures[47]. However, in the study of Martins and Pedro[34], due to the small sample and unclear inclusion criteria, extrapolating results may present limitations. Finally, considering the reduced quantity of studies surveyed in the review, it is possible to suggest that this topic is little explored. The studies included were published in the last six years, 71% as of 2018. In this sense, a new field of research in sports psychology may be designed to investigate the mechanisms and underlining processes that mediate motivation and recovery in the psychology of sports context.

Among the possible limitations from systematic review, we can point to the instruments used to assess the methodological quality. As reported by Page et al.[48], there are limitations to the instruments available in the literature to evaluate the quality of the studies, e.g., the scope, instructions for use, and measurement properties. In this sense, the methodological quality assessment is still a challenge because of the absence of specific instruments addressing characteristics of sport science-related designs; therefore, we tried an approach with the use of the JBI Critical Appraisal Tools proposed by Moola et al.[25].

Conclusions

The studies included in this review suggest interactions between motivational regulation, recovery and sports participation, and psychophysiological outcomes. High-quality motivation and perceived adequate recovery levels may be key factors for adaptive outcomes in the sports context, minimizing future risks of abandoning sports practice and impacting performance. Nonetheless, even with divergences, there are also considerations about the motivational regulation on recovery and readiness to perform the sports task, highlighting the need to study this relationship further and understand its mechanisms.

Practical applications

Adequate recovery conditions and a motivational climate must be promoted. In addition to a possible influence on preventing sports dropout, meeting these factors can contribute to a better perception of well-being and, consequently, recovery of training loads. Additionally, the psychological aspects and social context of the athlete's life must be considered, which can benefit or hinder recovery and, consequently, the readiness to perform the sports task. Individuals with intrinsic motivational regulation are more likely to implement proactive recovery strategies. Thus, they must have access, autonomy and adequate learning about the use of these strategies.

Data availability statement

The results of databases searching were stored in the EndNote® X9 software, and the archive endnote library has been deposited on in the Figshare Repository and it can be accessed through the link: https://doi.org/10.6084/m9.figshare.20689237

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Supplementary material

The following online material is available for this article

Table S1 - Searching strategies on databases.
Table S2 - Descriptive data of the participants of the included studies.

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Table S1 - *Searching Strategies on Databases*

EMBASE (*English*)
('sport'/exp OR 'competitive sport' OR 'sport' OR 'sports' OR 'athletic performance'/exp OR 'athletic performance' OR 'sport performance' OR 'sports performance' OR 'athlete'/exp OR 'athlete' OR 'athletes' OR 'sportman' OR 'sportmen' OR 'sportspeople' OR 'sportsperson' OR 'sportspersons' OR 'sportsmen' OR 'sportsman' OR 'sports player' OR 'sports players' OR 'sportsplayers') AND ('motivation'/exp OR 'motivation' OR 'self determination'/exp OR volition) AND (recovery OR regeneration OR regenerative)
PORTAL BVS (*English*)
(tw:(Sports OR Sport OR Athletics OR Athletic OR Athletes OR Athlete)) AND (tw:(Self Determination OR Motivation OR Motivations OR Volition OR Will)) AND (tw:(Recovery OR regeneration OR Regenerative))
PORTAL BVS (*Spanish*)
tw:((tw:(deporte OR deportes OR atletas)) AND (tw:(motivación OR motivaciones OR autodeterminación OR volición)) AND (tw:(regenerative OR recuperación)))
PORTAL BVS (*Portuguese)*
(tw:(Esporte OR Esportes OR Atletas)) AND (tw:(Motivação OR Motivações OR Autodeterminação OR Volição)) AND (tw:(Regenerativo OR Recuperação))
APA PsycNET (*English)*
Any Field: Sports OR Any Field: Athletes OR Any Field: Athletic Training OR Any Field: Sport Training OR Any Field: Athletic Participation AND Any Field: Motivation OR Any Field: Behavioral Intention OR Any Field: self-determination OR Any Field: volition AND Any Field: Recovery OR Any Field: regeneration OR Any Field: Regenerative
PUBMED/MEDLINE (*English*)
(((((((Sports) OR Sport) OR Athletics) OR Athletic) OR Athletes) OR Athlete)) AND ((((((Self Determination) OR Motivation) OR Motivations) OR Volition) OR Will)) AND (((Recovery) OR regeneration) OR Regenerative)
SCIELO (*English*)
(Sports OR Sport OR Athletics OR Athletic OR Athletes OR Athlete) AND (Self Determination OR Motivation OR Motivations OR Volition OR Will) AND (Recovery OR regeneration OR Regenerative)
SCIELO (*Spanish*)
(deporte OR deportes OR atletas) AND (motivación OR motivaciones OR autodeterminación OR volición) AND (regenerative OR recuperación)
SCIELO (*Portuguese*)
(Esporte OR Esportes OR Atletas) AND (Motivação OR Motivações OR Autodeterminação OR Volição) AND (Regenerativo OR Recuperação)
SPORTDISCUS
(Sport OR Sports OR Athletic OR Athletics OR Athlete OR Athletes) AND (SELF determination (Psychology) OR SELF-determination (Psychology) OR MOTIVATION (Psychology) OR SELF motivation OR VOLITION OR WILL) AND (Recovery OR Regeneration OR Regenerative)

Table S2 - *Descriptive Data of the Participants of the Included Studies*

Study	N	♂	♀	Age	Experience in the modality (years)	Modality	Training Volume
Borges et al. (2018)	17	17	--	55.6 ± 5 / 25.9 ± 3*	NM	Cycling	228.0 ± 69.6 (Kms per week) [masters] 213.1 ± 128.7 (Kms per week) [youngs]
Fagundes et al. (2019)	32	32	--	24.16 ± 4.58	4.82 ± 4.64	Football	NM
Martinent and Decret (2015)	141	99	42	13.85 ± 2.04	6.18 ± 2.22	Table Tennis	15.13 ± 5.92 (hours per week)
Martinent et al. (2018)	159	109	50	14.07 ± 2.13	6.36 ± 2.24	Table Tennis	15.04 ± 5.78 (hours per week)
Martins and Pedro (2017)	13	10	3	14.66 ± 0.75	5.7 ± 2.09	Wrestling	5±0.4 (sessions per week)
Rosa et al. (2020)	11	11	--	22.73 ± 5	7.2 ± 2.9	Swimming	5 (days per week)
Selmi et al. (2018)	16	16	--	25 ± 0.8	11.8 ± 1.55	Football	6-7 (days per week)

*Note: *: The sample was divided into two groups with different age categories; NM: Not mentioned*