Session rating of perceived exertion as an assessment tool for internal training load in brazilian jiu-jitsu: a systematic review and meta-analysis

Evaluación del esfuerzo percibido como herramienta para medir la carga interna de entrenamiento en jiu-jitsu brasileño: revisión sistemática y meta-análisis

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Abstract

Introduction. Subjective perception of effort, measured via session Rating of Perceived Exertion (sRPE), is a valuable tool for optimizing training load, preventing overtraining, and enhancing athlete performance in Brazilian Jiu-Jitsu (BJJ).
Objective. This systematic review and meta-analysis investigated the application of sRPE to assess ITL in BJJ, focusing on its effectiveness for understanding training intensity and preventing overtraining.
Methods. A systematic search was conducted using PubMed, SCIELO, and Web of Science to identify studies on sRPE in BJJ. Data extraction focused on sample size, athlete characteristics, and training load control mechanisms. A total of nine studies met the inclusion criteria and were included in the review and meta-analysis. Key outcomes, including pre-combat and post-combat sRPE values, were analyzed to evaluate physical stress and training intensity.
Results. The review revealed significant increases in sRPE values post-combat compared to pre-combat, indicating high levels of physical stress generated by both simulated combats and BJJ competitions. Similar responses across different sRPE measures demonstrated consistency in intensity across interventions. However, data heterogeneity and small sample sizes in some studies highlight the need for further research with standardized methodologies.
Conclusion. This research demonstrated a significant post-combat increase in sRPE, emphasizing the intensity of BJJ training and competitions. It also underscores the importance of standardized protocols to enable comprehensive comparisons across studies. By improving training periodization and athlete management, this study contributes to advancing the application of sRPE in optimizing performance and preventing overtraining in BJJ athletes.

Keywords

Martial arts; internal training load; fatigue; sport physiology; training load monitoring.

Resumen

Introducción. La percepción subjetiva del esfuerzo, medida mediante el session Rating of Perceived Exertion (sRPE), es una herramienta esencial para optimizar la carga de entrenamiento, prevenir el sobreentrenamiento y mejorar el rendimiento en Brazilian Jiu-Jitsu (BJJ).
Objetivo. esta revisión sistemática y metanálisis investigó la aplicación del sRPE para evaluar la carga interna de entrenamiento (ITL) en BJJ.
Métodos se realizó una búsqueda en PubMed, SCIELO y Web of Science, identificando nueve estudios que cumplieron los criterios de inclusión. Los datos analizados incluyeron el tamaño de la muestra, características de los atletas y valores de sRPE antes y después de los combates.
Resultados. Los resultados mostraron un aumento significativo en el sRPE posterior a los combates en comparación con los valores previos, indicando altos niveles de estrés físico tanto en combates simulados como en competiciones de BJJ. Además, las medidas de sRPE demostraron consistencia en la intensidad entre las diferentes intervenciones. Sin embargo, la heterogeneidad de los datos y el tamaño reducido de las muestras resaltan la necesidad de investigaciones futuras con metodologías más estandarizadas.
Conclusión. Esta investigación demostró un aumento significativo en el sRPE posterior al combate, destacando la intensidad del entrenamiento y las competiciones de BJJ. También subraya la importancia de protocolos estandarizados para permitir comparaciones exhaustivas entre estudios. Al mejorar la periodización del entrenamiento y la gestión de los atletas, este estudio contribuye al avance en la aplicación del sRPE para optimizar el rendimiento y prevenir el sobreentrenamiento en atletas de BJJ.

Palabras clave

Artes marciales; carga interna de entrenamiento; fatiga; fisiología del deporte; monitoreo de la carga de entrenamiento

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Introduction

The subjective perception of effort is a widely used concept in sports science, representing the interaction between peripheral signals (e.g., muscles and joints) and central signals (e.g., ventilation), which are decoded by the sensory cortex and translated into a general perception of exertion during a specific task (Borg, 1982). This model of "effort quantification" is based on the interpretation of sensory stimuli through feedback from actions and has become a common tool in sports performance monitoring due to its ease of application and the significant role of psychophysical responses in maintaining optimal physical performance during competitions (Shariat et al. 2018, Milot, Léonard et al. 2019).

The Rating of Perceived Exertion (RPE) method, particularly the session RPE (sRPE) protocol, was developed by Foster, Daines et al. (1996) to monitor training load through subjective quantification. This method is popular in the sports community because it is straightforward and requires minimal resources. The protocol involves administering a simple questionnaire approximately 30 minutes after a training session, asking athletes to rate the session's intensity on a scale from 0 to 10, where 0 represents complete rest and 10 represents maximum effort. The result is calculated by multiplying the sRPE score by the total session duration, in minutes (Shariat et al., 2018). This tool has proven effective across various sports, including Brazilian Jiu-Jitsu (BJJ), due to its practicality and cost-effectiveness (Brito et al., 2023; Del Vecchio et al., 2018; Massuça et al., 2014).

BJJ is a combat sport that requires not only physical strength but also technical and cognitive skills (Fernandes da Costa et al., 2024; Santos et al., 2023; Santos et al., 2024), making subjective perception of effort a comprehensive measure of athletes' exertion (Andreato, Julio et al., 2015). The use of subjective assessments, such as perceived effort scales, allows coaches to gain valuable insights into the psychophysiological responses of athletes during different phases of training (Andreato et al., 2017). This is particularly relevant in BJJ, where training often alternates between high-intensity bursts and strategic recovery periods (Bromley et al., 2018; Campos et al., 202; Tibana et al., 2019; Villar et al., 2018). Understanding these perceptions can guide coaches in adapting training programs to optimize load and intensity, prevent overtraining, and create a more individualized and effective training experience for athletes (Carneiro et al., 2013; Maurício et al., 2024; Slimani, Davis et al. 2017).

In combat sports similar to BJJ, such as Olympic wrestling and Judo, subjective perception of effort has been found to be a reliable indicator of fatigue and exertion (Carmo et al., 2021). For instance, studies conducted with Olympic wrestlers and Judo athletes have shown that sRPE scores tend to correlate with high levels of fatigue, particularly in muscle groups such as the forearms and deltoids (Nilsson et al., 2002, Branco et al., 2013, Bromley et al., 2018, Franchini et al., 2019; Massuça et al., 2014). Similar findings have been observed in BJJ, where Andreato, Julio et al. (2015) found that athletes reported moderate levels of exertion (average sRPE score of 12) after seven-minute simulated matches. Later, Campos et al. (2020) observed higher levels of perceived exertion in BJJ athletes undergoing two daily training sessions over a period of seven weeks, indicating the sensitivity of the sRPE method to varying training loads.

A review could not only provide a comprehensive synthesis of how subjective perception of effort is used to assess training and competition loads in BJJ but also highlight its practical applications. By aggregating data from multiple studies, this meta-analysis could contribute to the development of more precise training load management strategies for BJJ athletes. This includes adjusting training intensity to maximize athletic development, minimize injury risks, and foster more effective athlete-coach communication through the use of subjective feedback (Andreato et al., 2017, Lima, Lima et al. 2017). Additionally, it could offer insights into the psychophysiological demands of BJJ, aiding in the design of personalized training programs that better cater to the individual needs of athletes.

Our hypotesis indicates that systematic review and meta-analysis could address a critical gap in the literature by synthesizing evidence on subjective perception of effort in Brazilian Jiu-Jitsu. The findings could have practical implications for coaches, athletes, and sports scientists, contributing to a more refined understanding of how subjective perceptions of effort influence training outcomes and athlete well-being. While many individual studies have examined subjective perception of effort in BJJ, a comprehensive synthesis of these findings is lacking.

Therefore, this systematic review and meta-analysis aim to analize studies that assess subjective perception of effort in BJJ, specifically in the contexts of pre- and post-competition, simulated fights, and training sessions.

Method

Data Analysis

For a more detailed systematic review, the study was registered (CRD199663) and authorized in the PROSPERO database (International Prospective Register of Systematic Reviews) on 11/16/2021. PROSPERO is an international prospective registry for systematic reviews, managed by the National Institute for Health Research (NIHR) – UK, and maintained by the Centre for Reviews and Dissemination (CRD) at the University of York, with financial support from the NIHR [PROSPERO, 2020].

The extracted data included sample size, athlete characteristics, and pre-combat and post-combat conditions and data, with the aim of understanding the mechanisms of internal training load control in Brazilian Jiu-Jitsu, as investigated in the literature to date.

Inclusion Criteria: Studies that analyzed at sRPE (Session Rating of Perceived Exertion);

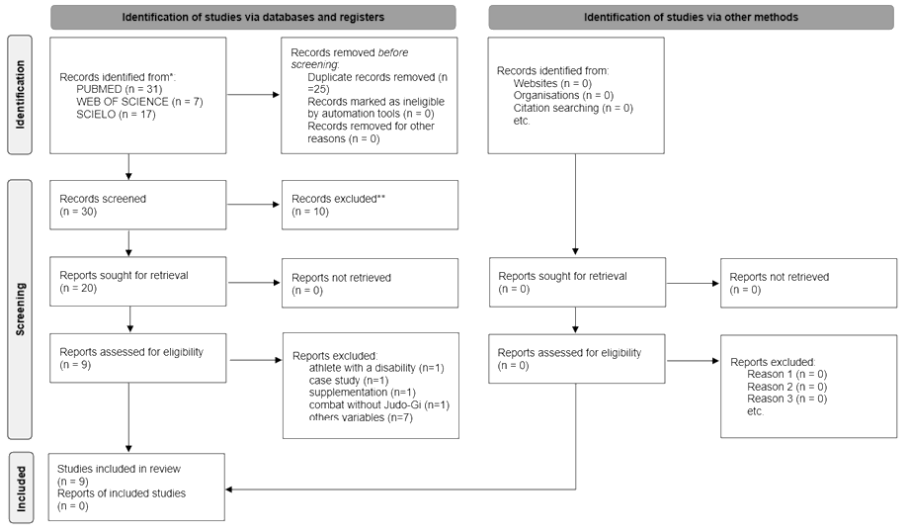
Exclusion Criteria: Systematic reviews or case studies; works involving athletes who were injured; research where athletes were using any ergogenic aid or supplementation;

studies involving athletes with a disability or with injuries; studies where athletes did not use the Judogi.

Data extraction was carried out from the databases PubMed, SCIELO, and WEB OF SCIENCE using the terms “Brazilian Jiu-Jitsu” and “subjective perception of effort”.

The figure 1 demonstrated the flow PRISMA diagram.

Figure 1. PRISMA Flow Diagram for Study Selection in the Meta-Analysis of sRPE in pre- and post-BJJ Combats.



The PRISMA flow diagram outlines the study selection process for the meta-analysis on session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu (BJJ) combats. The initial database search yielded 75 studies. After removing 25 duplicates, 50 studies were screened based on titles and abstracts. From these, 27 studies were excluded due to irrelevance or failure to meet inclusion criteria, leaving 9 full-text articles for further assessment. Ultimately, 9 studies met the inclusion criteria and were included in the meta-analysis. The final selection included randomized controlled trials, cross-sectional studies, and cohort studies with comparable sRPE measures before and after BJJ combat.

Assessing Study Quality

Present study used the Cochrane Risk of Bias (RoB) Tool (for RCTs). The Cochrane RoB tool is a tool in RevMan for assessing the quality of randomized controlled trials (RCTs). It evaluates the risk of bias in seven domains, including random sequence generation, allocation concealment, blinding, and more.

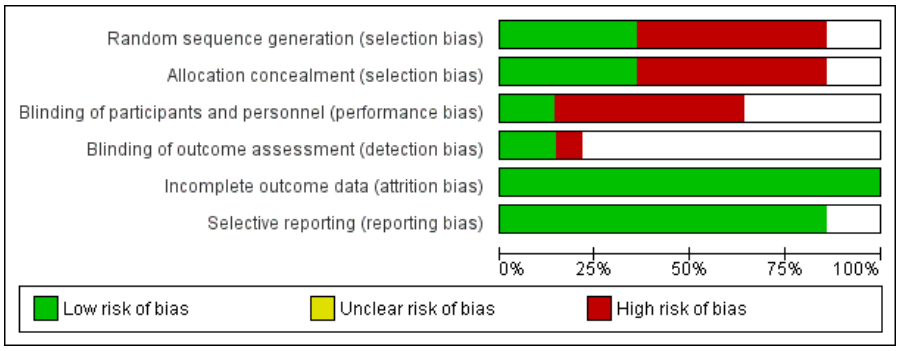
Meta-analysis

Comprehensive Meta-Analysis (CMA) software was used for statistical analysis. The effect size (Cohen's d) was calculated to compare pre- and post-combat sRPE across studies. A random-effects model was selected due to expected heterogeneity among the studies. Cohen's d was used to determine the standardized mean difference (SMD) between pre- and post- BJJ combat sRPE. Heterogeneity (I^2) statistics were used to quantify heterogeneity among studies, with values of 25%, 50%, and 75% representing low, moderate, and high heterogeneity, respectively. A funnel plot was generated to assess publication bias. The symmetry of the funnel plot was checked to determine the presence of small study effects.

Results

To assess the methodological rigor and potential biases of the studies included in this review, a quality analysis was conducted. The findings, presented in figure 2, provide an overview of the risk of methodological bias across the studies focusing on session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu (BJJ).

Figure 2. Quality analysis of studies on sRPE in BJJ and risk of methodological bias.



As shown in figure 2, the quality analysis of studies on sRPE in Brazilian Jiu-Jitsu (BJJ) reveals varying levels of methodological rigor, with some studies demonstrating a higher risk of bias. This analysis highlights the need for more standardized approaches in future research to ensure consistency and reliability in assessing internal training load through sRPE in BJJ athletes.

To provide a comprehensive overview of the studies included in this review, Figure 3 presents a summary of the key studies examining session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu (BJJ). This table includes information on the participants, interventions, pre- and post-combat sRPE scores, and the main findings from each study.

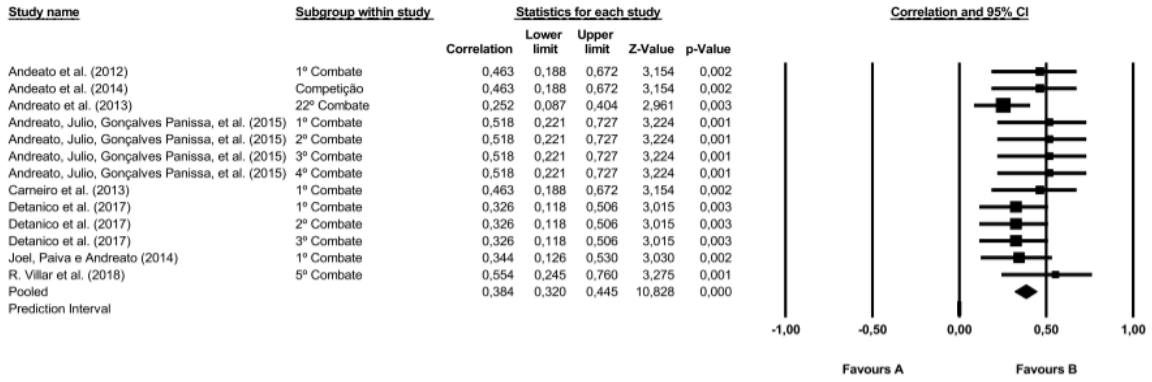
Table 1. Summary of Studies on Session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu (BJJ).

Author (Year)	Participants	Intervention	Pre-Combat	Post-Combat	Main Results
Andreato et al. (2012)	N=21; 27 ± 2.7 years; various belt ranks.	One simulated BJJ fight.	6.0	12.2	Athletes reported slightly light values on the Borg scale (6–20).
Andreato et al. (2014)	N=12; 25.2 ± 4.6 years; blue belt.	Regional-level BJJ competition.	6.0	12.3	Athletes reported very high intensity on the Borg scale (≥ 14) at the end of the competition.
Andreato, Franchini et al. (2015)	N=10; 30 ± 2.0 years; black belt.	22 simulated BJJ fights.	6.0	15.3	Increased reported intensity on the Borg scale (6–20).
Andreato et al. (2017)	N=20; 28 ± 4.0 years; black belt.	4 simulated BJJ fights.	6.0	13.2	Athletes reported increased levels of exertion on the Borg scale (6–20).

Carneiro et al. (2013)	N=27; 27 ± 4.0 years; athletes.	One simulated BJJ fight.	6.0	11.1	Athletes showed moderate exertion values on the sRPE scale.
Detanico et al. (2017)	N=22; 28.4 ± 4.9 years; purple and black belts.	Three simulated BJJ fights.	6.0	12.2	Athletes showed an increasing intensity of effort on the Borg scale after fights.
Detanico, Dellagrana et al. (2017)	N=22; 25.8 ± 4.9 years; athletes at various levels.	Three simulated BJJ fights.	8.0	17.3	Athletes showed moderate to high values on the sRPE scale.
Joel, Paiva & Giliis et al. (2018)	N=20; 28.2 ± 2.3 years; black belts.	One simulated BJJ fight.	7.0	11.6	Athletes showed moderate exertion values on the sRPE scale.
Villar et al. (2018)	N=9; 27.4 ± 5.6 years; brown & black belts.	Five simulated BJJ fights.	7.0	15.1	Athletes showed moderate increases in sRPE (using local adapted scale) after fights.

The meta-analysis presented in figure 4 illustrates the effect size of session Rating of Perceived Exertion (sRPE) in pre- and post-combat situations in Brazilian Jiu-Jitsu (BJJ).

Figure 3. Meta-analysis showing the effect size of sRPE before and after BJJ combat.



This analysis aggregates data from multiple studies to compare the subjective perception of effort reported by athletes before and after engaging in BJJ combat. The figure highlights the significant increase in perceived exertion following combat, emphasizing the physical demands and intensity of the sport.

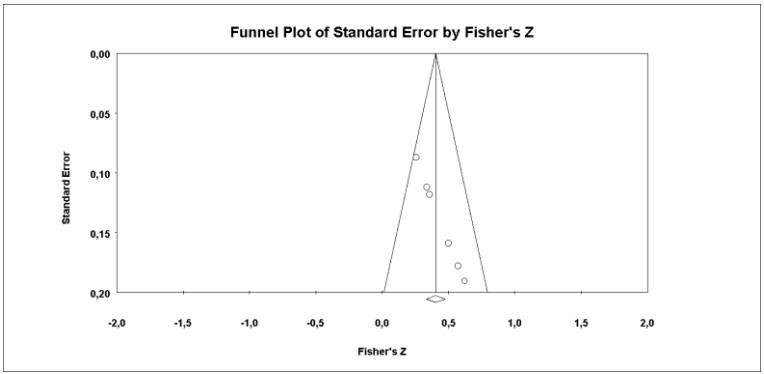
The data presented in figure 4 provide an analysis of the heterogeneity and homogeneity of sample correlations between pre- and post-combat sRPE in BJJ.

Figure 4. Results of Heterogeneity and Homogeneity of Sample Correlations in Pre- and Post- BJJ Combat sRPE

Model	Effect size and 95% interval			Test of null (2-Tail)		Prediction Interval		Between-study		Other heterogeneity statistics			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Lower limit	Upper limit	Tau	TauSq	Q-value	df (Q)	P-value	I-squared
Fixed	13	0,384	0,320	0,445	10,828	0,000					10,108	12	0,606	0,000
Random	13	0,384	0,320	0,445	10,828	0,000			0,000	0,000				

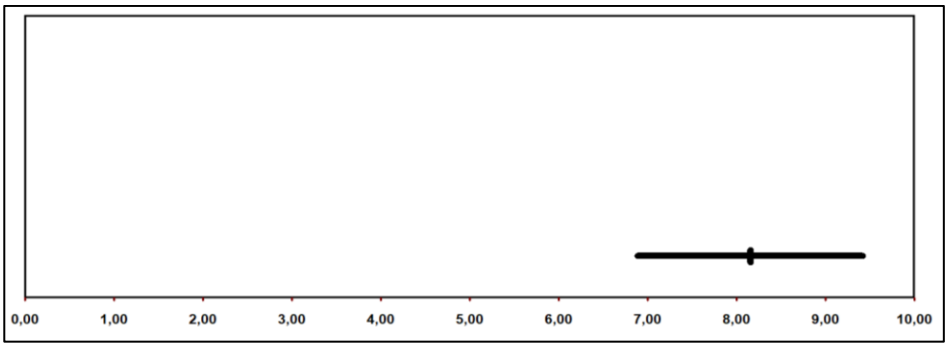
The funnel plot presented in figure 5 illustrates the distribution of standard errors for correlated pre- and post-combat session Rating of Perceived Exertion (sRPE) samples in Brazilian Jiu-Jitsu (BJJ).

Figure 5. Funnel Plot of Standard Errors for Correlated Pre- and Post-Combat sRPE Samples in BJJ.



This figure 6 helps assess the potential for publication bias in the included studies by examining the symmetry of the data points. A symmetric funnel shape would suggest a lower risk of bias, while asymmetry might indicate selective reporting or small study effects. This analysis is important for ensuring the reliability of the conclusions drawn from the meta-analysis.
The distribution of mean effects for pre- and post-combat session Rating of Perceived Exertion (sRPE) samples is depicted in figure 6.

Figure 6. Distribution of Mean Effects for pre- and post-BJJ combat sRPE studies.



This figure 6 showcases the variations in perceived exertion across different studies by comparing the mean sRPE values before and after combat in Brazilian Jiu-Jitsu (BJJ). The distribution of effects provides insights into how combat influences athletes' subjective perceptions of effort, highlighting the overall increase in exertion post-combat.

Discussion

The main results of this review on session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu (BJJ) highlight that sRPE is consistently used to assess internal training load, particularly in pre- and post-combat moments. Across studies, a significant increase in perceived effort was observed after combat compared to pre-combat values, indicating that the intensity of BJJ fights plays a crucial role in athletes' perceived exertion. In single-combat situations, athletes typically reported moderate to light intensity, while multiple combats resulted in higher sRPE scores, with athletes classifying the activity as "difficult." This variability in responses, especially in multiple combats, reflects the complex physiological and perceptual demands of BJJ. Moreover, the homogeneity in sRPE responses across studies suggests that the method is reliable and applicable in assessing training loads in BJJ athletes, though individual factors such as skill level and combat intensity must be considered for precise training adaptations.

As previously observed in the results, sRPE was the most frequently identified internal training load (ITL) variable in the articles comparing the effects of Brazilian Jiu-Jitsu (BJJ) combat in pre- and post-combat moments (n=9). All the studies found reported a significant increase in score values from pre-

combat to post-combat, which can be considered a normal trend due to the intensity of the combat (Villar et al., 2018).

In addition, the sRPE provides valuable insights into differences in performance levels among athletes, as supported by findings in the attached study. Specifically, elite competitors, such as brown and black belt athletes, report lower sRPE scores during simulated matches, reflecting their superior conditioning, technical efficiency, and psychological adaptation (Fernandes Costa et al., 2024; Maurício et al., 2024). Conversely, less experienced athletes or those engaging in multiple combats perceive higher effort levels, underscoring the need for improved fitness and recovery strategies. Structured and periodized training programs, as highlighted in the study, play a crucial role in managing ITL and ensuring consistent sRPE responses, thereby enabling athletes to optimize performance (Villar et al., 2018; Silva et al., 2022). These results emphasize the importance of tailoring training regimens to individual needs, focusing on technical skill development, efficient recovery strategies, and psychological resilience to manage perceived effort and enhance competitive outcomes (Slimani et al., 2017)

In single combat situations, athletes tended to show moderate to light intensity responses according to the Borg scale (1982) and the adapted Borg scale. This tendency may be due to the combat duration being insufficient to generate values corresponding to high intensity, as well as the possibility that some athletes were not familiar with the protocol, which relies heavily on the athlete's subjective response (Tibana et al., 2019).

In studies that investigated multiple combats, a significant increase in pre-combat values was observed in all cases. However, when analyzing post-combat values, the classification, according to the scale, showed discrepancies in some studies, although it was consistently higher than in single combat. Notably, the studies by Andreato et al. (2015) and Detanico et al. (2017) which subjected athletes to multiple simulated fights (4 and 3 fights, respectively), reported activity as 'difficult' according to the Borg scale (1982) used in the studies. This finding aligns with existing literature, as the high volume of activity consequently leads to a significant increase in exercise intensity. This heightened intensity results in a higher perceived effort by the athlete (Tibana et al., 2019).

The variability in post-combat responses among studies involving multiple fights highlights the complexity of the physiological and perceptual demands faced by Jiu-Jitsu fighters in extended competition contexts. The interaction between the number of fights, effort intensity, and perceived effort underscores the need for more individualized approaches when planning training protocols and recovery strategies for athletes involved in multiple combat competitions. This refined understanding contributes to more effective periodization, considering the specific nuances of the sport and the variable responses of athletes to different volumes of combat (Silva et al., 2022).

In the study by Villar et al. (2018), nine brown and black belt athletes were subjected to five simulated fights, and the Borg scale (1982) was applied. The athletes rated the series of fights as 'somewhat difficult.' Although this study involved more fights than previous studies, it yielded lower average values on the Borg scale (1982). This may be primarily related to the smaller sample size in the Villar et al. (2018) study. However, the same study included only brown and black belts, who may represent more physically prepared athletes, slightly lowering the scale scores compared to the other two studies, which used athletes of various ranks.

In a competition context, Andreato et al. (2014) observed 12 blue belt athletes in a regional competition, who rated the activity as 'difficult,' according to the Borg scale (1982). This finding is important, as the study presents an official competition, rather than a simulated combat, showcasing the intensity of a real competition.

Regarding the two scales observed in the study—Borg (1982), with a score range of 6 to 20, and the adapted Borg scale, with a score range of 0 to 10—both presented similar responses, especially when applied to simulated combat interventions.

The analysis of sample heterogeneity (Figures 4, 7, and 10) revealed notable homogeneity in the studies that evaluated session Rating of Perceived Exertion (sRPE) in Brazilian Jiu-Jitsu fighters (Silva et al., 2022). This uniformity suggests remarkable consistency in the subjective responses of fighters concerning perceived effort during training sessions. The observed homogeneity may have significant implications for the applicability of the sRPE assessment protocol in this specific population. The

consistency in results indicates that the instrument used to measure perceived effort in Jiu-Jitsu fighters may be robust and reliable, providing coherent data that can be generalized to the study sample.

However, it is crucial to interpret this homogeneity in light of the individual and contextual complexities involved in Jiu-Jitsu training (Santos, Maurício et al., 2023; Silva et al., 2022). Even with homogeneous results in subjective effort perception, other factors such as specific training strategies, variations in fighters' skill levels, and different combat intensities may influence the interpretation of these results. Therefore, while the homogeneity suggests consistency in fighters' responses regarding sRPE, it is essential to consider these contextual factors for a more accurate and tailored application of the perceived effort assessment protocol in Brazilian Jiu-Jitsu athletes.

Conclusions

The systematic review summarized nine studies on sRPE. The main results demonstrated a significant increase in sRPE in post-combat moments compared to pre-combat moments, indicating a high level of physical stress generated by simulated combat or BJJ competition. The sRPE analyzed, when compared to each other, showed similar responses regarding the intensity of the different interventions, whether simulated combat or BJJ competition. The practical application of this work highlights the intensity of BJJ training sessions and competitions through the observed sRPE. Additionally, it points to the similarity of protocols used to measure sRPE in BJJ. Further studies should be conducted in this field with better standardization of samples and interventions to enable a meta-analysis capable of comparing data from different studies.

Financing

None.

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