2022, *Retos, 45,* 351-363


# Profile of the Brazilian Jiu-Jitsu fighter, variables, techniques and instruments for measuring sports performance: A scoping review

# Perfil del luchador de Jiu-Jitsu Brasileño, variables, técnicas e instrumentos para medir el rendimiento deportivo: Una revisión de alcance

*Cristóbal R Riquelme-Hernández, **Juan P Reyes-Barría, ***Tomas Herrera-Valenzuela, ****Rafael Zapata-Lamana, ****,*****Daniel Reyes-Molina, *****Igor Cigarroa

*Centro de salud familiar (CESFAM) Padre las Casas (Chile), **Clínica Resilient (Chile), ***Universidad de Santiago de Chile (Chile), ****Universidad de Concepción (Chile), *****Universidad Santo Tomás (Chile),

**Abstract:** Aims: To verify a Brazilian Jiu-Jitsu fighter profile studied in the literature and to characterize the variables, techniques and instruments for measuring sports performance. Methods: The review was carried out according to the declaration criteria PRISMA, considering studies between the years 2010 and 2020 in the SportDiscus, PubMed/Medline, SCOPUS, LILACS, Dialnet and SCIELO. Results: A total of 51 studies were chosen, mostly of Brazilian origin (82.4%). The total sample was integrated by 1,493 fighters (98% men), with an average age of 27.1 years. The most assess variables were the physiological (24 studies) and the physical (13 studies). Of them, the most analyzed were the lactate and grip force, respectively. The assessment instruments most used were the Borg Rating of Perceived Exertion for the physiological variables (13 studies), the dynamometry for the physical variables (13 studies), and the weight scale for anthropometric and nutritional variables (15 studies). Conclusions: It has been generated a Brazilian Jiu-Jitsu fighter profile. The most frequently studied variables were the physiological and physical. The most assessment instrument used were the weight scale, dynamometry and Borg Rating of Perceived Exertion. Moreover, there are few studies that perform measurements in real time, in female fighters, in Brazilian Jiu-Jitsu fighters and who report the fighter style.
**Key words:** Brazilian jiu-jitsu; assessment; performance; athletic performance; martial arts; sport medicine.

**Resumen**: Objetivos: Verificar un perfil de luchador de Jiu-Jitsu brasileño estudiado en la literatura y caracterizar las variables e instrumentos utilizados para valorar el rendimiento deportivo. Metodología: La revisión se realizó de acuerdo con los criterios de declaración PRISMA, considerando estudios entre los años 2010 y 2020 en el SportDiscus, PubMed / Medline, SCOPUS, LILACS, Dialnet y SCIELO. Resultados: Se eligieron un total de 51 estudios, en su mayoría de origen brasileño (82,4%). La muestra total estuvo integrada por 1.493 combatientes (98% hombres), con una edad promedio de 27,1 años. Las variables más evaluadas fueron las fisiológicas (24 estudios) y las físicas (13 estudios). De ellos, los más analizados fueron el lactato y la fuerza de agarre, respectivamente. Los instrumentos de evaluación más utilizados fueron el Borg Rating of Perceived Esfuerzo para las variables fisiológicas (13 estudios), la dinamometría para las físicas (13 estudios) y la escala de peso para las variables antropométricas y nutricionales (15 estudios). Conclusiones: Se ha generado un perfil de luchador de Jiu-Jitsu brasileño. Las variables más estudiadas fueron las fisiológicas y físicas. Los instrumentos de evaluación más utilizados fueron la escala de peso, la dinamometría y el índice de Borg de esfuerzo percibido. Además, existen pocos estudios que realicen mediciones en tiempo real, en luchadoras femeninas, en luchadoras de Jiu-Jitsu brasileñas y que reporten el estilo de luchadores.
**Palabras clave:** jiu-jitsu brasileño; evaluación; rendimiento; rendimiento atlético; artes marciales; medicina deportiva.

## Introduction

The Brazilian Jiu-Jitsu (BJJ) is a grappling combat sport characterized by management techniques and leverage that was born in Japan, later it arrived to Brazil in 1915, which was improved by Carlos Gracie (Del Vecchio et al., 2007). Regarding its popularity, emerges through the significance that developed in the world championship starting in 1996, organized by International Brazilian Jiu-Jitsu Federation (IBJJF), Nowadays, the BJJ is developed in many countries and particularly in the last ten years it has been a substantial growth in BJJ popularity, part of this, must be to success of the BJJ athletes in mixed martial arts events (Andreato et al., 2016).

Regarding the characteristics of the BJJ, the athletes star in the fight standing up, however, the techniques allowed in competition are: projection of the opponent, immobilization, chokes, twists and on the other hand,

Fecha recepción: 05-09-21. Fecha de aceptación: 15-03-22
Igor Cigarroa
icigarroa@santotomas.cl

hyperextensions of the joints are not allowed (da Silva et al., 2016). On the contrary, if there is no submission, the fights are determined through the specific punctuation obtained from performed techniques (takedown, guard pass, mount, rear mount, back control, belly knee and sweep), and in case of dead heat by arbitrator decision (Andreato et al., 2017).

The BJJ most commonly physical characteristics are: muscular strength (Yates, 2017), hand grip (Corrêa et al., 2014), isometric strength (Corrêa et al., 2017), flexibility (Andreato et al., 2011) aerobic capacity (Pinheiro et al., 2011) and anaerobic capacity (Corrêa et al., 2014), and perception of effort (Detanico et al., 2017) measured by rating perceived exertion (RPE) as a result measure that allows to establish and dose exercise intensity (Zambrano & Manterola, 2016).

Physical capacities and abilities are required in order to endure BJJ training and competitions, given to intermittent efforts characteristics, with alternating high and low intensity stimulus (Villar et al., 2018), regarding the intermittency of the BJJ, the effort / pause ratio reported in the matches has been from 6: 1 to 13: 1, with periods of effort of 85 to 290 seconds and pauses of 5 to 44 seconds, respectively (Andreato et al., 2016). The BJJ has intermittent characteristics, therefore grapplers need a specific physical condition to withstand training and competitions, in this line the aerobic power provides the possibility of maintaining high intensity during combat, preventing fatigue and benefits recovery; muscle strength used for attack-defense movements and specific techniques; muscular endurance to maintain grip on the opponent's gi; and flexibility, which helps in specific attack or defense situations (Andreato et al., 2017).

In terms of BJJ psychological characteristics stand out: Stress (Campos et al., 2020), mood and anxiety, is consider that athletes show behaviors and similar patterns described in other sports, its means, an iceberg profile (Andreato et al., 2014). Nowadays, is found an increasing study body in relation to the performance parameters and its evaluation in different grappler combat sport, in the same way, Olympics sports have been researching such Judo and wrestling (Chaabene et al., 2017). However, there is a research lack about BJJ (Øvretveit, 2018a, Andreato et al., 2017, Andreato et al., 2015).

Regarding, existing BJJ researches aimed at knowing the variables related to the evaluation of physical and psychological parameters, there is a divergence between the physical and psychological variables that are most related to sports performance, as well as with the evaluation methods and measurement instruments used. As an example, for the strength evaluation method for the upper body segments of BJJ athletes, it has not been determined which is the best (Detanico et al., 2017), even in essential physical conditions for optimal performance of the fighter, there are contradictory results, where some authors show a decrease in the isometric strength of the grip measured after a simulated competition fight and other studies describe that the isometric strength does not decrease (Corrêa et al., 2017), even decreased grip strength only in the dominant hand (Andreato et al., 2014).

Nowadays, the sports are evolving to an improvement of physical- physiological, without diminishing the importance of the rest of the factors involved such as technical-tactical aspects, which is why it is necessary to create and use instruments that evaluate the physical component of the athlete, in order to know their performance (Mancha et al., 2019).

The BBJ has been gaining followers and more and more athletes who practice it, despite the increase in popularity of this sport, there is still little evidence of scientific evidence focused on this sports discipline. We were chosen as the study design a scoping review, to clarify and characterize concepts according to BJJ. This type of study is useful to explore areas of the literature in an exhaustive way (Peters et al., 2015). Thus, the scoping review will allow us to describe the fighter´s profile and the instruments used to assess their sport performance, also will allow us identify knowledge gap and suggest recommendations for future research. In this line, the aims of this review were to verify a Brazilian Jiu-Jitsu fighter profile studied in the literature and to characterize the variables, techniques and instruments for measuring sports performance.

## Methods

The scoping review was carried out in accordance with the norms established by the PRISMA 2020 statement (Figure 1) (Page et al., 2021). The PRISMA checklist can be found in the supplementary material (Table S1). The manuscript was not registered in PROSPERO. PROSPERO does not currently accept registrations for scoping reviews, literature reviews or mapping reviews.

### *Search strategy to identify studies*

A scoping review was developed in the following

electronic databases, in the order indicated:

PubMed/Medline, SCOPUS, SportDiscus, SCIELO and Dialnet. All the articles published in the available databases that studied the characteristics, variables and instruments to assess sports performance in BJJ fighters were identified. For effects, keywords were obtained, on which the general search syntax was generated: «Brazilian Jiu Jitsu» AND «performance» OR Assessment. These words were used in English, Spanish and Portuguese, according to the database. Thus, «Brazilian Jiu Jitsu», «performance» and valuation, «performance» and «avaliação» were used. The search was limited to the period between January 2010 and August 30, 2020. This period of time was decided to obtain the most updated data on the BJJ fighters profile, the variables and measurement instruments used in these athletes. The complete search strategy in all databases is presented in the supplementary material (Table S2).

### *Studies selection*

Systematic reviews, editorial documents, experimental studies, protocols, or theses were not included. The articles selected by title and abstract had to meet the conditions indicated in Table 1.

Table 1.
*Selection criteria*

| Criteria | Description |
|---|---|
| 1) Brazilian Jiu-jitsu | a)Use Works that study-related Brazilian Jiu-Jitsu<br>b)Assess aspects of sports performance in practitioners graduated or not of Brazilian Jiu-jitsu, in situations of official competition, training or evaluations of the physical determinants related to the discipline.<br>c)Male and female Brazilian jiu-jitsu wrestlers of amateur and/or professional adult level, master 1 and 2.<br>d)In active fighters either by competitive terms at the national level, international or training in established academies. |
| 2) Assessment and performance | a)Psychological variables: anxiety, stress, mood, concentration y attention.<br>b)Physical variables: qualities of muscle strength, grip strength, aerobic capacity, anaerobic capacity, flexibility, perception of effort.<br>c)Assessment of performance variables: sports achievements such as national, Pan-American, world.<br>d)It includes evaluative instruments: batteries, questionnaires, surveys, electronic devices, laboratory analysis and field tests. |
| 3) Type of article | a)Original analytical articles (descriptive of case and control, cohort and longitudinal, etc.)<br>b)Publications from January 2010 to August 30, 2020.<br>c)English language, Portuguese and Spanish. |

### *Data extraction*

In the first instance, duplicate articles were removed using the Mendeley program, then, two independent reviewers (C.R-H and J.R-B) applied inclusion/exclusion criteria to all titles and summaries. Articles that met the inclusion criteria were selected and, when decisions could not be made based on the title and abstract alone, the full-text documents were also retrieved. The selected articles and were independently verified by the same two reviewers (C.R-H. and J.R-B.); however, when there were discrepancies, a consensus was reached with a third reviewer (I.C.). Then, data were independently extracted by the same reviewer (C.R-H. and J.R-B.) and entered into a prepared Excel spreadsheet (Excel, Microsoft Corporation, Redmond, Washington, USA. Finally, the main results are presented in summary tables and figures.

### *Risk of the bias assessment tool*

The Newcastle-Ottawa Scale (NOS) tool was used. This scale assesses the quality of non-randomized studies. It is composed of eight items, divided into three dimensions (comparison, selection, type of study) of cross-sectional, cross-sectional or case-control investigations (Lo et al., 2014). NOS assesses the risk of bias from 0-9 stars. The higher the number of stars, the lower the risk of bias. NOS considered a high risk of bias d»6 stars and a low risk of bias e»7 stars (Lo et al., 2014). NOS has been used as in other studies (Ortiz Sánchez et al., 2020), The results of this analysis are presented in Table 2. Each article was independently graded by two reviewers (C.R-H and J.R-B), and the scores were compared. When there was disagreement, consensus was reached with a third reviewer (I.C.).

### *Strategy for data synthesis*

A narrative synthesis of the findings was provided from the included studies and the main information is presented in summary tables and figures. The results were ordered to present the PRISMA flow diagram (Figure 1). The general characteristics of the articles (author, country , year, sample, retirement, retirement cause, gender, age range, average age) (Table 2); methodological characteristics of the articles (focus, scope, timing) and risk of bias assessed using the Newcastle-Ottawa questionnaire (Table 3); Fighters characteristics (BJJ category, athlete situation, measurement situation, fighter style (Figure 2); analysis variables (psychological, physiological, physical, anthropometric) (Figure 3); Assessment instruments according to each variable (questionnaires, interviews, direct and indirect methods, field tests, laboratory tests) (Figure 4).

## Results

### *Literature search*

In the initial search, 345 scientific articles were identified, of which 62 articles were duplicates. After reading by titles and abstracts, 211 studies were excluded for not addressing the inclusion and exclusion

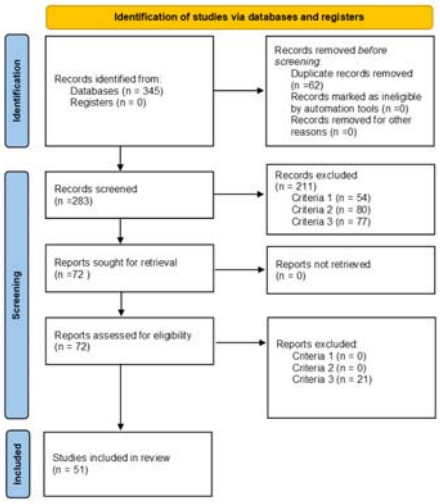


**Figure 1.** *PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only* (Page et al., 2021).

criteria, leaving 72 for reading the full text. After reading, 21 were excluded, finally 51 articles were selected for this review.

### *General characteristics of the studies*

A total of 51 studies were included, of these, 82.4% of origin in Brazil. 80.4% of the studies were concentrated between 2014 and 2020.The initial sample corresponded to a total of 1,583 BJJ fighters of which 5 fighters withdrew due to incomplete data (0.31% of the total population), so the final sample was 1,493 BJJ fighters (98% male; 27.7 years' average). Regarding the age range of the fighters, 96.1% were between 25-40 years old and 70.6% between 18-24 years old. (Table 2).

Table 2.
*General characteristics of the articles.*

| First author | | | Sample | | Withdrawal | Cause of withdrawal | Gender | | Age range (years) | | | Average age |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Initial | Final | | | ? | ? | | | | |
| (1° surname, initial 1° name) | Country | Year | n° | n° | % | | % | % | 18-24 | 25-40 | 41-64 | (years) |
| (Abad et al., 2016) | Brazil | 2016 | 21 | 21 | 0 | - | 0 | 100 | ✓ | ✓ | - | 27,8 |
| (Andrade et al., 2019) | Brazil | 2019 | 14 | 14 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,1 |
| (Andreato et al., 2014) | Brazil | 2014 | 12 | 12 | 0 | - | 0 | 100 | ✓ | ✓ | - | 22,5 |
| (Andreato et al., 2012) | Brazil | 2012 | 11 | 11 | 0 | - | 0 | 100 | ✓ | ✓ | - | 25,8 |
| (Andreato et al., 2013) | Brazil | 2013 | 35 | 35 | 0 | - | 0 | 100 | ✓ | ✓ | - | 33,0 |
| (Andreato et al., 2012) | Brazil | 2012 | 12 | 12 | 0 | - | 0 | 100 | - | ✓ | - | 27,1 |
| (Andreato, et al., 2015) | Brazil | 2015 | 10 | 10 | 0 | - | 0 | 100 | ✓ | ✓ | - | 28,0 |
| (Andreato et al., 2015) | Brazil | 2015 | 10 | 10 | 0 | - | 0 | 100 | ✓ | ✓ | - | 28,0 |
| (Andreato et al., 2016) | Brazil | 2016 | 15 | 15 | 0 | - | 0 | 100 | ✓ | ✓ | - | 28,0 |
| (Andreato et al., 2017) | Brazil | 2016 | 10 | 10 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,0 |
| (Andreato et al., 2016) | Brazil | 2016 | 10 | 10 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,0 |
| (Andreato et al., 2016) | Brazil | 2016 | 8 | 8 | 0 | - | 0 | 100 | ✓ | ✓ | - | 28,0 |
| (Báez et al., 2014) | Chile | 2014 | 25 | 25 | 0 | - | 0 | 100 | ✓ | ✓ | - | 26,3 |
| (Brandao et al., 2014) | Brazil | 2014 | 30 | 30 | 0 | - | 0 | 100 | ✓ | ✓ | - | 24,0 |
| (Bevilacqua & Turczyn, 2015) | Brazil | 2015 | 84 | 84 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,1 |
| (Brasil et al., 2015) | Brazil | 2015 | 34 | 34 | 0 | - | 0 | 100 | ✓ | ✓ | ✓ | 31,0 |
| (Carneiro et al., 2013) | Brazil | 2013 | 14 | 14 | 0 | - | 0 | 100 | ✓ | ✓ | - | 27,0 |
| (Andrade et al., 2019) | Brazil | 2019 | 8 | 8 | 0 | - | 0 | 100 | ✓ | ✓ | - | 24,9 |
| (Correa et al., 2017) | Brazil | 2017 | 20 | 20 | 0 | - | 0 | 100 | ✓ | ✓ | - | 25,7 |
| (Corrêa et al., 2014) | Brazil | 2014 | 40 | 40 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,0 |
| (Coswig et al., 2013) | Brazil | 2013 | 16 | 16 | 0 | - | 0 | 100 | ✓ | ✓ | - | 33,0 |
| (Coswig et al., 2018) | Brazil | 2018 | 40 | 40 | 0 | - | 0 | 100 | ✓ | ✓ | - | 23,0 |
| (Coswig et al., 2018) | Brazil | 2018 | 12 | 12 | 0 | - | 0 | 100 | ✓ | ✓ | - | 23,0 |
| (Coswig et al., 2013) | Brazil | 2013 | 4 | 4 | 0 | - | 0 | 100 | ✓ | ✓ | - | 27,5 |
| (da Silva Junior et al., 2019) | Brazil | 2019 | 60 | 60 | 0 | - | 0 | 100 | ✓ | ✓ | ✓ | 29,5 |
| (Da Silva et al., 2013) | Brazil | 2013 | 14 | 14 | 0 | - | 0 | 100 | ✓ | ✓ | - | 23,2 |
| (da Silva et al., 2012) | Brazil | 2012 | 30 | 30 | 0 | - | 0 | 100 | ✓ | ✓ | - | 29,0 |
| (Corrêa et al., 2014) | Brazil | 2014 | 23 | 23 | 0 | - | 0 | 100 | ✓ | ✓ | - | 26,3 |
| (de Sousa et al., 2020) | Brazil | 2020 | 24 | 24 | 0 | - | 0 | 100 | - | ✓ | - | 30,1 |
| (Detanico et al., 2017) | Brazil | 2016 | 22 | 22 | 0 | - | 0 | 100 | ✓ | ✓ | - | 25,8 |
| (Diaz-Lara et al., 2015) | Spain | 2015 | 26 | 26 | 0 | - | 0 | 100 | - | ✓ | - | 28,9 |
| (Diaz-Lara et al., 2014) | Spain | 2014 | 56 | 56 | 0 | - | 0 | 100 | - | ✓ | - | 30,2 |
| (Faro et al., 2020) | Brazil | 2020 | 113 | 113 | 0 | - | 0 | 100 | ✓ | ✓ | - | 26,6 |
| (Ferreira et al., 2016) | Brazil | 2016 | 18 | 18 | 0 | - | 0 | 100 | ✓ | ✓ | - | 24,0 |
| (Follmer et al., 2017) | Brazil | 2017 | 28 | 28 | 0 | - | 0 | 100 | ✓ | ✓ | - | 26,8 |
| (Franchini & da Silva, 2019) | Brazil | 2019 | 14 | 14 | 0 | - | 0 | 100 | ✓ | ✓ | - | 25,8 |
| (Silva et al., 2014) | Brazil | 2014 | 28 | 28 | 0 | - | 0 | 100 | - | ✓ | - | 31,9 |
| (Kohoutkova et al., 2018) | CR | 2018 | 141 | 136 | 4,6 | NCR | 0 | 100 | ✓ | ✓ | ✓ | 28,5 |
| (Keating et al., 2011) | USA | 2011 | 10 | 10 | 0 | - | 0 | 100 | - | ✓ | - | NE |
| (Kons et al., 2017) | Brazil | 2017 | 20 | 20 | 0 | - | 0 | 100 | ✓ | ✓ | - | 25,0 |
| (Joel et al., 2014) | Brazil | 2014 | 20 | 20 | 0 | - | 0 | 100 | - | ✓ | - | 27,8 |
| (Lima et al., 2017) | Brazil | 2017 | 38 | 38 | 0 | - | 0 | 100 | ✓ | - | - | 22,9 |
| (Øvretveit, 2018a) | Norway | 2018 | 42 | 42 | 0 | - | 0 | 100 | - | ✓ | - | 32,0 |
| (Øvretveit, 2018b) | Norway | 2018 | 12 | 12 | 0 | - | 0 | 100 | - | ✓ | - | 30,6 |
| (Øvretveit et al., 2018) | Norway | 2019 | 12 | 12 | 0 | - | 0 | 100 | - | ✓ | - | 30,6 |
| (Santos et al., 2019) | Brazil | 2019 | 6 | 6 | 0 | - | 0 | 100 | - | ✓ | - | 39,0 |
| (Silva de Araújo et al., 2019) | Brazil | 2019 | 10 | 10 | 0 | - | 0 | 100 | - | ✓ | - | 26,6 |
| (Stachoň et al., 2015) | Poland | 2015 | 43 | 43 | 0 | - | 0 | 100 | ✓ | - | - | 22,5 |
| (Vidal et al., 2011) | Brazil | 2011 | 11 | 11 | 0 | - | 0 | 100 | - | ✓ | - | 25,8 |
| (Villar et al., 2018) | Brazil | 2018 | 9 | 9 | 0 | - | 0 | 100 | - | ✓ | - | 27,1 |
| (Brandt et al., 2019) | Brazil | 2019 | 173 | 173 | 0% | - | 25% | 75% | - | ✓ | - | 28,5 |

CR: Czech Republic, *NCR: incomplete data, (-): not registered.* ✓= *registered data.*

### *Risk of bias and methodological characteristics of the articles*

The table 3 shows the methodological characteristics of the selected studies. The study designs were mostly analytical (64.7%). The largest number of studies corresponded to observational design (31.4%) and cohort (29.4%) and case-control (25.5%) studies. The most frequent scope was comparative (55%) and most of the studies had a transversal temporality (55%). According to the Newcastle Ottawa scale, 51% of the studies were at high risk of bias (Table 3).

### *Fighters characteristics*

Regarding the sporting level of the fighters, 43 studies included advanced category fighters (purple (roxa), brown and black belts), 29 novices (white and blue belts) and six elite ones.

Most of the studies were conducted on BJJ fighters (n = 50 studies) and only 1 study on Jiu-jitsu wrestlers. The studies were carried out in training sessions, without a competition situation (n = 23 studies), followed by

Table 3.
*Methodological characteristics of the articles*

| First author (1° surname, initial 1° name) | Study design | Type of study | Reach | Temporality | NOS | Level of Bias |
|---|---|---|---|---|---|---|
| (Abad et al., 2016) | analytical | prospective cohort | correlational | longitudinal | 6 * | high bias |
| (Andrade et al., 2019) | analytical | prospective cohort | correlational | longitudinal | 6 * | high bias |
| (Andreato et al., 2014) | analytical | prospective cohort | correlational | longitudinal | 6 * | high bias |
| (Andreato et al., 2012) | analytical | prospective cohort | descriptive | longitudinal | 6 * | high bias |
| (Andreato et al., 2013) | analytical | prospective cohort | descriptive | longitudinal | 6 * | high bias |
| (Andreato et al., 2012) | analytical | prospective cohort | correlational | longitudinal | 6 * | high bias |
| (Andreato et al., 2015) | analytical | prospective cohort | correlational | longitudinal | 7 * | low bias |
| (Andreato, et al., 2015) | analytical | prospective cohort | correlational | longitudinal | 7 * | low bias |
| (Andreato et al., 2016) | descriptive | transversal | descriptive | transversal | 6 * | high bias |
| (Andreato et al., 2017) | analytical | prospective cohort | comparison | longitudinal | 6 * | high bias |
| (Andreato, et al., 2016) | analytical | prospective cohort | comparison | longitudinal | 7 * | low bias |
| (Andreato et al., 2016) | analytical | prospective cohort | comparison | longitudinal | 7 * | low bias |
| (Báez et al., 2014) | descriptive | transversal | comparison | transversal | 6 * | high bias |
| (Brandao et al., 2014) | analytical | Case and control | comparison | longitudinal | 8 * | low bias |
| (Bevilacqua & Turczyn, 2015) | descriptive | transversal | comparison | transversal | 5 * | high bias |
| (Brasil et al., 2015) | descriptive | transversal | comparison | transversal | 8 * | low bias |
| (Carneiro et al., 2013) | analytical | prospective cohort | comparison | longitudinal | 6 * | high bias |
| (Andrade et al., 2019) | descriptive | transversal | correlational | transversal | 6 * | high bias |
| (Correa da Silva et al., 2017) | analytical | prospective cohort | comparison | longitudinal | 6 * | high bias |
| (Corrêa da Silva et al., 2014) | descriptive | transversal | comparative | transversal | 8 * | low bias |
| (Coswig et al., 2013) | descriptive | transversal | comparative | transversal | 8 * | low bias |
| (Coswig et al., 2018) | descriptive | transversal | comparative | transversal | 6 * | high bias |
| (Coswig et al., 2018) | analytical | prospective cohort | comparative | longitudinal | 7 * | low bias |
| (Coswig et al., 2013) | descriptive | Number of cases | comparative | longitudinal | 6 * | high bias |
| (da Silva Junior et al., 2019) | descriptive | transversal | comparative | transversal | 7 * | low bias |
| (Da Silva et al., 2013) | analytical | Case and control | comparative | longitudinal | 5 * | high bias |
| (da Silva et al., 2012) | analytical | Case and control | correlational | transversal | 6 * | high bias |
| (Corrêa et al., 2014) | analytical | prospective cohort | descriptive | longitudinal | 6 * | high bias |
| (de Sousa et al., 2020) | analytical | Case and control | Group comparison | transversal | 5 * | high bias |
| (Detanico et al., 2017) | analytical | transversal | descriptive | longitudinal | 6 * | high bias |
| (Diaz-Lara et al., 2015) | descriptive | transversal | descriptive | longitudinal | 8 * | low bias |
| (Diaz-Lara et al., 2014) | analytical | Case and control | Group comparison | transversal | 7 * | low bias |
| (Faro et al., 2020) | analytical | Case and control | Group comparison | longitudinal | 5 * | high bias |
| (Ferreira Marinho et al., 2016) | analytical | Case and control | Group comparison | transversal | 7 * | low bias |
| (Follmer et al, 2017) | descriptive | transversal | descriptive | transversal | 8 * | low bias |
| (Franchini & da Silva, 2019) | analytical | Case and control | descriptive | longitudinal | 7 * | low bias |
| (Silva et al., 2014) | analytical | Case and control | Group comparison | transversal | 7 * | low bias |
| (Kohoutkova et al., 2018) | analytical | transversal | Group comparison | transversal | 5 * | high bias |
| (Keating et al., 2011) | analytical | Case and control | Group comparison | transversal | 6 * | high bias |
| (Kons et al., 2017) | analytical | Case and control | Group comparison | transversal | 7 * | low bias |
| (Joel et al., 2014) | analytical | Case and control | Group comparison | longitudinal | 7 * | low bias |
| (Lima et al., 2017) | analytical | case and control | Group comparison | transversal | 7 * | low bias |
| (Øvretveit, 2018a) | descriptive | transversal | Descriptive | transversal | 8 * | low bias |
| (Øvretveit, 2018b) | descriptive | prospective cohort | Descriptive | transversal | 8 * | low bias |
| (Øvretveit et al., 2018) | Descriptive | transversal | Descriptive | transversal | 6 * | high bias |
| (Santos Silva Lopes et al., 2019) | Descriptive | Number of cases | Exploratory | transversal | 5 * | high bias |
| (Silva de Araújo et al., 2019) | Descriptive | transversal | correlational | transversal | 8 * | low bias |
| (Stachoń et al., 2015) | analytical | case and control | Group comparison | transversal | 7 * | low bias |
| (Vidal Andreato et al., 2011) | descriptive | transversal | descriptive | transversal | 8 * | low bias |
| (Villar et al., 2018) | analytical | case and control | correlational | transversal | 7 * | low bias |
| (Brandt et al., 2019) | analytical | case and control | Group comparison | transversal | 5 * | high bias |

*NOS: Newcastle Ottawa Scale, high risk of bias: =6, low risk of bias: =7.*

simulated competition situations (n = 19 studies) and only nine studies were carried out in a competition situation. Of these, international competitions were the most frequent (n = six studies). In most of the studies, BJJ's wrestling style was not indicated (47/51) and only four of them reported the wrestler's style, referring to them as passer or keeper (Figure 2).

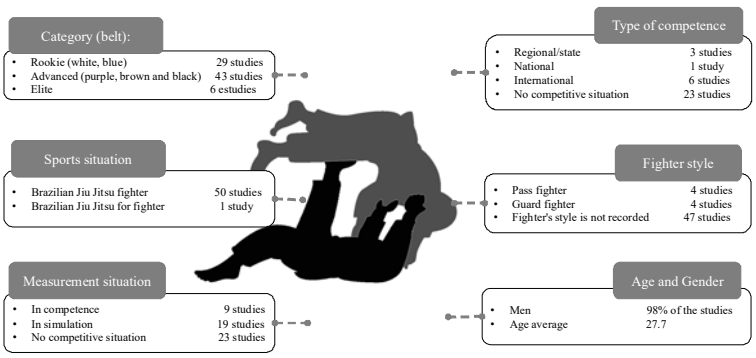


**Figure 2.** *BJJ fighters' characteristics*

### *Description of the analysis variables*

a) Figure 3 describes the distribution of the variables analyzed in each study, which were grouped into six categories (a) psychological, b) physiological, c) physical, d) technical-tactical, e) anthropometric and f) nutritional) (Figure 3).

b) Psychological variables: eight variables were found. The most frequent were mood in four studies, anxiety and level of recovery in two studies.

c) Physiological variables: 24 variables were found. The most frequent were lactate 17 studies, RPE / Borg 15 and Heart rate 12 studies.

d) Physical variables: 13 variables were found. The most frequent were prehensile / grip strength 20 studies, lower limb power 12, upper limb strength seven, and flexibility with six studies.

e) Technical and tactical variables: Only two variables, which were technical and tactical with five studies respectively.

f) Anthropometric variables: five anthropometric variables were found. The most frequent were body weight and height with 11 studies, and body composition eight studies.

g) Nutritional variables: three variables were found, intake of macronutrients / micronutrients four studies.

### *Assessment instruments*

The figure 4 describes the instruments used for the assessment of the analyzed variables, which were grouped into four categories (a) psychological, b) physiological, c) physical and d) anthropometric and nutritional. The technical-tactical variables used video analysis and not considered in the figure and the anthropometric variables were unified with the nutritional ones.

Assessment instruments for psychological variables: seven instruments were found. The most frequent were Brunel Mood Scale: four studies and State Competitive Anxiety Inventory 3 studies.

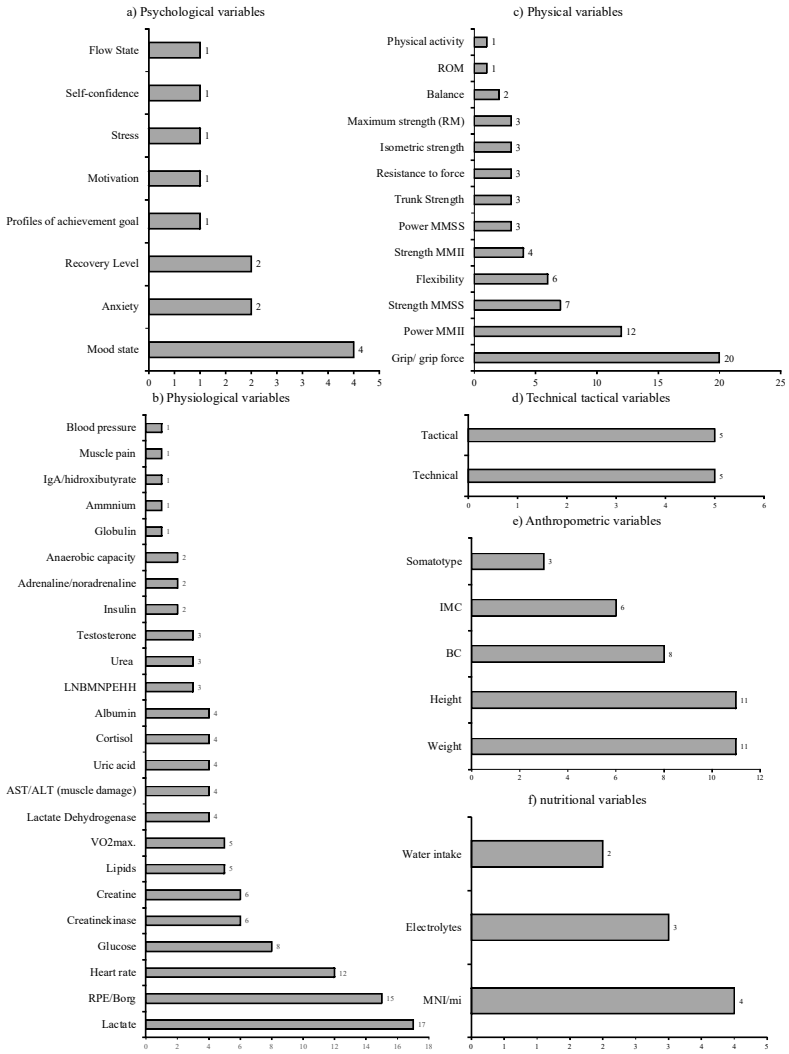


**Figure 3.** *Analysis variables*
***LNRMNPEHH**: leukocytes, neutrophils, rods, monocytes, platelets, eosinophils, hemoglobin, hematocrit, **Strength MMSS**: upper limb strength, **Strength MMII**: lower limb strength, **Power MMSS**: upper limb power, **ROM**: range of motion, **BC**: body composition, **BMI**: body mass, **MNI / mi**: macronutrient / micronutrient intake.*

a) Instruments for assessing physiological parameters: 12 instruments were found. The most frequent were RPE / Borg scale 13 studies, heart rate monitoring ten studies, portable lactate analyzer and biochemical analysis nine studies each.

b) Instruments for assessing physical parameters: 20 instruments were found. The most frequent were dynamometry with 13 studies, Suspension Gripping a Kimono Test nine studies, jump platform and Sit and Reach with seven studies respectively.

c) Instruments for assessing anthropometric and nutritional parameters: six instruments were found. The most frequent were weight scale 15 studies, height rod 14 studies and plicometer with ten studies.

## Discussion

### *What are the main results?*

The main results of this scoping review are grouped in relation to the profile of the fighter, the variables, and instruments most used in the literature to analyze the BJJ performance. The studies mainly analyzed BJJ male fighters, originally from Brazil, with an age ranging between 25-40 years, from advanced categories and who were in training situations.

In relation to the variables, six types were analyzed, the most frequent were physiological variables (24 variables) physical variables (13 variables) and of these the most analyzed were lactate and grip strength, respectively. Regarding the valuation instruments, the most used were; for psychological variables the Brunel Mood Scale (four studies), physiological variables the RPE / Borg scale (13 studies), physical variables dynamometry (13 studies), technical-tactical variables the video analysis (three studies) and for anthropometric variables and nutritional balance (15 studies).

### *What was known before this review?*

This review synthesized the studies of the last ten years that used the methods of evaluating sports performance in BJJ fighters, the psychological, physiological, physical, technical-tactical, anthropometric and nutritional variables were observed. The studies reviewed contained a profile of the fighters, which stands out for analyzing young male athletes of Brazilian origin (27 years) who probably, given their origin (Brazil), concentrate the majority of BJJ fighters (Vicentini & Marques, 2019).

This suggests that there is still a lack of studies that use other populations, for example, Parajiu-Jitsu (Santos et al., 2019), of which only 1 study was found that uses fighters with disabilities as a population to investigate. Additionally, regarding female fighters, there are few studies in this population, therefore, there is no evidence of what their profiles could be (Spanias et al., 2019). This information would be of great value for this discipline, considering that similar fighting sports such as judo show contradictory results in physical aptitude

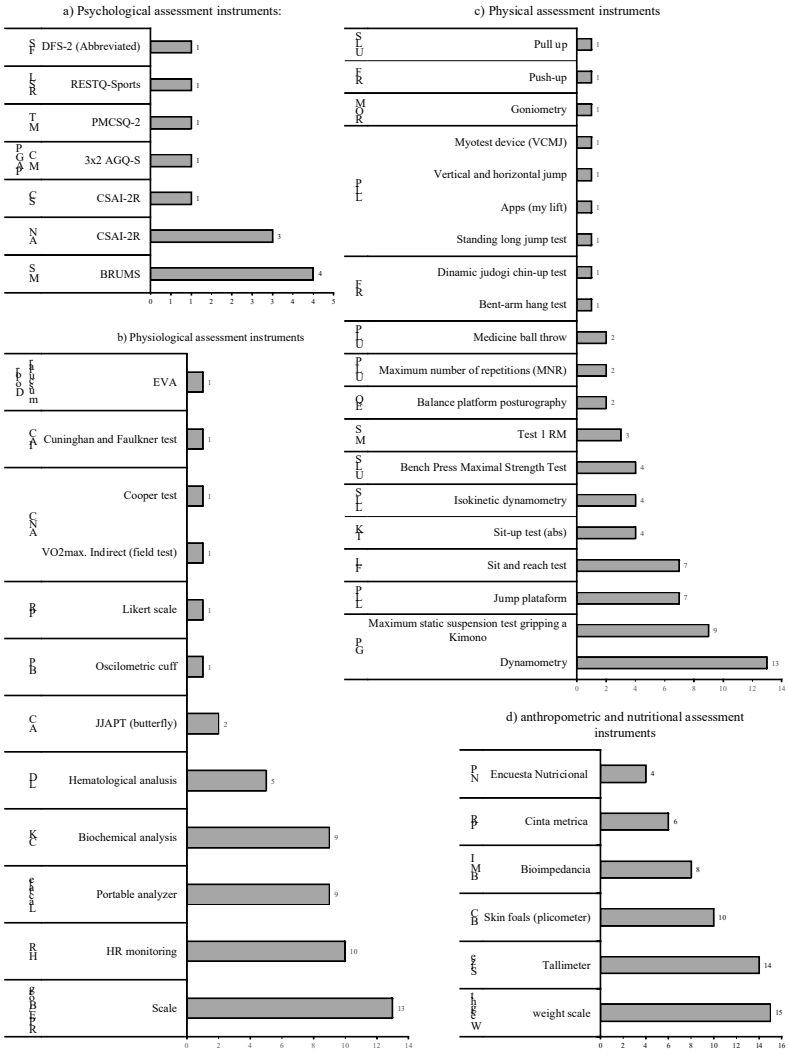


**Figure 4.** *Valuation instruments according to each variable*
***MS:** mood state, **AN:** anxiety, **SC:** self- confidence, **PAGPMC:** profiles of achievement goals and perceptions of motivational climate, **MT:** motivation, **RSL:** recovery and stress level, **FS:** flow state, **HR:** heart rate, **CK:** creatine kinase, **LD:** lactate dehydrogenase, **AC:** aerobic capacity, **BP:** blood pressure, **PR:** perception of recovery, **ANC:** anaerobic capacity, **IAC:** indirect anaerobic capacity, **GP:** grip strength / grip, **LLP:** lower limb power: **FL:** flexibility, **TK:** trunk strength, **LLS:** lower limb strength, **ULS:** upper limb strength, **MS:** maximum strength **EQ:** equilibrium, **ULP:** upper limb power, **RF:** resistance to force, **ROM:** range of motion, **BC:** body composition, **BMI:** body mass index, **PR:** perimeter, **NP:** nutritional profile.*

tests between male and female athletes (Sterkowicz-Przybycien. & Fukuda, 2014), therefore the need to specifically study this discipline arises in women.

The highest concentration of studies was found in Brazil (83%), which may be related to the fact that this is the country of origin of the discipline, as well as greater international projection of the BJJ, becoming a famous and popular fighting sport as a whole. with Mixed Martial Arts (MMA) among young people (Blomqvist, 2020). However, a low scientific exploration is observed in other countries of the world, it may be due to the modern and unexplored characteristics of this sport. Likewise, from the field of sports medicine there are only a few studies that refer to the prevalence of injuries in combat sports (Jensen et al., 2017; Prieto, 2015), with little evidence to date on specific performance parameters for this sport.

Only 9 studies were found with measurements of situation in real competitions, this may be due to the complexity of the sampling and the invasive nature of some physiological measurements, which could eventually disrupt mental strength, since it is in sports of Combat is a determinant of success both in tournaments and in the training environment (Slimani et al., 2016).

A low percentage of abandonment of wrestlers was observed in the studies (0.31%). It was not expressly mentioned if the evaluated athletes abandon for any reason, no withdrawals were recorded due to an injury or accident attributable to sports practice. Only one study mentioned abandon due to not meeting criteria. These results suggest that, despite the nature of the sport, the athletes studied could be a safe and adherent population for conducting studies in this area.

In relation to the study variables, it was determined that the most studied psychological variable was the state of mind. This is relevant since it has been observed that psychological states prior to competition are one of the predictive factors of sports performance in a wide range of sports (González Hernández & Valadez Jiménez, 2016; Keikha et al., 2015). At a physiological level, lactate is the most frequent followed by perceived exertion and heart rate to a lesser extent. There are difficulties in measuring physiological demands in BJJ, due to the complexity of gas analysis measurements during the BJJ, alternative markers have been used such as heart rate, blood tests, salivary evaluations and rating of perceived exertion (RPE) (Andreato, et al., 2016). The lactate measurement is relevant as some studies have shown an increase in blood lactate concentration in successive BJJ matches (Andreato et al., 2015), in turn, a decrease in the accumulation of delta lactate during the sequence of matches (which suggests a decrease in the activation of the glycolytic pathway during the simulation of competition) (Abad et al., 2016). Within the physical variables, the grip or grip strength

is the most frequent, this is attributed to the characteristics of grappling sports such as Brazilian Jiu Jitsu, judo and Olympic fighting, where there is a great demand for isometric grip strength resistance, to achieve immobilizations, knockdowns, throws and submissions (Andreato et al., 2017). The power of the lower limbs and the strength of the upper limbs are also frequent in studies, this reaffirms the relevance of this component in the development of sport (Øvretveit & Tøien, 2018) (Correa et al., 2015) Similar to what occur in grip sports like judo (Norambuena et al., 2021), and as a differentiating physical conditioner in the profiles of wrestling athletes successful (James et al., 2020). Another variable identified was the technical-tactics, these are of interest due to the intermittent demand that occurs in the fighting phases, with attention to attacks and skills (Miarka et al., 2016). Anthropometric variables highlight weight and height more frequently, this could indicate what usually happens in fighting sports where body mass is manipulated, with acute weight loss in MMA being greater prevalence and magnitude (Barley et al., 2017). In addition, for the importance of body composition in the development of high performance (Borges et al., 2016).

Regarding the instruments, the Brunel Mood Scale was found to assess mood, this stands out mainly because it has been used and validated in multiple countries for different populations, such as athletes, adolescents, people with disabilities, among others (Lan et al., 2012).

Scales of perceived exertion (RPE / Borg) are essential because the RPE can be used in a variety of competitive levels and genders to monitor workload, so physical exertion can play a more important role than mental exertion when athletes reflect on effort during training (Bromley et al., 2018).

Dynamometry was the most widely used instrument for the assessment of physical variables. Grip strength measurements are very specific for sports of grip modalities, especially in those that use kimono, as is the case of BJJ (Kons et al., 2020), In addition, grip strength is an objective index of the functional integrity of the upper limb, it is evaluated by dynamometry, since it is a cheap, fast and easy to use technique that also serves to detect the loss of physiological muscle function (Rojas et al., 2012). The technical-tactical variable was mostly recorded by video analysis, which allows to know the structure of time and movement of the combats, since the time and pause of the actions of the fighters may be different according to the duration of the combat (Andreato et al., 2016) which is necessary to identify to plan the preparation of athletes. The most widely used anthropometric instruments were the height rod and scale, this can be attributed to the fact that they allow knowing indices of the body structure of a fighter, thanks to which a specific change in physical structure can be observed according to the type of combat sport (Dopsaj et al., 2017) and differ between fighters with different fighting styles (Báez et al., 2014).

***What are the strengths and weaknesses of this review?***

An analysis of studies collected in the last ten years was carried out that allow us to indicate that there is a lack of qualitative information about the assessment instruments for the performance of BJJ fighters. Which provides an opportunity to develop new lines of research on the development of assessment methods according to sports demands.

Likewise, it was evidenced that the evaluation instruments collected are easily accessible, without the need for high-cost tools. This provides the technical team with the fundamental tools to objectify these variables.

The main limitation for this systematic review was that the studies to a large extent present low methodological quality according to the NOS, consequently there is low research production in this sport, mostly concentrated in Brazil.

## Contributions to the discipline and practical implications

The existing literature on the aspects of sports performance assessment in BJJ is limited. In the same way, no systematic reviews have been found that address the analysis of specific instruments for the different aspects of the psychological, physiological, physical, technical, nutritional field of the sphere of the fighter of this sport. Thus, this is the first scoping review that delves into the characteristics of the study population, the methodological aspects of the BJJ studies, the characteristics of the BJJ fighters and the identification of the most frequent variables and assessment instruments used for the last 10 years in BJJ fighters. In addition, this review characterizes the most studied profile of BJJ fighters, which allowed to generate an updated profile of BBJ fighters. Besides, this study helped identify the variables of analysis, techniques and measurement instruments most used today. This information could be used for the evaluation and planning of these athletes.

## Conclusion

It is concluded that the profile of the BBJ fighters was: BJJ fighters, mostly men, from Brazil with an average age of 27 years, from advanced categories and who were found in training situations. In relation to the variables, techniques and instruments to measure sports performance: Lactate and RPE / Borg were the most analyzed physiological variables, grip strength and lower limb power were the most analyzed physical variables, and body weight and height variables were the most analyzed anthropometric variables.The most widely used assessment instruments were the weight scale, dynamometry and RPE / Borg.

In addition, it was shown that there are few studies that perform measurements in real competition, in female fighters, in for BJJ fighters, as well as that report the style of the fighter. We encourage researchers to focus their efforts on addressing these knowledge gaps.


## Funding

This scoping review did not receive funding.


## Interest conflict

The authors stated that they have no conflict of interest.

## References


Abad, C. C., McAnulty, S. R., Barros, M. P., Almeida, A. L., Santos-Junior, R. B., Smolarek, A. C., Mascarenhas, L. P., & Souza, T. P. (2016). Lactate response to Brazilian Jiu-Jitsu matches across time. *Journal of Exercise Physiology Online*, *19*(4), 12–20.

Andrade, A., Silva, R. B., Flores Junior, M. A., Rosa, C. B., & Dominski, F. H. (2019). Changes in mood states of Brazilian jiu-jitsu athletes during training and competition. *Sport Sciences for Health*, *15*(2), 469–475. https://doi.org/10.1007/s11332-019-00562-0

Andrade, J. H. C., Lustosa, R. P., Uchoa, F. N. M., Lima, D. L. F., Machado, A. A. N., & Abreu, E. S. de. (2019). Correlação de variáveis cineantropométricas morfológicas com o desempenho de força em atletas de jiu-jitsu brasileiro resumo. *Março/Abril*, *13*(81), 70–77.

Andreato, L.V., de Moraes, S. M. F., Del Conti Esteves, J.V., Miranda, M. L., Pastório, J. J., Pastório, E. J., Magnani Branco, B. H., & Franchini, E. (2014). Psychological, physiological, performance and perceptive responses to Brazilian jiu-jitsu combats. *Kinesiology*, *46*(1), 44–52. https://doi.org/10.13140/2.1.2975.5522

Andreato, L.V., Esteves, J.V. D. C., Julio, U. F., Panissa, V. L. G., Hardt, F., Franzói de Moraes, S. M., & Franchini, E. (2017). Physical performance, time-motion, technical-tactical analyses, and perceptual responses in Brazilian jiu-jitsu matches of varied duration. *Kinesiology*, *49*(1), 30–40. https://doi.org/10.26582/k.49.1.11

Andreato, L.V., Esteves, J.V. D. C., Julio, U. F., Panissa, V. L. G., Hardt, F., Pastório, E. J., Franzói De Moraes, S. M., & Franchini, E. (2016). Metabolic, muscle damage and heart rate responses in Brazilian Jiu-Jitsu matches of varied duration. *Kinesiology*, *48*(2), 182–192. https://doi.org/10.26582/k.48.2.13

Andreato, L.V., Follmer, B., Celidonio, C. L., & Honorato, A. D. S. (2016). Brazilian Jiu-Jitsu Combat among Different Categories: Time-Motion and Physiology. A Systematic Review. *Strength and Conditioning Journal*, *38*(6), 44–54. https://doi.org/10.1519/SSC.0000000000000256

Andreato, L.V., Franchini, E., de Moraes, S. M. F., Esteves, J.V. del C., Pastório, J. J., Andreato, T.V., Gomes, T. L. de M., & Vieira, J. L. L. (2012). Morphological profile of Brazilian Jiu-Jitsu elite athletes. *Revista Brasileira de Medicina Do Esporte*, *18*(1), 46–50. https://doi.org/10.1590/S1517-86922012000100010

Andreato, L.V., Franzói de Moraes, S. M., Esteves, J.V. C., Pereira, R. R. de A., Gomes, T. L. de M., Andreato, T.V., & Franchini, E. (2012). Physiological responses and rate of perceived exertion in brazilian jiu-jitsu athletes. *Kinesiology*, *44*(2), 173–181.

Andreato, L.V., Lara, F. J. D., Andrade, A., & Branco, B. H. M. (2017). Physical and Physiological Profiles of Brazilian Jiu-Jitsu Athletes: a Systematic Review. *Sports Medicine - Open*, *3*(1), 9. https://doi.org/10.1186/s40798-016-0069-5

Andreato, L.V., Pastório, E. J., de Moraes, S. M. F., Del Conti Esteves, J.V., Panissa, V. L. G., Julio, U. F., & Franchini, E. (2016). Hydroelectrolytic balance of Brazilian jiu-jitsu athletes during a simulated competition. *Sport Sciences for Health*, *12*(2), 183–188. https://doi.org/10.1007/s11332-016-0273-1

Andreato, L.V., Franchini, E., De Moraes, S. M. F., Pastório, J. J., da Silva, D. F., Esteves, J.V. D. C., Branco, B. H. M., Romero, P.V. da S., & Machado, F. A. (2013). Physiological and technical-tactical analysis in brazilian jiu-jitsu competition. *Asian Journal of Sports Medicine*, *4*(2), 137–143. https://doi.org/10.5812/asjsm.34496

Andreato, L.V., Julio, U. F., Gonçalves Panissa, V. L., Del Conti Esteves, J.V., Hardt, F., Franzói De Moraes, S. M., Oliveira De Souza, C., & Franchini, E. (2015). Brazilian Jiu-Jitsu Simulated Competition Part II: Physical Performance, Time-Motion, Technical-Tactical Analyses, and Perceptual Responses. *Journal of Strength and Conditioning Research*, *29*(7), 2015–2025.

https://doi.org/10.1519/JSC.0000000000000819

Andreato, L.V., Julio, U. F., Panissa, V. L. G., Esteves, J. V. D. C., Hardt, F., De Moraes, S. M. F., De Souza, C. O., & Franchini, E. (2015). Brazilian Jiu-Jitsu simulated competition Part I: Metabolic, hormonal, cellular damage, and heart rate responses. *Journal of Strength and Conditioning Research*, *29*(9), 2538–2549. https://doi.org/10.1519/JSC.0000000000000918

Andreato, L.V., Santos, J. F., Esteves, J.V., Panissa, V. L., Julio, U. F., & Franchini, E. (2016). Physiological, Nutritional and Performance Profiles of Brazilian Jiu-Jitsu Athletes. *Journal of Human Kinetics*, *53*(1), 261–271. https://doi.org/10.1515/hukin-2016-0029

Andreato, L.V., de Moraes, S. M. F., Del Conti Esteves, J.V, Miranda, M. L., Pastório, J. J., Pastório, E. J., Magnani Branco, B. H., & Franchini, E. (2014). Psychological, physiological, performance and perceptive responses to Brazilian jiu-jitsu combats | Psihološka, fiziološka i subjektivna reakcija te promjene u fizièkim performansama nakon borbe u Brazilskom jiu jitsu. *Kinesiology*, 30702. http://www.scopus.com/inward/record.url?eid=2-s2.0-84903778443&partnerID=MN8TOARS

Andreato, L.V., Franzói de Moraes, S. M., Lopes de Moraes Gomes, T., Del Conti Esteves, J.V., Vidal Andreato, T., & Franchini, E. (2011). Estimated aerobic power, muscular strength and flexibility in elite Brazilian Jiu-Jitsu athletes. *Science and Sports*, *26*(6), 329–337. https://doi.org/10.1016/j.scispo.2010.12.015

Báez, E., Franchini, E., Ramírez-Campillo, R., Cañas-Jamett, R., Herrera, T., & C, C. B.-J. & C. H.-O. (2014). Anthropometric Characteristics of Top-Class Brazilian Jiu Jitsu Athletes: Role of Fighting Style Características Antropométricas en Atletas de Jiu Jitsu Brasilero de Alto Nivel: Rol del Estilo de Lucha. *Int. J. Morphol*, *32*(3), 1043–1050. http://repositorio.unab.cl/xmlui/bitstream/handle/ria/876/Báez_Anthropometric_Characteristics.pdf?sequence=1&isAllowed=y

Barley, O. R., Chapman, D.W., & Abbiss, C. R. (2017). Section: Original Investigation Article Title: Weight Loss Strategies in Combat Sports and Concerning Habits in Mixed Martial Arts. *Journal: International Journal of Sports Physiology and Performance Acceptance Date*.

Bevilacqua, G. G., & Turczyn, B. (2015). Humor pré-competitivo em atletas brasileiros de jiu-jitsu. *Caderno de Educação Física e Esporte*, *13*(1), 21–30.

Blomqvist Mickelsson, T. (2020). Modern unexplored martial arts – what can mixed martial arts and Brazilian Jiu-Jitsu do for youth development? *European Journal of Sport Science*, *20*(3), 386–393.

Borges Hernández, P. J., Ruiz Lara, E., & Argudo Iturriaga, F. M. (2016). Relación entre parámetros antropométricos, agarre máximo y velocidad de lanzamiento en jugadores jóvenes de waterpolo. *Retos*, *2041*(31), 212–218. https://doi.org/10.47197/retos.v0i31.50563

Brandao, F., Fernandes, H. M., Alves, J.V., Fonseca, S., & Reis, V. M. (2014). Hematological and biochemical markers after a Brazilian Jiu-Jitsu tournament in world-class athletes. *Rev. Bras. Cineantropom. Desempenho Hum*, 144–151. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1980-00372014000200144

Brandt, R., Bevilacqua, G. G., Crocetta, T. ^A. B., Monteiro, C. B. D. M., Guarnieri, R., Hobold, E., Flores, L. J. F., Miarka, B., & Andrade, A. (2019). Comparisons of Mood States Associated With Outcomes Achieved by Female and Male Athletes in High-Level Judo and Brazilian Jiu-Jitsu Championships: Psychological Factors Associated With the Probability of Success. *School of Physical Education and Sports*, 1–7. www.nsca.com

Brasil, B., Chiviacowsky, s., del Vecchio, f. b., & Alberton, c. l. (2015). Comparação do equilíbrio dinâmico entre praticantes de Brazilian Jiu-Jitsu com diferentes níveis de experiência. *Revista Brasileira de Educação Física e Esporte*, *29*(4), 535–541. https://doi.org/10.1590/1807-55092015000400535

Bromley, S. J., Drew, M. K., McIntosh, A., & Talpey, S. (2018). Rating of perceived exertion is a stable and appropriate measure of workload in judo. *Journal of Science and Medicine in Sport*, *21*(10), 1008–1012. https://doi.org/10.1016/j.jsams.2018.02.013

Campos, F., Correa, J. C. M., Canevari, V. C. M., Branco, B. H. M., Andreato, L.V., & Ramos, S. de P. (2020). Monitoring Internal Training Load, Stress-Recovery Responses, and Immune-Endocrine Parameters in Brazilian Jiu-Jitsu Training - PubMed. *Journal of Strength and Conditioning Research*, *0*, 1–9. https://pubmed.ncbi.nlm.nih.gov/31972820/

Carneiro, R., Mattos Frota de Souza, T., de Oliveira Assumpçao, C., Neto, J., Asano, R., & de Oliveira, J. (2013). Comportamento da frequência cardíaca e percepção subjetiva de esforço durante combate de Jiu-Jitsu brasileiro. *Revista Brasileira de Prescrição e Fisiologia Do Exercício (RBPFEX)*, *7*(37), 10.

Chaabene, H., Negra, Y., Bouguezzi, R., Mkaouer, B., Franchini, E., Julio, U., & Hachana, Y. (2017). Physical and physiological attributes of wrestlers: An update. In *Journal of Strength and Conditioning Research* (Vol. 31, Issue 5). https://doi.org/10.1519/JSC.0000000000001738

Corrêa, B., Junior, M., de Moura Simim, M., Franchini, E., & da Mota, G. (2014). Performance in kimono grip strength tests among Brazilian Jiu-Jitsu practitioners from different levels. *Journal of Combat Sports and Martial Arts*, *5*(1), 11–15. https://doi.org/10.5604/20815735.1127447

Correa, B., Moura Simim, M. A., da Silva, C. F., Oliveira Ventura, E. F. de, & Ribeiro da Mota, G. (2017). Desempenho da resistência de força isométrica após simulação de luta em atletas de brazilian jiu-jitsu. *Revista Brasileira de Prescrição e Fisiologia Do Exercício*, *11*(68), 519–524. http://www.repositorio.ufc.br/handle/riufc/62768

Correa, B.V., De, M. M. J., Antônio, M., Simim, D. M., Rezende, F.

N., Franchini, E., & da Mota, G. R. (2012). Reliability in kimono grip strength tests and comparison between elite and non-elite Brazilian Jiu-Jitsu players. *Archives of Budo*, *8*(2), 103–107.

Correa, B.V., Neme Ide, B., De Moura Simim, M.A., Marocolo, M., & Da Mota, G. R. (2014). Neuromuscular responses to simulated Brazilian Jiu-Jitsu fights. *Journal of Human Kinetics*, *44*(1), 249–257. https://doi.org/10.2478/hukin-2014-0130

Correa, B.V., Marocolo Júnior, M., de Monteiro, G. G. F. S., Junior, L. O. S., de Moura Simim, M.A., Mendes, E. L., & da Mota, G. R. (2013). Blood lactate response after Brazilian Jiu-Jitsu simulated matches. *Journal of Exercise Physiology Online*, *16*(5), 63–67.

Correa, B. V., De Moura Simim, M.A., Marocolo, M., Franchini, E., & Da Mota, G. R. (2015). Optimal load for the peak power and maximal strength of the upper body in Brazilian jiu-jitsu athletes. *Journal of Strength and Conditioning Research*, *29*(6), 1616–1621. https://doi.org/10.1519/JSC.0000000000000799

Coswig, V. S., Neves, A. H. S., & DelVecchio, F. B. (2013). Efeitos do tempo de prática nos parâmetros bioquímicos, hormonais e hematológicos de praticantes de jiu-jitsu brasileiro. *Revista Andaluza de Medicina Del Deporte*, *6*(1), 17–23. https://doi.org/10.1016/S1888-7546(13)70030-3

Coswig, V. S., Gentil, P., Bueno, J. C. A., Follmer, B., Marques, V. A., & DelVecchio, F. B. (2018). Physical fitness predicts technical-tactical and time-motion profile in simulated Judo and Brazilian Jiu-Jitsu matches. *PeerJ*, *2018*(5). https://doi.org/10.7717/peerj.4851

Coswig, V. S., Bartel, C., & DelVecchio, F. B. (2018). Brazilian jiu-jitsu matches induced similar physiological and technical-tactical responses in gi and nogi conditions. *Archives of Budo*, *14*, 291–301.

Coswig, V. S., Neves, A. H. da S., & Del Vecchio, F. B. (2013). Respostas bioquímicas, hormonais e hematológicas a lutas de jiu-jitsu brasileiro. *Rev. Bras. Ciênc. Mov*, 19–30. http://portalrevistas.ucb.br/index.php/RBCM/article/view/3800/2589

Da Silva, J., Voltolini, J., & Mine, C. (2016). Fatores associados às lesões de atletas do Brazilian Jiu-Jitsu no Vale do Paraíba Paulista. *Revista Brasileira de Prescrição e Fisiologia Do Exercício (RBPFEX)*, *10*(60), 497–503.

Da Silva Junior, J., Kons, R., de Lucas, R., & Detanico, D. (2019). Jiu-Jitsu-Specific Performance Test: Reliability Analysis and Construct Validity in Competitive Athletes. *Journal of Strength and Conditioning Research*, 1. https://doi.org/10.1519/JSC.0000000000003429

De Sousa, D. F., Eustaquio, J. M. J., Marocolo, M., Mota, G. R., & Neto, O. B. (2020). Cardiac autonomic alterations in different tactical profiles of brazilian jiu jitsu. *Revista Brasileira de Medicina Do Esporte*, *26*(3), 196–200. https://doi.org/10.1590/1517-869220202603216617

DelVecchio, F. B., Bianchi, S., Hirata, S. M., & Chakon-Mikahil, M. (2007). Análise morfo-funcional de praticantes de brazilian jiu-jitsu e estudo da temporalidade e da quantificação das ações motoras na modalidade. *Movimento & Perceção*, *7*(10), 263–281.

Detanico, D., Dellagrana, R. A., Athayde, M. S. da S., Kons, R. L., & Góes, A. (2017). Effect of a Brazilian Jiu-jitsu-simulated tournament on strength parameters and perceptual responses. *Sports Biomechanics*, *16*(1), 115–126. https://doi.org/10.1080/14763141.2016.1206143

Diaz-Lara, F. J., Del Coso, J., García, J. M., & Abián-Vicén, J. (2015). Analysis of physiological determinants during an international Brazilian jiu-jitsu competition. *International Journal of Performance Analysis in Sport*, *15*(2), 489–500. https://doi.org/10.1080/24748668.2015.11868808

Diaz-Lara, F. J., García, J. M. G. J. M. G., Monteiro, L. F., & Abian-Vicen, J. (2014). Body composition, isometric hand grip and explosive strength leg – similarities and differences between novices and experts in an international competition of Brazilian jiu jitsu. *Archives of Budo*, *10*(1), 211–217. http://archbudo.com/view/abstract/id/10500

Dopsaj, M., Markovic, M., Kasum, G., Jovanovic, S., Koropanovski, N., Vukovic, M., & Mudric, M. (2017). Discriminación de diferentes Índices de estructura corporal de atletas de elite en deportes de combate medidos por el Método de Bioimpedancia de Múltiples Frecuencias. *International Journal of Morphology*, *35*(1), 199–207. https://doi.org/10.4067/S0717-95022017000100033

Faro, H. K. C., Tavares, M. P. M., Gantois, P. M. D., Pereira, D. C., de Lima, M. N. M., de Lima, D., Daniel, D. G., & Fortes, L. S. (2020). Comparison of competitive anxiety and self-confidence in Brazilian Jiu-Jitsu skills levels: A cross-sectional in-event study. *Ido Movement for Culture*, *20*(1), 30–39. https://doi.org/10.14589/ido.20.1.4

Ferreira Marinho, B., Vidal Andreato, L., Follmer, B., & Franchini, E. (2016). Comparison of body composition and physical fitness in elite and non-elite Brazilian jiu-jitsu athletes. *Science and Sports*, *31*(3), 129–134. https://doi.org/10.1016/j.scispo.2015.12.001

Folmer, B., Dellagrana, R. A., Pereira de Lima, L. A., Herzog, W., Diefenthaeler, F. (2017) Analysis of elbow muscle strength parameters in Brazilian jiu-jitsu practitioners. *Journal of Sports Sciences* (2017). Dec;35(23):2373-2379. https://doi.org/10.1080/02640414.2016.1267388

Franchini, E., & da Silva, J. P. L. (2019). Performance, rating of perceived exertion and physiological responses during a Brazilian jiu-jitsu match: comparisons between winning and losing athletes. *Sport Sciences for Health*, *15*(1), 229–235. https://doi.org/10.1007/s11332-019-00528-2

González Hernández, J., & Valadez Jiménez, A. (2016). Personalidad y respuesta psicológica en deportistas. Representación temporal y adaptativa del proceso persona-depor-

te. *Retos*, *30*(30), 211–215. https://doi.org/10.47197/retos.v0i30.50267

James, L. P., Connick, M., Haff, G. G., Kelly, V. G., & Beckman, E. M. (2020). The Countermovement Jump Mechanics of Mixed Martial Arts Competitors. *Journal of Strength and Conditioning Research*, *34*(4), 982–987. https://doi.org/10.1519/JSC.0000000000003508

Jensen, A. R., Maciel, R. C., Petrigliano, F. A., Rodriguez, J. P., & Brooks, A. G. (2017). Injuries Sustained by the Mixed Martial Arts Athlete. *Sports Health*, *9*(1), 64–69. https://doi.org/10.1177/1941738116664860

Joel, G., Paiva, L., & Andreato, L. (2014). Blood lactate and rate of perceived exertion in Brazilian jiu-jitsu and Submission combats. *Journal of Combat Sports and Martial Arts*, *5*(1), 7–10. https://doi.org/10.5604/20815735.1127446

Keating, T., Kennedy, E., & Rivera, A. (2011). Differences in Grip Strength, Adductor Strength and External Hip Rotation Range of Motion Between Trained Grapplers and Recreationally Trained Males. *Journal of Strength and Conditioning Research*, *25*, S50–S51. https://doi.org/10.1097/01.jsc.0000395657.13917.80

Keikha, B. M., Yusof, S., & Jourkesh, M. (2015). The relationship between pre-competition state anxiety components and mood state sub-scales scores and the result of among college athletes through temporal patterning. *International Journal of Sport Science*, *5*(1), 8–15. https://doi.org/10.5923/j.sports.20150501.02

Kohoutkova, J., Masaryk, P., & Reguli, Z. (2018). The experience of the state of flow in Brazilian Jiu-Jitsu. *Ido Movement for Culture*, *18*(3), 1–6. https://doi.org/10.14589/ido.18.3.1

Kons, R. L., Orssatto, L. B. R., & Detanico, D. (2020). Acute performance responses during repeated matches in combat sports: A systematic review. *Journal of Science and Medicine in Sport*, *23*(5), 512–518. https://doi.org/10.1016/j.jsams.2019.12.004

Kons, R. L., Athayde, M. S. da S., da Silva, J. N., Tavares, W. da S., & Detanico, D. (2017). Vertical jump performance in judo and Brazilian jiu-jitsu athletes: An approach with different training levels. *Ido Movement for Culture*, *17*(4), 25–31. https://doi.org/10.14589/ido.17.4.5

Lan, M. F., Lane, A. M., Roy, J., & Hanin, N. A. (2012). Validity of the Brunel Mood Scale for use with Malaysian athletes. *Journal of Sports Science and Medicine*, *11*(1), 131–135.

Lima, P. O. de P., Lima, A. A., Coelho, A. C. S., Lima, Y. L., Almeida, G. P. L., Bezerra, M. A., & de Oliveira, R. R. (2017). Biomechanical differences in brazilian jiu-jitsu athletes: the role of combat style. *International Journal of Sports Physical Therapy*, *12*(1), 67–74. http://www.ncbi.nlm.nih.gov/pubmed/28217417

Lo, C. K. L., Mertz, D., & Loeb, M. (2014). Newcastle-Ottawa Scale: Comparing reviewers' to authors' assessments. *BMC Medical Research Methodology*, *14*(1), 1–5. https://doi.org/10.1186/1471-2288-14-45

Mancha Triguero, D., García-Rubio, J., & Ibáñez Godoy, S. J. (2019). Batería de test de campo para evaluar la condición física de jugadores de baloncesto: sbafit. / sbafit: a field-based test battery to assess physical fitness in basketball players. *E-Balonmano.Com: Journal of Sports Science / Revista de Ciencias Del Deporte*, *15*(2), 107–126. https://go.openathens.net/redirector/[illegible]live%26scope%3Dsite%26authtype%3Dathens

Miarka, B., Fabricio B.D. Vecchio, Camey, S., Amtmann, & A., J. (2016). Comparisons: technical-tactical and time-motion analysis of mixed martial arts by outcomes. *Journal of Strength and Conditioning Research*, *30*(7), 1975–1984.

Norambuena, Y., Winkler, L., Guevara, R., Lavados, P., Monrroy, M., Ramírez-Campillo, R., Herrera-Valenzuela, T., & Gajardo-Burgos, R. (2021). 5-week suspension training program increase physical performance of youth judokas: A pilot study. *Retos*, *2041*(39), 137–142. https://doi.org/10.47197/retos.v0i39.78624

Ortiz Sánchez, J. A., Del Pozo-Cruz, J., Alfonso-Rosa, R. M., Gallardo-Gómez, D., & Álvarez-Barbosa, F. (2020). Efectos del sedentarismo en niños en edad escolar: revisión sistemática de estudios longitudinales. *Retos*, *2041*(40), 404–412. https://doi.org/10.47197/retos.v0i40.83028

Øvretveit, K. (2018a). Anthropometric and physiological characteristics of brazilian jiu-jitsu athletes. *Journal of Strength and Conditioning Research*, *32*(4), 997–1004. https://doi.org/10.1519/JSC.0000000000002471

Øvretveit, K. (2018b). Acute physiological and perceptual responses to Brazilian jiu-jitsu sparring: the role of maximal oxygen uptake. *International Journal of Performance Analysis in Sport*, *18*(3), 481–494. https://doi.org/10.1080/24748668.2018.1493634

Øvretveit, K., Sæther, S. A., & Mehus, I. (2018). Achievement goal profiles, and perceptions of motivational climate and physical ability in male Brazilian jiu-jitsu practitioners. *Archives of Budo*, *14*, 311–318.

Øvretveit, K., & Tøien, T. (2018). Maximal strength training improves strength performance in grapplers. *Journal of Strength and Conditioning Research*, *32*(12), 3326–3332. https://doi.org/10.1519/jsc.0000000000002863

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. *The BMJ*, *372*.

https://doi.org/10.1136/bmj.n71

Peters, M. D. J., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *International Journal of Evidence-Based Healthcare*, *13*(3), 141–146. https://doi.org/10.1097/XEB.0000000000000050

Prieto, A. J. M. (2015). Variables deportivas y personales en la ocurrencia de lesiones deportivas. Diferencias entre deportes individuales y colectivos. *Retos*, *28*(28), 21–25. https://doi.org/10.47197/retos.v0i28.34819

Pinheiro, R. M., J. A. A., Morais, Yukio Asano, P. K., Pardono, Iorrany Raquel Castro Sousa, E., & Simões, H. G. (2011). Validade do teste de corrida de 1600m em estimar o VO2max em praticantes de Jiu Jitsu. *Educação Física Em Revista*, *5*(2).

Rojas, J. A., Vazquez, L. del C. U., Sánchez, G. V., Banik, S. D., & S., J. A. (2012). Dinamometria de manos en estudiantes de Merida, México. *Revista Chilena Nutrición*, *39*(3), 45–51.

Santos Silva Lopes, J., Monteiro de Magalhães Neto, A., Oliveira Gonçalves, L. C., Lourenço Alves, P. R., Castilho de Almeida, A., & Marlise Balbinotti Andrade, C. (2019). Kinetics of Muscle Damage Biomarkers at Moments Subsequent to a Fight in Brazilian Jiu-Jitsu Practice by Disabled Athletes. *Frontiers in Physiology*, *10*(August), 2020. https://doi.org/10.3389/fphys.2019.01055

Silva, B. V. C., Marocolo Júnior, M., Rogério, F. C., Dias, I. S., Simim, M. A. M., & Mota, G. R. (2014). Testes Físicos Discriminam Praticantes de Brazilian Jiu-Jitsu? *Revista Brasileira de Ciência e Movimento*, *22*(1), 90–96. https://doi.org/10.18511/0103-1716/rbcm.v22n1p90-96

Silva de Araújo, S., Marques, L., Gama de Matos, D., de Souza, R. F., Miguel-dos-Santos, R., Uilien de Oliveira, J., de Araujo, A. C., dos Santos Silva, R. J., Lopes dos Santos, J., Rodrigues Santos, C. R., Marçal, A. C., & Aidar, F. J. (2019). Avaliação da recuperação do nível de estresse e desempenho cardiovascular de atletas brasileiros de Jiu-Jitsu. / Evaluation of stress level recovery and cardiovascular performance of Brazilian Jiu-Jitsu athletes. *Motricidade*, *15*(S3), 120–127. https://go.openathens.net/redirector/

[illegible]

live%26scope%3Dsite%26authtype%3Dathens

Slimani, M., Miarka, B., Briki, W., & Cheour, F. (2016). Comparison of mental toughness and power test performances in high-level kickboxers by competitive success. *Asian Journal of Sports Medicine*, *7*(2). https://doi.org/10.5812/asjsm.30840

Spanias, C., Nikolaidis, P. T., Rosemann, T., & Knechtle, B. (2019). Anthropometric and Physiological Profile of Mixed Martial Art Athletes: A Brief Review. *Sports*, *7*(6), 146. https://doi.org/10.3390/sports7060146

Stachoñ, A., Burdukiewicz, A., Pietraszewska, J., & Andrzejewska, J. (2015). A comparative analysis of male judo and Brazilian jiu-jitsu practitioners based on motor performance and body build. *Journal of Combat Sports and Martial Arts*, *6*(2), 53–58. https://doi.org/10.5604/20815735.1193158

Sterkowicz-Przybycien., K. L., & Fukuda, D. H. (2014). Establishing normative data for the special judo fitness test in female athletes using systematic review and meta-analysis. *Journal of Strength and Conditioning Research*, *28*(12), 3585–3593.

Vicentini, L., & Marques, R. F. R. (2019). a Produção Científica Sobre O Jiu-Jítsu: Análise Dos Artigos, Teses E Dissertações Publicados Entre 1996 E 2016. *Movimento (ESEFID/UFRGS)*, *24*(4), 1335. https://doi.org/10.22456/1982-8918.83697

Villar, R., Gillis, J., Santana, G., Pinheiro, D. S., & Almeida, A. L. R. A. (2018). Association between anaerobic metabolic demands during simulated brazilian jiu-jitsu combat and specific jiu-jitsu anaerobic performance test. *Journal of Strength and Conditioning Research*, *32*(2), 432–440. https://doi.org/10.1519/jsc.0000000000001536

Yates, J. M. P. (2017). Brazilian jiu jitsu: considerations for strength and conditioning training plan design. *Journal of Australian Strength and Conditioning Needs*, *25*(4), 46–53.

Zambrano, L., & Manterola, C. (2016). Criterion-related validity of perceived exertion scales in healthy children: a systematic review and meta-analysis. *Archivos Argentinos de Pediatria*, *114*(2), 120–128. https://doi.org/10.5546/aap.2016.eng.120