

# Hooper Questionnaire in Training Load Control in High-Performance Athletes: Systematic Review with Meta-Analysis

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## Abstract

**Introduction** Training load management is a fundamental process for optimizing athlete performance. Knowing the training load will enable us to assess fatigue, anticipate overload and overtraining, and minimize the risk of injury.

**Objective** To evaluate the effectiveness of the Hooper questionnaire in controlling training load and identifying fatigue, sleep, Delayed Onset Muscle Soreness (DOMS), and stress in athletes of high-performance sports modalities.

**Methods** To achieve the objectives proposed in this study, a systematic review was conducted in accordance with the PRISMA 2020 recommendations and the methodological guidelines of the Cochrane Handbook for Systematic Reviews of Interventions. The search strategy included both scientific databases and grey literature, including MEDLINE, LILACS, DEDALUS, Biblax UNIFESP, SportDiscus, Scopus, PubMed/CENTRAL, PEDro, Embase, and thesis and dissertation repositories.

**Result** The exclusion criteria were studies that used other well-being questionnaires, participation in less than 80% of training sessions, no medical clearance for training, the relationship of the Hooper questionnaire with wins, draws, and losses in games, a follow-up time of less than 16 weeks, and other types of studies. For study screening, the Rayyan (2) application was used, which identified 8 duplicates. 339 studies were excluded because they did not involve the application of the Hooper questionnaire, 17 studies were eligible for full-text reading, 9 studies were excluded using the exclusion criteria, and 8 studies were included for quantitative analysis.

**Conclusion** This systematic review with meta-analysis indicates that the Hooper questionnaire did not show statistically significant effectiveness when all assessed variables for training load control were considered together. New studies are recommended for each sport modality in order to deepen the analysis of the effectiveness of the instrument in identifying fatigue, sleep quality, stress, and DOMS, contributing to the prevention of overtraining and injuries in high-performance athletes exposed to the accumulation of training and games. CRD42021254277

## Keywords

- athletes
- workload
- Hooper questionnaire
- overtraining

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## Introduction

Training load management is one of the fundamental processes for optimizing athlete performance. Knowing the training load will allow us to assess fatigue, anticipate overload, and overtraining to minimize the risk of injury. Indeed, there is a relationship between workload and injury incidence.<sup>3</sup> The study of variables that quantify the training load of high-performance athletes aims to analyze the adaptations produced by training to find the best way to prevent fatigue and the occurrence of injuries. Among these variables, we can mention biochemical markers (creatin kinase, lactate, cortisol, testosterone, immunoglobulin A, among others<sup>4</sup>), electronic devices (global positioning system (GPS), among others), and well-being questionnaires, such as the Hooper questionnaire, Recovery-Stress Questionnaire for Athletes (RESTQ-S), Profile of Mood States (POMS), among others.

It is observed that during long periods of training and competitions, athletes are daily exposed to fatigue-generating factors such as excessive training and game loads. These factors can lead athletes to present changes in the sensation of fatigue, sleep quality, stress, and biochemical markers, which can influence sports performance. In this sense, the use of well-being questionnaires can be an adjuvant in controlling training stimuli with the objective of early identification of fatigue (4) and reducing the risk of overtraining and the occurrence of injuries in high-performance sports athletes.

The Hooper questionnaire<sup>5a5b</sup> is a well-being questionnaire that quantifies (subjectively, from 1 to 7) 4 items: DOMS, stress, fatigue, and sleep quality. Taking into account a longer period or an entire season of daily monitoring of athletes' training and games, the Hooper questionnaire can be considered a fast, practical method for applicability when compared to other well-being questionnaires (RESTQ-S and POMS, with 76 and 65 questions, respectively) and low-cost.<sup>13</sup> This importance becomes more evident when observing studies in the literature that present morning assessments of fatigue, sleep quality, and DOMS, clearly demonstrating that they are more sensitive than HR-derived indices to daily fluctuations in session load experienced by elite soccer players in a standard in-season week.<sup>5a5b6,8</sup> The objective of this study is to evaluate the effectiveness of the Hooper well-being questionnaire in controlling training load and identifying fatigue in athletes of high-performance sports modalities.

## Methodology

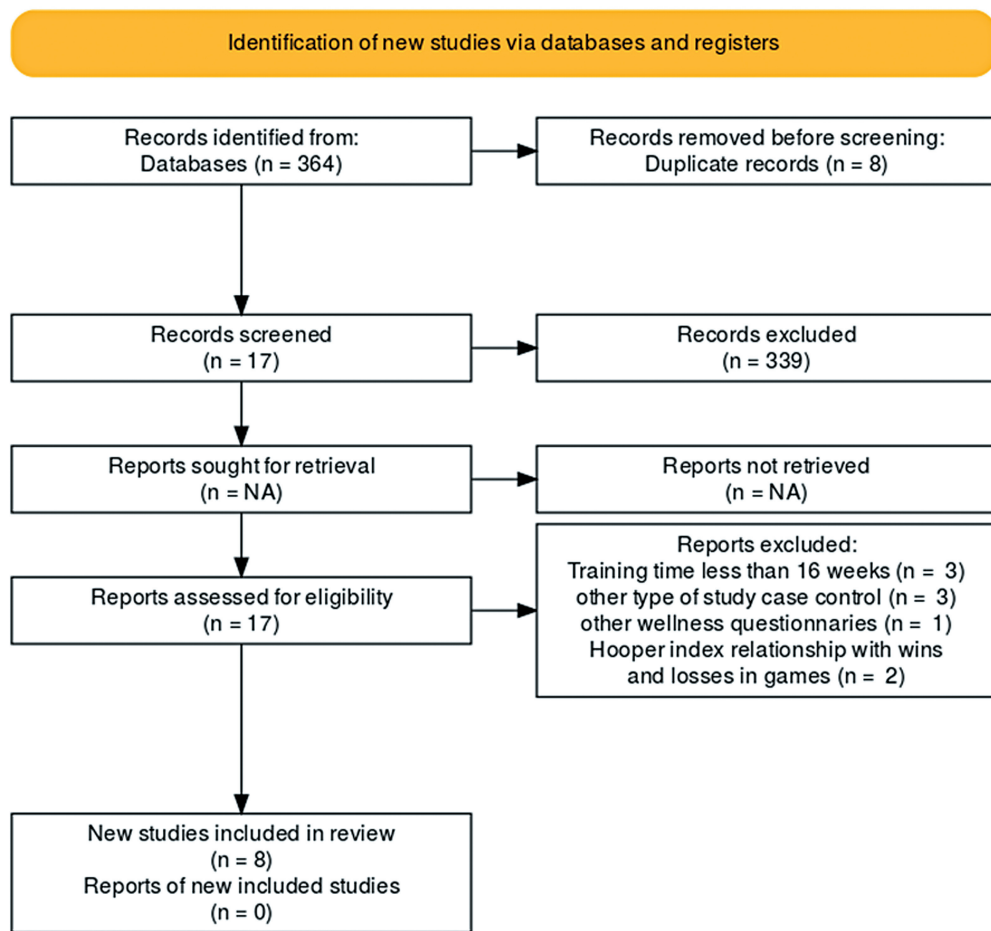
This study was conducted as a systematic review, in accordance with the recommendations of PRISMA 2020

and the methodological guidelines of the Cochrane Handbook for Systematic Reviews of Interventions. This approach enables an ordered and critical synthesis of the available knowledge, allowing the reader access to a wide diversity of relevant studies in a shorter time. The bibliographic search covered databases and gray literature, including MEDLINE, LILACS, DEDALUS, Biblac UNIFESP, SportDiscus, Scopus, PubMed/CENTRAL, PEDro, Embase, Google Scholar, and repositories of theses and dissertations. The terms applied were training load, monitoring, sport, athlete, Hooper, index, questionnaire, and well-being. The descriptors were extracted from the controlled vocabularies DeCS/MeSH and combined with free terms. The searches were conducted between May 2020 and May 2021, resulting in 364 identified publications. No additional studies were obtained from gray literature sources. The inclusion criteria were studies that used only the Hooper questionnaire for well-being assessment, high-performance athletes who participated in more than 80% of training sessions, medical clearance for training, the relationship of the Hooper questionnaire with training load, a follow-up time of at least 16 weeks, and prospective cohort studies. The robustness of a systematic review depends directly on the quality of the included studies. For this assessment, the GRADE-CERQual approach was used, which provides a transparent method for estimating confidence in the evidence. The analysis highlighted limitations, such as the small number of participants and the use of a well-being questionnaire with subjective variables. On the other hand, it emphasized the inclusion of professional athletes from international sports leagues, long-term follow-up, and the exclusive use of prospective cohort designs, factors that contributed to reducing biases.

## Results

The exclusion criteria were studies that used other well-being questionnaires, participation in less than 80% of training sessions, no medical clearance for training, the relationship of the Hooper questionnaire with wins, draws, and losses in games, a follow-up time of less than 16 weeks, and other types of studies. For study screening, the Rayyan<sup>2</sup> application was used, which identified 8 duplicates. 339 studies were excluded because they did not involve the application of the Hooper questionnaire, 17 studies were eligible for full-text reading, 9 studies were excluded using the exclusion criteria, and 8 studies were included for quantitative analysis.

PRISMA 2021 Flowchart for the selection of scientific articles from the database



#### Characteristics of the articles included in the review

| Title                                                                  | Hooper application before training | Outcomes | Effects                      | Population    | Database | Study Design       | Focus Country |
|------------------------------------------------------------------------|------------------------------------|----------|------------------------------|---------------|----------|--------------------|---------------|
| In-season internal and external training load .....                    | 39 weeks                           | –        | FATIGUE STRESS<br>DOMS SLEEP | football      | PUBMED   | prospective cohort | Portugal      |
| Perceived Training Load, Muscle Soreness, Stress, Fatigue, ....        | 42 weeks                           | SC       | FATIGUE STRESS<br>DOMS SLEEP | basketball    | PUBMED   | prospective cohort | Portugal      |
| Training load and well-being status variations of ...                  | 42 weeks                           | SS       | FATIGUE STRESS<br>DOMS SLEEP | futsal        | PUBMED   | prospective cohort | Portugal      |
| Variations of perceived load and well-being between ...                | 40 weeks                           | SS       | FATIGUE STRESS<br>DOMS SLEEP | handball      | PUBMED   | prospective cohort | Portugal      |
| Daily and weekly training load and wellness status in preparatory, ... | 36 weeks                           | SC       | FATIGUE STRESS<br>DOMS SLEEP | volleyball    | PUBMED   | prospective cohort | Portugal      |
| Relationship between daily training load and ...                       | 16 weeks                           | –        | FATIGUE STRESS<br>DOMS SLEEP | football      | PUBMED   | prospective cohort | Tunisia       |
| Internal training load and its longitudinal relationship. .            | 39 weeks                           | SC       | FATIGUE STRESS<br>DOMS SLEEP | football      | PUBMED   | prospective cohort | Portugal      |
| Variations of season workload and ...                                  | 44 weeks                           | SS       | FATIGUE STRESS<br>DOMS SLEEP | roller hockey | PUBMED   | prospective cohort | Portugal      |

*Forest plot on the effectiveness of the Hooper questionnaire in controlling training load and identifying fatigue, sleep, DOMS, and stress in athletes of high-performance sports modalities.*

| Study                                                        | Experimental |      |        | Control    |      |        | Mean Difference | MD          | 95%-CI               | Weight (fixed) | Weight (random) |
|--------------------------------------------------------------|--------------|------|--------|------------|------|--------|-----------------|-------------|----------------------|----------------|-----------------|
|                                                              | Total        | Mean | SD     | Total      | Mean | SD     |                 |             |                      |                |                 |
| Clemente et al                                               | 15           | 2.56 | 0.2000 | 15         | 2.54 | 0.1000 |                 | 0.02        | [-0.09; 0.13]        | 82.9%          | 33.9%           |
| Clemente et al                                               | 20           | 3.89 | 0.5700 | 20         | 3.36 | 0.8900 |                 | 0.53        | [0.07; 0.99]         | 4.9%           | 17.1%           |
| Clemente et al                                               | 20           | 3.89 | 0.5700 | 20         | 3.36 | 0.8900 |                 | 0.53        | [0.07; 0.99]         | 4.9%           | 17.1%           |
| Mendes et al                                                 | 13           | 3.19 | 1.1300 | 13         | 3.65 | 1.3700 |                 | -0.46       | [-1.43; 0.51]        | 1.1%           | 6.2%            |
| Clemente et al                                               | 35           | 3.10 | 1.1300 | 35         | 3.33 | 1.2600 |                 | -0.23       | [-0.79; 0.33]        | 3.4%           | 13.7%           |
| Gonçalves et al                                              | 10           | 2.90 | 0.4900 | 10         | 2.90 | 0.8800 |                 | 0.00        | [-0.62; 0.62]        | 2.7%           | 12.0%           |
| <b>Fixed effect model</b>                                    | <b>113</b>   |      |        | <b>113</b> |      |        |                 | <b>0.06</b> | <b>[-0.05; 0.16]</b> | <b>100.0%</b>  | <b>-</b>        |
| <b>Random effects model</b>                                  |              |      |        |            |      |        |                 | <b>0.13</b> | <b>[-0.14; 0.39]</b> | <b>-</b>       | <b>100.0%</b>   |
| Heterogeneity: $I^2 = 53\%$ , $\tau^2 = 0.0502$ , $p = 0.06$ |              |      |        |            |      |        |                 |             |                      |                |                 |

| Study                                                        | Experimental |      |        | Control    |      |        | Mean Difference | MD           | 95%-CI               | Weight (fixed) | Weight (random) |
|--------------------------------------------------------------|--------------|------|--------|------------|------|--------|-----------------|--------------|----------------------|----------------|-----------------|
|                                                              | Total        | Mean | SD     | Total      | Mean | SD     |                 |              |                      |                |                 |
| Clemente et al                                               | 15           | 2.66 | 0.1000 | 15         | 2.71 | 0.1200 |                 | -0.05        | [-0.13; 0.03]        | 89.9%          | 25.2%           |
| Clemente et al                                               | 20           | 4.13 | 0.5900 | 20         | 3.53 | 0.7400 |                 | 0.60         | [0.19; 1.01]         | 3.3%           | 18.6%           |
| Clemente et al                                               | 20           | 4.13 | 0.5900 | 20         | 3.53 | 0.7400 |                 | 0.60         | [0.19; 1.01]         | 3.3%           | 18.6%           |
| Mendes et al                                                 | 13           | 2.94 | 1.0800 | 13         | 3.27 | 0.9800 |                 | -0.33        | [-1.12; 0.46]        | 0.9%           | 10.8%           |
| Clemente et al                                               | 35           | 2.99 | 1.1900 | 35         | 3.18 | 1.3500 |                 | -0.19        | [-0.79; 0.41]        | 1.6%           | 14.4%           |
| Gonçalves et al                                              | 10           | 2.87 | 0.5900 | 10         | 3.40 | 0.9700 |                 | -0.53        | [-1.23; 0.17]        | 1.1%           | 12.3%           |
| <b>Fixed effect model</b>                                    | <b>113</b>   |      |        | <b>113</b> |      |        |                 | <b>-0.02</b> | <b>[-0.09; 0.06]</b> | <b>100.0%</b>  | <b>-</b>        |
| <b>Random effects model</b>                                  |              |      |        |            |      |        |                 | <b>0.08</b>  | <b>[-0.26; 0.43]</b> | <b>-</b>       | <b>100.0%</b>   |
| Heterogeneity: $I^2 = 76\%$ , $\tau^2 = 0.1204$ , $p < 0.01$ |              |      |        |            |      |        |                 |              |                      |                |                 |

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| Study                                                        | Experimental |      |        | Control    |      |        | Mean Difference | MD           | 95%-CI               | Weight (fixed) | Weight (random) |
|--------------------------------------------------------------|--------------|------|--------|------------|------|--------|-----------------|--------------|----------------------|----------------|-----------------|
|                                                              | Total        | Mean | SD     | Total      | Mean | SD     |                 |              |                      |                |                 |
| Clemente et al                                               | 15           | 2.45 | 0.3100 | 15         | 2.58 | 0.2200 |                 | -0.13        | [-0.32; 0.06]        | 57.9%          | 30.3%           |
| Clemente et al                                               | 20           | 2.98 | 0.5700 | 20         | 2.72 | 0.6500 |                 | 0.26         | [-0.12; 0.64]        | 14.9%          | 20.9%           |
| Clemente et al                                               | 20           | 2.98 | 0.5700 | 20         | 2.72 | 0.6500 |                 | 0.26         | [-0.12; 0.64]        | 14.9%          | 20.9%           |
| Mendes et al                                                 | 13           | 2.66 | 1.3500 | 13         | 2.78 | 1.3100 |                 | -0.12        | [-1.14; 0.90]        | 2.0%           | 5.7%            |
| Clemente et al                                               | 35           | 2.97 | 1.1300 | 35         | 2.99 | 1.1800 |                 | -0.02        | [-0.56; 0.52]        | 7.3%           | 14.5%           |
| Gonçalves et al                                              | 10           | 2.69 | 0.5700 | 10         | 3.70 | 1.2500 |                 | -1.01        | [-1.86; -0.16]       | 3.0%           | 7.7%            |
| <b>Fixed effect model</b>                                    | <b>113</b>   |      |        | <b>113</b> |      |        |                 | <b>-0.03</b> | <b>[-0.18; 0.11]</b> | <b>100.0%</b>  | <b>-</b>        |
| <b>Random effects model</b>                                  |              |      |        |            |      |        |                 | <b>-0.02</b> | <b>[-0.29; 0.25]</b> | <b>-</b>       | <b>100.0%</b>   |
| Heterogeneity: $I^2 = 53\%$ , $\tau^2 = 0.0514$ , $p = 0.06$ |              |      |        |            |      |        |                 |              |                      |                |                 |

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| Study                                                  | Experimental |      |        | Control    |      |        | Mean Difference | MD          | 95%-CI               | Weight (fixed) | Weight (random) |
|--------------------------------------------------------|--------------|------|--------|------------|------|--------|-----------------|-------------|----------------------|----------------|-----------------|
|                                                        | Total        | Mean | SD     | Total      | Mean | SD     |                 |             |                      |                |                 |
| Clemente et al                                         | 15           | 1.81 | 0.1200 | 15         | 1.81 | 0.7000 |                 | 0.00        | [-0.36; 0.36]        | 30.4%          | 30.4%           |
| Clemente et al                                         | 20           | 2.21 | 0.5700 | 20         | 2.05 | 0.7100 |                 | 0.16        | [-0.24; 0.56]        | 24.7%          | 24.7%           |
| Clemente et al                                         | 20           | 2.21 | 0.5700 | 20         | 2.05 | 0.7100 |                 | 0.16        | [-0.24; 0.56]        | 24.7%          | 24.7%           |
| Mendes et al                                           | 13           | 2.81 | 1.4200 | 13         | 3.15 | 1.6800 |                 | -0.34       | [-1.54; 0.86]        | 2.7%           | 2.7%            |
| Clemente et al                                         | 35           | 2.50 | 1.3000 | 35         | 2.37 | 1.2800 |                 | 0.13        | [-0.47; 0.73]        | 10.7%          | 10.7%           |
| Gonçalves et al                                        | 10           | 2.22 | 0.6200 | 10         | 2.30 | 1.0600 |                 | -0.08       | [-0.84; 0.68]        | 6.8%           | 6.8%            |
| <b>Fixed effect model</b>                              | <b>113</b>   |      |        | <b>113</b> |      |        |                 | <b>0.08</b> | <b>[-0.12; 0.28]</b> | <b>100.0%</b>  | <b>-</b>        |
| <b>Random effects model</b>                            |              |      |        |            |      |        |                 | <b>0.08</b> | <b>[-0.12; 0.28]</b> | <b>-</b>       | <b>100.0%</b>   |
| Heterogeneity: $I^2 = 0\%$ , $\tau^2 = 0$ , $p = 0.95$ |              |      |        |            |      |        |                 |             |                      |                |                 |

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Stress

## Discussion

The objective of this review is to evaluate the effectiveness of the Hooper questionnaire as a tool for controlling training load in high-performance athletes to identify early signs of fatigue and consequently prevent overtraining and the occurrence of injuries. To the best of our knowledge, this is the first systematic review with this objective. The studies included in the systematic review applied the Hooper questionnaire to athletes from various sports modalities, 30 minutes before the start of training sessions, during the follow-up weeks. These data were related to the training days before and after the games and with the training weeks, being weeks with at most one game (non-congested) and weeks with more than one game (congested).

Oliveira et al.,<sup>10</sup> with professional soccer athletes, showed a significant increase in the values of DOMS, fatigue, stress, and a worsening of sleep quality on the day after the game, and did not show significant variation in these items on training days before the games, suggesting that the high load subjected during the match may be related to this result.

Clemente et al.,<sup>11</sup> with professional basketball athletes, showed a moderate but not statistically significant increase in fatigue and worsening of sleep quality in congested weeks, and demonstrated that there were no statistically significant variations in DOMS and stress between non-congested and congested weeks.

Clemente et al.,<sup>12</sup> with professional futsal athletes, and Clemente et al.,<sup>14</sup> with professional handball athletes, demonstrated statistically significantly higher values of DOMS and fatigue in non-congested weeks, showing no statistically significant changes in stress and sleep quality.

Mendes et al.,<sup>13</sup> with professional volleyball athletes demonstrated that DOMS, fatigue, and stress were higher, and sleep quality was lower in congested weeks, but without statistical significance.

Moalla et al.,<sup>14</sup> with professional soccer athletes, provide evidence that there was a significant correlation of the four items with training load, with DOMS and fatigue being of great significance, and sleep quality and stress being moderate significance.

Clemente et al.,<sup>13–16</sup> with professional soccer athletes, provide evidence that the items DOMS and fatigue were more affected in congested weeks, with no difference in sleep quality between the weeks, without statistical significance.

Gonçalves et al.<sup>16</sup>, with professional roller hockey athletes, showed that DOMS, fatigue, and stress are not statistically affected in the weeks under study, whereas sleep quality is worse in congested weeks.

The included studies showed results evidencing a relationship between training load and the indices addressed by the Hooper questionnaire on training days before and after matches and in non-congested and congested training weeks.

Observing the forest plots generated in the meta-analysis, it is concluded that, regarding sleep quality, there was no statistically significant difference between the weeks,

except in the study by Gonçalves et al.<sup>16</sup> which showed a significant worsening of sleep quality in congested weeks. Regarding stress, there was no statistically significant difference between the weeks in any study. Regarding fatigue and DOMS, there was no statistically significant difference between the weeks except in the studies by Clemente et al.<sup>11,14</sup> which showed a statistically significant increase in non-congested weeks. That being said, it is understood that the use of player recovery techniques after training and games and the reduction of training load in periods with a higher number of games may have influenced this result. Furthermore, in some modalities such as futsal and handball, players do not participate in the entire game, but they participate in all training sessions of the non-congested weeks,<sup>11,14</sup> also potentially influencing the results observed in the forest plots. Most of the included studies are by similar authors. This fact shows the need for more studies on the subject. The use of different statistical methods in each study complicates the statistical analysis, a fact that could be considered in future studies, seeking uniformity. Another point to be highlighted is that there are no studies in literature that directly analyze the Hooper questionnaire with biomarkers of fatigue and overtraining, such as cortisol, lactate, and creatine kinase, among others. Such studies could contribute to building knowledge about the use of the Hooper questionnaire in training load control.

## Final Considerations

In this systematic review with meta-analysis on the use of the Hooper questionnaire for training load control in high-performance athletes from various sports modalities, it can be concluded that there is no concomitant statistically significant effectiveness of all variables combined in the Hooper questionnaire. Therefore, the Hooper questionnaire is not effective as a sole method of training load control. It is suggested that new studies should present, in addition to rigor in design, an adequate sample size and be applied to each sports modality to better evaluate the effectiveness of the Hooper questionnaire in identifying fatigue, sleep quality, stress, and DOMS for the prevention of overtraining and injuries in high-performance athletes exposed to load accumulation in training and games.

### Conflict of Interest

There is no conflict of interest to declare.

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