PSYCHOLOGICAL WORKLOAD IN SPORTS. THE EFFECTS OF SPORT TYPE AND QUALIFICATION LEVEL

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ABSTRACT
Background: The concept of Mental Workload (MW) evaluates the cognitive resources invested by an athlete relative to their available capacity. While crucial for performance, its perception varies significantly across different athletic contexts.
Objective: This study aimed to analyze the differences in perceived workload, as measured by the NASA-TLX, based on two factors: type of sport (individual, team, or combat) and sport qualification level (international medalists, national-level competitors, or recreational athletes).
Methods: A total of 183 athletes completed the NASA Task Load Index (NASA-TLX). Sport type (individual, team, combat) and qualification (international medalists, national-level, recreational) were treated as between-subject factors. One-way and two-way ANOVAs were used to test main and interaction effects.
Results: The results revealed significant main effects for both sport qualification and sport type on the dimensions of Mental Demand, Physical Demand, Temporal Demand, and Effort. Professional athletes consistently reported higher workloads than recreational athletes. Combat sports were perceived as the most physically and mentally demanding, while team sports were associated with the lowest effort. Crucially, a significant interaction effect was found for Temporal Demand, indicating that national-level competitors in team sports experience a unique peak in time pressure not observed in other groups. No significant differences were found for the Performance or Frustration dimensions.
Conclusion: These findings demonstrate that MW is a multifactorial construct shaped by both an athlete's expertise and the specific demands of their sport. The results highlight the need for a differentiated approach to workload management and provide a valuable tool for coaches and sport psychologists to better tailor training programs.

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INTRODUCTION

The concept of Mental Workload (MW) is an approach to understanding the resources an individual invests relative to those available to them. It depends on the effort expended, the complexity of the task, and the total resources for information processing (Paas, Tuovinen, Tabbers, & Van Gerven, 2003).

Yakovlev (2002) defines mental workload as a random process of interaction between external conditions (i.e., objective workload demands, such as ecological, behavioral, and situational factors) and internal conditions (i.e., subjective manifestations, such as functions, states, and properties) that mobilize or drive the individual towards a specific purposeful activity.

In the field of sports, physical load and fatigue are traditionally measured and quantified. The concept of mental workload, although acknowledged as essential for performance and athletic results, remains poorly studied theoretically and even less investigated experimentally. Yakovlev and Litovchenko (2007) note that the term "mental workload" has not yet been officially recognized in psychology. Four components of mental workload are derived. The first includes the demands placed on the athlete's personality by external and internal conditions. The second component is related to the evaluation and correction of actions and the activity level of mental functions, including changes in emotional arousal. The third component involves ensuring an optimal level of emotional arousal, which is achieved through the athlete's mental self-regulation skills. The fourth component involves mobilizing the athlete's functional resources to achieve a specific goal. While the first component

represents a set of conditions that are independent and uncontrollable by the athlete at the time, the other three components represent processes that the athlete can control. Mental strain emerges as a reaction to the workload and is formed under the influence of several components, including structural-functional, informational-operational, situational, and personal characteristics.

The origin of mental workload research is associated with the work of O'Donnell and Eggemeier (1986), who define it as the portion of an operator's limited capacity required at a given moment to perform a specific task. The authors describe MW as a hypothetical construct representing the "cost" incurred by the operator to achieve a particular level of performance.

To adequately measure this "cost", a clear operational definition is required. In this context, Cárdenas, Conde-González, and Perales (2015) propose viewing mental workload as uncertainty or entropy within the task. Entropy is defined as the degree of disorder in a system; the more unstable and unpredictable a system (such as a sports situation) is, the greater its entropy. According to the authors, the degree of uncertainty is determined by four key parameters in sports activity: 1) the numerical ratio of competitors (e.g., superiority, equality, or inferiority), 2) the degree of freedom in the players' actions, 3) the available time to make a decision, and 4) the available space for action. This theoretical framework is particularly valuable for the present study, as it provides a clear model for why team sports (which are inherently more unstable and have higher entropy) might generate a different workload profile compared to individual or combat sports.

One of the most established instruments for assessing subjective workload is the NASA-Task Load Index (NASA-TLX), developed by Hart and Staveland (1988). This instrument provides an overall workload score based on a weighted average of six subscales:

Mental Demand: How much mental and perceptual activity was required?

Physical Demand: How much physical activity was required?

Temporal Demand: How much time pressure was felt due to the rate or pace at which the tasks occurred?

Performance: How successful was the individual in accomplishing the goals of the task?

Effort: How hard did the individual (mentally and physically) have to work to accomplish their level of performance?

Frustration: How insecure, discouraged, irritated, or stressed was the individual during the task?

The application of NASA-TLX in sports enables the assessment of an athlete's subjective experience, which may not always directly correlate with objective physical metrics.

However, the relationship between mental effort and performance is not straightforward and must also be considered from a motivational perspective. Paas et al. (2005) argue that the invested mental effort can be considered a reliable indicator of the learner's (in our case, the athlete's) motivation or involvement in the task. From this viewpoint, the same situation can be interpreted in two ways: 1) from the perspective of cognitive efficiency, where high performance achieved with low effort is optimal, or 2) from the perspective of high involvement, where high performance is associated with high invested effort. This second perspective is extremely important when analyzing elite athletes. High levels of workload and effort in this group should not necessarily be seen as a negative factor, but rather as an indicator of maximum mobilization and motivation to achieve high results in a highly complex and demanding environment.

High or inadequately regulated mental workload can also act as a significant psychological stressor, affecting performance by altering levels of competitive anxiety. As Núñez and Garcia-Mas (2017) point out in their systematic review, the relationship between anxiety and athletic achievement is complex and non-linear. The classic Inverted-U Theory posits that there is an optimal level of arousal for maximal performance, whereas more contemporary models, such as Hanin's Individual Zone of Optimal Functioning (IZOF), emphasize the individual nature of this relationship. In this sense, the mental workload generated by a training or competitive task is one of the key factors that determines an athlete's level of arousal. The ability to manage this workload can be decisive in whether an athlete operates within their zone of optimal functioning or experiences dysfunctional anxiety that impairs their performance. This underscores the importance of investigating the subjective perception of workload, as was done in the current study and in the previous research by Núñez et al., which explored the links between MW, anxiety, and burnout.

METHODOLOGY

Study Design

This study employed a cross-sectional, comparative design to identify and analyze differences

in perceived workload among athletes grouped by two independent factors: "type of sport" and "sport qualification." The dependent variables were the six dimensions of workload, measured using the NASA-TLX, as well as the Overall Workload Index.

Participants

A total of 183 athletes participated in the study. By sport type, the sample comprised 102 athletes from individual sports, 37 from team sports, and 44 from combat sports. By qualification, the sample included 59 international medalists, 81 national-level competitors, and 43 recreational athletes. All participants were adults (aged 18 and above). Before the procedure, each was fully informed about the study's objectives, tasks, and methods. Participation was entirely voluntary, and each participant signed an informed consent form before participation. All participants were informed of their right to withdraw from the study at any time, without providing a reason, and without facing any negative consequences.

The participants were categorized based on two primary criteria:

By type of sport, participants were divided into three categories:

- *Individual Sports:* Athletes whose competitive performance is individual and does not directly depend on other teammates.
- *Team Sports:* Athletes participating in team-based sports that require coordination and interaction with teammates.
- *Combat Sports:* Sports characterized by direct fights with an opponent.

By sport qualification, participants were divided into three levels:

- *International Medalists:* Elite athletes with proven achievements and medals from international competitions (e.g., international events, World and European Championships, Olympic Games).
- *National-Level Competitors:* Active athletes who participate and place in national championships and tournaments.
- *Recreational Athletes:* Individuals who engage in sports regularly for health, pleasure, and physical fitness, without competing at a high level.

Instruments

To measure the subjectively perceived workload, the NASA-Task Load Index (NASA-TLX), developed by Hart and Staveland (1988), was used. This instrument is a globally established standard for workload assessment and consists of two phases:

1. *Pairwise Weighting Phase:* Participants make pairwise comparisons of the six workload dimensions to determine which are more significant sources of workload for their specific activity.
2. *Rating Phase:* Participants rate the intensity of each of the six dimensions on a scale from 0 to 100 immediately after performing the activity.

The six dimensions (subscales) measured are: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration.

The final result is an Overall Weighted Workload index.

Procedure

The research protocol was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the National Sports Academy "Vassil Levski" (Approval No. EC-NSA-2025-012, March 25, 2025). The questionnaires were administered individually to the athletes. Each participant was instructed on the study's objectives and the method for completing both parts of the NASA-TLX questionnaire. Participation was voluntary and anonymous. The collected data were processed, and both raw (unweighted) and weighted scores were calculated for each of the six subscales and the overall workload index for every participant, as well as for each group.

Data Analysis

The data analysis focused on the weighted scores, as they reflect the individual subjective importance of each workload component for the athletes. The statistical software package SPSS (Version 25) was used for all data processing and analysis.

The primary method for hypothesis testing was a two-way analysis of variance (ANOVA). This analysis was applied to examine the simultaneous effects of the independent factors "type of sport" (with three levels: individual, team, and combat) and "sport qualification" (with three levels: international medalists, national-level competitors, and recreational athletes) on each of the six workload dimensions (dependent variables). The analysis included testing for the main effects of both factors, as well as for their interaction effect.

When statistically significant main effects were found, post-hoc tests using Tukey's Honestly

Significant Difference (HSD) were conducted to identify specific differences between the groups. Before each analysis, Levene's test was performed to check the assumption of homogeneity of variances. The critical level of significance for all statistical tests was set at $p < .05$.

RESULTS

Table 1. *Comparison of Perceived Workload Across Sport Types*

Workload Dimension	Individual sports	Team sports	Combat Sports
Mental Demand	**209.00**	204.23	205.70
Physical Demand	300.36	279.79	**310.70**
Temporal Demand	**187.23**	174.60	180.00
Effort	213.63	**239.74**	208.43
Performance	276.46	271.72	**284.65**
Frustration	**143.77**	125.55	114.00

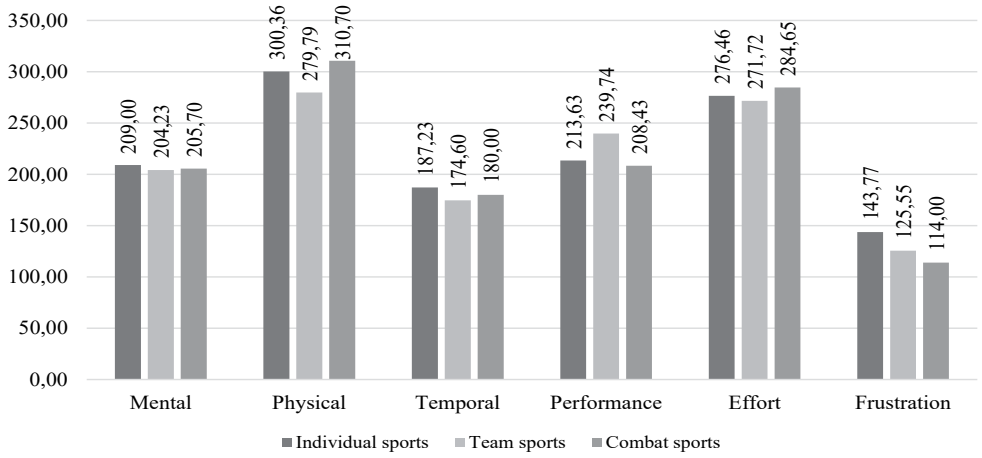

Figure 1. *Comparison of Scores for Perceived Workload Dimensions Across Sport Types.*

Physical Demand and Effort: The highest scores on these two subscales were observed in combat sports (310.70 and 284.65, respectively). This is an entirely expected result, given the direct physical confrontation and the high demands for strength and speed endurance.

Temporal Demand: Individual sports showed the highest time pressure (187.23). This can be explained by the need for precise execution within strictly defined time frames (e.g., track and field, gymnastics).

Performance: Team sports had the highest score on this subscale (239.74). This is likely attributable to the game's dynamics, the need for rapid and situationally appropriate actions, the responsibility towards teammates, and the constant evaluation from coaches and the public, all of which contribute to this perception.

Frustration: An interesting finding emerged from the frustration subscale. Athletes in individual sports showed significantly higher levels of frustration (143.77) compared to the other two groups. These results support the hypothesis that when the responsibility for success and failure rests solely on the individual, it leads to higher levels of stress and dissatisfaction. In team sports, responsibility is distributed, which may have a protective function, as noted in the study by Núñez et al. (2025).

Table 2. *Comparison of Perceived Workload Across Sport Qualification Levels*

Workload Dimension	International Medalists	National-Level Competitors	Recreational Athletes
Mental Demand	**220.09**	201.58	153.93
Physical Demand	**285.43**	275.19	261.55
Temporal Demand	167.5	**176.72**	158.53
Effort	230.73	**235.07**	202.65
Performance	**273.88**	270.94	248.33
Frustration	109.85	**125.43**	109

Mental Demand, Physical Demand, and Performance: On all three subscales, international medalists reported the highest scores. These results are logical, as the demands and expectations placed on elite competitors are exceptionally high, and competitions at the highest level require maximum mobilization of both physical and mental resources.
Temporal Demand, Effort, and Frustation: It is interesting to note that national-level athletes (Qualification 2) showed the highest scores on these three subscales. This may be due to the fact that they are at a pivotal stage in their careers, where the pressure to achieve results that could elevate them to the international stage is immense. International medalists may have already adapted to this pressure or possess more effective coping strategies.
A particularly interesting result was observed here again. The highest levels of frustration were reported by national-level competitors (125.43), while medalists and recreational athletes had nearly identical and significantly lower scores (around 109). This reinforces the hypothesis that the national level is the most psychologically challenging phase—athletes have already invested a great deal but have not yet reached the top, or have accepted that they cannot, which can lead to feelings of dissatisfaction from blocked needs and doubt about their outcomes.
It was established that across all qualification types, no dimension was rated highest by the recreational athletes. The highest scores were consistently found among the active competitors.

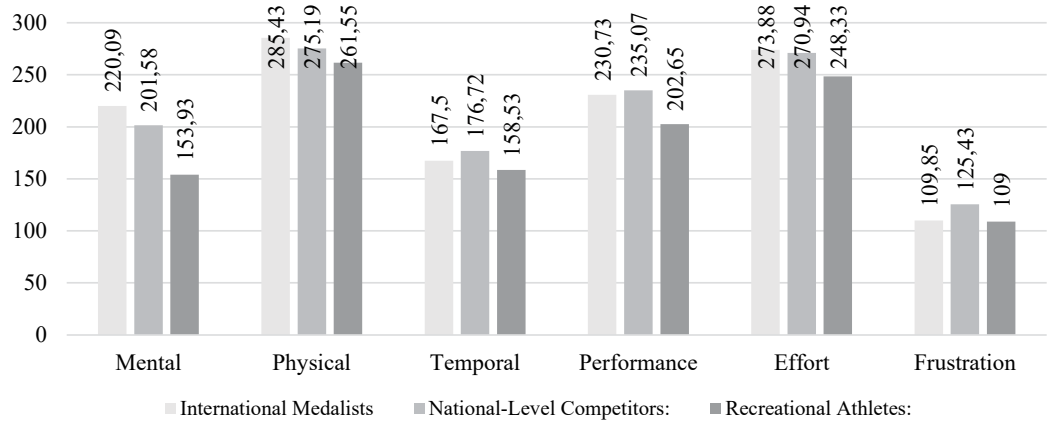

Figure 2. *Mean NASA-TLX Subscale Scores by Sport Qualification Level.*

Table 3. *Comparative Analysis of Mean (M) and Standard Deviation (SD) values on NASA-TLX subscales by Sport Qualification Level*

Workload Dimension	International Medalists (N=59) M (SD)	National-Level Competitors (N=81) M (SD)	Recreational Athletes (N=43) M (SD)	F(2, 180)	p	Significant Group Differences (Tukey HSD)
Mental Demand	82.88 (20.20)	75.00 (20.59)	57.09 (33.19)	14.69	**<.001**	**1 > 3; 2 > 3**
Physical Demand	83.81 (20.62)	83.40 (18.45)	73.95 (22.48)	3.75	**.025**	**1 > 3; 2 > 3**
Temporal Demand	76.95 (22.26)	80.06 (19.79)	68.60 (23.94)	3.98	**.020**	**2 > 3**
Effort	91.27 (14.73)	89.81 (10.97)	81.05 (21.67)	6.37	**.002**	**1 > 3; 2 > 3**
Performance	71.10 (21.21)	72.59 (19.09)	67.56 (21.42)	0.86	.424	N.S.
Frustration	45.85 (25.51)	51.11 (29.18)	42.91 (29.96)	1.33	.267	N.S.

Note: Group codes: 1 = International Medalists; 2 = National-Level Competitors; 3 = Recreational Athletes. The ">" symbol indicates a significantly higher mean (p < .05). N.S. = Not Significant.

To determine the differences in perceived workload as a function of sport qualification, a one-way analysis of variance (ANOVA) was conducted. As presented in Table 3, the analysis revealed a statistically significant effect of the "qualification" factor on four of the six workload dimensions: Mental Demand, Physical Demand, Temporal Demand, and Effort.
Subsequent Tukey post-hoc tests, the results of which are also summarized in Table 3, revealed the specific differences between the groups. A similar trend was observed for Mental Demand, Physical Demand, and Effort, where athletes in the recreational group (Qualification 3) reported signifi-

cantly lower workload levels compared to both the international medalists (Qualification 1) and the national-level competitors (Qualification 2). For Temporal Demand, a more specific difference was identified, with national-level competitors perceiving significantly higher time pressure only in comparison to the recreational athletes. No statistically significant differences were found between the three groups for the Performance and Frustration dimensions.

Table 4. *ANOVA and Tukey's Post-Hoc Test Results for Perceived Workload (NASA-TLX) by Type of Sport*

Workload Dimension	Individual Sports *(N=102)* *M (SD)*	Team Sports *(N=37)* *M (SD)*	Combat Sports *(N=44)* *M (SD)*	*F*(2, 180)	*p*	Significant Group Differences (Tukey HSD)
Mental Demand	73.73 (25.66)	65.00 (26.98)	79.43 (23.56)	3.26	**.041**	**3 > 2**
Physical Demand	81.57 (20.51)	72.84 (23.14)	87.84 (15.15)	5.70	**.004**	**3 > 2**
Temporal Demand	88.73 (14.26)	81.08 (21.41)	93.07 (10.69)	6.32	**.002**	**1 > 2; 3 > 2**
Effort	51.13 (27.04)	35.95 (22.69)	48.75 (33.05)	4.10	**.018**	**1 > 2**
Performance	74.36 (22.17)	74.86 (25.62)	82.27 (17.10)	2.13	.122	N.S.
Frustration	71.76 (18.61)	71.08 (19.15)	68.86 (24.96)	0.31	.733	N.S.

Note: Group codes: 1 = Individual Sports; 2 = Team Sports; 3 = Combat Sports. The ">" symbol indicates a significantly higher mean (p < .05). N.S. = Not Significant.

The results presented in Table 4 show a statistically significant effect of the "type of sport" factor on four of the six workload dimensions: Mental Demand ($F(2,180) = 3.26$, $p = .041$), Physical Demand ($F(2, 180) = 5.70$, $p = .004$), Temporal Demand ($F(2, 180) = 6.32$, $p = .002$), and Effort ($F(2, 180) = 4.10$, $p = .018$).

Subsequent Tukey post-hoc tests revealed specific workload profiles. Athletes in combat sports reported significantly higher Mental and Physical demand compared to athletes in team sports (3>2). For the Effort dimension, individual sports athletes reported significantly higher levels compared to athletes in team sports (1>2). No statistically significant differences were found among the three groups on the Performance ($p = .122$) and Frustration ($p = .733$) dimensions.

These results delineate clear profiles: combat sports are perceived as the most demanding in mental and physical aspects; individual sports are associated with the highest level of effort.

Table 5. *Summary of Two-Way ANOVA Results for the Effects of Sport Type and Qualification on Workload Dimensions*

Dimension (Dependent Variable)	Main Effect of Qualification *F*(2, 174)	Main Effect of Sport Type *F*(2, 174)	Interaction Effect *F*(4, 174)
Mental Demand	**F = 8.740, p < .001, η^2 = .091**	***F* = 3.342, p = .038, η^2 = .037**	*F* = 1.112, p = .352, η^2 = .025
Physical Demand	***F* = 3.151, p = .045, η^2 = .035**	***F* = 5.118, p = .007, η^2 = .056**	*F* = 1.146, p = .337, η^2 = .026
Temporal Demand	***F* = 5.936, p = .003, η^2 = .064**	*F* = 2.999, p = .052, η^2 = .033	***F* = 3.240, p = .014, η^2 = .069**
Effort	***F* = 4.225, p = .016, η^2 = .046**	***F* = 6.640, p = .002, η^2 = .071**	*F* = 1.065, p = .375, η^2 = .024
Performance	*F* = 0.639, p = .529, η^2 = .007	*F* = 0.228, p = .796, η^2 = .003	*F* = 0.438, p = .781, η^2 = .010
Frustration	*F* = 0.467, p = .628, η^2 = .005	*F* = 2.463, p = .088, η^2 = .028	*F* = 0.303, p = .875, η^2 = .007

To simultaneously examine the effects of sport type and sport qualification on perceived workload, a two-way analysis of variance (ANOVA) was conducted for each of the six NASA-TLX dimensions. The summarized results of these analyses are presented in Table 5.

Mental Demand: The analysis of mental demand revealed no significant interaction effect ($p = .352$). However, statistically significant main effects were found for both factors. The main effect of *qualification* was highly significant ($F(2, 174) = 8.740$, $p < .001$). Post-hoc tests revealed that recreational athletes ($M = 57.09$) reported significantly lower mental demand compared to both international medalists ($M = 82.88$) and national-level competitors ($M = 75.00$). The main effect of *sport type* was also significant ($F(2, 174) = 3.342$, $p = .038$), with combat sports athletes (M=79.43) perceiving significantly higher mental demand than those in team sports (M=65.00).

Physical Demand: Similar to mental demand, no interaction effect was found for physical demand (p = .337), but significant main effects were observed. The main effect of *qualification* (F(2, 174) = 3.151, p = .045) again shows that recreational athletes (M = 73.95) perceive a lower workload compared to international medalists (M = 83.81) and national-level competitors (M = 83.40). The main effect of *sport type* was highly significant (F(2, 174) = 5.118, p = .007), with combat sports athletes (M = 87.84) rating their physical demand as significantly higher than athletes in team sports (M = 72.84).

Temporal Demand: For temporal demand, a statistically significant *interaction effect* was found between sport type and qualification (F(4, 174) = 3.240, p = .014). This indicates that the effect of sport qualification on perceived time pressure differs across the various sport types. While temporal demand remained relatively stable across qualification levels for individual and combat sports, a sharp peak in temporal demand was observed in team sports for national-level competitors (M = 90.56). Although there was also a significant main effect of qualification (F(2, 174) = 5.936, p = .003), it must be interpreted in light of this interaction.

Effort: No interaction effect was detected for the Effort dimension (p = .375), but significant main effects were found for both factors. The main effect of qualification (F(2, 174) = 4.225, p = .016) shows that recreational athletes (M=81.05) reported significantly less invested effort compared to international medalists (M=91.27) and national-level competitors (M=89.81). The main effect of sport type (F(2, 174) = 6.640, p = .002) indicates that team sports (M=81.08) are perceived as requiring significantly less effort compared to both individual sports (M=88.73) and combat sports (M=93.07).

Performance: The analysis of the Performance dimension yielded no statistically significant results, neither for the main effects (qualification: p = .529; sport type: p = .796) nor for their interaction (p = .781). This suggests that the perception of one's own performance is fundamental to sport and is not significantly influenced by the factors examined.

Frustration: Similar to Performance, no statistically significant effects were found for the Frustration dimension. No significant influence was observed for qualification (p = .628), sport type (p = .088), or their interaction (p = .875). This suggests that frustration levels are comparable across the studied groups.

LIMITATIONS OF THE STUDY

The findings of this study should be considered in light of some limitations. The cross-sectional nature of our design prevents causal claims and does not capture the dynamic changes in workload over time. Another limitation might include the fact that our sample consisted solely of Bulgarian athletes; caution is warranted when generalizing these results to other cultural contexts. Future cross-cultural research is needed to validate these findings in a broader population.

CONCLUSIONS

The findings of this study validate the NASA-TLX as an effective instrument for differentiating perceived workload within the sports context. The results clearly demonstrate that perceived workload in athletes is a complex, multi-determined phenomenon, which is significantly and independently influenced by both the type of sport and the athlete's qualification level.

Sport qualification emerged as a crucial discriminator of perceived workload. Professional athletes—comprising both international medalists and national-level competitors—consistently reported higher levels of mental demand, physical demand, and effort when compared to their recreational counterparts.

Distinct workload profiles also emerged based on the type of sport. Combat sports were distinguished by the highest levels of mental and physical demand, whereas team sports were associated with lower perceived effort and frustration. Individual sports, conversely, were characterized by the highest levels of frustration when compared to team sports.

Of particular importance is the significant interaction effect observed for temporal demand, which indicates that national-level competitors in team sports face a unique peak in time pressure that distinguishes them from all other groups. It is noteworthy that no significant differences were found for perceived performance, implying that this aspect of workload may be more universal or contingent on other individual factors.

In summary, these results highlight the need for a differentiated approach to workload analysis and management, one that takes into account both the sport's specific demands and the athlete's developmental stage. Combat sports are defined by their high physical demands, while individual sports are characterized by heightened frustration. Concurrently, national-level athletes appear to be subject

to unique psychological pressures that differentiate them from both elite medalists and recreational athletes. These findings offer significant practical implications for coaches and sport psychologists, informing the design of training programs and the provision of tailored psychological support.

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