The Effects of Unprogrammed Training In Athletes Prior To Competition On Musculoskeletal and Metabolic Function: A Systematic Review

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Abstract.
Unplanned training before competition may affect athletes' musculoskeletal function, metabolic responses, recovery, and competitive performance. However, the extent of these effects remains insufficiently established. This systematic review aimed to examine the potential effects of unplanned pre-competition training on musculoskeletal function and metabolism. Relevant international publications addressing training-load changes, injury risk, physiological responses, recovery, and pre-competition tapering were synthesized narratively. The reviewed literature included systematic reviews, meta-analyses, and international consensus statements. The findings suggest that sudden or poorly coordinated increases in training load may contribute to accumulated fatigue and potentially increase injury risk when training demands exceed athletes' physical capacity and recovery opportunities. Evidence also indicates that planned reductions in training volume before competition can improve selected performance outcomes. Nevertheless, associations between workload indicators and injury were inconsistent, emphasizing the importance of individual characteristics, training history, sport-specific demands, and recovery conditions. Importantly, most reviewed publications investigated workload management and planned tapering rather than unplanned training directly. Therefore, the specific causal effects of unplanned training on musculoskeletal and metabolic outcomes remain uncertain. Future research should employ prospective study designs, clearly define unplanned training exposure, and assess standardized physiological, biochemical, musculoskeletal, and performance indicators. Individualized training management and systematic recovery monitoring are recommended to support athlete health and competitive readiness.
Keywords: *Unplanned training; Musculoskeletal function and Metabolic responses.*

I. INTRODUCTION

Physical training is essential for improving athletic performance, physical capacity, and physiological readiness for competition. Optimal performance depends on the integration of musculoskeletal function, neuromuscular coordination, energy metabolism, and adequate recovery. Therefore, training programs should be systematically designed according to the principles of progressive overload, individualization, and periodization. These principles are particularly important before competition, when athletes must maintain physical readiness while minimizing excessive fatigue and injury risk [1]. Recent sports medicine research emphasizes the importance of managing training load, nutritional status, and recovery to support athlete health and performance [2].

Unplanned training refers to additional physical activity or changes in training load that are not adequately integrated into an athlete's established training program. Examples include suddenly increasing training intensity, adding unscheduled exercise sessions, or performing strenuous activities without sufficient recovery. Such practices may occur when athletes attempt to improve performance rapidly before competition. Although additional training is not necessarily harmful, an imbalance between training demands and recovery capacity may compromise physical readiness. The effects depend on exercise intensity, duration, frequency, previous training exposure, and the athlete's individual condition [3]. Consequently, unplanned training should be examined in relation to overall training load rather than automatically considered detrimental [4].

The musculoskeletal system is particularly susceptible to changes in mechanical loading. Excessive or unfamiliar exercise may contribute to muscle soreness, temporary reductions in strength, restricted range of motion, and impaired neuromuscular coordination. These responses may affect movement quality and performance in sports requiring acceleration, jumping, rapid changes of direction, or physical contact. However, injury risk is multifactorial and cannot be attributed to training load alone. Previous injuries, physical conditioning, movement technique, and recovery status may also influence outcomes. Therefore,

evaluating musculoskeletal function requires consideration of both training exposure and individual athlete characteristics [4].

Unplanned training may also influence metabolic processes and physiological recovery. Exercise increases the demand for adenosine triphosphate (ATP), which is supplied through the phosphagen system, glycolysis, and oxidative metabolism. Additional training without adequate nutritional intake and recovery may increase fatigue and interfere with adaptation. Low energy availability is another concern because inadequate energy intake relative to exercise expenditure can negatively affect health and performance. The International Olympic Committee's consensus statement on Relative Energy Deficiency in Sport highlights the importance of sufficient energy availability in maintaining physiological function and athletic performance [1].

Metabolic and physiological responses can be assessed through indicators such as blood lactate, creatine kinase, inflammatory markers, and selected hormonal measures. Nevertheless, these indicators should not be interpreted individually as definitive evidence of overtraining or impaired recovery. Their meaning depends on exercise characteristics, individual variability, and measurement timing. Furthermore, the distinction between unplanned training and overtraining syndrome is important: unplanned training describes how exercise is organized, whereas overtraining syndrome involves persistent maladaptation and prolonged performance impairment. Comprehensive assessment is therefore necessary to interpret physiological responses accurately [5].

Although research has examined training load, sports injuries, metabolic responses, fatigue, and recovery, evidence specifically addressing unplanned training immediately before competition remains insufficiently synthesized. Existing studies frequently focus on training-load monitoring, overtraining, or tapering strategies separately. Tapering involves a planned reduction in training load before competition to reduce accumulated fatigue while preserving performance adaptations. Research indicates that appropriately structured tapering may improve athletic performance, emphasizing the importance of systematic preparation during the final pre-competition phase [2]. A systematic review is therefore needed to synthesize available evidence regarding the relationship between unplanned training and musculoskeletal and metabolic outcomes. Relevant outcomes include muscle strength, soreness, range of motion, neuromuscular function, injury incidence, blood lactate, creatine kinase, inflammatory markers, and indicators of energy availability. The review should distinguish unplanned training from sudden increases in training load and overtraining, while considering differences in sport type, competitive level, training intensity, and recovery status. Such distinctions are essential because additional exercise does not inevitably cause adverse outcomes; its effects depend on the characteristics and context of the training exposure [4].

The review should follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure transparent reporting of the literature search, study selection, data extraction, and risk-of-bias assessment [6]. Meta-analysis may be conducted if the included studies demonstrate sufficient methodological and statistical comparability; otherwise, a structured narrative synthesis may be more appropriate. Accordingly, this systematic review aims to examine the effects of unplanned training before competition on musculoskeletal function and metabolism, identify factors that may influence these outcomes, and determine gaps in the existing evidence. The findings are expected to inform sports physicians, physiotherapists, exercise physiologists, nutritionists, and coaches in developing safer and more effective pre-competition training strategies. Ultimately, this review may support evidence-based decisions regarding training-load management, physiological monitoring, and recovery to optimize athletic readiness.

II. METHODS

This study will employ a systematic review to examine the effects of unplanned training before competition on musculoskeletal function and metabolism in athletes. The review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure transparent and reproducible reporting of the search, selection, and synthesis processes [6]. A systematic search will be conducted in PubMed/MEDLINE, Scopus, Web of Science, SPORTDiscus, and Embase,

where available. The search will cover studies published from database inception until the final search date in 2026. Search terms will combine keywords related to athletes, unplanned training, training-load changes, musculoskeletal function, and metabolism. Example terms include athletes, unplanned training, additional training, sudden increase in training load, muscle damage, neuromuscular fatigue, metabolic responses, and recovery. Reference lists of relevant articles will also be screened to identify additional eligible studies.

Studies will be included if they investigate human athletes participating in organized sports and examine unplanned or additional training, sudden changes in training load, or unscheduled exercise relevant to pre-competition preparation. Eligible outcomes will include musculoskeletal function, muscle damage, fatigue, injury incidence, metabolic biomarkers, energy availability, and physiological recovery. Randomized trials, observational studies, and other relevant quantitative primary studies will be considered. Editorials, study protocols without results, and publications without relevant outcome data will be excluded. Because the term unplanned training may not be consistently defined in the literature, studies examining sudden workload increases or inadequate recovery will be classified as related evidence rather than automatically considered direct evidence. Two independent reviewers will screen titles and abstracts, assess potentially eligible full texts, and resolve disagreements through discussion or consultation with a third reviewer. The selection process will be documented using a PRISMA flow diagram [6].

Data will be extracted using a standardized form covering author, publication year, country, study design, sample size, athlete characteristics, sport type, training exposure, timing before competition, outcome measures, main findings, and study limitations. Musculoskeletal outcomes will include muscle strength, muscle soreness, range of motion, neuromuscular function, and injuries. Metabolic outcomes will include blood lactate, creatine kinase, inflammatory markers, hormonal responses, and energy availability. The methodological quality and risk of bias of included studies will be assessed using tools appropriate to their study designs. RoB 2 will be used for randomized trials, while ROBINS-I or an appropriate tool for observational studies will be selected when applicable. Assessments will be conducted independently by two reviewers where feasible, and the results will inform the interpretation of the evidence [7].

Findings will initially be synthesized narratively and organized into musculoskeletal and metabolic outcomes. Results will be compared according to training characteristics, athlete populations, timing before competition, and study design. If sufficient comparable data are available, meta-analysis will be conducted using appropriate effect measures and statistical models, with heterogeneity assessed using the (I^2) statistic. If quantitative pooling is inappropriate because of substantial methodological or clinical heterogeneity, a structured narrative synthesis will be presented in accordance with the SWiM reporting guideline [8]. The review will follow PRISMA 2020 reporting recommendations, and the protocol should be established before formal screening begins. The conclusions will distinguish direct evidence concerning unplanned pre-competition training from indirect evidence concerning general training-load changes. This distinction is essential to avoid overstating the effects of unplanned training when the available evidence is limited.

III. RESULT AND DISCUSSION

a. Characteristics of the Reviewed Studies

The ten selected international publications provide evidence relevant to the relationship between training-load management, pre-competition preparation, musculoskeletal health, metabolic responses, and athletic performance. The literature comprises systematic reviews, meta-analyses, and consensus statements addressing training-load fluctuations, cumulative workload, injury risk, recovery, and tapering strategies. However, the studies differ in their populations, sports, exposure definitions, and outcome measurements. Consequently, their findings are more appropriately synthesized narratively than combined into a single pooled effect estimate.

A key distinction emerging from the literature is the difference between unplanned training and high training load. Unplanned training refers to additional, unscheduled, or inadequately coordinated exercise that occurs outside an athlete's established training programme. High training load, by contrast, may be deliberately prescribed and appropriately monitored. Similarly, tapering is a planned reduction in training load before competition, not an example of unplanned training. This distinction is essential because a high

workload does not necessarily indicate poor preparation, and a reduction in training volume does not necessarily indicate inadequate training.

The reviewed publications therefore contribute at different levels. Research on tapering provides evidence about the importance of managing training volume and recovery before competition. Reviews of workload and injury offer evidence about the possible consequences of abrupt or excessive load changes. Studies of internal and external load monitoring help explain how training stress can be evaluated. Nevertheless, these findings cannot automatically establish that unplanned training itself causes musculoskeletal impairment or metabolic disturbance. The strength of the conclusions must reflect this difference in directness of evidence.

b. Summary of the Ten Reviewed Articles

Table 1 summarizes the main characteristics and contributions of the ten publications. The table emphasizes the type of evidence, major findings, and relevance to the research question rather than treating all publications as direct tests of unplanned training.

Table 1. Summary of International Publications Relevant to Unplanned Pre-Competition Training

No.	Article	Study type and focus	Main Findings	Relevance to the present review
1.	Wang et al. (2023), Effects of tapering on performance in endurance athletes [2]	Systematic review and meta-analysis of 14 studies involving 174 endurance athletes.	Systematic review and meta-analysis of 14 studies involving 174 endurance athletes.	Demonstrates that planned reductions in training volume before competition can improve selected performance outcomes.
2.	Dudley et al. (2023), Methods of monitoring internal and external loads [4]	Systematic review and best-evidence synthesis; 59 studies of adolescent athletes.	Moderate evidence linked resistance-training volume with strength gains and throwing volume with injury; many other load–outcome relationships were limited or inconsistent	Supports monitoring both training exposure and athletes' responses, while recognizing uncertainty in individual load indicators.
3.	Sniffen et al. (2022), Is cumulative load associated with injuries in youth team sport? [9]	Systematic review of 11 studies in youth team sports.	Of 66 assessed load–injury relationships, 39 (59%) were significant; 31 of those 39 relationships (79%) were positive associations.	Suggests that cumulative load may be related to injury, but measurement inconsistency limits certainty.
4.	Vachon et al. (2021), Effects of tapering on neuromuscular and metabolic fitness in team sports [10]	Systematic review and meta-analysis of 14 articles on tapering in team-sport athletes.	Evaluated how tapering strategies involving volume, intensity, frequency, pattern, and duration affect neuromuscular and metabolic fitness.	Provides a comparison between planned pre-competition load reduction and the less controlled exposure represented by unplanned additional training.
5.	Verstappen et al. (2021), The association between training load and injury risk in elite youth	Systematic review and best-evidence synthesis; five studies	Found moderate evidence of no association for several specific load measures, while evidence for other relationships was	Counters the assumption that every increase in training load necessarily causes injury.

No.	Article	Study type and focus	Main Findings	Relevance to the present review
	soccer players [11]		insufficient or conflicting.	
6.	Griffin et al. (2020), The association between the acute:chronic workload ratio and injury and its application in team sports [12]	Systematic review of the acute:chronic workload ratio (ACWR) and injury in team sports.	Examined whether the relationship between recent and longer-term workload could inform injury-risk management; interpretation depends on the method and evidence used.	Highlights the importance of considering recent load in relation to the athlete's prior training exposure.
7.	Maupin et al. (2020), The relationship between acute:chronic workload ratios and injury risk in sports [13]	Systematic review of ACWR and injury risk across sports	Examined the evidence linking workload ratios with injury and the practical use of this metric in monitoring athletes.	Supports contextual interpretation of workload changes, rather than evaluating a single session in isolation.
8.	Soligard et al. (2016), How much is too much? Part 1: IOC consensus statement on load in sport and risk of injury [3]	International Olympic Committee consensus statement on training load and injury.	Identified rapid changes in load, inadequate recovery, and individual differences in load tolerance as important considerations in injury prevention	Provides a physiological and practical framework for interpreting sudden increases in training exposure
9.	Schwellnus et al. (2016), How much is too much? Part 2: IOC consensus statement on load in sport and risk of illness [14]	International Olympic Committee consensus statement on training load, illness, and overtraining	Reported evidence linking high loads and load changes with illness in some athlete populations, while emphasizing variation between groups and individuals.	Broadens the review beyond musculoskeletal outcomes to the wider health consequences of insufficient recovery.
10.	Meeusen et al. (2013), Prevention, diagnosis, and treatment of the overtraining syndrome: Joint consensus statement of the ECSS and ACSM	International expert consensus on overtraining syndrome.	Emphasized that prolonged maladaptation involves complex interactions among training stress, recovery, performance changes, and other factors; no single marker is sufficient for diagnosis.	Provides background for interpreting persistent fatigue and impaired performance, while distinguishing them from short-term fatigue after exercise.

These publications do not all directly investigate unplanned training immediately before competition. They are included because they provide relevant evidence about workload changes, recovery, injury, metabolic or neuromuscular fitness, and planned pre-competition training. The final review should classify each included article according to whether its exposure directly matches the research question or provides indirect contextual evidence. The two most directly relevant bodies of evidence are research on pre-competition tapering and research on workload changes in relation to injury and recovery. Tapering studies

are useful because they investigate how deliberately modifying training before competition affects performance. Workload studies are useful because they help explain the potential consequences when training demands change without sufficient consideration of the athlete's previous exposure and recovery. However, neither evidence group should be interpreted as a direct estimate of the effect of unplanned training unless the original study actually measured that exposure.

c. Effects on Musculoskeletal Function

The reviewed literature suggests that the relationship between training load and musculoskeletal outcomes is complex. Training provides a stimulus for physiological adaptation, including improvements in muscular strength, physical capacity, and tolerance to sport-specific demands. Nevertheless, the benefits of training depend on the interaction between the magnitude of the stimulus, the athlete's existing capacity, and the time available for recovery. A session that is appropriate within a planned training programme may produce a different response when added unexpectedly to an already demanding schedule. Dudley et al. (2023) found moderate evidence that resistance-training volume load was positively related to improvements in strength among adolescent athletes [4]. This finding supports the principle that an adequate training stimulus can promote positive physical adaptation. However, the review also found that relationships between load measures and injury or other physical outcomes were limited or inconsistent for many variables. Consequently, the evidence does not support a simple conclusion that greater training load always produces either better physical function or greater injury risk. The athlete's age, training history, maturation, sport, and exposure to specific movements may influence the response.

Evidence from youth team sports further demonstrates this complexity. Sniffen et al. (2022) identified 66 relationships between cumulative workload and injury across the included studies. Thirty-nine relationships (59%) were statistically significant, and 31 of these significant relationships (79%) were positive associations between greater cumulative load and injury. Although these results suggest that higher cumulative workload can be associated with increased injury occurrence, 27 of the 66 assessed relationships were not statistically significant. The findings therefore support careful workload management, but they do not establish a universal threshold at which injury will occur [9]. A related systematic review of elite youth soccer by Verstappen et al. (2021) reported moderate evidence of no association between injury and several specific workload indicators, including certain cumulative-load measures and the acute:chronic workload ratio. Evidence for other comparisons was insufficient or conflicting. These findings are important because they caution against treating any single workload measure as a definitive predictor of musculoskeletal injury. In the context of unplanned training, a sudden increase in training duration or intensity should therefore be interpreted as a potential concern requiring individual assessment, not as proof that injury will result [11].

The International Olympic Committee consensus statement by Soligard et al. (2016) provides a physiological explanation for why rapid or poorly coordinated increases in load may be problematic. Training stresses muscles, tendons, bones, and other structures, while recovery allows the body to adapt to that stress. If the applied load exceeds the athlete's current capacity or recovery is insufficient, accumulated fatigue and tissue microdamage may contribute to a higher risk of injury. Fatigue may also affect force production, coordination, and neuromuscular control, potentially changing the mechanical demands placed on the musculoskeletal system. However, these mechanisms operate within a multifactorial injury process and should not be used to claim that all additional training is harmful [3]. The findings of Griffin et al. (2020) and Maupin et al. (2020) also make workload history relevant to interpretation. An athlete's response to a given session may depend not only on the immediate load but also on the training load accumulated over previous days and weeks. An additional session may be tolerable for an athlete who has progressively developed the relevant capacity, but less tolerable for an athlete whose recent workload has been low or whose recovery has been compromised. Workload ratios can help describe this relationship, although their interpretation depends on how load is calculated and on the limitations of the underlying evidence [12][13]. Taken together, the evidence indicates that the principal musculoskeletal concern is not simply whether training is planned or unplanned, but whether the additional exposure creates a mismatch between training demands and the athlete's current capacity. Unplanned training may be more problematic when it introduces unfamiliar movements, high eccentric loading, additional sprinting or jumping, or repeated high-intensity

sessions close to competition. These are plausible risk pathways derived from workload and injury research, rather than a demonstrated effect size specific to unplanned pre-competition training. Direct prospective studies are needed to establish how often these exposures lead to measurable changes in muscle function or injury occurrence.

d. Effects on Metabolic Responses and Recovery

Metabolic responses provide another important dimension for understanding the effects of training before competition. Exercise requires energy production to meet muscular demands and can produce temporary changes in substrate utilization, cardiovascular function, perceived exertion, and biochemical indicators of physiological stress. These changes are not inherently harmful: they are expected responses to exercise and may contribute to adaptation. The critical issue is whether the athlete has sufficient time and resources to recover before the next demanding session or competition. Evidence from pre-competition tapering provides an important reference point. Wang et al. (2023) conducted a systematic review and meta-analysis of 14 studies involving 174 endurance athletes. Their analysis found improvements in time-trial performance (standardized mean difference [SMD] = −0.45) and time to exhaustion (SMD = 1.28) following tapering, whereas changes in maximal oxygen uptake (VO_2max) and movement economy were not statistically significant. The authors reported that tapering strategies involving a progressive reduction in training volume of approximately 41–60%, while maintaining training intensity and frequency, could improve time-trial performance when implemented over a period of up to 21 days [2].

These results suggest that successful pre-competition preparation does not necessarily require maintaining or increasing training volume until the competition date. Instead, reducing accumulated training stress while retaining relevant training stimuli may help athletes express their existing physical capacity. Importantly, the study evaluated planned tapering rather than unplanned training. It therefore provides evidence about the potential value of structured load reduction, not direct evidence that an additional training session causes metabolic impairment. Vachon et al. (2021) examined tapering in team-sport athletes through a systematic review and meta-analysis focused on neuromuscular and metabolic fitness. This body of evidence is relevant because team sports require repeated high-intensity efforts, changes of direction, acceleration, and recovery between bouts of activity. Training modifications before competition may influence both the athlete's ability to produce force and the physiological capacity to sustain repeated efforts. However, the effects depend on the tapering strategy and the outcomes assessed; findings from planned tapering cannot be directly generalized to unscheduled additional sessions [10].

The IOC consensus on training load and illness also indicates that excessive or inadequately managed training demands may be associated with health problems in some athlete populations. Schwellnus et al. (2016) discussed evidence linking high training loads and changes in training intensity or volume with illness and overtraining-related concerns. Nevertheless, the relationship between training load and illness varies across athlete groups, and the available evidence does not establish one universal load threshold that predicts a specific outcome. These findings support attention to recovery and athlete well-being, rather than the assumption that a single additional session necessarily produces metabolic dysfunction [14]. In practice, metabolic recovery should be assessed through multiple indicators rather than a single biomarker. Depending on the sport and the study design, relevant measures may include blood lactate under standardized testing conditions, creatine kinase as an indirect indicator of muscle damage, heart-rate responses, perceived exertion, performance tests, sleep quality, and subjective fatigue. These indicators reflect different physiological processes and should not be treated as interchangeable. For example, an elevated creatine kinase concentration may be consistent with muscle damage, but it does not independently establish a clinically meaningful injury or prove that an athlete is unable to compete. Likewise, lactate concentration is influenced by exercise intensity, sampling time, and clearance; it should not be interpreted as a general measure of harmful metabolic stress without appropriate context.

The consensus statement on overtraining by Meeusen et al. (2013) further emphasizes the complexity of prolonged maladaptation. Persistent performance deterioration and fatigue cannot be explained reliably by one isolated physiological measurement. They must be interpreted alongside training history, recovery, symptoms, and other possible contributing factors. This distinction is particularly important for the present

review: acute fatigue after exercise is not equivalent to overtraining syndrome, and a transient metabolic response does not necessarily indicate lasting impairment [15]. Overall, the available evidence supports the importance of coordinating pre-competition training with recovery. Unplanned additional sessions could plausibly increase cumulative stress, particularly when they involve high intensity, unfamiliar exercise, or inadequate recovery intervals. However, the magnitude and duration of their metabolic effects remain uncertain because the reviewed literature primarily examines workload management and planned tapering rather than unplanned training as a distinct exposure.

e. Implications for Pre-Competition Training Management

The reviewed evidence has several practical implications for athletes, coaches, and sports-science practitioners. First, pre-competition training should be managed according to the athlete's training history, current condition, sport-specific demands, and the time remaining before competition. Training decisions should not be based exclusively on the assumption that more exercise will necessarily produce better performance. The tapering evidence indicates that reducing training volume while preserving selected training stimuli can improve performance in endurance athletes [2]. Second, internal and external training loads should be monitored together. External load can include training duration, distance, repetitions, jumps, throws, and resistance-training volume. Internal load can include session rating of perceived exertion, heart rate, and athlete-reported fatigue. Dudley et al. (2023) found that evidence for relationships between individual load indicators and health or performance outcomes was inconsistent for many variables, supporting the use of a broader assessment rather than relying on a single measurement [4]. Third, additional training should be evaluated in relation to the existing programme. An extra session may be appropriate when it is deliberately prescribed, takes account of previous exposure, and allows adequate recovery. Conversely, sessions introduced without coordination between the athlete, coach, and support team may create unnecessary load or interfere with planned recovery. This is especially relevant when competition is approaching and there is limited time to recover from demanding exercise. Fourth, decisions should be individualized. Athletes differ in age, training experience, physical capacity, injury history, nutritional status, sleep, and response to exercise. The same additional training session may therefore produce different outcomes in different individuals. The workload literature supports monitoring and individualized interpretation, but does not justify a universal numerical threshold that can reliably predict injury or metabolic impairment for every sport and athlete.

Finally, future research should explicitly define unplanned training rather than using high workload as a substitute for this exposure. Researchers should record whether sessions were scheduled, who prescribed them, how they differed from the established programme, their timing relative to competition, and whether athletes completed additional sessions independently. Outcomes should include both musculoskeletal measures such as strength, range of motion, muscle soreness, neuromuscular function, and prospectively recorded injuries—and metabolic or recovery indicators collected at standardized time points. Such designs would make it possible to distinguish short-term physiological responses from persistent impairment and would strengthen causal interpretation.

The central finding of this review is that the literature provides relevant but predominantly indirect evidence concerning the effects of unplanned training before competition. Studies of cumulative workload and injury suggest that increased training exposure may be associated with injury in some settings, although findings are inconsistent across measures and populations. Studies of tapering demonstrate that planned reductions in training volume can improve selected performance outcomes. Meanwhile, research on load monitoring highlights the importance of interpreting training exposure alongside individual physiological and perceptual responses. These findings support the proposition that poorly coordinated additional training may be problematic when it increases workload beyond an athlete's current capacity or reduces the opportunity for recovery. However, the reviewed evidence does not establish that unplanned training invariably causes musculoskeletal dysfunction, metabolic disturbance, or poorer competition performance. Nor does it identify a universal threshold for the amount of unplanned exercise that is harmful. The outcome is likely to depend on the type, intensity, duration, and timing of the exercise, the athlete's prior preparation, and the availability of recovery. A major research gap remains the limited distinction between unplanned

training, rapid changes in workload, excessive cumulative load, and planned overload training. These exposures are related but not identical. Future systematic reviews should identify whether included studies measure unplanned training directly or provide only indirect evidence from workload management and tapering research. This classification would help prevent conclusions from exceeding what the underlying studies demonstrate.

IV. CONCLUSION

This systematic review highlights the potential importance of managing training load before competition to maintain musculoskeletal function, optimize metabolic responses, and support athletic performance. The reviewed literature suggests that excessive or poorly coordinated increases in training load may contribute to accumulated fatigue and increased injury risk, particularly when the training demands exceed an athlete's current capacity or recovery opportunities. However, the relationship between training load and injury is inconsistent across studies, indicating that outcomes depend on individual characteristics, training history, sport-specific demands, and recovery conditions.

Evidence from tapering studies demonstrates that planned reductions in training volume before competition can improve selected performance outcomes. These findings emphasize the importance of structured training programmes rather than assuming that additional exercise will necessarily enhance competitive readiness. Monitoring internal and external training loads, fatigue, musculoskeletal function, and recovery indicators may help coaches and athletes make more informed training decisions. Nevertheless, the available evidence predominantly addresses workload management and planned tapering rather than unplanned training as a distinct exposure. Therefore, the direct effects of unplanned pre-competition training on musculoskeletal and metabolic outcomes remain insufficiently established. Future research should employ prospective designs, clearly define unplanned training, and assess standardized physiological, biochemical, and performance outcomes. Such evidence would strengthen causal interpretation and support the development of individualized, evidence-based training strategies to improve athlete safety, recovery, and competitive performance.

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