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Original Articles

Effects of curcumin supplementation on biochemical parameters and muscle pain in soccer athletes: a narrative review

Efeitos da suplementação de curcumina em parâmetros bioquímicos e de dor muscular em atletas de futebol: uma revisão narrativa

Efectos de la suplementación con curcumina sobre los parámetros bioquímicos y el dolor muscular en atletas de fútbol: una revisión narrativa

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Keywords:
Turmeric;
Soccer;
Athletes;
Supplement.

ABSTRACT
Turmeric has been widely studied for its antioxidant and anti-inflammatory properties, with potential benefits for athlete recovery. This narrative review investigated the effects of curcumin supplementation on biochemical parameters and muscle pain in soccer athletes. Clinical trials analyzing outcomes such as creatine kinase, C-reactive protein, and delayed-onset muscle soreness were examined. Findings suggest that curcumin may reduce inflammation and enhance muscle recovery, although effects vary depending on dosage and bioavailability. Further studies are needed to establish effective supplementation protocols.

Palavras-chave:
Cúrcuma;
Futebol;
Atletas;
Suplemento.

RESUMO
A cúrcuma tem sido amplamente estudada por suas propriedades antioxidantes e anti-inflamatórias, com potencial benefício na recuperação de atletas. Esta revisão narrativa investigou os efeitos da suplementação de curcumina em parâmetros bioquímicos e dor muscular em jogadores de futebol profissional. Foram analisados ensaios clínicos que avaliaram desfechos como creatina quinase, proteína C- reativa e dor muscular tardia. Os achados sugerem que a curcumina pode reduzir a inflamação e melhorar a recuperação muscular, embora os efeitos variem conforme a dose e biodisponibilidade. Mais estudos são necessários para estabelecer protocolos eficazes de suplementação.

Palabras clave:
Cúrcuma;
Fútbol;
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RESUMEN
La cúrcuma ha sido ampliamente estudiada por sus propiedades antioxidantes y antiinflamatorias, con un potencial beneficio en la recuperación de atletas. Esta revisión narrativa investigó los efectos de la suplementación con curcumina sobre parámetros bioquímicos y el dolor muscular en atletas de fútbol. Se analizaron ensayos clínicos que evaluaron desenlaces como la creatina quinasa, la proteína C reactiva y el dolor muscular de aparición tardía. Los hallazgos sugieren que la curcumina puede reducir la inflamación y mejorar la recuperación muscular, aunque los efectos varían según la dosis y la biodisponibilidad. Se requieren más estudios para establecer protocolos eficaces de suplementación.

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INTRODUCTION

Sports injuries are a concern at any sporting event, from amateur events to major events such as World Championships and Olympic Games. Recent data on injuries or illnesses at major sporting events were recorded at the London 2012 and Rio 2016 Olympics, where there was an incidence of 128.8 injuries and 71.7 illnesses per 1000 athletes (Collins et al., 2021). Some sports stand out in terms of injury risk: taekwondo, judo, football, and athletics are classified as high-risk for injury, as they presented the highest number of recorded muscle strains (Engebretsen et al., 2013; Soligard et al., 2017). Injuries in football, in particular, occur during game performance or intense muscle contractions, exacerbating the level of systemic and local inflammation after the injury (Collins et al., 2021).

In this context, sports nutrition has demonstrated evidence of optimizing the physical and mental performance of elite soccer athletes during training, competition, and recovery phases, as well as in maintaining general health throughout a long season (Collins et al., 2021), whether through food or the use of supplements. Among the foods studied, turmeric (*Curcuma longa* L.) has gained prominence. It is a perennial herbaceous plant with a rhizome, yellow flowers, and broad leaves, belonging to the ginger family and growing in tropical climates. This plant is rich in phenolic compounds, such as curcuminoids, and exhibits antioxidant, antimicrobial, anti-inflammatory, antiangiogenic, antimutagenic, and antiplatelet aggregation properties (Kocaadam and Şanlier, 2017). Among the curcuminoids, curcumin stands out, and its supplementation in sports appears to be beneficial in attenuating exercise-induced muscle damage (EIMD). The proposed mechanism for this benefit includes the regulation of performance markers following intense exercise, potentially leading to membrane-protective effects, antioxidant responses, and anti-inflammatory action (Harty et al., 2019).

Curcumin supplementation in sports and physical activity practitioners is likely safe and beneficial due to its ability to reduce inflammation and oxidative stress, alleviate pain and muscle damage, enhance muscle recovery, and improve psychological responses during training (Davis et al., 2007). However, curcumin is still considered a level B sports supplement in terms of evidence, requiring further studies to evaluate its effects and establish a safe and effective dosage (Suhett et al., 2021; Altarriba-Bartes et al., 2020; Fang and Nasir, 2021). Therefore, this study aims to gather and analyze the available evidence from studies that have assessed the effects of curcumin supplementation in soccer athletes.

METHODS

This is a narrative review with a systematized search conducted between September and December 2024. The stages of the study included a literature search, study selection, data extraction, and data synthesis.

LITERATURE SEARCH

Studies were retrieved from the following databases: Latin-American and Caribbean System on Health Sciences Information (LILACS), Medical Literature Analysis and Retrieval System Online (Medline) via PubMed, Scientific Electronic Library Online (SciELO), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, Cochrane Library, SPORTDiscus, Web of Science, and Embase, with no publication date restrictions.

The search strategy combined terms related to curcumin and exercise, including Medical Subject Headings (MeSH) and free terms, using Boolean operators: ("Curcuma"[Mesh] OR "Curcuma" OR "Curcumas" OR "Zedoary zedoaria" OR "Zedoary zedoarias" OR "Tumeric" OR "Tumerics" OR "Turmeric" OR "Turmerics") AND ("Soccer"[Mesh] OR "Soccer" OR "Football European" OR "European Football" OR "Athletes"[Mesh] OR "Athletes" OR "Athlete"). The main PubMed search strategy was adapted for each database. The search was limited to studies published in English and the strategy was reviewed by a librarian from the Federal University of Santa Catarina.

ELIGIBILITY CRITERIA

The inclusion criteria were as follows: published interventional studies in humans that assessed the effects of curcumin supplementation on sports performance in soccer athletes.

Exclusion criteria: studies conducted in animals or in vitro; use of food instead of supplements; review articles; book chapters; books; abstracts; studies involving factors other than sports and physical exercise (e.g., osteoarthritis, depression, cardiovascular diseases, fibrosis, cancer); monographs; theses; dissertations; studies in which authors declared conflicts of interest.

STUDY SELECTION

Studies retrieved from the databases were imported into the Mendeley reference manager for duplicate removal and subsequently transferred to the Rayyan software for screening. Initially, studies were screened by title and abstract, followed by full-text reading based on the eligibility criteria. The entire process was carried out independently and in duplicate by two authors (GCR and ATM). Discrepancies between authors were resolved by consensus or by involving a third researcher (LPL).

DATA EXTRACTION

The following data were collected from the selected studies: author; year of publication; country; study protocol; sample size; participant age; dosage used; duration of the intervention; type of physical exercise; evaluated outcomes; main results found.

DATA SYNTHESIS

Data were synthesized and presented in descriptive tables or charts. The synthesis was based on the main findings, discussion of the general scope and applicability of the results, agreements and disagreements with other studies and/or reviews, and highlighted strengths, potential biases, and limitations. Although a rigorous and structured literature search was employed to minimize selection bias and maximize transparency, a narrative synthesis approach was ultimately chosen due to the substantial clinical and methodological heterogeneity observed across the included studies.

RESULTS

STUDY SELECTION

The initial search identified 119 references (Figure 1). No additional references were identified through screening of reference lists or citation tracking of relevant articles. After the removal of duplicates, 56 titles and abstracts were screened. Nine studies were retained for full-text analysis. Subsequently, 5 studies were excluded for the following reasons: the participants were not soccer athletes in four studies, and one study was a duplicate publication (Faria et al., 2020; Shiravand et al., 2019; Fernández-Lázaro et al., 2020; Nosrati-Oskouie et al., 2022). In the end, four studies were included in the review (Rosidi et al., 2022; Clayton et al., 2023; Choi et al., 2023; Abbott et al., 2023.

STUDY CHARACTERISTICS

Table 1 presents the general characteristics of the studies included in the review. A total of 61 participants were included in the review, with a mean age of 19.87 ± 2.2 years, ranging from 14 to 26 years. The competitive level of the soccer athletes in the studies was heterogeneous, including amateur athletes (Rosidi et al., 2022), semi-professional (Abbott et al., 2023), women's soccer (Choi et al., 2023), and elite or professional (Clayton et al., 2023). Of the included studies, two used curcumin supplementation in capsule form (Choi et al., 2023 and Abbott et al., 2023), highlighting that the study by Choi et al., 2023 uses curcumin with nanotechnology promoting greater absorption, one in drink form (Clayton et al., 2023) that added piperine (black pepper extract) to enhance curcumin absorption, and one study used supplementation in ice cream form (Rosidi et al., 2022).

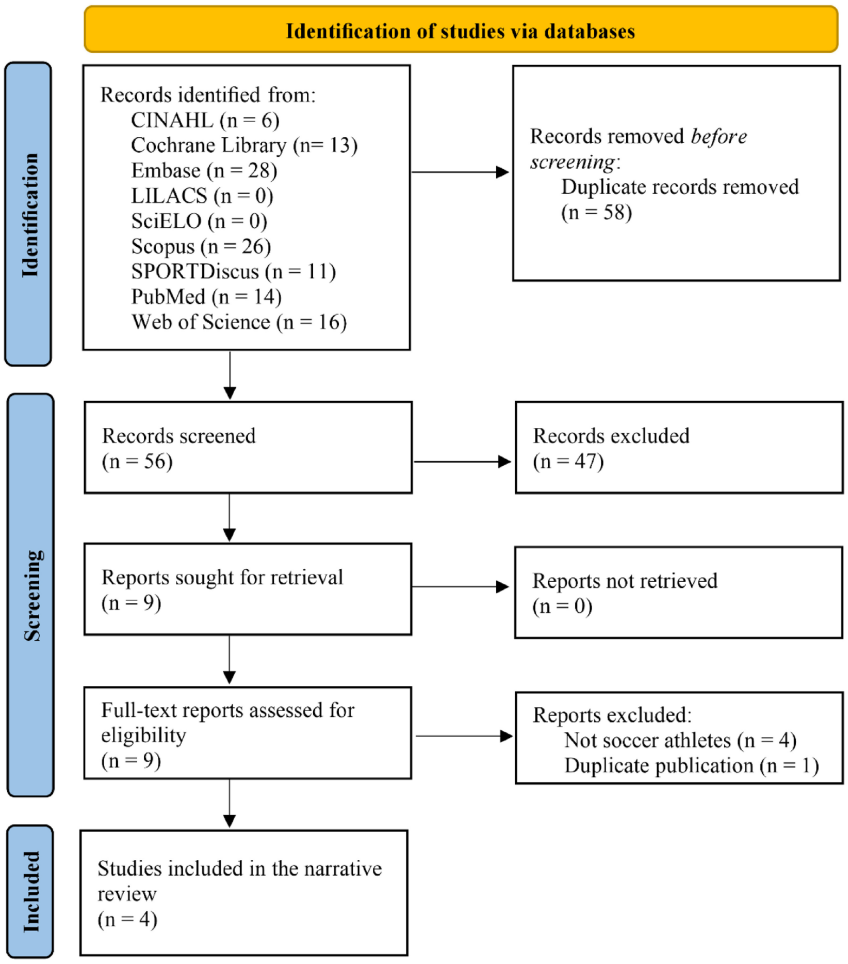

Figure 1. Flowchart of the process of identification, eligibility, screening, and inclusion of studies in the review.
Source: Page et al. (2021).

In addition to the different sporting contexts, the analyzed studies presented methodological differences in the investigation of the effects of curcumin supplementation. Most of the analyzed studies adopted a randomized clinical trial design (Rosidi et al., 2022; Abbott et al., 2023; Choi et al., 2023), with the exception of the experimental pilot study by Clayton et al. (2023). Regarding the experimental design, both parallel-scale studies (Rosidi et al., 2022; Clayton et al., 2023) and crossover trials (Choi et al., 2023; Abbott et al., 2023) were identified. As for blinding, two studies used a double-blind design (Rosidi et al., 2022; Abbott et al., 2023), while Choi et al. (2023) adopted a single-blind procedure. The study by Clayton et al. (2023), was conducted in an open-label manner. Although it presents some methodological variations, all studies included comparison groups and employed objective measures to evaluate the effects of curcumin supplementation on muscle recovery and the inflammatory response.

Table 2 presents the main findings related to curcumin supplementation in the evaluated studies.

Studies have shown variations in the timing of supplementation, dietary control procedures, and outcomes assessed. Rosidi et al. (2022) administered curcumin after physical activity for 21 days, with strict dietary restrictions (avoiding coffee, alcohol, drugs, tobacco, and other supplements), and reported reductions in creatine kinase and lactic acid levels, an increase in hemoglobin, and no effect on interleukin-6. In contrast, Clayton et al. (2023) during 8 official soccer matches, observed clinical changes and evaluated the daily consumption of beverages containing raw turmeric and piperine, finding a decrease in subjective pain

Table 1. Description of the characteristics of the studies included in the review, such as: study type, population, participants' age, number of participants, type of intervention, type of control, duration of use, and form of supplement administration.

Author/Year	Study type	Population	Age (Years)	Sample size	Intervention group	Control group	Duration	Route of supplementation
Rosidi et al. (2022)	Randomized, double-blind, placebo-controlled clinical trial	Amateur soccer athletes	14-18	20	Ice cream with turmeric extract – 250 mg/100 g	Ice cream without turmeric extract	21d	Ice cream
Clayton et al. (2023)	Pilot experimental, controlled study	Professional soccer athletes	26±3 / 25±4 (Supplement/ Control groups)	24	Curcumin 1400 mg + Piperine 10 mg	Did not receive supplementation	8 official matches	Drink
Choi et al. (2023)	Placebo-controlled, single-blind, crossover clinical trial	Female university soccer players	11.8 ± 1.3	6	Curcumin 90 mg / 3x per day	Starch/dextrin capsules similar to curcumin capsules	14d	Capsule - Theracurmin
Abbott et al. (2023)	Randomized, double-blind, placebo-controlled crossover trial.	Under-23 soccer athletes	19 ± 1	11	Curcumin 500 mg	Medium-chain triglyceride (MCT) oil	Immediately, 12h and 36h post-match	Capsule

Source: Prepared by the author.

Table 2. Description of the main findings of the studies according to: timing of supplementation, dietary record analysis, outcomes assessed, and results reported by the authors.

Author/Year	Timing of supplementation	Dietary intake records	Evaluated outcomes	Results
Rosidi et al. (2022)	After physical activity, daily	Daily intake recorded using dietary recall form	**Primary**: CK; Lactic acid **Secondary**: IL-6; Hemoglobin (Hb)	↓ CK ↓ Lactic acid ↔ IL-6 ↑ Hb
Clayton et al. (2023)	Twice daily, including match and recovery days	No dietary intake assessment	**Primary**: CRP; CK **Secondary**: Subjective pain (whole body and legs); CMJ; IMTP	↓ Subjective pain (Whole body) ↓ Subjective pain (legs) ↔ CRP (↓ 64h post-match) ↔ CK ↔ CMJ ↔ IMTP
Choi et al. (2023)	Capsules consumed daily after breakfast, lunch, and dinner throughout pre-season	No dietary intake assessment	Borg Scale of Perceived Exertion (6–20 point scale; 6 = "no effort", 20 = "maximal effort")	↓ IL-6 ↔ Muscle Damage
Abbott et al. (2023)	Not reported	Participants were instructed to record dietary intake and not consume other supplements during each test phase	DOMS assessed via Visual Analog Scale (VAS) during 90° knee flexion squat; VAS ranged from 0 mm ("no pain") to 200 mm ("unbearably painful")	↓ Subjective pain (Whole body) ↓ Subjective pain (legs) ↑ CMJ (better recovery - 12h post-match) ↑ RSI (*except at 60h post-match*)

CK: [Creatine kinase]; IL-6: [Interleukin-6]; CRP: [C-Reactive Protein]; CMJ: [Countermovement Jump]; IMTP: [Isometric Mid-Thigh Pull]; DOMS: [Delayed onset muscle pain]; ↓: statistically significant reduction; ↑ statistically significant increase; ↔ statistical non-significant difference.
Source: Prepared by the author.

(both total body and leg pain), but without significant laboratory changes in (C-Reactive Protein (CRP), Creatine kinase (CK), or in muscle performance parameters (CMJ (Countermovement Jump) and IMTP (Isometric Mid-Thigh Pull)). Choi et al. (2023) performed curcumin capsule supplementation administered after main meals during the pre-season (14 days), observing a significant reduction in interleukin-6 (IL-6) release (−30.2±28.1% in the curcumin condition versus 13.4±17.4% in the placebo; $P < 0.05$), without impact on muscle damage indices. Finally, Abbott et al. (2023), during 4 days, but without specifying the timing of Regarding supplementation, participants were instructed to record their food intake and not to consume other supplements. Positive effects were found in reducing CK, as assessed by a visual scale, with an effect also observed in the time to CRP variable, although no changes were identified in CK, CMJ, or IMTP.

DISCUSSION

This review synthesized evidence from 61 soccer players (mean age 19.87 ± 2.2 years), characterized by a marked heterogeneity in both competitive levels, ranging from amateur athletes to the professional elite, and methodological approaches, including diverse curcumin delivery formats (traditional vs. nanotechnological capsules, drinks co-administered with piperine, and ice cream). Although most investigations adopted a randomized controlled trial design, substantial variations were observed in experimental setups (parallel vs. crossover), intervention periods (ranging from 4 to 21 days), and dietary control measures. Regarding biological and clinical outcomes, the findings remain equivocal: while some studies reported an attenuation of classical markers of muscle damage and inflammation, such as creatine kinase (CK) and interleukin-6 (IL-6), others demonstrated improvements restricted solely to subjective pain perception, with no corresponding impact on laboratory parameters or neuromuscular performance metrics (CMJ and IMTP). This disparity in results underscores that, despite the therapeutic potential of curcumin in sports recovery, the magnitude of its effects in soccer appears to be heavily conditioned by the bioavailability of the formulation used and the specific context of the intervention.

In physically active men, the intake of a turmeric extract for 7 days prior to exercise and 4 days after exercise (90 mL, twice daily, after breakfast and dinner) resulted in a significant reduction in CRP levels and post-match muscle soreness perception, suggesting a relevant anti-inflammatory effect for recovery (Tanabe et al., 2019). In women's soccer, one study reported that supplementation with 270 mg/day of curcumin during the pre-season reduced interleukin-6 (IL-6) levels by 30%, with no significant impact on markers of muscle damage such as creatine kinase (CK) and myoglobin. This suggests that curcumin may reduce inflammation and pain without impairing natural muscle regeneration processes, underscoring the need for further research to define its optimal application in soccer (Rawson et al., 2018). Beyond inflammatory modulation, curcumin may support functional recovery. In high-level soccer athletes, supplementation with 500 mg of curcumin within the first 36 hours after a match attenuated DOMS and reduced losses in CMJ height and reactive strength index (RSI)—factors that are crucial for physical performance and injury prevention (Fernandes, 2021; Collins et al., 2021).

Exercise-induced muscle damage (EIMD) is a common phenomenon following intense physical activities, especially those involving eccentric contractions, resulting in inflammation, DOMS, and reduced functional strength (Clarkson and Hubal, 2002). This damage is characterized by microlesions in muscle fibers, excitation-contraction coupling dysfunction, and increased muscle membrane permeability, leading to the release of biomarkers such as CK and myoglobin into the bloodstream (Hyldahl; Hubal, 2014; Oxley and Peart, 2024). The recovery process involves a complex inflammatory response, in which neutrophils and macrophages play essential roles in removing cellular debris and promoting muscle regeneration (Tidball, 2005). The subsequent inflammation activates cellular signaling pathways, such as the nuclear factor kappa B (NF-κB) cascade, which regulates the production of pro-inflammatory cytokines, including IL-6 and tumor necrosis factor-alpha (TNF-α), both crucial for tissue remodeling (Fischer, 2006).

Different strategies have been studied to minimize the effects of muscle damage and optimize recovery. Among these approaches, the use of natural antioxidants, such as curcumin, has stood out due to its anti-inflammatory and oxidative stress-modulating properties (Bai et al., 2023). Studies suggest that curcumin supplementation can reduce the severity of EIMD by decreasing plasma CK and IL-6 concentrations, in addition to alleviating muscle soreness and post-exercise fatigue (Popescu-Radu et al., 2024; Nicol et al., 2015). A recent meta-analysis demonstrated that curcumin supplementation significantly reduces DOMS symptoms and inflammation levels up to 96 hours post-exercise, reinforcing its potential as an ergogenic aid for athletes and individuals engaging in intense physical activity (Oxley and Peart, 2024).

Muscle damage induced by intense physical activity, especially eccentric exercise, triggers an inflammatory process that may impair the athlete's functional capacity (Abbott et al., 2023). This process is associated with elevated levels of inflammatory biomarkers such as CRP and IL-6, as well as increased CK, an indirect marker of muscle injury (Choi et al., 2023). Curcumin supplementation has shown beneficial effects in reducing delayed onset muscle soreness (DOMS) and enhancing functional recovery, evidenced by attenuated CK levels and improvements in performance tests such as the CMJ and the RSI (Clayton et al., 2023). Furthermore, a study in soccer players demonstrated that curcumin can significantly reduce IL-6 levels and mitigate post-exercise inflammatory responses (Rosidi et al., 2022).

Nutrition plays a fundamental role in athletes recovery, and supplementation with bioactive compounds such as curcumin has been investigated due to its anti-inflammatory and antioxidant properties (Choi et al., 2023). Studies by Gorabi et al. (2022) and Uchio et al. (2024) indicate that curcumin can significantly reduce CRP and DOMS. Additionally, the form of supplementation may influence curcumin absorption and, consequently, its therapeutic effects (Purpura et al., 2018). However, the lack of strict control over the consumption of other supplements and dietary factors may have influenced the results, as antioxidant intake from the diet can also modulate inflammatory responses and muscle recovery (Abbott et al., 2023).

Muscle recovery can also be enhanced through proper nutrition and structured training. The intake of high-biological-value proteins combined with carbohydrates supports protein synthesis and glycogen resynthesis, promoting muscle regeneration and maintaining athletic performance (Jäger et al., 2017). Additionally, interventions such as cold water immersion and stretching can help reduce inflammation and improve post-exercise muscle function (Dupuy et al., 2018). Although recovery time may vary depending on the extent of muscle damage and the individual's fitness level, the adoption of evidence-based strategies can minimize the negative effects of EIMD and enhance training benefits. Injury prevention in soccer remains a constant challenge, intensified by high training loads and insufficient recovery (Choi et al., 2023). Chronic inflammation resulting from prolonged muscular stress can increase injury risk, and curcumin emerges as a promising strategy to modulate this frequent inflammatory response in athletes (Rosidi et al., 2022). Furthermore, the mechanisms by which curcumin reduces inflammation include modulation of pro-inflammatory cytokines such as IL-6 and TNF-α, fostering a more favorable muscular environment for recovery (Chainani-Wu, 2003).

Soccer players are exposed to intense physical demands that lead to exercise-induced muscle damage (EIMD), triggering an inflammatory process marked by elevated biomarkers such as CK, CRP, and IL-6, along with the development of DOMS (Abbott et al., 2023). Curcumin supplementation has been investigated as a potential strategy to accelerate muscle recovery and mitigate these adverse effects. One study demonstrated that curcumin can reduce perceived muscle soreness and modulate inflammation by decreasing the expression of pro-inflammatory cytokines such as TNF-α and IL-6, thereby promoting a more favorable environment for muscle regeneration (Choi et al., 2023). Moreover, in elite soccer athletes, curcumin supplementation resulted in less reduction in isometric strength (IMTP) and better recovery of performance in functional tests, such as the Countermovement Jump (CMJ) and Reactive Strength Index (RSI) (Clayton et al., 2023). However, the effectiveness of supplementation may be influenced by curcumin's bioavailability, which varies according to the formulation used, with differences observed between traditional compounds and optimized versions such as nanoparticles and piperine complexes ROSIDI et al., 2022). Given this heterogeneity in supplementation protocols, standardization of formulations and dosages in clinical trials becomes essential for a clearer understanding of curcumin's effects on athlete recovery.

Curcumin supplementation has been widely studied as a potential strategy to mitigate muscle damage and modulate inflammation in soccer athletes. The analyzed studies showed significant methodological heterogeneity, both in terms of dosage (ranging from 270 mg/day to 1,400 mg/day) and timing/form of administration (pre- and post-exercise, daily intake, or limited to recovery periods). Despite this variation, curcumin was effective in reducing subjective muscle soreness perception in nearly all protocols examined (Abbott et al., 2023; Clayton et al., 2023; Choi et al., 2023). Additionally, supplementation showed effects in modulating inflammation, with reductions in IL-6 and CRP levels reported in specific studies (Choi et al., 2023; Clayton et al., 2023). However, effects on classical markers of muscle damage, such as CK, LDH, and myoglobin, were inconsistent, with no significant differences in most studies (Rosidi et al., 2022; Clayton et al., 2023; Choi et al., 2023).

It is important to highlight that the study by Rosidi et al. (2022) used an ice cream enriched with "Curcuma longa extract," containing 250 mg/100 g of the product. However, the authors did not use a standardized extract with 95% curcuminoids, nor did they report the exact concentration of curcumin present in the formulation. The preparation method described involved using the raw turmeric rhizome, which was washed, sliced, dried in an oven at 50 °C until it reached approximately 10% moisture, and subsequently ground to obtain the powder used in the ice cream. Therefore, it is not possible to determine the actual dose of curcumin ingested by the participants, which represents a significant methodological limitation for comparison with studies that use standardized and quantified extracts. When analyzing the impacts on physical performance, the findings were also divergent. While a study conducted by Abbott et al. (2023) in professional athletes reported improved recovery in CMJ vertical jump and RSI up to 36 hours after the match, other studies did not observe direct benefits in performance parameters (Rosidi et al., 2022; Clayton et al., 2023). This inconsistency may be related to variability in administered doses and the timing of supplementation. Studies that used higher doses (≥500 mg/day) and administered curcumin during the critical recovery period (up to 36 hours after exercise) demonstrated more robust effects in attenuating muscle soreness and functional recovery (Abbott et al., 2023; Clayton et al., 2023). On the other hand, lower doses and protocols with chronic administration, such as the study that used 270 mg/day for 14 days (Choi et al., 2023), did not demonstrate an impact on markers of muscle damage.

Although curcumin shows promising effects on muscle recovery, the current findings do not allow for determining an ideal dose for soccer athletes. The positive effect on muscle soreness appears to be a consistent response to supplementation, regardless of the dose used (Abbott et al., 2023; Clayton et al., 2023). However, modulation of inflammatory biomarkers and the impact on functional recovery seem to depend on higher doses and strategic administration close to periods of greater muscle damage (Rosidi et al., 2022; Choi et al., 2023; Clayton et al., 2023). Further studies are still needed with better control of bioavailability and direct comparisons between different doses to suggest a more specific protocol for curcumin use in post-exercise recovery. Curcumin supplementation appears to be a safe and sustainable alternative for sports recovery, minimizing gastrointestinal side effects and preserving muscle regeneration (Abbott et al., 2023).

In the study by Rosidi et al. (2022), 21-day supplementation with 250 mg of turmeric extract in ice cream form significantly reduced CK and lactic acid levels in amateur players, suggesting a positive effect on muscle damage mitigation and energy metabolism optimization. However, no significant changes were observed in IL-6 levels, possibly due to the administered dose or duration of supplementation. Similarly, Clayton et al. (2023) reported that supplementation with 1,400 mg/day of turmeric in liquid form significantly reduced CRP and subjective muscle soreness in elite soccer athletes. However, no significant changes were observed in physical performance markers such as countermovement jump (CMJ) and isometric mid-thigh pull (IMTP). These findings indicate that while curcumin may offer benefits in terms of inflammation and soreness, its direct impact on immediate athletic performance remains unclear. In the study by Choi et al. (2023), university-level female soccer players who consumed 270 mg/day of curcumin showed a significant reduction in IL-6 levels, but no changes in CK or other muscle damage biomarkers. This supports the hypothesis that curcumin may modulate inflammation without necessarily affecting classical muscle injury markers, posing challenges for supplementation strategies and adjustments for this specific population.

CONCLUSIONS

The positive effects of curcumin appear to be related to dosage and duration of use, with protocols involving doses above 500 mg/day over extended periods showing better responses in recovery. However, the lack of standardization in formulations and protocols across studies makes direct comparison of results difficult. Furthermore, the absence of control over dietary factors and the concurrent use of other supplements may have influenced the observed outcomes.

Therefore, future studies should aim to standardize methodologies, assess the bioavailability of formulations, and control dietary factors to validate the effectiveness of curcumin as a recovery strategy in soccer athletes. A detailed analysis of supplementation timing and individual athlete responses may contribute to the development of more precise guidelines for its use in high-performance sports.

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CONFLICTS OF INTEREST

The authors have declared that no competing interests exist.

DATA AVAILABILITY

All data analyzed in this narrative review were obtained from previously published studies cited in the manuscript. The extracted data supporting the findings of this review are presented within the article and its tables. Additional information regarding the search strategy or data extraction process may be made available by the corresponding author upon reasonable request.

AUTHORS' CONTRIBUTION

GCR: Conceptualization, Methodology, Writing - Original Draft Preparation, Writing - Review & Editing; LPL: Conceptualization, Methodology, Writing - Review & Editing; ATM: Conceptualization, Methodology, Formal analysis, Writing - Review & Editing; EBSMT: Conceptualization, Methodology, Writing - Review & Editing.

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