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The effects of acute nutritional strategies on performance in soccer players: a systematic review with meta-analysis

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ADMINISTRATIVE INFORMATION

Support - NA.

Review Stage at time of this submission - Formal screening of search results against eligibility criteria.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 12 January 2024 and was last updated on 12 January 2024.

INTRODUCTION

Review question / Objective The aim of this systematic review with meta-analysis is to summarize and assess the effects of ergogenic aids ingested before or during the exercise in soccer players and, in addition, to discuss the main confounding factors that can affect the accuracy of such interventions.

Rationale Over the years, the physical demands of professional soccer have changed significantly (Nassis et al., 2020). Although the technical reports of the UEFA Champions League noted that distances covered per match are maintained relatively constant, the number and top speed performance tends to increase over the last four years (UEFA, 2019, 2020, 2021, 2022). The top speed in the last competition was 37.1 km.h-1 while in 2016-2017, the fastest sprint was 33.8 km.h-1 (UEFA, 2017, 2022). Data collected from 2006 to 2013 in the English Premier League competition showed a general increment in distance covered at high-intensity running (19-25.1 km.h-1) and sprinting (>25.1 km.h-1) (Bush et al., 2016). Longitudinal observations from 2012 to 2019 in the Spanish La Liga also described an increment in the number of high-intensity running actions (Lago Penas et al., 2021). Modern soccer is physically demanding, and consequently, the performance data on match day is often monitored, analyzed and interpreted by professional clubs (Asian-Clemente, 2022; Caldbeck et al., 2022; Djaoui et al., 2022; Modric et al., 2022; Modric et al., 2023). Significant fluctuations in physical performance indicated that the capacity to perform high-intensity effectors is progressively lower, supporting the development of fatigue towards to the end of the match (Mohr et al., 2003; Bradley et al., 2013; Fransson et al., 2017; Silva et al., 2018).
Muscle fatigue is related to multiple mechanisms, but it could be partially explained by alterations in muscle metabolism and the depletion of glycogen stores (Saltin et al., 1973). Studies conducted on male and female elite players found that >60% of fast and slow muscle fibers were completely or

almost empty of glycogen (Krusturp et al., 2022; Mohr et al., 2023). In addition, after a 90-minute soccer match, muscle glycogen concentration was, on average, below the threshold of~250 mmol·kg-1 dry weight (d.w.), which was proposed as the critical value to maintain muscular performance (Krustrup et al., 2022; Vigh-Larsen et al., 2023). These findings are even more evident when players compete for 30 minutes of extra time (Field et al., 2020; Mohr et al., 2023). Soccer-induced fatigue negatively impacts technical aspects performed during the match (Rampini et al., 2008; Rampini et al., 2011). Therefore, acute nutritional interventions by consuming the appropriate supplement before and during the match are often recommended to reduce fatigue and optimise performance (Meyer et al., 2020; Collins et al., 2021; Hulton et al., 2022).

The ergogenic effects of carbohydrates (CHO) have been considered during the match since it represents a nutritional strategy that increases and delays glycogen depletion and improves performance (Williams & Rolo, 2015; Rollo & Williams, 2023). In general, the recommendations of CHO for a soccer match are 30–60 g.hour-1 or 60 g before each half (Russel & Kingsley, 2014; Hulton et al., 2022). The ingestion of CHO before and during the match is limited most of the time to the warm-up and half-time. The tolerance of the gastrointestinal tract to higher quantities of CHO is an additional problem (Jeunkendrup et al., 2014; Jenkendrup et al., 2017; Anderson et al., 2017; Collins et al., 2021). Furthermore, mouth rinsing and splitting a CHO solution activate brain centres associated with reward and motor control (Carter et al., 2004), attenuating fatigue and improving performance (Oliveira et al., 2013; Rollo et al., 2015). The effects of CHO ingestion were examined during soccer activities (i.e., physical or technical actions); however, the potential CHO benefits are inconsistent in the literature.

Condition being studied The studies to be included in the present review will follow PICOS criteria – the population will involve elite, professional or semi-professional soccer players (males and females); short-term (i.e., acute) nutritional interventions will be investigated; placebo, control and other nutritional strategies will be defined as comparators; the outcome of interest is performance (soccer-specific protocols, laboratory or field assessments (e.g. peak power, sprints, jumping, distance covered in a match, number of sprints, high-speed running, passing, dribbling, shooting, reaction time)); control or placebo trials that examined the effects of nutritional strategies before or during protocols will be considered in the review.

METHODS

Search strategy (nutrition* OR "nutritional strategy" OR "nutritional intervention" OR diet* OR carbohydrate OR glucose OR protein OR collagen OR fat* OR ketone* OR antioxidant* OR "vitamin D" OR polyphenol* OR fruit OR creatine OR caffeine OR nitrate* OR beetroot OR "beta alanine" OR "sodium bicarbonate") AND (soccer or football).

Participant or population Elite, professional or semi-professional soccer players (males and females).

Intervention Acute nutritional interventions.

Comparator Placebo, control or other supplement.

Study designs to be included Randomized control trial.

Eligibility criteria The population will involve elite, professional or semi-professional soccer players (males and females); short-term (i.e., acute) nutritional interventions will be investigated; placebo, control and other nutritional strategies will be defined as comparators; the outcome of interest is performance (soccer-specific protocols, laboratory or field assessments (e.g. peak power, sprints, jumping, distance covered in a match, number of sprints, high-speed running, passing, dribbling, shooting, reaction time)); control or placebo trials that examined the effects of nutritional strategies before or during protocols will be considered in the review.

Information sources The electronic search will be in three databases (PubMed, Web of Science and Scopus).

Main outcome(s) Performance: soccer-specific protocols, laboratory or field assessments (e.g. peak power, sprints, jumping, distance covered in a match, number of sprints, high-speed running, passing, dribbling, shooting, reaction time).

Quality assessment / Risk of bias analysis The risk of bias in the included studies will be assessed using the PEDro scale (Mayer et al., 2003). The PEDro scale is an 11-item (higher scores = lower risk of bias) valid tool to measure the risk of bias and statistical reporting of clinical trials (Morton et al., 2009). Two independent observers will complete the risk of bias using tool for randomized trials (DVM/AR), and possible disagreements will be solved by a third reviewer (HS).

Strategy of data synthesis An Excel sheet will organise descriptive statistics (i.e. mean, standard deviation and number of soccer players). The statistical analyses will be conducted using Comprehensive Meta-Analysis software (CMA, version 2.2.064, Biostat, NJ, USA). Statistical significance will be determined at a two-sided level of $p<0.05$. The primary focus of this investigation was to assess the impact of carbohydrate or caffeine supplementation on soccer performance indicators. The synthesis of study data was executed utilizing a random-effects model, and inconsistencies were quantified employing the I2 statistic. Furthermore, variations in the effects of carbohydrates and caffeine supplementation, specifically, the impact of carbohydrate strategy supplementation on soccer performance indicators, were explored. Subgroup differences were tested using (Q-test-based ANOVA). A Funnel plots were generated by plotting the effect size against a measure of study precision (e.g., standard error or sample size). The asymmetry in the funnel plot was visually inspected for potential publication bias, with an emphasis on the dispersion of smaller studies around the apex of the funnel (Harbord et al., 2006). Additionally, Egger's regression intercept method was employed to quantify the potential publication bias. This method involves regressing the standardized effect sizes against their precision, and the intercept of this regression provides an estimate of funnel plot asymmetry. A statistically significant intercept suggests the presence of publication bias. Additionally, the Duval and Tweedie trim and fill computation was applied to estimate the influence of publication bias on the outcomes (Duval & Tweedie, 2000).

Subgroup analysis The impact of carbohydrate timing or form was examined - sub-group analysis of carbohydrates ingested before and during and using the mouth rinsing strategy was performed. Descriptive data pertaining to intervention groups and participants are presented as the mean ± standard deviation (SD).

Sensitivity analysis NA.

Country(ies) involved Portugal, Brazil, UK.

Keywords performance; carbohydrates; caffeine; soccer; nutrition.

Contributions of each author

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