# INPLASY

## To systematically review the effects of evening caffeine consumption on sleep in athletes

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**ADMINISTRATIVE INFORMATION**

**Support -** N/A.

**Review Stage at time of this submission -** Preliminary searches.

**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 18 September 2024 and was last updated on 19 September 2024.

## INTRODUCTION

**R**eview question / Objective Does afternoon / evening caffeine consumption impair sleep in athletes? This question will guide the systematic review in exploring how caffeine consumption in the evening affects various sleep parameters in athletes, with the goal of informing recommendations for caffeine use in relation to sleep and athletic performance.

**Rationale** Evidence strongly links caffeine intake to sleep disturbances, as noted by Gardiner et al. (2023), who emphasized its adverse effects on various sleep parameters. Recently, the rise in sleep studies involving athletes has highlighted the significance of sleep alongside diet for optimal performance. Researchers are now investigating dietary factors that may affect sleep through different mechanisms. While athletes often consume caffeine for performance enhancement, its effects on sleep, particularly when taken in the evening, remain underexplored. Although independent studies report negative impacts of evening caffeine intake, a review is lacking. Similarly, not all outcomes for sleep in response to caffeine are similar for athletes, and it is unknown if the benefits for athletic performance outweighs the risk for sleep disturbances. Thus, examining the effects of evening caffeine consumption on sleep is necessary.

**Condition being studied** The inclusion criteria for the systematic review are as follows: the population includes athletes aged 18+ years, with the intervention being caffeine ingestion prior to a training session or competition in the late afternoon or evening (4pm or later). The comparison group includes those with no caffeine consumption or placebo. The outcomes must include at least one measure of sleep duration or quality, and the study design should be randomised control trials, quasi-experimental designs, or observational designs. The exclusion criteria are animal studies, non-athletes, subjects with medical conditions affecting sleep (such as insomnia), studies that do not report the timing and dosage of caffeine intake, studies where caffeine is

consumed prior to 4pm, and studies that do not report measures of sleep. Case studies are also excluded.

## METHODS

**Search strategy** Use of the the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram to document the study selection process, including the number of studies identified, screened, and included/excluded.
Electronic Data Bases: – PubMed, Scopus, Web of Science, Embase, PsycINFO, Cochrane Library. The search strategy will be developed using the PICO framework. The search terms will include, Caffeine, Sleep, Sleep Quality, Athletes, Evening as well as combined terms using AND, OR, and NOT to refine the search will be performed. The terms employed within each component will be searched using the Boolean operator "OR," and each component will be linked together through the Boolean operator "AND" to run the search.

Initial Screening: Titles and abstracts will be screened to identify relevant studies. Two independent reviewers will screen articles, and resolve any discrepancies through discussion or a third reviewer.

Full-Text Review: Full-text articles of potentially relevant studies will be assessed against the inclusion/exclusion criteria (see below).
Reference Management Software: Endnote will be used to organise references and manage the search process.

**Participant or population** Age restriction removed (so no longer only pertained to athletes 18+ years) Using the term athletes will be used with no 18+ years restriction.

**Intervention** The intervention to be evaluated in the review is the consumption of caffeine and its impact on subsequent sleep. This includes examining various doses of caffeine and the timing of its consumption relative to bedtime. Specific interventions to be evaluated include the consumption of common caffeinated beverages such as coffee and tea, as well as pre-workout supplements with known caffeine content in the afternoon / evening and examining subsequent sleep, including at least one metric of sleep quality and quantity and performance (e.g., sport-specific skills, aerobic or anaerobic measures), or mental health and mood states (e.g., well-being, affect, psychological symptoms).

**Comparator** The comparative intervention applied to the target population will be a placebo or no caffeine consumption.

**Study designs to be included** Randomised Control Trials, Quasi-experimental designs, Observational Designs.

**Eligibility criteria** Inclusion Criteria
To be included in this review, studies had to meet the following criteria:
1. Population: Studies must include healthy adult participants (18 years or older).
2. Intervention: Studies must investigate the effects of caffeine consumption on sleep.
3. Comparison: Studies must include a comparison group or condition where no caffeine is consumed.
4. Outcome: Studies must report objective and/or subjective measures of sleep outcomes.
5. Study Design: Only randomized controlled trials, cross-over trials, and observational studies were included.
In instances where additional interventions will be examined, studies will be included if the effect of caffeine can be isolated.

Exclusion Criteria
Studies that did not meet these criteria were excluded from the review:
1. Population: Animal studies, non-athletes, and subjects with medical conditions affecting sleep (such as insomnia).
2. Intervention: Studies that do not report the timing and dosage of caffeine intake and studies where caffeine is consumed prior to 4 p.m.
3. Outcome: Studies that do not report measures of sleep.

Papers will be excluded if
1. Nutrition intervention was influenced by other intervention or condition.
2. Sleep-related data were assessed after travel, other manipulated intervention (e.g., altitude or light exposure) or any other dietary or other pharmacological intervention.

**Information sources** Electronic Data Bases: – PubMed, Scopus, Web of Science, Embase, PsycINFO, Cochrane Library.

**Main outcome(s)** Sleep Duration: Total sleep time (TST) post-caffeine consumption compared to placebo or no caffeine.
Variations in TST based on different doses and timing of caffeine consumption.
Sleep Quality: Objective measures of sleep quality such as sleep efficiency, latency, and wake after sleep onset (WASO).

Subjective sleep quality using validated sleep scales (e.g., Pittsburgh Sleep Quality Index).

Sleep Timing: Shifts in sleep onset time and wake-up time due to caffeine intake.

Changes in the midpoint of sleep relative to caffeine ingestion in the evening.

Athletic Performance Impact: Whether any benefits of caffeine consumption for athletic performance (e.g., sport-specific skills, endurance) outweigh the observed impairments in sleep quality or quantity.

Dose-Response Relationship: Examination of how varying doses of caffeine impact sleep parameters differently (e.g., low-dose vs high-dose caffeine consumption).

Impact on Different Athlete Populations: Any differences in sleep disturbance based on athletic level (e.g., sub-elite vs elite athletes), type of sport (endurance vs strength sports), and caffeine tolerance.

Mental Health and Mood States: The effect of evening caffeine consumption on mood, psychological symptoms, and well-being, with consideration of its impact on sleep-related mental health metrics.

**Additional outcome(s)** The findings will help add to the body of evidence about caffeine and its influence on sleep for athletics populations. Specifically, we anticipate that caffeine consumption will result in increased sleep onset latency (SOL), meaning athletes may take longer to fall asleep. Additionally, we expect to observe a decrease in total sleep time (TST), indicating a reduction in overall sleep duration due to caffeine's stimulating effects. We also foresee an increase in the number and duration of nighttime awakenings, leading to more fragmented sleep. Consequently, sleep efficiency is likely to decrease, reflected by a lower percentage of time spent asleep relative to the total time spent in bed.

Furthermore, athletes may report lower subjective sleep quality, perceiving their sleep as less restful or restorative after consuming caffeine in the evening. We anticipate an earlier final awakening time, potentially reducing sleep duration and leading to increased variability in sleep patterns across different nights.

This is likely also to have a effects on subsequent performance, and ultimately allow for better guidelines diet-sleep interactions for athletes.

**Data management** Records will be managed through endnote.

Full text articles will be viewed when the abstract provides insufficient information or in the case of disagreement between the reviewers. Two independent reviewers extract data to ensure consistency and resolve any discrepancies through discussion or a third reviewer.

**Quality assessment / Risk of bias analysis** The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials.

The revised JBI critical appraisal tool for the assessment of risk of bias quasi-experimental studies.

**Strategy of data synthesis** We will conduct a subgroup analysis based on the data obtained. If the studies included in the review demonstrate homogeneity in their design, populations, interventions, and outcomes, we will perform a meta-analysis to quantitatively synthesise the results. If heterogeneity is significant, a narrative review will be conducted to qualitatively assess and discuss the findings across different subgroups.

A narrative synthesis of differences between sleep under conditions of caffeine use vs placebo will be completed. Sleep parameters (sleep duration, quality, time to sleep onset) collected via actigraphy and subjective sleep diaries will be considered. The results of papers will be interrogated for heterogeneity and quality. If appropriate, a meta-analysis based on mean difference effect size will be completed.

**Subgroup analysis** Analyse data separately for subgroups (e.g., type of sport, gender, caffeine dosage) based on paper homogeneity, and investigate potential differences in effects among these groups.

**Sensitivity analysis** TBD.

**Language restriction** Yes.

**Country(ies) involved** Australia.

**Other relevant information** The author is beginning preliminary search strategies with professional personal.

The inclusion of other authors are yet to be determined, but will be added if need be as the review progresses.

**Keywords** Caffeine; Athletes; Sleep; Evening; Afternoon; Training; Performance.

**Dissemination plans** Athletes and coaches: Findings may influence training strategies or performance management.

Submit to an open access journal affiliated with the University.

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