



E-ISSN: 2707-7020
P-ISSN: 2707-7012
JSSN 2023; 4(2): 170-175
Received: 16-06-2023
Accepted: 21-07-2023

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The effect of phosphatidylserine supplementation on athletic performance: A systematic review of randomized clinical trials

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DOI: <https://doi.org/10.33545/27077012.2023.v4.i2c.209>

Abstract

This review aims to critically evaluate the existing evidence derived from randomized clinical trials to determine the effectiveness of phosphatidylserine in enhancing athletic performance. Extensive searches were conducted in databases including PubMed, ClinicalTrials.gov, Google Scholar, Embase, Web of Science, CINAHL, and Medline. Among the initially identified 538 articles with potential relevance, a thorough assessment of full-text articles was performed, resulting in the inclusion of seven studies that satisfied all predefined inclusion criteria. All studies were evaluated as having a low risk of bias. Five of the included studies reported statistically significant differences before and after intervention, thus providing support for the use of phosphatidylserine as a supplement to support athletic performance. However, despite these promising results obtained from clinical trials, the current evidence remains insufficient to firmly endorse the use of phosphatidylserine for its impact on athletic performance.

Keywords: Phosphatidylserine, athletic performance, sports performance, nutrition

1. Introduction

In the pursuit of optimizing athletic performance, athletes and sports professionals continually explore various strategies to enhance physical capabilities, improve training adaptations, and hasten recovery. Among the wide array of supplements geared towards the athletic community, phosphatidylserine (PS) has emerged as a promising supplement with potential benefits for athletic performance [1]. As a naturally occurring phospholipid present in cell membranes, PS plays a crucial role in numerous physiological processes [2]. Further research elucidated its presence in other tissues, emphasizing its significance in cellular structure and function [3].

Phosphatidylserine is a phospholipid composed of two fatty acid chains attached to a glycerol backbone, with a serine moiety occupying the phosphate group position [4]. This composition allows phosphatidylserine to play a significant role in cell signaling, cell recognition, and membrane stability [5].

PS has been implicated in various physiological functions relevant to athletic performance. PS has been found to modulate the hypothalamic-pituitary-adrenal axis, which regulates the body's stress response and cortisol release [6, 7]. PS has demonstrated potential cognitive benefits by influencing neurotransmitter systems and neuronal signaling [8]. Studies have suggested that PS supplementation may improve cognitive function, particularly in tasks involving memory, attention, and processing speed [9]. These cognitive benefits have implications for athletes, as optimal cognitive function is essential for decision-making, focus, and reaction times during training and competition. It has been proposed that PS supplementation could enhance cell membrane integrity and fluidity, potentially influencing muscle fiber recruitment, force production, and power output during exercise [1].

The objective of this review is to offer an extensive assessment of the potential advantages and limitations of phosphatidylserine in enhancing various facets of athletic performance, including recovery, exercise capacity, and cognitive performance. The approach utilized in this review ensures the results are derived from rigorous scientific evidence, offering an impartial evaluation of the effectiveness of phosphatidylserine supplementation. This evaluation focuses on aspects such as methodology, standardization, and quality control to provide a well-rounded perspective.

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By critically analyzing the existing evidence, this systematic review intends to enhance our understanding of the potential benefits and limitations of PS supplementation as an aid for athletes. The findings will provide valuable insights for athletes, coaches, and sports professionals regarding the practical application of PS supplementation in the context of athletic performance. This analysis will highlight the importance of conducting carefully planned, randomized clinical trials to establish the safety and effectiveness of phosphatidylserine.

2. Methods

2.1 Search strategy

In June 2023, a comprehensive search was conducted across various electronic databases, including CINAHL, Medline, ClinicalTrials.gov, Google Scholar, Embase, Web of Science, and PubMed. The search aimed to identify articles with specific terms ('phosphatidylserine,' 'randomized,' and 'performance') present anywhere in the text. To refine the search, articles with the words 'rats' or 'mice' in their titles were excluded. Additionally, the search parameters required the presence of either phrase 'sport' or 'athletic' anywhere in the text.

A manual scoping search was conducted across major electronic databases. Experts in the field of herbal medicine and clinical researchers specializing in dietary supplementation were contacted to uncover any unpublished material that might contribute to the research. The reference sections of potentially relevant full-text articles identified in the initial search were searched manually.

2.2 Criteria for inclusion

Randomized clinical trials that evaluated the effectiveness of phosphatidylserine supplementation on athletic

performance were included. The trials had to compare phosphatidylserine supplementation against a control group (placebo, active control, or no treatment). After removing duplicates using EndNote 20 software, the titles and abstracts of studies were screened [10]. Studies that met the inclusion criteria were reviewed in full by two independent reviewers. A study was included if both reviewers agreed that it fulfilled all the inclusion criteria.

2.3 Data analysis

All relevant articles were managed and organized using EndNote 20 software.[10] The data, including study design, study quality, participant details, intervention methods, outcomes, and adverse events, were extracted and discussed by the reviewers based on predefined criteria.

Key data from each study was summarized in Table 1. Each study was independently assessed by two reviewers using the Cochrane risk-of-bias tool for randomized trials [11]. (Table 2). Any discrepancies between the two reviewers were resolved by a third reviewer.

3. Results

The database and manual searches conducted in this study yielded a total of 538 potentially relevant journal articles. After removing duplicates and conducting initial screenings of titles and abstracts, four articles were identified as potentially relevant. Three additional resources were added from the reference sections of the four initially reviewed articles. The full texts of all seven articles were retrieved and thoroughly reviewed [12-18]. Figure 1 provides a visual representation of the selection process. Seven randomized clinical trials were found to meet the inclusion criteria and were included in this review [12-18].

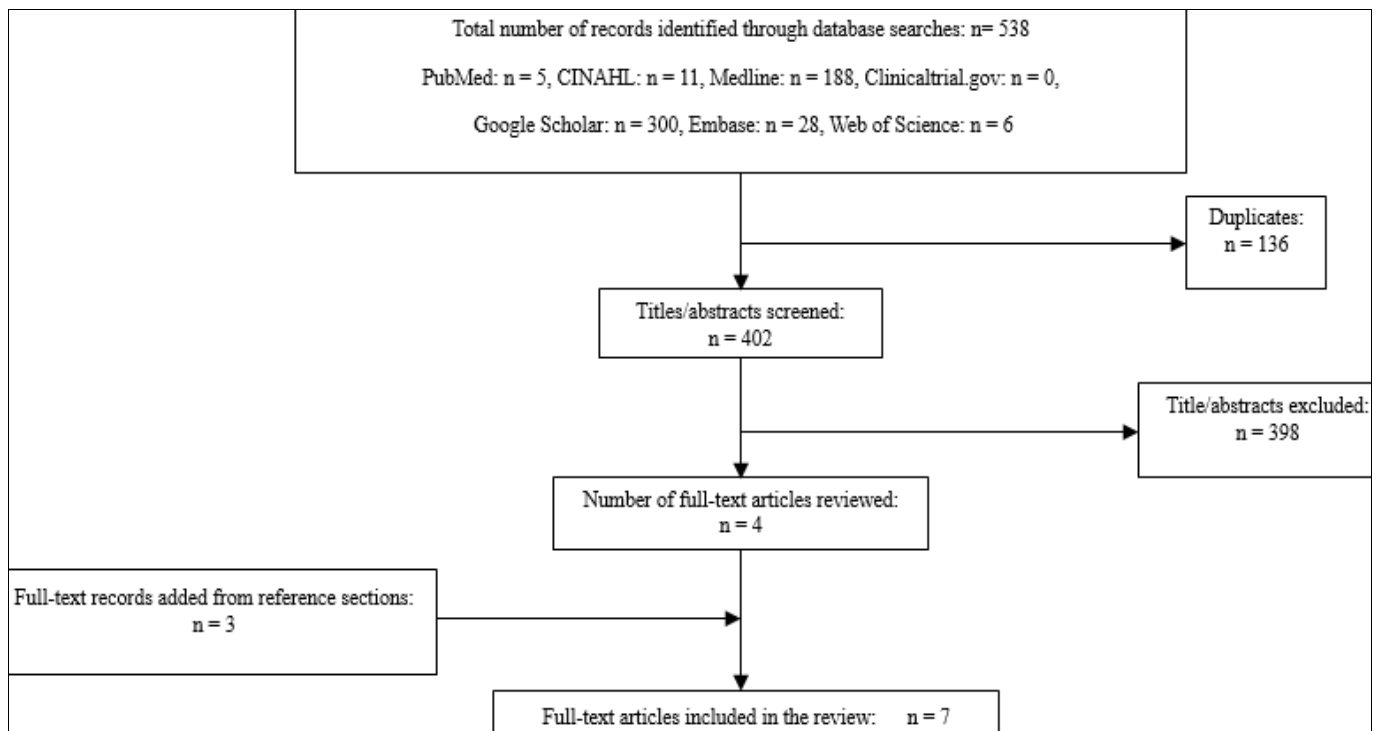


Fig 1: Flowchart of inclusion process

Figure 1: Flowchart illustrating the selection process for inclusion in the review. A total of 538 articles were

identified through database searches. Seven articles were found to meet the inclusion criteria.

Table 1: Randomized controlled trials of phosphatidylserine

First Author (year)	Design	Sample Size (Treatment/ Control)	Subjects (Age Range)	Treatment	Dependent variables	Conclusion
Jäger R. (2007) ^[12]	Double blind; placebo-controlled, 2 parallel groups	20 (10/10)	Young healthy golfers with handicaps between 15-40, (20-55)	200 mg of PS nutritional bar or nutrient matched placebo bar; daily for 42 days	(1) Ball flight (accuracy) (2) Heart rate (3) Perceived stress	PS supplementation significantly improves the number of good ball flights during tee-off along with a not significant increase in perceived stress levels
Kingsley M. (2006) ^[13]	Double blind; placebo-controlled; crossover	8 (N/A)	Healthy males, (20.7-21.3)	750 mg of S-Ptd Ser capsule and placebo (glucose polymer); daily 10 days each	(1) Biomarkers derived from venous blood samples (hormone response, blood composition, muscle damage markers, oxidative stress) (2) Perceived soreness rating (3) Feeling states	PS supplementation does not improve muscle soreness and markers of muscle damage, inflammation, or oxidative stress.
Kingsley M. (2006) ^[14]	Double blind; placebo-controlled; 2 parallel groups	14 (7/7)	Healthy males (21.1-25.3)	750 mg of S-Ptd Ser or placebo (glucose polymer); daily 10 days	(1) Oxygen uptake and heart rate (2) Biomarkers derived from venous blood (hormone response, blood composition)	PS supplementation showed a significant increase in exercise capacity.
Kingsley M. (2005) ^[15]	Double blind; placebo-controlled; 2 parallel groups	16 (8/8)	Male soccer players (21.4-23.3)	750 mg of S-Ptd Ser capsule or placebo (glucose polymer); daily for 10 days	(1) Biomarkers derived from venous blood (hormone response, blood composition, muscle damage markers, lipids) (2) Perceived exhaustion (3) Time to exhaustion and sprint speed	Supplementation with phosphatidylserine had no effect on the cortisol response, perceived soreness, markers of muscle damage and lipid peroxidation but did show a not significant increase in running time to exhaustion.
Monteleone P. (1990) ^[16]	Double blind; placebo-controlled; crossover	8 (N/A)	Healthy men, within 15% of ideal body weight, smoked less than 10 cigarettes a day, and no regular sport activity (24-42)	50 mg BC-PS injection, 75 mg of BC-PS injection and placebo (100 ml saline); each at 1-week intervals	(1) Hormone levels (2) Blood composition (3) blood pressure and heart rate	PS supplementation significantly blunted the ACTH and cortisol response to physical stress.
Parker A. (2011) ^[17]	Double blind; placebo controlled; crossover	18 (NA)	Physically active men (20.3-24.7)	400 mg of PS and placebo (rice flour); daily for 14 days each	(1) Mood (2) Cognitive function (3) Endocrine response	There was a significant increase in cognitive function pre-exercise in the treatment group. PS did not affect mood or endocrine response
Starks M. (2008) ^[18]	Double blind; placebo controlled; crossover	10 (5/5)	Healthy males (24.7-27.7)	600 mg PS tablet and placebo (maltodextrin) tablet; daily for 10 days	(1) Blood composition (2) Hormone levels	There was a significant increase in testosterone to cortisol ratio in the treatment groups.

Table 2: Methodological quality of trials

First Author (Year)	Was the allocation sequence random?	Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	Did baseline differences between intervention groups suggest a problem with the randomization process?	Domain 1: Risk-of-bias judgement	Were participants aware of their assigned intervention during the trial?	Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?	Were there deviations from the intended intervention that arose because of the trial context?	Were these deviations likely to have affected the outcome?	Were these deviations from intended intervention balanced between groups?	Was an appropriate analysis used to estimate the effect of assignment to intervention?	Was there potential for a substantial impact (on the result) of the failure to analyze participants in the group to which they were randomized?	Domain 2: Risk-of-bias judgement
Jager (2007) ^[12]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Kingsley (2006) ^[13]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Kingsley (2005) ^[14]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Kingsley (2005) ^[15]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Monteleone (1990) ^[16]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Parker (2011) ^[17]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk
Starks (2008) ^[18]	Y	Y	N	Low risk	N	N	N/A	N/A	N/A	Y	N/A	Low risk

Table 2: Table 2 depicts the application of the Cochrane risk-of-bias tool to all included studies to assess the methodological quality of each trial.

Table 1 summarizes the main characteristics of all included studies. All the studies included in this review were published in English during the years of 1990-2011. The countries represented in the selected articles include: Germany [12], the United Kingdom [13, 14, 15, 18], Italy [16], and the United States [17, 18]. The ages of participants ranged from 20-55 with a total sum of 94 participants.^[12-18] Of the studies analyzed, three studies utilized parallel groups [12, 14, 15] and four studies utilized crossover methods [13, 16-18]. All of the studies identified the contents of the placebo being: IQ PLUS brain bar, glucose polymer, saline, rice flour, and maltodextrin^[12-18].

3.1 Blood composition

Four of the studies assessed the effect of phosphatidylserine on blood composition^[13-16]. All four of these studies assessed the change in blood glucose concentration due to phosphatidylserine supplementation, with none of them reporting any significant changes between the control and treatment groups. Other blood composition metrics measured include plasma volume, which was assessed in three studies^[13-15], as well as serum myoglobin concentration, plasma creatine kinase activity, and lipid hydroperoxide concentrations which were assessed in two studies^[13-15]. None of these metrics yielded any significant difference between trials.

3.2 Hormones

Six of the studies assessed the effect of phosphatidylserine on different hormone levels^[13-18]. All of the six studies assessed the impact of PS on cortisol concentration, with only two studies finding a significant change in the treatment group^[16, 18]. Of these two studies, one found that supplementation blunted cortisol in its response to physical stress^[16], with the other study finding that supplementation lead to an increase ratio of testosterone to cortisol^[18].

3.3 Mood/cognitive function

Two of the studies examined the effect of phosphatidylserine on the cognitive function of patients such as perceived stress^[12, 17]. One study found a significant increase in cognitive function prior to exercise within the treatment group. In the same study however, mood was not seen to be affected by PS^[17]. The other study found contradictory results, finding no significant change in perceived stress^[12].

3.4 Direct sport performance

Four of the studies assessed the effect of phosphatidylserine intake on the performance of athletic activities such as running and golfing^[12-15]. Two of these studies found significant increases in athletic performance such as golf ball flight accuracy^[12] and in VO₂ at 85% work load^[14]. One study was able to find an insignificant increase in running time till exhaustion^[15]. One study found no significant changes in muscle indicators such as muscle soreness, muscle damage, or inflammation after treatment with PS^[13].

3.5 Adverse events

None of the studies reviewed included any dropouts.^[12-18] No adverse events were reported in any of the studies.^[12-18]

4. Discussion

A total of seven randomized clinical trials of phosphatidylserine met the inclusion criteria of this review. In accordance with PRISMA,^[19] the Cochrane risk-of-bias tool,^[11] was applied to all included studies. All trials were determined to have a low risk of bias. (Table 2)

The results of this review demonstrate the potential positive effects of phosphatidylserine on athletic performance. Results were not consistent across all studies, as there were two studies that reported insignificant findings between control and treatment groups^[13, 15]. The use of phosphatidylserine as a supplement to increase athletic performance is promising, with five trials resulting in significant benefits^[12, 14, 16-18] There is evidence to suggest that phosphatidylserine supplementation can lower cortisol levels, increase maximum exercise capacity, increase cognitive levels, and even increase athletic prowess.

Phosphatidylserine is currently known for promoting memory and cognitive function due to its fatty phospholipid nature helping protect nerve cells^[3]. While only one study explicitly examined cognitive function and the effect of phosphatidylserine, a statistically significant increase in cognitive function was observed^[17]. There is also evidence supporting physical activity leading to an increase in cognitive function in older adults at risk for Alzheimer's^[20]. Studies utilizing elderly populations as subjects should be conducted to explore the possible beneficial relationship between supplementation with phosphatidylserine in conjunction with exercise on cognitive function.

There are multiple limitations of this review. Despite diligent efforts to locate relevant studies, it must be acknowledged that complete success in retrieving all pertinent data cannot be assured. Another aspect of concern in this study is the possibility of publication bias, as the data analyzed were exclusively sourced from scientific journals. There was also no standardized source or method of delivery for PS. This could potentially lead to variations in outcomes due to added variables between studies.

5. Conclusion

Phosphatidylserine supplementation may have a positive impact on athletic performance, specifically in areas concerning cognitive function and endocrine response. However, there is a lack of quality studies to support this claim. Additional research is necessary to make accurate claims of the validity of this supplement.

6. Registration and protocol

This review is not registered, and the protocol is not available.

7. Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

8. Funding

The authors received no financial support for the research and/or authorship of this article.

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