

Dosing strategies for β -alanine supplementation in strength and power performance: a systematic review

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ABSTRACT

Background: β -alanine is a well-established ergogenic aid that enhances muscle carnosine levels and buffering capacity during high-intensity efforts. However, its role in improving strength and power performance remains inconsistent across the literature. This systematic review investigates whether dosing strategy, rather than duration alone, is the critical determinant of efficacy in resistance-trained populations.

Methods: A systematic search was conducted across PubMed, SPORTDiscus, Scopus, Web of Science, and Google Scholar up to 28 May 2025, following PRISMA guidelines. Studies were included based on the PICO framework, targeting trained individuals receiving β -alanine supplementation with defined dosing protocols and strength- or power-based outcomes. Methodological quality was assessed using the Joanna Briggs Institute tools.

Results: Nine studies comprising 197 participants were reviewed. Daily β -alanine doses between 4 g and 6.4 g, especially when divided into multiple smaller servings such as 0.8 g taken several times a day, were more likely to enhance maximal strength and power-related outcomes. In contrast, studies that used high total doses but relied on sustained-release formats, single large servings, or training protocols with limited metabolic stress such as low volume or long rest intervals often failed to show improvements in performance. These findings suggest that cumulative dose and delivery method may play a more critical role than duration alone in promoting strength and power adaptations.

Conclusion: To optimize strength and power outcomes, β -alanine supplementation should emphasize fragmented dosing protocols of 4–6.4 g/day sustained over 5–8 weeks, particularly when implemented during training phases characterized by high metabolic stress – such as repeated submaximal efforts, short rest intervals, or high-volume hypertrophy sessions that elevate intramuscular acidity. These findings offer refined guidelines for coaches, athletes, and sport nutrition practitioners, and highlight the need for more individualized and mechanistically informed supplementation strategies.

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1. Introduction

1.1. Role of β -alanine in muscle carnosine synthesis and exercise performance

The optimization of nutritional strategies is a critical component of athletic performance, supporting enhanced training adaptations, improved recovery, and elevated physical output [1,2]. Among ergogenic aids, β -alanine stands out as a non-essential amino acid that plays a unique role in buffering intramuscular acidity. As the rate-limiting precursor to carnosine, a dipeptide concentrated in skeletal muscle β -alanine contributes directly to the intracellular buffering of hydrogen ions (H^+), delaying fatigue and preserving muscular function during high-intensity exercise [3,4]. This mechanism is particularly beneficial in strength and power-based activities where repeated bouts of anaerobic exertion induce significant acid-base disturbances [5,6].

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1.2. Inconclusive findings on β -alanine's impact on strength performance

While β -alanine's role in enhancing anaerobic performance is well-documented [4,7], evidence regarding its effectiveness for improving maximal strength remains inconsistent. Some studies have demonstrated significant improvements in one-repetition maximum (1RM) and related strength and power metrics following daily intakes of approximately 6.4 grams [8,9]. However, other trials using similar daily doses have shown no greater benefit than placebo [10–13]. These discrepancies indicate that factors beyond supplementation duration – such as dosing structure and compatibility with training variables like repeated submaximal sets, short rest intervals, or high-volume hypertrophy phases – may play a more critical role in optimizing intramuscular carnosine accumulation and performance outcomes.

A well-documented side effect of high-dose β -alanine supplementation is paresthesia, a harmless but uncomfortable tingling sensation that typically occurs when single doses exceed around 0.8 grams. While not dangerous, this sensation may reduce user compliance. This highlights the importance of fragmented dosing protocols, where multiple smaller servings throughout the day help maintain effective carnosine synthesis while minimizing side effects. These observations suggest that both the total daily intake and the amount per serving are critical factors influencing tolerability and performance outcomes.

1.3. Rationale for focusing on dose as a determinant of strength and power performance

Previous research and reviews on β -alanine supplementation have primarily emphasized the importance of supplementation duration in achieving ergogenic effects, particularly for endurance and high-intensity efforts [4,14]. However, emerging evidence suggests that cumulative dose and daily intake patterns may exert a more decisive influence than duration alone in the context of strength and power performance [15].

Notably, several studies employing similar total daily doses (e.g. ≥ 6.4 g/day) have reported inconsistent outcomes, highlighting the need to examine how dosing structure such as frequency, per-serving amount, and formulation affects muscle carnosine kinetics and training adaptations [15–17]. While meta-analyses have confirmed β -alanine's role in enhancing high-intensity performance through improved buffering capacity [4,6], its translation to strength and power gains appears to require more individualized and precisely structured dosing protocols.

The present study aims to address these gaps by evaluating the effects of varying β -alanine dosing strategies on strength performance. By synthesizing evidence from existing literature, we seek to provide practical recommendations for athletes and practitioners while identifying key directions for future research. The present review will contribute to refining β -alanine supplementation protocols, ensuring their applicability across diverse strength training contexts.

2. Methods

2.1. Protocol registration

This systematic review protocol was registered in the PROSPERO database (Registration ID: CRD420251078765) and is publicly available at: https://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD420251078765. The protocol was registered prior to data extraction to enhance methodological transparency and minimize risk of bias.

2.2. Search strategy and study selection

This systematic review followed the PICO framework. Eligible populations (P) included healthy, physically active adults or youth, such as resistance-trained individuals and athletes. Studies involving clinical populations or individuals with known medical conditions were excluded. The intervention (I) included β -alanine supplementation of any dosing strategy, formulation, or duration. Studies using multi-ingredient supplements were excluded unless β -alanine's effects could be clearly isolated. The comparators (C) were placebo or nonintervention control groups. The outcomes (O) were strength- and power-related performance measures, including one-repetition maximum (1RM), isometric or isokinetic

strength, or other validated assessments. Only randomized controlled trials (RCTs) and quasi-experimental studies were included; observational studies, case reports, and non-controlled trials were excluded.

To address the research objective— β -alanine supplementation for strength and power performance – a comprehensive literature search was conducted from May 20 to 28 May 2025, across five databases: PubMed, SPORTDiscus, Scopus, Web of Science, and Google Scholar. Boolean operators were used to refine the search string: (“ β -alanine” OR “beta-alanine”) AND (“strength” OR “resistance training” OR “muscle strength”) AND (“dosage” OR “dosing protocols” OR “ergogenic aid”). The number of records retrieved were: PubMed ($n = 37$), SPORTDiscus ($n = 85$), Scopus ($n = 132$), Web of Science ($n = 249$), and Google Scholar ($n = 3,620$, based on manual screening of the first 200 results).

Following de-duplication, titles and abstracts were screened according to the predefined inclusion and exclusion criteria. Full-text articles of potentially relevant studies were retrieved for detailed evaluation. No automated filters for study design were applied during the initial database search to avoid overly restrictive results; instead, eligible designs (RCTs and one quasi-experimental study) were confirmed during the full-text review stage. Additionally, reference lists of relevant systematic reviews and meta-analyses were manually examined to ensure comprehensive coverage of all pertinent literature.

2.3. Inclusion criteria

Studies were included if they involved recreationally active male individuals or trained athletes engaged in regular resistance training or structured physical activity. Eligible studies had to examine strength or power-related outcomes, such as 1RM, isometric or isokinetic strength, or other validated muscular strength or power measures. Detailed descriptions of β -alanine dosing and duration were required. Only peer-reviewed, full-text articles in English were included.

2.4. Exclusion criteria

Studies were excluded if they involved sedentary, untrained, or clinical populations. Research using multi-ingredient supplements was excluded unless β -alanine effects could be isolated. Studies were also excluded if they lacked clear supplementation details or did not assess strength- or power-related outcomes. Research focused solely on nonperformance outcomes such as cognition, biomarkers was outside the scope of this review. Additionally, studies restricted participation to males to reduce variability linked to hormonal fluctuations, as menstrual cycle phases and estrogen-progesterone dynamics can affect carnosine metabolism, substrate use, and training adaptations in women [15].

2.5. Assessment of methodological quality

Methodological quality was assessed independently by two reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Tools for both randomized controlled trials (RCTs) and quasi-experimental studies. These tools were chosen for their suitability in evaluating intervention-based research within exercise and sports nutrition contexts. [18] They provided a structured framework to appraise essential methodological elements such as randomization, allocation concealment, blinding, baseline comparability, and outcome measurement – criteria particularly relevant for performance-based outcomes. Any discrepancies between reviewers were resolved through discussion or, if needed, consultation with a third reviewer. Although alternative tools like GRADE exist for evaluating certainty of evidence in clinical guideline development, their scope is less aligned with the objectives of this non-clinical review. As such, the JBI tools were deemed most appropriate for assessing study rigor and internal validity in this context.

2.6. Study selection process

The study selection process was conducted in three key stages and performed entirely manually, without the use of AI-supported screening platforms. All screening, full-text review, and data

extraction were completed by the lead author in accordance with predefined inclusion and exclusion criteria.

- (1) *Initial Screening*: Titles and abstracts of all retrieved studies were reviewed, and studies that did not have β -alanine supplementation as a primary focus or lacked full-text availability were excluded.
- (2) *Full-Text Review*: The remaining studies underwent a detailed assessment for methodological quality and alignment with the review's objective. Studies meeting the inclusion criteria proceeded to the final analysis.
- (3) *Final Selection and Review Synthesis*: This phase involved synthesizing results from the selected studies and constructing the final review, which highlighted findings from studies reporting both positive and negative effects of β -alanine dosing on strength and power performance.

3. Results

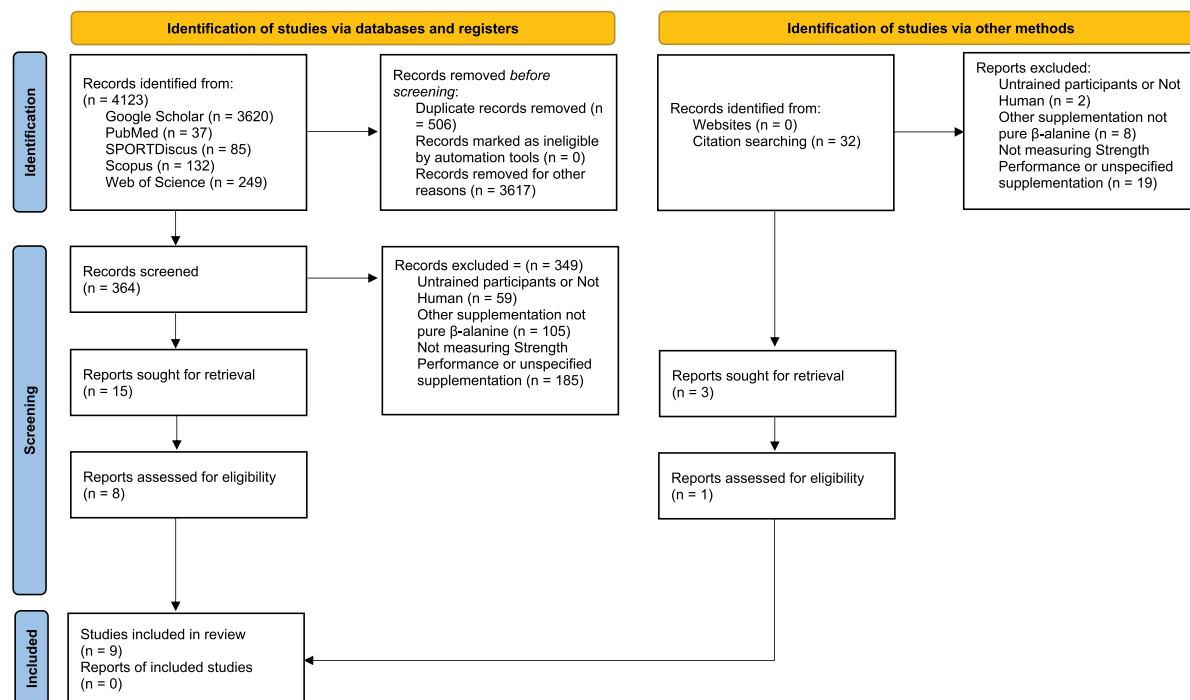
3.1. Study selection

A total of 4,123 records were retrieved across five databases: PubMed ($n = 37$), SPORTDiscus ($n = 85$), Scopus ($n = 132$), Web of Science ($n = 249$), and Google Scholar ($n = 3,620$; first 200 results screened manually). After removing 506 duplicates, 3,617 records remained for title and abstract screening. Of these, 3,253 were excluded based on relevance.

Subsequently, 364 full-text articles were assessed, with 356 excluded due to ineligible populations, interventions, outcomes, or study designs. An additional 32 articles were identified through manual citation searches; 31 of these were excluded upon full-text review. Ultimately, 9 studies met the inclusion criteria. The PRISMA 2020 flow diagram (Figure 1) summarizes the full selection process.

3.2. Study characteristic

The total number of participants across the 9 studies reviewed was 197, including experienced resistance-trained males ($n = 28$), recreationally resistance-trained males ($n = 24$), resistance-trained men ($n = 19$),



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Figure 1. Preferred reporting items for systematic reviews flow diagram.

strength-trained men ($n = 30$), healthy trained men ($n = 20$), physically active males ($n = 13$), collegiate wrestlers and football players ($n = 37$), and trained students with limited resistance training experience ($n = 26$).

The duration of supplementation spanned from 4 weeks [1,10,13,19] to 8 weeks [12,20,21], while one study utilized a 5-week regimen [8] and another implemented a 10-week protocol [11]. The β -alanine supplementation protocols exhibited variability across the studies, with daily doses ranging from 3.2 g to 6.4 g. β -Alanine was administered in various forms, including capsules, tablets, or gels, with daily doses often divided into multiple smaller servings (e.g. 0.8 g taken 4–8 times per day) [8,10,11,13,19,20]. Various assessments were used to measure strength performance. These included one-repetition maximum (1RM) tests for exercises such as the squat, bench press, and leg press [1,8,10,12,20], isometric and isokinetic strength tests [19], isotonic endurance tests [13], and whole-body strength tests [11]. One study assessed upper-body endurance using the 90° flexed-arm hang test [21].

Outcomes varied across studies. Five studies reported no significant improvements in strength performance with β -alanine supplementation [1,10–13]. Conversely, five studies reported positive effects, including improvements in 1RM strength, isometric endurance, and upper-body endurance [8,19–21]. The characteristics of the included studies summarized in Table 1.

3.3. Study results

Our analysis revealed that total cumulative dosage, rather than duration alone, appears to play a more critical role in the effectiveness of β -alanine supplementation on strength and power outcomes (Table 1). Specifically, studies with cumulative β -alanine intakes nearing or surpassing 200 to 300 grams were more likely to report improvements in one-repetition maximum strength, muscular endurance, or isokinetic performance. For instance, Mate-Muñoz et al. administered 6.4 grams per day over five weeks, totaling 224 grams; Askari et al. used 4.8 grams per day for eight weeks, totaling 268.8 grams; and Kern and Robinson applied 4 grams per day for eight weeks, also totaling 224 grams. These studies observed significant gains in muscular strength and/or endurance following supplementation. Conversely, studies with similar durations but lower cumulative intakes – such as Hoffman et al. with 4.8 grams daily for four weeks (134.4 grams total), Freitas et al. with 6.4 grams daily for four weeks (179.2 grams total), and Bassinello et al. with 6.4 grams daily for four weeks (179.2 grams total) – did not report significant improvements in strength or power performance.

These observations are consistent with dose-response modeling from Rezende et al. [22], who estimated that a cumulative dose of approximately 377 g represents the effective dose (ED50) needed to achieve 50% of the maximum carnosine saturation response. Their Bayesian E-max model further estimated that the probability of achieving $\geq 70\%$ of maximum effect increased substantially when cumulative β -alanine intake approached 1,000 g. While none of the included studies in the present review reached this upper threshold, those approaching or exceeding 250–300 g demonstrated more favorable outcomes, particularly when paired with consistent training stimuli and dietary intake monitoring.

Additionally, the form and frequency of administration may influence supplementation outcomes. Most studies divided daily doses into smaller portions such as 0.8 g administered 4–8 times per day to optimize absorption and minimize the risk of paresthesia. However, studies utilizing slow-release formulations or larger single doses [10] tended to show limited effectiveness, suggesting that both dose distribution and formulation type are relevant considerations for maximizing the ergogenic potential of β -alanine.

Together, these findings highlight the importance of evaluating total cumulative intake, dosing strategy, and supplement formulation when interpreting the variability in strength outcomes across β -alanine trials. Duration alone appears insufficient as a predictive factor of efficacy without accounting for these additional variables.

3.4. Methodological quality

The methodological rigor of the studies was evaluated using the Joanna Briggs Institute (JBI) checklists. The 8 RCTs displayed variability in methodological reporting (Table 2). Blinding of outcome assessors was either unclear or not reported in four studies [8,19–21], which raises potential concerns about detection bias.

Table 1. Summary of the characteristics of the included studies.

Study	Population	Supplementation Protocol	Total Cumulative Dose	Placebo Details (Type, Dosage, Matching Protocol)	Dietary Monitoring Method	Reported Dietary Intake Before Testing	Side Effects Reported	Assessment	Outcome
Hoffman et al., 2008 - No significant effect	Experienced resistance-trained males (n = 8)	4.8 g/day for 4 weeks (1.6 g × 3/day, capsules)	134.4 g	Capsules matched in appearance (1.6 g × 3/day), 4.8 g/day for 4 weeks	3-day food logs analyzed (FoodWorks); dietary intake monitored.	Yes – dietary composition analyzed (41% CHO, 36% fat, 23% protein); no mention of standardized intake prior to testing.	None reported	Maximal strength, 1RM Squat	No significant strength improvement
Freitas et al., 2019 - No significant effect	Recreationally resistance-trained males (n = 23)	6.4 g/day for 4 weeks (2 × 0.8 g × 4/day, slow-release gel capsules)	179.2 g	Maltodextrin capsules (2 × 0.8 g, 4 × /day), 6.4 g/day for 4 weeks	3-day food records (2 weekdays + 1 weekend) analyzed with Dietpro; intake standardized across trials.	None reported	None reported	One-maximum repetition test (1 RM) – Leg Press	No significant improvements
Camargo et al., 2023 - No significant effect	Resistance-trained men (n = 19)	6.4 g/day for 8 weeks (1.6 g × 4/day, capsules)	358.4 g	Maltodextrin capsules (1.6 g × 4/day), 6.4 g/day for 8 weeks	3-day 24 h recalls (2 weekdays + 1 weekend) analyzed (NutWin); usual diet maintained	Yes – macronutrient intake monitored (protein: ~1.6–1.7 g/kg, CHO: ~4.1–4.3 g/kg, fat: ~0.5 g/kg); no standardization prior to testing reported.	None reported	One-maximum repetition test (1 RM) – Bench Press and Back Squat	Beta-alanine showed no added benefit over placebo
Kendrick et al., 2008 - No significant effect	Limited experience in resistance training – Trained students (n = 26)	6.4 g/day for 10 weeks (0.8 g × 8/day, capsule)	448 g	Maltodextrin capsules (0.8 g × 8/day), 6.4 g/day for 10 weeks	No dietary monitoring; general pretest instructions given (e.g. rest, no alcohol/caffeine)	None reported	None reported	Whole-body strength	No significant strength increase
Bassolino et al., 2018 - No significant effect	Experienced resistance-trained males (n = 20)	6.4 g/day for 4 weeks (2 × 0.8 g × 4/day, capsules)	179.2 g	Matched sustained-release capsules (2 × 0.8 g, 4 × /day), 6.4 g/day for 4 weeks	24-h food diaries (PRE/POST): 2 weekdays + 1 weekend) analyzed (Virtual Nutri); participants followed consistent diet and training	Yes – macronutrient intake (kcal, protein, CHO, fat) assessed pre- and post-intervention; no standardization prior to testing.	None reported	Isotonic endurance (Bench press and Leg press), isometric and isokinetic lower limb endurance	No Improvement in Isometric, Isotonic or Isokinetic Strength.
Mate-Munoz et al., 2018 - Positive effect	Strength-trained men (n = 26)	6.4 g/day for 5 weeks (0.8 g × 8/day, capsules)	224 g	Sucrose capsules (0.8 g × 8/day), 6.4 g/day for 5 weeks	Not Reported	None reported	None reported	1RM (Back Squat), power output	Improvement in 1RM and power
Askari et al., 2019 - Positive effect	Healthy, trained men (n = 20)	4.8 g/day for 8 weeks (0.8 g × 6/day, tablets)	268.8 g	Polydextrose tablets (0.8 g × 6/day), 4.8 g/day for 6 weeks	Usual diet maintained; no dietary monitoring	None reported	None reported	1RM bench press, leg press	Strength improved in 1RM
Sale et al., 2012 - Positive effect	Physically active males (n = 13)	6.4 g/day for 4 weeks (0.8 g × 8/day, tablets)	179.2 g	Maltodextrin tablets (0.8 g × 8/day), 6.4 g/day at 2-h intervals	Usual diet maintained; compliance verbally confirmed	None reported	None reported	Isometric endurance of the knee extensors at 45% maximal voluntary isometric contraction (MVIC)	Improves endurance capacity of the knee extensors at 45% MVC
Kern and Robinson., 2011 - Positive effect	Collegiate wrestlers and football players (n = 22 + 15)	4.0 g/day for 8 weeks (2 g × 2/day, capsule)	224 g	Powdered capsules (4 g/day in 2 doses, 8 weeks); placebo matched with dextrose-filled capsules (IntraXcell®)	3-day food record analyzed during Week 3; usual diet maintained	Yes – 3-day diet record; kcal/kg: 21.9–35.9, protein: 0.76–1.19 g/kg BW (FB/WR groups)	None reported	90° flexed-arm hang (FAH)	Increase in FAH time of 6.5 ± 7.3 seconds (Improved upper body strength and endurance)

Table 2. Summary of Joanna Briggs Institute (JBI) Checklist for randomized controlled trials (RCTs) and quasi-experimental studies.

JBI Checklist for RCTs														
Study	Q1: Randomization Used	Q2: Allocation Concealed	Q3: Groups Similar	Q4: Blinding of Participants	Q5: Blinding of delivering treatment	Q6: Blinding of Assessors	Q7: Groups Treated Identically	Q8: Follow-Up Complete	Q9: Analyzed as Randomized	Q10: Outcomes Measured Similarly	Q11: Outcomes Reliable	Q12: Appropriate Analysis	Q13: Appropriate Design	Overall %
Askari et al. (2019)	Yes	Unclear	Yes	No	No	No	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	61.54
Bassinello et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.00
Camargo et al. (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.00
Freitas et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.00
Hoffman et al. (2008)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	92.31
Kern & Robinson (2011)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	76.92
Mate-Muñoz et al. (2018)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.31
Sale et al. (2012)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	84.62
Overall %	100	7/8 87.5	1 100	7/8 87.5	7/8 87.5	1/2 50	1 100	7/8 87.5	1/2 50	7/8 87.5	1 100	1 100	1 100	
JBI Checklist for Quasi-Experimental Studies														
Study	Q1: Cause and Effect Clear	Q2: Participants Similar	Q3: Treatment Identical	Q4: Control Group Present	Q5: Multiple Measurements Pre/Post	Q6: Complete Follow-Up	Q7: Outcomes Measured Similarly	Q8: Outcomes Reliable	Q9: Appropriate Analysis	Overall %				
Kendrick et al. (2008)	Yes	Yes	Unclear	Yes	No	No	Yes	Yes	Yes	66.67				

Similarly, unclear or incomplete descriptions of randomization processes were observed in four studies [1,19–21], indicating possible reporting inconsistencies.

One study [20] explicitly reported no blinding of participants and delivery personnel, which could affect performance outcomes. Allocation concealment was not clearly described in one study [20]. On the other hand, all studies used randomization effectively and reported reliable outcomes. Additionally, complete participant follow-up was maintained in all studies. Three studies [10,12,13] achieved comprehensive methodological transparency without identifiable risks of bias.

An additional quasi-experimental study [11] was reviewed (Table 2). This study showed limitations in treatment consistency, lacked multiple pre/post measurements, and had incomplete follow-up, resulting in an evaluation score of 66.67%. Despite these aspects, the study effectively established cause-and-effect relationships, ensured similar participant characteristics, and reliably measured outcomes. The full critical appraisal findings for each study are presented in Table 2.

4. Discussion

4.1. Major findings

This review highlights that while β -alanine supplementation has the potential to enhance strength and power performance, its effectiveness appears more dependent on total daily dose, cumulative intake and delivery strategy. Notably, several studies using high doses such as ≥ 6.4 g/day still failed to yield performance improvements particularly when dosing strategies were suboptimal such as sustained-release forms, unfragmented dosing or when the training protocol did not induce sufficient metabolic stress.

4.2. Dose as a primary determinant

High-dose β -alanine supplementation has been associated with greater improvements in strength-related outcomes, particularly when the total cumulative intake exceeds approximately 200 grams. [8,20,21] These benefits are more pronounced in training contexts involving repeated submaximal efforts and high metabolic stress, which promote greater reliance on intramuscular buffering.

Across the included studies, daily β -alanine doses ranged from 4 to 6.4 grams, with total cumulative intakes between 134.4 grams and 448 grams. [1,8,10–12,19–21] Evidence suggests that higher cumulative doses especially those approaching or exceeding 200 grams are more likely to support improvements in maximal strength, isometric force, and muscular endurance. [8,20,21] This relationship appears particularly strong when supplementation is paired with resistance training protocols that induce high metabolic stress. However, not all high-dose studies demonstrated significant performance benefits. [11,12] Those that did not often shared specific methodological limitations. A key issue was the use of sustained-release β -alanine formulations, which may reduce absorption efficiency and slow carnosine accumulation, thereby diminishing the expected ergogenic effects. [10]

β -alanine supplementation has been associated with greater improvements in strength-related outcomes, particularly when the total cumulative intake exceeds approximately 200 grams. These benefits are more pronounced in training contexts involving repeated submaximal efforts and high metabolic stress, which promote greater reliance on intramuscular buffering.

This supports earlier findings by Artioli et al. [17], who reported that only $\sim 6\%$ of ingested β -alanine contributes to muscle carnosine synthesis due to the saturable nature of the TauT and PAT1 transporters. When larger doses are consumed in fewer sittings, plasma concentrations may exceed transporter capacity, leading to diminished muscular uptake and increased urinary excretion. Therefore, fragmented dosing strategies such as administering 0.8 g every 3–4 hours may be more effective in maintaining optimal plasma levels for carnosine synthesis without increasing the risk of paresthesia [6,23].

This physiological rationale aligns with findings from several included studies that failed to observe performance benefits despite high total daily or cumulative doses. For example, Bassinello et al. [13] and Freitas et al. [10] used 6.4 grams per day over 4 weeks but relied on sustained-release capsules and showed no strength improvements. Similarly, Camargo et al. [20] employed a relatively high cumulative dose of 358.4

grams over 8 weeks, but used larger single servings of 1.6 grams taken four times daily – an approach that may have exceeded transporter capacity and compromised absorption efficiency.

4.3. Dose alone is not sufficient

Importantly, higher β -alanine doses do not necessarily lead to improved performance if the delivery method or training conditions are not compatible with the supplement's physiological mechanisms. β -alanine enhances exercise performance primarily by increasing intramuscular carnosine concentrations, which buffer hydrogen ions (H^+) produced during anaerobic metabolism. This buffering delays the onset of muscular fatigue during high-intensity efforts that generate substantial acidosis. Therefore, if supplementation protocols do not promote efficient absorption – such as using unfragmented or sustained-release forms – or if training sessions involve minimal acid accumulation, such as those with low volume or long rest intervals, the ergogenic potential of β -alanine may not be achieved. [11,24]

In Kendrick et al. [11], participants consumed 6.4 g/day for 10 weeks but showed no significant strength gains. Their training protocol included 2–5-minute rest intervals between sets, which allowed sufficient time for pH recovery and reduced the physiological demand for intramuscular buffering – thereby minimizing the ergogenic effect of β -alanine. Similarly, Hoffman et al. [1] observed no improvements in one-repetition maximum (1RM) after 4.8 g/day over 4 weeks. However, participants receiving β -alanine demonstrated a significantly greater increase in total training volume, calculated as the product of sets, repetitions, and load. This was especially evident in compound lifts like the bench press and squat, where the β -alanine group completed more repetitions under fatigue. These findings suggest that while β -alanine may not directly increase maximal strength under low-acidosis conditions, it can enhance fatigue resistance, thereby supporting higher training loads and potentially contributing to performance over time.

These results emphasize that β -alanine is most effective in training conditions that elevate intramuscular H^+ levels, such as repeated submaximal efforts, short rest periods, or high-volume hypertrophy-style training [4,25,26]. When exercise intensity and structure do not induce substantial metabolic acidosis, the buffering capacity of carnosine has limited influence on performance outcomes.

4.4. Total intake and performance outcomes

Hobson et al. [4], in a systematic review and meta-analysis, noted that a median total β -alanine intake of 179 g was associated with a 2.85% improvement in exercise performance, particularly in efforts lasting 60–240 seconds. However, the variability in individual responses and training modalities across studies underscores the need for precision in matching total dose and delivery format to the metabolic demands of exercise.

In this review, studies reporting positive outcomes typically employed total cumulative doses between 179.2 and 358 grams, delivered through fragmented or gradually increased daily intakes over 5 to 8 weeks [8,19–21]. These protocols enhanced absorption efficiency by avoiding transporter saturation and were paired with training modalities likely to induce acidosis, thereby maximizing the buffering benefits of elevated intramuscular carnosine.

4.5. Strengths and limitations

4.5.1. Strengths

This systematic review provides a focused investigation of β -alanine supplementation protocols, emphasizing dose-dependent effects on strength and power outcomes – a topic underrepresented in current literature. While previous reviews primarily addressed endurance-based or time-to-exhaustion outcomes [4], this review specifically examines β -alanine's influence on maximal and submaximal strength performance across various resistance training modalities, helping to fill a key gap in sports nutrition research.

One notable strength is the synthesis of findings across studies using daily doses between 4–6.4 g, particularly in protocols utilizing fragmented dosing strategies (e.g. 0.8 g administered multiple times per day). These methods appear to enhance muscle carnosine availability while mitigating adverse effects such as paresthesia [6,23], thereby promoting adherence and optimizing ergogenic efficacy.

This review also integrates results from a diverse set of populations – including trained males, recreational lifters, and master’s athletes – and delivery forms (capsule, gel, sustained-release), enabling a more real-world applicable framework. Importantly, the review emphasizes that high doses alone are insufficient if dosing frequency and absorption kinetics are not aligned with physiological uptake capacity. This perspective enhances practical application for coaches, dietitians, and researchers working with resistance-trained individuals.

Furthermore, the review incorporates methodological quality assessments, including randomization, placebo controls, dietary tracking, and valid performance outcome measures, all of which strengthen the reliability and translatability of the findings.

4.5.2. Limitations

Despite its contributions, this review is subject to several limitations. The heterogeneity of included studies – in training protocols, supplementation formats, dose frequency, and strength assessment methods such as 1RM, isometric, isokinetic limits direct comparability and contributes to inconsistent findings.

Although the current review prioritizes dose over duration, some supporting studies [4,6] were not designed to assess maximal strength, instead focusing on endurance or time-to-exhaustion. These were included to contextualize the relationship between cumulative β -alanine dose and carnosine saturation, not as direct evidence for strength enhancement.

Another limitation is the lack of standardized dietary control across studies. Inconsistent macronutrient intake and insufficient monitoring of β -alanine-rich foods (e.g. meat) could influence baseline carnosine levels and supplement responsiveness. Only a minority of studies implemented controlled feeding or prospective diet tracking, which introduces possible confounding.

Additionally, female participants and novice lifters remain underrepresented. [27] Most included studies examined trained male populations, making it difficult to generalize findings across sexes, age groups, or training backgrounds. Hormonal influences on carnosine metabolism and neuromuscular function may also contribute to differential responses that remain unexplored.

Lastly, training modalities that do not prioritize strength, such as hypertrophy-based or concurrent endurance programs, are under-investigated in relation to β -alanine supplementation. Future studies should explore standardized, mechanistically informed protocols across a wider spectrum of athletic populations and resistance training goals.

4.6. Practical applications

The findings of this review offer targeted, evidence-based guidance for athletes, coaches, and practitioners seeking to enhance strength and power performance through β -alanine supplementation.

Daily doses of 4 to 6.4 g have shown the greatest effectiveness, particularly when administered using fragmented dosing protocols (e.g. 0.8 g per serving, multiple times per day). This strategy helps maintain stable plasma β -alanine concentrations, improves muscle carnosine uptake, and reduces side effects like paresthesia. [16,17,19,28]

These dosing approaches are especially applicable in strength and power-based sports involving repeated maximal efforts, short rest intervals, and training modalities that produce high rates of glycolysis and hydrogen ion accumulation – conditions under which carnosine’s buffering role is most critical. [4] Supplementing during training phases such as hypertrophy or maximal strength mesocycles may increase training volume, delay fatigue, and enhance neuromuscular adaptations over time. [8,20]

Practitioners should also consider individual factors such as training experience, sex, and dietary habits when prescribing β -alanine. For instance, baseline carnosine levels and transporter efficiency may differ between individuals, influencing their responsiveness. [15]

Incorporating structured β -alanine supplementation protocols into resistance training programs may improve fatigue resistance, enhance recovery between sets, and ultimately optimize strength and power performance.

5. Conclusion

This systematic review underscores the importance of optimizing β -alanine supplementation protocols to support strength and power performance. Daily doses between 4 and 6.4 grams, particularly when delivered in fragmented servings, enhance absorption, minimize side effects, and improve intramuscular carnosine accumulation. [16,19] However, high cumulative doses alone are insufficient. Studies reporting null findings often featured suboptimal training stimuli such as long rest intervals or delivery formats that compromised uptake. [4,17] Thus, β -alanine's effectiveness is determined not only by total dose, but by how well the dosing protocol aligns with training-induced acidosis and individual absorption dynamics.

While β -alanine's buffering role is well established, its ergogenic benefits are maximized when dosing strategies are tailored to the metabolic demands of resistance training.

To maximize performance outcomes, strength-focused supplementation strategies should prioritize fragmented dosing, consider individual variability, and be timed to coincide with high-intensity training phases that promote acid-base stress.

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Data availability statement

Extracted data, data collection templates, and any supplementary materials used in this review are available from the corresponding author upon reasonable request. The protocol was registered on PROSPERO (CRD420251078765) and is publicly accessible.

References

1. Hoffman JR, Ratamess NA, Ross R, et al. β -alanine and the hormonal response to exercise. *Int J Sports Med.* 2008;29(12):952–14. doi: [10.1055/s-2008-1038678](https://doi.org/10.1055/s-2008-1038678)
2. Trexler ET, Smith-Ryan AE, Stout JR. β -alanine supplementation in humans: a review of the current literature. *Nutrients.* 2015;7(3):2164–2176. doi: [10.3390/nu7032164](https://doi.org/10.3390/nu7032164)
3. Harris RC, Tallon MJ, Dunnett M, et al. The absorption of orally supplied β -alanine and its effect on muscle carnosine synthesis in human vastus lateralis. *Amino Acids.* 2006;30(3):279–289. doi: [10.1007/s00726-006-0299-9](https://doi.org/10.1007/s00726-006-0299-9)
4. Hobson RM, Saunders B, Ball G, et al. Effects of β -alanine supplementation on exercise performance: a meta-analysis. *Amino Acids.* 2012;43(1):25–37. doi: [10.1007/s00726-011-1200-z](https://doi.org/10.1007/s00726-011-1200-z)
5. Derave W, Ozdemir MS, Harris RC, et al. Beta-alanine supplementation augments muscle carnosine content and attenuates fatigue during repeated isokinetic contraction bouts in trained sprinters. *J Appl Physiol* (1985). 2007;103(5):1736–1743. doi: [10.1152/japplphysiol.00397.2007](https://doi.org/10.1152/japplphysiol.00397.2007)
6. Fernández-Lázaro D, Fiandor EM, García JF, et al. β -Alanine supplementation in combat sports: evaluation of sports performance, perception, and anthropometric parameters and biochemical markers—A systematic review of clinical trials. *Nutrients.* 2023;15(3755):3755. doi: [10.3390/nu15173755](https://doi.org/10.3390/nu15173755)
7. Salvadori P, Caputo M, Mansur V, et al. Beta-alanine supplementation and improvement of performance in swimming and water polo: a systematic review. *Braz J Health Biomed Sci.* 2023;22(2):117–125. doi: [10.12957/bjhbs.2023.80048](https://doi.org/10.12957/bjhbs.2023.80048)
8. Maté-Muñoz JL, Lougedo JH, Garnacho-Castaño MV, et al. Effects of β -alanine supplementation during a 5-week strength training program: a randomized, controlled study. *J Int Soc Sports Nutr.* 2018;15(1):19. doi: [10.1186/s12970-018-0224-0](https://doi.org/10.1186/s12970-018-0224-0)

9. Sale C, Saunders B, Harris RC. Effect of beta-alanine supplementation on muscle carnosine concentrations and exercise performance. *Amino Acids*. 2010;39(2):321–333. doi: [10.1007/s00726-009-0443-4](https://doi.org/10.1007/s00726-009-0443-4)
10. Freitas MC, Cholewa J, Panissa V, et al. Short-time β -alanine supplementation on the acute strength performance after high-intensity intermittent exercise in recreationally trained men. *Sports*. 2019;7(5):108. doi: [10.3390/sports7050108](https://doi.org/10.3390/sports7050108)
11. Kendrick IP, Harris RC, Kim HJ, et al. The effects of 10 weeks of resistance training combined with β -alanine supplementation on whole body strength, force production, muscular endurance, and body composition. *Amino Acids*. 2008;34(4):547–554. doi: [10.1007/s00726-007-0008-3](https://doi.org/10.1007/s00726-007-0008-3)
12. Camargo JB, Brigatto FA, Zaroni RS, et al. Does beta-alanine supplementation enhance adaptations to resistance training? A randomized, placebo-controlled, double-blind study. *Biol Sport*. 2023;40(1):217–224. doi: [10.5114/biolSport.2023.112967](https://doi.org/10.5114/biolSport.2023.112967)
13. Bassinello D, de Salles Painelli V, Dolan E, et al. Beta-alanine supplementation improves isometric, but not isotonic or isokinetic strength endurance in recreationally strength-trained young men. *Amino Acids*. 2018;50(5):1–12. doi: [10.1007/s00726-018-2593-8](https://doi.org/10.1007/s00726-018-2593-8)
14. Hill CA, Harris RC, Kim HJ, et al. Influence of β -alanine supplementation on skeletal muscle carnosine concentrations and high-intensity cycling capacity. *Amino Acids*. 2007;32(2):225–233. doi: [10.1007/s00726-006-0364-4](https://doi.org/10.1007/s00726-006-0364-4)
15. Smith-Ryan AE, Cabre HE, Moore SR. Active women across the lifespan: nutritional ingredients to support health and wellness. *Sports Med*. 2022;52(Suppl 1):101–117. doi: [10.1007/s40279-022-01755-3](https://doi.org/10.1007/s40279-022-01755-3)
16. Stautemas J, Van de Loock A, Van der Stede T, et al. Fragmented dosing of β -alanine induces a body weight-independent pharmacokinetic response. *Nutrients*. 2019;11(12):2869. doi: [10.3390/nu11122869](https://doi.org/10.3390/nu11122869)
17. Artioli GG, Gonçalves LS, Kratz C, et al. Insulin does not stimulate β -alanine transport into human skeletal muscle. *Am J Physiol Cell Physiol*. 2020;318(4):C777–C786. doi: [10.1152/ajpcell.00550.2019](https://doi.org/10.1152/ajpcell.00550.2019)
18. Aromataris E, Lockwood C, Porritt K, et al. , editors. *JBI Manual for Evidence Synthesis*. JBI. 2024. Available from: <https://jbi-global-wiki.refined.site/space/MANUAL>
19. Sale C, Hill CA, Ponte J, et al. β -alanine supplementation improves isometric endurance of the knee extensor muscles. *J Int Soc Sports Nutr*. 2012;9(1):26. doi: [10.1186/1550-2783-9-26](https://doi.org/10.1186/1550-2783-9-26)
20. Askari F, Rahmaninia F. The effect of 8 weeks beta-alanine supplementation and resistance training on maximal-intensity exercise performance adaptations in young males. *Phys Educ Students*. 2019;23(1):4–8. doi: [10.15561/20755279.2019.0101](https://doi.org/10.15561/20755279.2019.0101)
21. Kern BD, Robinson TL. Effects of β -alanine supplementation on performance and body composition in collegiate wrestlers and football players. *J Strength Cond Res*. 2011;25(7):1804–1815. doi: [10.1519/JSC.0b013e3181eaf4c2](https://doi.org/10.1519/JSC.0b013e3181eaf4c2)
22. Rezende NS, Swinton P, de Oliveira LF, et al. The muscle carnosine response to beta-alanine supplementation: a systematic review with Bayesian individual and aggregate data E-max model and meta-analysis. *Front Physiol*. 2020;11:913. doi: [10.3389/fphys.2020.00913](https://doi.org/10.3389/fphys.2020.00913)
23. Quesnele JJ, Laframboise MA, Wong JJ, et al. The effects of beta-alanine supplementation on performance: a systematic review of the literature. *Int J Sport Nutr Exerc Metab*. 2014;24(1):14–27. doi: [10.1123/ijsnem.2013-0007](https://doi.org/10.1123/ijsnem.2013-0007)
24. Sweeney KM, Wright GA, Glenn Brice A, et al. The effect of beta-alanine supplementation on power performance during repeated sprint activity. *J Strength Cond Res*. 2010;24(1):79–87. doi: [10.1519/JSC.0b013e3181c63bd5](https://doi.org/10.1519/JSC.0b013e3181c63bd5)
25. Saunders B, Elliott-Sale K, Artioli GG, et al. β -alanine supplementation to improve exercise capacity and performance: a systematic review and meta-analysis. *Br J Sports Med*. 2017;51(7):658–669. doi: [10.1136/bjsports-2016-096396](https://doi.org/10.1136/bjsports-2016-096396)
26. Baguet A, Koppo K, Pottier A, et al. β -alanine supplementation reduces acidosis but not oxygen uptake response during high-intensity cycling exercise. *Eur J Appl Physiol*. 2010;108(3):495–503. doi: [10.1007/s00421-009-1225-0](https://doi.org/10.1007/s00421-009-1225-0)
27. Glenn JM, Gray M, Stewart RW, et al. Effects of 28-day beta-alanine supplementation on isokinetic exercise performance and body composition in female masters athletes. *J Strength Cond Res*. 2016;30(1):200–207. doi: [10.1519/JSC.0000000000001128](https://doi.org/10.1519/JSC.0000000000001128)
28. Brisola GM, Zagatto AM. Ergogenic effects of β -alanine supplementation on different sports modalities: strong evidence or only incipient findings? *J Strength Cond Res*. 2019;33(1):253–282. doi: [10.1519/JSC.0000000000003008](https://doi.org/10.1519/JSC.0000000000003008)