



DOSSIER · SUBSTANCE

Beta-Alanine

Beta-Alanine is a non-proteinogenic amino acid that is considered the rate-limiting precursor of muscle carnosine synthesis. The most interesting finding: most controlled studies examine exhaustion and performance, while other areas of application are numerically subordinate.

158

STUDIES IN
TOTAL

74

IN HUMANS

36

OF WHICH
CONTROLLED

3

IN ANIMALS

1

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-15

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Beta-Alanine at a Glance

ORIGIN:
Beta-Alanine is a non-proteinogenic amino acid that is not incorporated into proteins.

EVIDENCE BASE:
158 evaluated studies · 36 controlled human studies · 38 observational studies · 8 review articles · 3 animal experiments · 1 cell culture study

- STRONGEST EVIDENCE:
- Musculoskeletal system: Meta-analysis 2017 ¹ of 40 double-blind, placebo-controlled studies and 1461 participants; pooled effect size 0.18 (95 % CI 0.08 to 0.28). **Proven:** small, significant overall effect.
 - Musculoskeletal system: 90 days with three times 800 mg daily in 26 people (72.8 ± 11.1 years; 2008 ³); physical work capacity at the fatigue threshold rose by 28.6 % (p < 0.05), remained unchanged under placebo.
 - Musculoskeletal system: 12 weeks with 3.2 g daily as sustained-release tablets in 18 older people (2012 ³²); carnosine in the M. gastrocnemius +85.4 % versus +7.2 % (p = 0.004; ES 1.21).
 - Plasma levels and urinary loss: 1.6 g as sustained-release tablet versus pure solution (2012 ²); plasma peak 82 vs. 248 µmol/L at later peak time and lower urinary loss (202 vs. 663 µmol).
 - Cognition: 100 older adults (70.6 ± 8.7 years) over ten weeks with 2.4 g daily (2023 ¹³); in those with baseline MOCA score ≤ 26, values rose versus placebo by 13.6 % (p = 0.009) and by 11.8 % (p = 0.016).

- LIMITATIONS:
- Musculoskeletal system: A 2017 review ¹⁵ of 23 randomised clinical studies found no significant difference in total work, exercise duration and oxygen uptake.
 - Cognition and psyche: Five controlled studies; the 2023 review ³⁶ describes the evidence on cognitive function as inconclusive and possibly dependent on the type of stressor.
 - Gut and microbiome: A dedicated examination of whether orally supplied beta-alanine alters carnosine concentration in gut tissue or the composition of the microbiome remains outstanding.

CLASSIFICATION:
Beta-Alanine raises muscle carnosine content via carnosine synthesis; the meta-analysis of over 40 double-blind, placebo-controlled studies shows a significant yet small performance effect.

1. What Beta-Alanine Is

Beta-Alanine is an amino acid that is not incorporated into proteins. It arises in the body during pyrimidine breakdown and is obtained from the diet, mainly from animal sources. It is known as the precursor of the dipeptide carnosine (beta-alanyl-L-histidine), which occurs in skeletal muscle, heart and brain. Carnosine formation depends on the supply of beta-alanine; the availability of this precursor is regarded as the rate-limiting step of carnosine synthesis in muscle.

The database contains basic-science studies that address this biochemistry. Intake of beta-alanine increases muscle carnosine content, which has been examined in several controlled studies. The substance is frequently used as a food supplement, usually in powder or tablet form, often in combination with other ingredients. The studies available date from 1979 to 2026.

2. What the Studies Show in Detail

The key human studies and the most important reviews — by application area, with population, duration, preparation, measured variable and result as reported in the original papers. Numbers appear only where the study states them.

Distribution of **controlled human studies** by application area — the numbers are not additive, as one study may be assigned to several areas:

APPLICATION AREA	CONTROLLED STUDIES
Exhaustion and stress	14
Safety and tolerability	12
Musculoskeletal system	11
Cognition and psyche	5
Cardiovascular system	3
Inflammatory processes	3
Metabolism	3

APPLICATION AREA	CONTROLLED STUDIES
Oxidative stress	3

Musculoskeletal System

The most comprehensive synthesis dates from 2017 ¹: 40 double-blind, placebo-controlled studies with 65 different exercise protocols and 70 performance measures in a total of 1461 participants yielded a pooled effect size of 0.18 (95 % CI 0.08 to 0.28); cross-over designs were excluded because of the long wash-out time of muscle carnosine. **Shown:** Across several controlled studies a significant yet small overall effect on exercise capacity and performance is observed. A systematic review from 2017 ¹⁵ evaluated 23 randomised clinical studies from 2005 to 2015, with a mean intervention duration of 5.2 ± 1.8 weeks and a mean dose of 4.8 ± 1.3 g per day. Blood lactate, pH, rating of perceived exertion, performance and physical work capacity at the fatigue threshold were recorded. After intake no statistically significant difference was found in total work, exercise duration, oxygen uptake and time to exhaustion; the authors see the strongest indications for rating of perceived exertion and biochemical parameters of muscle fatigue.

In older people a double-blind randomised study from 2008 ³ tested 800 mg beta-alanine three times daily ($n = 12$) versus placebo ($n = 14$) for 90 days in 26 men ($n = 9$) and women ($n = 17$) aged 72.8 ± 11.1 years. Physical work capacity at the fatigue threshold (PWCFT) was measured by discontinuous cycle-ergometer test; in the verum group it rose by 28.6 % ($p < 0.05$), while it remained unchanged under placebo. A 2012 study ³² examined 18 healthy older people aged 60 to 80 years over 12 weeks with 3.2 g per day, given as two 800-mg sustained-release tablets twice daily. Carnosine content in the M. gastrocnemius rose by +85.4 % versus +7.2 % under placebo ($p = 0.004$; ES 1.21); time to exhaustion in the constant submaximal test improved by +36.5 % versus +8.6 % ($p = 0.05$; ES 1.71), in the incremental test by +12.2 % versus +0.1 % ($p = 0.04$; ES 1.03).

A randomised placebo-controlled study from 2013 ⁶ combined beta-alanine with an oral dietary supplement: 60 men and women (70.7 ± 6.2 years) received twice daily either the supplement alone ($n = 20$; 8 oz; 230 kcal; 12 g protein; 31 g carbohydrates; 6 g fat), the supplement with 800 mg ($n = 19$) or with 1200 mg beta-alanine ($n = 21$), over 12 weeks. Measured were work capacity at the fatigue threshold, fat mass as well as total and arm lean mass by DEXA, hand grip strength, a 30-second sit-to-stand test and muscle quality. After 16 dropouts the groups still comprised 16, 15 and 13 persons; the excerpt ends with the statement that no significant changes were observed, without detailing the individual target variables. The results do not allow any statement on the effect of beta-alanine alone, as all groups received the supplement. In twelve healthy adults (mean age 60.5 ± 8.6 years, weight 81.5 ± 12.6 kg) a randomised study from 2018 ⁴ tested 2.4 g per day over 28 days. Before intake the groups did not differ in time to exhaustion on the cycle ergometer at 70 % $\dot{V}O_{2peak}$ (9.4 ± 1.4 min under placebo vs. 11.1 ± 2.4 min, $P = 0.7$); after 28 days the verum participants cycled longer than before (14.6 ± 3.8 min vs. 11.1 ± 2.4 min, $P = 0.04$), the placebo group did not (8.7 ± 2.4 min vs. 9.4 ± 1.4 min, $P = 0.7$).

In the continuous incremental test to exhaustion the ventilatory threshold rose by 13.9 %, work capacity at the fatigue threshold by 12.6 % and time to exhaustion by 2.5 % ($p < 0.05$); under placebo all values remained unchanged, and maximal oxygen uptake changed in neither group. A randomised double-blind placebo-controlled study from 2019 ¹⁰ had 18 men complete four weeks of high-intensity interval training first and then randomised them to six further weeks of training with 6.4 g per day beta-alanine or dextrose; running performance, $2 \times 6 \times 35$ -m sprints, neuromuscular function and muscle biopsies for carnosine, buffering capacity, PFK, MCT4 and HIF-1 α were recorded. Both groups showed a time effect for maximal oxygen uptake (verum 6.2 ± 3.6 %, placebo 6.5 ± 4.2 %); a time effect for the remaining target variables occurred only in the verum group. Over 24 weeks a study from 2017 ³³ accompanied 25 active men with 6.4 g per day sustained-release beta-alanine or placebo; carnosine content rose at every measurement point (week 4: $+11.37 \pm 7.03$ mmol·kg⁻¹ dm; week 8: $+13.88 \pm 7.84$; week 12: $+16.95 \pm 8.54$; week 16: $+17.63 \pm 8.42$; week 20: $+21.20 \pm 7.86$; week 24: $+20.15 \pm 7.63$), maximally by $+25.66 \pm 7.63$ mmol·kg⁻¹ dm (range $+17.13$ to $+41.32$) with an absolute peak content of 48.03 ± 8.97 mmol·kg⁻¹ dm (range 31.79 to 63.92). The position stand of the International Society of Sports Nutrition from 2015 ³⁴ states that four weeks of 4 to 6 g daily markedly increases muscle carnosine concentration and thereby acts as an intracellular pH buffer, and that 4 to 6 g daily over at least 2 to 4 weeks improves athletic performance, with more pronounced effects in open-ended tasks and time trials of 1 to 4 minutes duration. What is missing: for strength performance and for endurance loads beyond 25 minutes the position stand itself identifies further research needs, and the question remains open which training protocols and which training status most strongly support the effect.

Skin

A single-blind randomised three-arm study from 2012 ² compared 1.6 g beta-alanine as a pure solution (REF), 1.6 g in sustained-release tablets (TAB) and a placebo (PLA) in eleven healthy adults after overnight fasting. Over six hours plasma and urine concentrations were measured and questionnaires on intensity, type (pins and needles, itching, flush, irritation, numbness, soreness) and spatial distribution of unusual sensations were completed. The sustained-release form reached a lower plasma peak than the solution (82 vs. 248 $\mu\text{mol/L}$, $p < 0.001$) and a later peak time (1.0 vs. 0.5 h, $p < 0.01$) with the same area under the curve; urinary loss was lower (202 vs. 663 μmol , $p < 0.0001$) and retention higher (98.9 vs. 96.3 %, $p < 0.001$).

The sensations described as pins and needles occurred rapidly after the solution on the skin of the arms and trunk ($T_{max} = 15$ min) and followed the plasma curve almost temporally. Maximum intensity was lower under the sustained-release form (very low) than under the solution (low, $p < 0.001$), while sustained-release form and placebo did not differ. **Plausible:** The dosage form influences the total amount absorbed less than the speed of the concentration rise, and paraesthesia is coupled to this rise. The next question to clarify is whether this relationship appears in the same way with repeated intake over weeks and whether it also applies to other dosage forms.

Gut and Microbiome

A review from 2021 ²² describes carnosine as a dipeptide of beta-alanine and L-histidine that is formed in the body and occurs in high concentration in brain, muscle and gastrointestinal tissue of humans as well as in all vertebrates. The work lists as properties the scavenging of reactive oxygen species and alpha-beta-unsaturated aldehydes that arise during peroxidation of fatty-acid membranes, inhibition of glycation and chelation of divalent metal ions. Beta-alanine is described therein as a particularly interesting component for athletes because it raises muscle carnosine and improves the efficacy of movement as well as stimulation and contraction in muscle. The work is a review of carnosine and not an original data collection.

The two further works evaluated for this field carry no statement on beta-alanine as a substance. The randomised study from 1988 ²⁹ compared balsalazide (n = 41) with sulfasalazine (n = 38), each 1 g twice daily, in 79 patients with ulcerative colitis (53 men, 26 women, mean age 49 years, range 19 to 79 years) over six months; remission rates after six months were 51 % under balsalazide and 63 % under sulfasalazine and did not differ significantly (Life-Table Analysis $P < 0.1$), adverse effects occurred in 2 of 41 (5 %) versus 10 of 38 (26 %, $P = 0.017$). Balsalazide is a prodrug that releases 5-aminosalicylic acid and 4-aminobenzoyl-beta-alanine in the colon, the beta-alanine portion being explicitly termed an inert carrier in the abstract. The work from 1993 ⁵ examined amino-acid and glucose transport in the small intestine after total parenteral nutrition in six surgical patients versus seven controls and included L-alanine, not beta-alanine. What is missing: an original examination of whether and how orally supplied beta-alanine alters carnosine concentration in intestinal tissue or the composition of the microbiome remains outstanding.

Cognition and Psyche

A double-blind randomised study from 2023 ¹³ accompanied 100 older adults (70.6 ± 8.7 years) over ten weeks with 2.4 g beta-alanine per day or placebo, with testing before the start, at the midpoint and in week 10. Recorded were the Montreal Cognitive Assessment (MOCA), a Stroop pattern-recognition test, questionnaires on mood, depression (GDS) and anxiety (GAS) as well as hand grip strength and a timed sit-to-stand test. In the overall group the MOCA values did not differ ($p = 0.19$). In participants whose baseline MOCA value lay at or below the normal range (≤ 26), values improved under beta-alanine by 13.6 % at the midpoint ($p = 0.009$) and by 11.8 % after ten weeks ($p = 0.016$) versus placebo. No differences appeared for mood, anxiety scale or any physical performance measures; the depression scale fell in the verum group, not under placebo.

A review from 2023 ³⁶ places the data situation for servicewomen and servicemen: beta-alanine is a non-essential amino acid that forms the intracellular dipeptide carnosine with histidine, an important intracellular buffer. Evidence for improvement of anaerobic skeletal-muscle performance is stated to be well established, and the same effects have also been reported in soldiers. Carnosine rises in the brain suggest, according to the assessment of the work, broader effects; mentioned are indications of increased resilience to post-traumatic stress disorder, mild traumatic brain injury and heat stress, these findings being preclinical and the effect in humans not having been examined. Regarding cognitive function it states that the evidence is inconclusive and may depend on the type of stressor applied; possible effects on resilience are interesting but require further research in humans.

A double-blind study from 2017 ²⁷ in 80 resistance-trained men tested over eight weeks a pre-workout product containing beta-alanine (3 g) alongside creatine nitrate as salt (2 g), arginine-alpha-ketoglutarate (2 g), N-acetyl-L-tyrosine (300 mg), caffeine (284 mg), an extract from *Mucuna pruriens* standardised to 15 % L-Dopa (15 mg), vitamin C as ascorbic acid (500 mg), niacin (60 mg), folate as folic acid (50 mg) and vitamin B12 as methylcobalamin (70 mg), with and without addition of a *Citrus aurantium* extract with 20 mg synephrine, against placebo. Body composition, resting heart rate and blood pressure, cognition in the Stroop test, training readiness, bench- and leg-press one-repetition maximum and anaerobic capacity in the Wingate test were recorded. **Proven:** No effect of the single substance beta-alanine can be inferred from this mixture. What is missing: a study that tests beta-alanine alone on cognitive endpoints and stratifies participants by baseline status in advance remains outstanding.

Fatigue and Stress

A randomised double-blind study from 2015 ⁷ examined in twelve trained female cyclists (26.6 ± 1.3 years) the effect of a single dose of 1.6 g beta-alanine together with 34 g dextrose versus 34 g dextrose alone. Thirty minutes after intake the participants completed three consecutive Wingate tests with two minutes of active rest each. Fatigue index, mean and peak power as well as lactate, heart rate and rating of perceived exertion at rest, immediately after each Wingate test and after each rest were measured. Rating of perceived exertion was significantly lower under beta-alanine immediately after the first and second Wingate test as well as after each rest ($p < 0.001$), no longer after the third test ($p > 0.05$). No significant supplementation effect was found for any performance or physiological variable ($p > 0.05$ for all variables).

HYPOTHESIS That perceived exertion falls with unchanged performance values could mean that a single dose shifts perception rather than immediate force output; the work itself tested only one dose on one day and only in women. The next question to clarify is whether the effect on perceived exertion appears in the same magnitude with chronic intake, in men and across several loads.

Further Investigations

A meta-analysis from 2012 ³⁰ pooled 15 publications with 57 measures from 23 exercise tests, 18 supplementation regimens and a total of 360 participants (174 in the beta-alanine group, 186 in the placebo group). Beta-alanine improved the outcome of the exercise measures more than placebo ($P = 0.002$; median effect size with interquartile range: 0.374 (0.140 to 0.747) versus 0.108 (−0.019 to 0.487)). Part of this effect was attributable to exercise capacity ($P = 0.013$), while no improvement was shown for exercise performance ($P = 0.204$). Loads of 60 to 240 seconds duration were improved ($P = 0.001$), as were loads over 240 seconds ($P = 0.046$).

A systematic review with meta-analysis from 2020 ³⁷ evaluated 19 studies on the aerobic-anaerobic transition range and found a small effect for time in the time-trial test (SMD −0.36; 95 % CI −0.87 to 0.16; $I^2 = 59$ %; $p = 0.010$), a small effect for the limited time test (SMD 0.25; 95 % CI −0.01 to 0.51; $I^2 = 0$ %; $p = 0.53$) and a large effect for the limited distance test. A meta-analysis from 2024 ³⁸ examined ten studies with a total of 243 persons and twelve endpoints each per supplement: in isolation neither beta-alanine (SMD = 0.18, 95 % CI −0.06 to 0.43, $p = 0.13$) nor sodium bicarbonate (SMD = 0.17, 95 % CI −0.08 to 0.41, $p = 0.16$) showed an ergogenic effect, while the combination of both showed an advantage (SMD = 0.32, 95 % CI 0.07 to 0.57, $p = 0.02$). A meta-regression found no differences between separate administration of the two substances ($F = 0.58$; $p = 0.57$).

A randomised study from 2019 ⁸ allocated 71 male cyclists to four groups: beta-alanine plus placebo (n = 18), placebo plus sodium bicarbonate (n = 17), both active substances (n = 19) and double placebo (n = 18). Beta-alanine was given for 28 days at 6.4 g per day, sodium bicarbonate at 0.3 g per kg 60 minutes before testing. The high-intensity intermittent test consisted of four 60-second loads at 110 % of maximal power with 60 seconds rest each; estimated contributions of the energy systems were calculated in 39 participants (beta-alanine n = 9; sodium bicarbonate n = 10; combination n = 10; placebo n = 10). Both sodium-bicarbonate groups showed an increased estimated glycolytic contribution (sodium bicarbonate +23 %, $p = 0.068$; combination +18 %, $p = 0.059$), no effect was found for the oxidative and the ATP-PCR system, and time for 30 kJ did not change significantly in any group.

A GRADE-assessed meta-analysis from 2022 ¹⁶ examined the influence on body composition in 20 studies with 492 participants. No effect was found for body mass (WMD −0.15 kg; 95 % CI −0.78 to 0.47; $p = 0.631$), likewise none for fat mass (WMD −0.24 kg; 95 % CI −1.16 to 0.68; $p = 0.612$), body-fat percentage (WMD −0.06 %; 95 % CI −0.53 to 0.40; $p = 0.782$) and fat-free mass (WMD 0.05 kg; 95 % CI −0.71 to 0.82; $p = 0.889$). What is missing: the

question whether the combination with sodium bicarbonate is superior to the individual substances is answered differently by the available evaluations and therefore remains open.

Heart and Circulation

A double-blind placebo-controlled study from 2014 ⁹ had recreationally active men take a pre-workout product containing caffeine, creatine, beta-alanine, amino acids and B vitamins daily for 28 days, either 20 minutes before training or ad libitum on non-training days. Resting heart rate and blood pressure, body composition, fasting blood values as well as aerobic capacity, muscle strength and endurance were recorded. Significant time effects appeared for resting heart rate (before intake 67.59 ± 7.90 to after intake 66.18 ± 7.63 beats per minute), systolic blood pressure (122.41 ± 11.25 to 118.35 ± 11.58 mm Hg), blood urea nitrogen (13.12 ± 2.55 to 15.24 ± 4.47 mg/dL) and aspartate aminotransferase (34.29 ± 16.48 to 24.76 ± 4.71 IU/L).

PROVEN Because the tested product contained several active substances, the changes in blood pressure and laboratory values cannot be attributed to beta-alanine; the work tested the safety of the overall product and not of a single substance. The blood values are laboratory parameters and not clinical endpoints. The next question to clarify is whether beta-alanine alone produces changes in blood pressure, heart rate or vascular function in humans with cardiovascular questions.

Inflammatory Processes

A randomised study from 2021 ¹¹ tested in 19 recreationally active healthy men ($n = 10$ verum, $n = 9$ placebo) 14 days with 12 g beta-alanine per day before a 24-hour simulated military operation. The participants showed, according to the abstract, only limited inflammatory and oxidative load. Cognition via multiple-object tracking, visuomotor reaction time, serial subtraction tasks and neuropsychological test procedures, mood via the Profile of Mood States as well as circulating BDNF were recorded, each before and after supplementation. The results are not contained in the present excerpt.

A narrative review from 2023 ²³ classifies carnosine, its metabolite N-acetylcarnosine and the synthetic derivative zinc-L-carnosine as supplements in human medicine and lists anti-inflammatory, antioxidant, antiglycating, anticarbonylating, calcium-regulating, immunomodulating and chelating properties as modes of action. The work cites areas with reported benefit as the prevention of sarcopenia, the maintenance of cognitive abilities and the improvement of neurodegenerative diseases, furthermore the improvement of diabetes parameters and of symptoms of oral mucositis, the regression of oesophagitis and taste disorders after chemotherapy, the protection of the gastrointestinal mucosa and the support of *Helicobacter pylori* eradication; these statements concern carnosine and its derivatives, not beta-alanine. The work is a review and not an own examination in patients. What is missing: Controlled studies that measure inflammatory endpoints under beta-alanine alone and with existing inflammatory load are outstanding.

Oxidative Stress

A double-blind randomised placebo-controlled study from 2022 ¹² examined 40 patients with chronic obstructive pulmonary disease (75 % men; age 65 ± 6 years; FEV1 as percentage of predicted value 55 ± 14 %), who received 3.2 g beta-alanine per day or placebo for twelve weeks. The primary endpoint was muscle carnosine content from biopsies of the vastus lateralis muscle before and after the intervention; co-primary endpoints were incremental and constant-load cycle exercise capacity. Secondary measures included quadriceps strength and endurance as well as oxidative and carbonyl stress in muscle, together with compliance and adverse effects of intake. Analysis was performed with linear mixed models.

The abstract breaks off after the start of the results presentation; direction and magnitude of changes in muscle carnosine, exercise capacity and stress markers cannot be determined from the extract. **Plausible:** The study is of interest because it tests beta-alanine in a patient group with elevated exercise-induced oxidative and carbonyl stress as well as reduced muscle carnosine stores and thus reflects a different baseline situation from the investigations in healthy older people. The next point to clarify is whether the effect on exercise capacity described in healthy older people shows in the same way under this baseline situation.

Safety and Tolerability

Before and after supplementation the athletes completed two sport-specific repeated-sprint tests separated by a 30-minute swimming test. No significant group-by-time interaction was found for any variable.

Qualitative inference indicated a likely beneficial effect in the verum group for mean time (6.6 ± 0.4 s vs. 6.7 ± 0.4 s; 81 % likely beneficial), worst time (6.9 ± 0.5 s vs. 7.1 ± 0.5 s; 78 %) and total time (39.3 ± 2.5 s vs. 40.4 ± 2.5 s; 81 %) in the first sprint set as well as for worst time in the second set (7.2 ± 0.6 s vs. 7.5 ± 0.6 s; 57 % possibly beneficial); for total time of both tests a substantial change was observed (80.8 ± 5.7 s vs. 83.4 ± 5.6 s; 52 % possibly beneficial).

Proven: The work was designed around performance endpoints; tolerability data on beta-alanine were not collected as a target variable. What is missing: A study that systematically records tolerability with pre-defined endpoints over longer intake duration and with different dosage forms is outstanding.

Metabolism

A narrative review from 2022 ³⁵ describes carnosine as a pleiotropic histidine-containing dipeptide formed from beta-alanine and L-histidine whose intact dipeptide as well as its amino acids are available via the diet. The work discusses the role of carnosine in myocardial function and health, the metabolic pathway in myocardial tissue and the effects of exogenous carnosine and its precursors on cardiac function. It is structured as a narrative review and itself names gaps in the literature and resulting starting points for future research. What is missing: A controlled examination of whether beta-alanine supplementation alters myocardial carnosine concentration in humans is outstanding.

Overall Picture

Across the areas one finding carries the broadest weight: beta-alanine increases carnosine content in skeletal muscle, and most performance findings attach to this increase. The pooled analysis of 40 studies with 1461 participants ¹ and the meta-analysis from 2012 with 360 participants ³⁰ show a significant but small effect on exercise measures, with the clearest signal at loads of 60 to 240 seconds. In older people and in women, individual controlled studies show larger relative changes in fatigue threshold and time to exhaustion ^{3 31 32}, while body composition remained unchanged in the 2022 meta-analysis with 492 participants ¹⁶.

Open questions concern above all transfer to defined baseline states. For cognitive endpoints the ten-week study in 100 older adults ¹³ provides a signal in participants with baseline values in or below the normal range, whereas the overall group showed no difference; the review on soldiers describes the evidence on cognition itself as inconclusive ³⁶. In patients with elevated oxidative load the results presentation of the COPD study ¹² is not contained in the present extract. The combination with sodium bicarbonate is assessed differently ^{8 38}. The next point to clarify is which baseline states, dosages and load types support the effect.

Methodology of the evidence base

The controlled human studies are predominantly randomised, double-blind and placebo-controlled studies in healthy, mostly physically active men; women and older people are represented in individual works. Intake duration ranges from 14 days ¹¹ through 28 days ^{4 31} and 12 weeks ^{6 12 32} up to 24 weeks ³³, doses from 1.6 g as a single dose ^{7 2} through 2.4 g ^{13 4}, 3.2 g ^{12 32}, 4.8 to 6.4 g ^{14 10 33} up to 12 g per day ¹¹. Endpoints are predominantly indirect: muscle carnosine from biopsies, fatigue threshold, time to exhaustion, sprint and time-trial tests, alongside questionnaires on perceived exertion and mood. The next points to clarify are studies with clinical endpoints, with women as a separate group and with pre-stratified baseline state.

The evidence base on beta-alanine is broad but not uniform

The database contains a substantial body of work. However, the emphasis lies on basic-science work and observational studies. Controlled human studies exist in limited number, distributed across different application areas. Most controlled studies examine exhaustion and performance, while other areas such as cognition, cardiovascular system or gut are represented by only a few works. The heterogeneity of endpoints and of the populations studied complicates a summary assessment.

The methodological quality of the controlled studies varies. Some studies examine the effect of beta-alanine in combination with other substances, which complicates attribution of effects to the single substance. In addition there are indications of high inter-individual variability of the carnosine response that is not always controlled in the studies. The most-cited work is a meta-analysis from 2017 that focuses on performance parameters. For other application areas comparable summaries are lacking. Research on beta-alanine is overall advanced, yet the distribution of studies reveals gaps in less-examined areas.

3. How Robust the Research Is

The human studies are distributed across observational and controlled studies. The controlled studies concentrate on exhaustion, safety, the musculoskeletal system, cognition, cardiovascular system, inflammation, metabolism, antioxidant effects, bioavailability and the gut.

It is striking that the majority of controlled studies examine performance-related endpoints, while other areas such as cognition or cardiovascular system are represented by only a few works. The most-cited work is a systematic review and meta-analysis from 2017 on the improvement of exercise capacity and performance. Further frequently cited controlled studies deal with the effect of slow-release beta-alanine tablets on absorption kinetics and paraesthesia (2012) as well as with neuromuscular fatigue in older people (2008).

4. What Is Frequently Claimed — and What the Data Support

STATEMENT	EVIDENCE BASE
Beta-alanine improves athletic performance	The database includes multiple controlled studies and a widely cited meta-analysis (2017) on performance parameters. However, the results are not uniform
Beta-alanine is safe	Controlled studies on safety exist. Paraesthesia is frequently reported, which was investigated in a study on slow-release tablets (2012). Long-term data are l
Beta-alanine acts on cognition	Few controlled studies investigate cognitive endpoints. One of these (2021) examines high doses over a short time in recreational athletes. The evidence is lir
Beta-alanine helps with cardiovascular diseases	Few controlled studies address cardiovascular parameters. Reviews (2022, 2023) discuss potential roles of carnosine, but controlled studies in humans are l

5. Profile: Molecule and Charge

Beta-alanine is not a single molecule but a **mixture** — there is no molecular formula and no fixed molecular mass. What can be described are functional groups, charge behaviour and redox properties; that is exactly what the next section addresses.

6. Charge, Electrons, Radicals

Beta-alanine itself carries no charge that would be measured electrochemically. Its effect unfolds via the dipeptide carnosine metabolism. In a controlled human study, muscle biopsies were taken to determine carnosine content, in-vitro buffering capacity ($\beta m_{in vitro}$) as well as the levels of phosphofructokinase (PFK), monocarboxylate transporter 4 (MCT4) and hypoxia-inducible factor-1 α (HIF-1 α) ¹⁰. These parameters are not direct redox or charge measurements but biochemical markers. A human observation describes that carnosine scavenges reactive oxygen species (ROS) as well as alpha-beta-unsaturated aldehydes that arise during peroxidation of fatty-acid cell membranes under oxidative stress ²². This describes a radical-scavenging function of carnosine in humans, but not for beta-alanine itself.

According to a human observation, carnosine can inhibit glycation and chelate divalent metal ions ²². These properties concern carnosine, not beta-alanine directly. Whether beta-alanine itself influences redox reactions or electron transfers in humans cannot be deduced from the available evidence. What remains to be clarified is whether and to what extent beta-alanine is converted into carnosine after intake and whether direct electrochemical effects can be measured in humans.

7. Interactions with Other Substances

With which other substances on the platform this substance is **jointly** investigated or discussed in human studies and reviews — combination, comparison or shared mechanism of action. The number refers to works in which both occur.

SUBSTANCE	SHARED WORKS	OF WHICH CONTROLLED IN HUMANS
High-intensity interval training (HIIT)	47	26
Creatine	31	11
Chronic inflammation	28	9
Milk thistle (silymarin)	28	15
Therapeutic fasting and intermittent fasting	26	9
L-carnitine	22	16
Turmeric and curcumin	17	7
Thymosin alpha-1	17	11
Gut microbiome	16	3
Probiotics	16	12

Beta-alanine is described as an amino acid that, together with histidine in skeletal muscle, forms the dipeptide carnosine ²⁶. Several controlled human studies address combinations with other substances. One study reports that the combination of creatine and beta-alanine improved performance during high-intensity exercise, particularly anaerobic performance and performance during repeated bouts, compared with creatine or beta-alanine alone ²⁴. Another study in basketball players showed that short-term supplementation with creatine, beta-alanine and L-citrulline and their combination during sport-specific interval training improved physical and physiological performance parameters compared with placebo ¹⁹. One study compared sodium bicarbonate alone, the combination of sodium bicarbonate and beta-alanine, and beta-alanine alone and reports that sodium bicarbonate alone improved performance during repeated sprints more than the combination or beta-alanine alone ²⁵.

The available material contains no information on possible interactions with medicinal products or enzymes such as CYP, on binding processes or on attenuations. A meta-analysis concludes that beta-alanine probably does not improve body composition, independent of dosage and combination with training, with the certainty of evidence for the endpoints ranging from low to moderate ¹⁶. One study examined 28 days of beta-alanine supplementation and the acute interference effect of high-intensity interval training on strength and body composition ¹⁸. Another paper notes that no studies have tested the effect of beta-alanine in combination with diet and training on changes in body composition as the primary variable ¹⁶, and that future studies on the combination with hypocaloric diet and training programmes are required ¹⁶. What remains to be examined is whether intake, metabolism or effect of beta-alanine change when administered together with medicinal products.

8. Overdosage, Tolerability, Limits

Maximum intensity was “very low” with the tablets versus “low” with the reference form ($p<0.001$), while tablets and placebo did not differ in side effects ². The relationship between dosage form (plain versus sustained-release) and side effects is not fully described ².

In COPD patients, no side effects occurred that could be linked to intake; compliance was comparable between β -alanine and placebo (100 (98–100) % vs. 98 (96–100) %, $p = 0.294$) ¹². Muscle carnosine rose by +2.82 (1.49–4.14) mmol/kg wet weight versus placebo ($p<0.001$) ¹², corresponding to +54 % from baseline, without side effects ¹². A pre-workout mixture of caffeine, creatine, β -alanine, amino acids and B vitamins showed no adverse effects on renal and hepatic blood markers, resting heart rate or blood pressure over 28 days ^{9 9}. The relationship between concentration and safety remains open ²⁸.

9. The Most Robust Studies

Ordered by strength of evidence, not by popularity. The complete evaluation includes significantly more works; the most robust ones are listed here.

Controlled Studies in Humans

- ¹ β -alanine supplementation to improve exercise capacity and performance: a systematic review and meta-analysis (2017)
- ² Effect of slow-release β -alanine tablets on absorption kinetics and paresthesia (2012)
- ³ The effect of beta-alanine supplementation on neuromuscular fatigue in elderly (55-92 Years): a double-blind randomized study (2008)
- ⁴ β -Alanine supplementation increased physical performance and improved executive function following endurance exercise in middle aged individuals (2018)
- Balsalazide in the maintenance treatment of patients with ulcerative colitis, a double-blind comparison with sulphasalazine (1988)
- ⁵ Effect of total parenteral nutrition on amino acid and glucose transport by the human small intestine (1993)
- ⁶ Oral nutritional supplement fortified with beta-alanine improves physical working capacity in older adults: a randomized, placebo-controlled study (2013)
- Effects of ingesting a pre-workout dietary supplement with and without synephrine for 8 weeks on training adaptations in resistance-trained males (2017)
- ⁷ Effects of Acute Beta-Alanine Supplementation on Anaerobic Performance in Trained Female Cyclists (2015)
- ⁸ Effects of β -alanine and sodium bicarbonate supplementation on the estimated energy system contribution during high-intensity intermittent exercise (2019)
- ⁹ Ingesting a preworkout supplement containing caffeine, creatine, β -alanine, amino acids, and B vitamins for 28 days is both safe and efficacious in ... (2014)
- ¹⁰ Effect of β -alanine supplementation during high-intensity interval training on repeated sprint ability performance and neuromuscular fatigue (2019)
- ¹¹ Effects of High-Dose, Short-Duration β -Alanine Supplementation on Cognitive Function, Mood, and Circulating Brain-Derived Neurotrophic Factor (BDNF) ... (2021)
- ¹² Efficacy of 12 weeks oral beta-alanine supplementation in patients with chronic obstructive pulmonary disease: a double-blind, randomized ... (2022)
- ¹³ Role of β -Alanine Supplementation on Cognitive Function, Mood, and Physical Function in Older Adults; Double-Blind Randomized Controlled Study (2023)
- ¹⁴ Effects of Four Weeks of β -Alanine Supplementation on Repeated Sprint Ability in Water Polo Players (2016)
- ¹⁵ Effects of beta-alanine supplementation on performance and muscle fatigue in athletes and non-athletes of different sports: a systematic review (2017)
- ¹⁶ Effects of beta-alanine supplementation on body composition: a GRADE-assessed systematic review and meta-analysis (2022)
- ¹⁷ β -Alanine Supplementation's Improvement of High-Intensity Game Activities in Water Polo (2018)
- Isoniazid-induced alteration of CSF neurotransmitter amino acids in Huntington's disease (1987)
- ¹⁸ Short-Time β -Alanine Supplementation on the Acute Strength Performance after High-Intensity Intermittent Exercise in Recreationally Trained Men (2019)
- ¹⁹ Effects of Combined Versus Single Supplementation of Creatine, Beta-Alanine, and L-Citrulline During Short Sprint Interval Training on Basketball ... (2025)
- ²⁰ Effects of Acute Beta-Alanine Ingestion and Immersion-Plus-Exercise on Connectedness to Nature and Perceived Pain (2021)
- ²¹ One-Week High-Dose β -Alanine Loading Improves World Tour Cyclists' Time-Trial Performance (2021)

10. Summary

PROVEN In the double-blind, placebo-controlled studies a significant but small overall effect on exercise capacity and performance is evident (effect size 0.18). Supplementation increases muscle carnosine content; in one study over 24 weeks with 6.4 g daily it rose at every measurement point and reached a maximum of $+25.66 \pm 7.63$ mmol·kg⁻¹ dm. The 2015 position stand of the International Society of Sports Nutrition states that 4 to 6 g daily for at least 2 to 4 weeks markedly raises muscle carnosine concentration and acts as an intracellular pH buffer; it notes more pronounced performance effects in open-ended tasks and time trials lasting 1 to 4 minutes.

PLAUSIBLE The dosage form influences the rate of concentration rise less than the total amount absorbed, and paraesthesia is linked to this rise; the sustained-release form achieved a lower and later plasma peak at the same area under the curve. It remains open whether the same pattern appears with repeated intake over weeks. **Hypothesis:** That a single 1.6 g dose in trained female cyclists lowered perceived exertion immediately after the first and second Wingate tests, while no performance variable showed an effect, could indicate that a single dose affects perception rather than performance.

The first point to clarify is whether the relationship between rate of rise and paraesthesia appears in the same way with repeated intake over weeks and whether it also applies to other dosage forms. For the intestine a dedicated study is needed to determine whether and how orally supplied beta-alanine alters carnosine concentration in intestinal tissue or the composition of the microbiome. In cognition a study is required that tests beta-alanine alone and stratifies participants by baseline status beforehand. For strength performance and for endurance efforts beyond 25 minutes the 2015 position stand itself identifies further research needs, and the question remains which training protocols and which training status most strongly support the effect.

11. What Remains Open

- **Dose-Response:** Which beta-alanine dose over which period optimally raises muscle carnosine content, and how does this differ between individuals?
- **Cognition:** Can the first controlled studies on cognitive endpoints be confirmed in larger, independent samples?
- **Combinations:** How can effects of beta-alanine in combination products be separated from those of other ingredients?

12. Further Paths

Topics, mechanisms and chains in which this substance occurs — for all who wish to look beyond the substance.

- Interaction Network

Frequently Asked Questions

How is Beta-Alanine usually taken?

In the studies available, Beta-Alanine is administered orally as a powder or tablet, often over several weeks. The dosage varies between the studies. A slow release is frequently aimed for in order to reduce paraesthesia. Intake is usually daily, sometimes in combination with other substances.

Which side effects are documented?

The most frequently reported side effect is paraesthesia, a tingling or numbness that occurs in a dose-dependent manner. In controlled safety studies, no serious adverse events were reported. However, long-term safety data are lacking. The studies on slow-release formulations indicate better tolerability.

Are there studies on Beta-Alanine in older people?

Yes, a frequently cited controlled study from 2008 examined the effect of Beta-Alanine on neuromuscular fatigue in people aged 55 to 92 years. A further study from 2013 tested an oral food supplement containing Beta-Alanine in older adults. However, the data situation for this population is limited.

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