Boron

Boron is a dietary mineral which is claimed to increase testosterone when supplemented at doses higher than from food.

This page features 40 unique references to scientific papers.

How to Take

Recommended dosage, active amounts, other details

The lowest active dose of Boron supplementation appears to be 3mg, which is effective in supporting hormonal parameters in postmenopausal women. Studies on osteoarthritis have used 6mg of Boron while studies in youth investigating hormonal changes have used 10mg.

The optimal dose is currently not known, but the above doses appear to be active for their aforementioned goals.

Confused about supplements?

Human Effect Matrix
The **Human Effect Matrix** looks at human studies (it excludes animal and *in vitro* studies) to tell you what effects boron has on your body, and how strong these effects are.

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<td>Robust research conducted with repeated double-blind clinical trials</td>
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<td>Multiple studies where at least two are double-blind and placebo controlled</td>
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<td>Single double-blind study or multiple cohort studies</td>
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<td>Uncontrolled or observational studies only</td>
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<th>CONSISTENCY OF RESEARCH RESULTS</th>
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Scientific Research

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Cortisol

- See study (/rubric/effects/view/258/Cortisol/all/)

No significant effect on cortisol has been noted with supplemental boron

DHT

- See study (/rubric/effects/view/258/DHT/all/)

No significant influences on serum DHT noted
Sources and Structure

Boron is a dietary mineral that, although it has a daily intake, has not been accepted as an Essential Vitamin or Mineral (/supplements/essential-vitamin-or-mineral/). It currently does not have a known minimum requirement.

1.1. Sources
The most prominent sources of Boron in the diet are fruits, vegetables, tubers, and drinking water. It is also used in some industrial products, and the possibility of serum levels of boron being increased secondary to these is plausible, especially if coming into contact with wounds. Good sources of Boron are:

- Avocado (about 1.11mg/0.102mmol per avocado)
- Flaked onions, dehydrated (6.573+/−3.228mcg/g)
- Ground Cinnamon (10.37+/−0.661mcg/g)
- Parsley (26.878+/−1.778mcg/g)
- Apple Juice (1.881+/−0.082mcg/g) and Sauce (2.828+/−0.12mcg/g)
- Cherries (1.482+/−0.243mcg/g)
- Grape Juice (2.020+/−0.265mcg/g)
- Peaches (1.872+/−0.112mcg/g)
- Beef bouillon (1.264+/−0.609mcg/g)
- Ice Cream (0.192+/−0.03mcg/g)
- Flour (0.275+/−0.139)
- Fortified Cornflakes (0.314+/−0.079mcg/g)
- Enriched White Bread (0.202+/−0.07mcg/g)
- Broccoli stalk (0.889+/−0.039mcg/g)

Products with a negligible (less than 0.015mcg/g) are:

- Beef and Chicken
- Cheese and Dairy products excluding Ice Cream
- Cornstarch
- Rice
- Spaghetti
- Gelatin, Puddings, or Sugar

1.2. Biological Significance

Boron is a mineral which also participates as a Lewis acid, binding to hydroxyl groups (an anti-oxidant action, but likely to be insignificant due to low quantities of Boron de novo); when Boron binds to three hydroxyl groups, the structure is referred to as Boric Acid or Boracic Acid.

2 Pharmacology
2.1. Absorption

Boron appears to be absorbed from the intestines and is reported to be nearly complete\textsuperscript{[5]} as 84\% of a radiolabelled dose has been found in the urine following an oral dose of 10mg in otherwise healthy persons\textsuperscript{[6]}.

It is thought that passive transportation may play a role as boron is the smallest known metalloid\textsuperscript{[7]} (this has been noted in plants\textsuperscript{[8]}) although plants have also shown transporters which accept boron selectively\textsuperscript{[9][10]} In regards to mammals a sodium coupled borate transporter (NaBCl or SLC4A11) has been identified in rat\textsuperscript{[11]} swine\textsuperscript{[12]} as well as human intestinal tissue\textsuperscript{[13]} and is responsive to dietary boron\textsuperscript{[12]}.  

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Boron appears to be well absorbed from the intestines, and this may be due to being absorbed (as borate) via the transporter known as SLC4A11
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2.2. Serum

Oral administration of 11.4mg Boron (via 102.6mg sodium tetra borate decahydrate) alongside a meal can elevate plasma boron concentrations within one hour peaking at 4 hours post-consumption\textsuperscript{[14]} fluctuating from 0.008-0.016mg/L in placebo yet spiking to 0.058mg/L at 1 hour and peaking at 0.136mg/L at 4 hours.\textsuperscript{[14]} This study failed to note differences in urinary boron concentrations for 2 days of collection. A study measuring effects of Boron in serum noted that standard boron supplementation at 10mg was able to influence select biomarkers according to the same timeline (with peak efficacy at 4 hours and some at 1 hour).\textsuperscript{[15]}

2.3. Elimination

It has been noted that at dietary levels of intake boron is minimally lost in the feces (2\%) with other routes of loss being urinary and, to a degree, via sweat and breath.\textsuperscript{[5][16]}

One study conducted in postmenopausal women given 3mg supplemental Boron found that the majority of supplemental born was excreted (primarily via the urine), which failed to support the notion that Boron builds up in the body.\textsuperscript{[17]} Extremely rapid boron excretion via the urine has been noted elsewhere in humans.\textsuperscript{[18]}

3. Neurology and the Brain

3.1. Deficiency

A Boron deficiency (intake of less than 0.23mg daily) appears to alter brainwave activity; enhancing delta power in the left parietal and temporal lobes and decreasing frontal lobe activity; similar results to intentional Magnesium (supplements/magnesium/) deficiency.\textsuperscript{[19]} This state of deficiency is associated with cognitive impairment when paired against an adequate intake of 3mg or more\textsuperscript{[20]} which may be associated with Boron being involved in neuronal membrane stabilization.\textsuperscript{[21][22]}

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May play a role in preserving neuronal function, but no intervention evidence exists to support supplementation currently
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4. Interactions with Performance
5 Glucose Metabolism

5.1. Interventions

Oral administration of 11.6mg Boron fails to influence plasma insulin or glucose following a test meal despite serum levels of Boron being increased.[14]

6 Bone and Skeletal Mass

6.1. Osteoarthritis

It has been hypothesized that 6mg daily Boron (tetraborate) could alleviate inflammation of the joints,[23] which was followed by a pilot study in 20 patients with confirmed osteoarthritis showed 50% response (half of patients reporting benefit) with 55mg Sodium tetraborate decahydrate (6mg elemental Boron) suggesting some possible benefit to osteoarthritis.[24] This may be related to the observation that the bone and synovial fluid of arthritic persons is less than healthy controls.[23]

6.2. Interventions

In a single-blind study assessing both athletic women and sedentary women given 3mg Boron (mixed chelation of Aspartate, Citrate, and Glycinate) daily for 10 months in conjunction with a Boron sufficient diet, Boron was associated with a slight reduction in circulating phosphorus levels (1.5mmol/L reduced to 1.3mmol/L in athletic; 1.7mmol/L reduced to 1.4mmol/L in sedentary) with no significant influence on calcium or Magnesium (/supplements/magnesium/) serum levels.[25] There appeared to be a reduced urination of phosphorus and a slight increase in urinary calcium in female athletes only.[25]

When Magnesium deficient, supplemental Boron still appears to suppress phosphorus urinary levels,[26] the reduction of urinary calcium has been noted in women with low Magnesium levels in another study and this was not noted alongside Magnesium supplementation (non-deficient).[17]

7 Inflammation and Immunology

7.1. Cytokines

6 days of supplementation of 10mg Boron is able to reduce TNF-a levels in serum by 19.1%, high sensitivity C-Reactive Protein by 45%, and IL-6 by 43.9% in otherwise healthy males.[15]

8 Interactions with Hormones
8.1. Testosterone

Mechanistically, concentrations of boron in testicular homogenates are not associated with conversion rates of androstenedione to testosterone.[27]

One study in otherwise healthy men noted that acute supplementation of Boron, over the period of 6 hours, failed to increase total testosterone levels yet trended to increase free testosterone (+14.7%) and DHT (+9.9%) although neither was statistically significant, yet significantly reduced Sex-Hormone Binding Globulin (SHBG) by 9% at the 6 hour mark yet required 2 hours to reach significance.[15] After 7 days of supplementation, the increase in free testosterone (28.3%) reached significance yet the SHBG decrease was not.[15] Another study using 4 weeks of 10mg Boron supplementation noted a trend towards increased testosterone (11.4%) but failed to reach statistical significance.[6]

One study has been conducted on athletic males participating in bodybuilding, using a lower dose. 2.5mg of Boron daily for 9 weeks elevated plasma boron levels (20.1ppb to 32.6ppm; a 62% increase) yet failed to find significant differences between groups for any hormones measured.[28]

In healthy male adults, supplemental Boron appears to be have mixed results. It has been implicated in increasing testosterone, but these may be dependent on time or dose as prolonged studies with the same or a lesser dose fail to replicate the increase in free testosterone seen in one study.

In postmenopausal women on a Boron deficient diet (0.25mg daily), 3mg in supplementation can preserve a decrease in testosterone induced by the diet.[26] The increase appeared to be of greater magnitude when dietary Magnesium (/supplements/magnesium/) was low, suggesting Boron may act on similar mechanisms.

8.2. Estrogen

In otherwise healthy adult men, 10mg of Boron daily for a week significantly reduces serum estradiol (an estrogen) from 42.33pg/mL to 25.81pg/mL (39%), although no significant effect was seen after a single dose when measured for 6 hours afterwards.[15] Conversely, another study found 4 weeks of 10mg Boron found increases of serum estradiol from 51.9pmol/mL to 73.9pmol/L in 18 apparently healthy men.[6]

8.3. Luteinizing Hormone

10mg of Boron daily for a week does not significantly influence LH in adult males[15] and varying doses in rats ranging into toxic doses also fail to influence LH.[29]
8.4. Follicle-Stimulating Hormone

In rats fed 500, 1000, or 2000ppm Boron for 60 days, a time and dose dependent increase in FSH was seen in all groups.[29]

8.5. Cortisol

A week of 10mg Boron supplementation in otherwise healthy males fails to influence cortisol.[15]

9 Interactions with Organ Systems

9.1. Testicles

One rat study noted that higher doses (associated with testicular toxicity) had elevated testicular concentrations of boron, indicative of either selective accumulation of boron in the testicles or perhaps the concentration was skewed due to testicular atrophy; it was not noted with a lower dose of 500ppm.[29]

9.2. Prostate

In assessing a cohort of 35,222 men with 832 confirmed cases of prostate cancer over 3 years of surveillance, it was noted that the highest quartile was not significantly protected against prostate cancer when compared to the lowest quartile; respective RR was 1.17 (CI 0.85-1.61).[30] This is in contrast to a previous study finding a RR of 0.63 indicating close to half the risk with a higher boron diet.[31]

9.3. Bladder and Urinary Tract

A letter to the editor of the *Journal of Alternative and Complementary Medicine* makes note of a small study with 14 participants.32 10mg of Boron daily was given to persons with confirmed urolithiasis (kidney stones) and patients tended to report pain reduction after 2-3 days of treatment and multiple patients noted passing of kidney stones within a few weeks of treatment; the time to pass kidney stones was highly variable.[32]

10 Nutrient-Nutrient Interactions

10.1. Vitamin D

*Boron supplementation interacts with Vitamin D metabolism*.[33] This is exemplified by a boron-deficient diet (marginal in Magnesium (/supplements/magnesium/) and copper) reducing Vitamin D levels to 44.9nM 25-hydroxyvitamin D after 63 days but being increased back to 62.4nM after 49 days of repletion with 3mg Boron[34] and an intervention using 6mg fructoborate (fruit storage form of boron) noting a 20% increase in 25-hydroxyvitamin D in Vitamin D deficient individuals, and was said to not be due to seasonal fluctuations.[33]

Currently, these observations do not have proven mechanisms; one author hypothesized that boron may be reacting with a vitamin D metabolite to form a competitive inhibitor of 24-hydroxylase, an enzyme in Vitamin D synthesis, or otherwise directly inhibiting the enzyme.[33] These hypothesis’ has not been tested.
11 Safety and Toxicology

11.1. General

The Tolerable Upper Limit (TUL) of Boron has been set at 20mg daily for persons over the age of 18. This is slightly higher than the No Observable Adverse Upper Limit (NOAEL) of 17.5mg based on rat studies.

It has been noted that there is no clear evidence for testicular harm from excess boron exposure, which is in contrast to many dietary metals. Water levels of 6.5mg/L in a boron mining area are not associated with testicular harm and when serum levels were confirmed at 499.2ppb and concentrated in seminal fluid there was no adverse harm on seminal parameters nor have they been observed in a cohort averaging 14.45mg daily, with a range of intake exceeding 30mg.

These lack of toxic effects on the testicles have been extended to rats receiving 500ppm daily for 60 days, although 1000-2000ppm were associated with accumulation of testicular boron and testicular atrophy. These effects were replicated in rats exposed to 1173mg for 90 days.

Testicular harm from excess Boron levels appears to be at least three-fold higher than standard supplemental doses, and are likely not a concern with proper supplementation.

11.2. Boron Acute Toxicity

It has been reported (no cited case studies) that oral doses of 5-6g Boron (5,000-6,000mg) in infants or 15-20g in adults (15,000-20,000mg) causes acute death in humans. Boron, being used in pesticides, has some toxicological information in animals who are greatly overexposed to Boron.

Scientific Support & Reference Citations

References

Boron - Scientific Review on Usage, Dosage, Side Effects | Examine.com


Examine.com SUPPLEMENTS NUTRITION STORE

(Common misspellings for Boron include: borin, baring)

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(Refer/subid/sidebar-supplements/?loc=store/reference)

This guide sums up over 5000 human studies into a monster 1000+ page reference that clearly tells you what works (and what doesn't)
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