



TBM™ Brief:

# Calcium

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Updated 22 May 2015

## Background and Physiology

- Calcium is the most abundant mineral in the body.<sup>1</sup> Calcium, however, is not the most abundant mineral in the human diet. The typical human diet includes more potassium, sodium and phosphorus than calcium.<sup>2-4</sup>
- The body demonstrates the importance of calcium through three major mechanisms of calcium-regulation:
  - Skeletal structures have a “flexible bone pool” of 150-200mg of calcium that can be readily utilized to maintain optimal serum calcium levels. If exhausted, calcium is then “borrowed” from the bone matrix and may permanently degrade bone composition.<sup>5</sup>
  - The endocrine system is centrally involved in both intestinal absorption and serum management of calcium through parathormone, calcitonin and vitamin D.<sup>6</sup>
  - The kidneys play a central role in the acute regulation of serum calcium.
- Calcium absorption occurs via two major pathways:
  - Simple diffusion dominates when dietary calcium proves plentiful.
  - Hormone-driven absorption dominates when dietary calcium intake is inadequate.<sup>6</sup>
- When dietary calcium intake is chronically insufficient, the body upregulates calcium absorption<sup>7</sup> and begins using skeletal reserves. At this point, the body rations calcium, leading to suboptimal physiologic processes. Such a deficit may elicit multiple symptoms and result in numerous pathologies.<sup>8-11</sup>
- In addition to its importance within the skeletal system, calcium is required for virtually all physiologic processes including: transmission of nerve impulses;<sup>11,12</sup> skeletal, cardiac and smooth muscle contractions;<sup>11,13</sup> ligament and tendon integrity;<sup>14</sup> heart rhythm;<sup>15,16</sup> activation of enzymatic reactions<sup>17</sup> and the release of hormones and neurotransmitters.<sup>12</sup>

## Review of Research

- Low calcium levels affect morbidity and mortality. Several studies show that intake of calcium above the RDA is associated with a reduction in all-cause mortality.<sup>11,18-20</sup> The following summaries highlight this finding:
  - *Calcium and the Immune System*
    - Increased dietary calcium decreases the pro-inflammatory effects seen with increased adipose tissue.<sup>21,22</sup>
    - Low calcium levels are associated with increased risk of contracting dengue fever. Additional small studies suggest that calcium may have a role in the treatment of dengue fever.<sup>23</sup>
  - *Calcium and Cancer*
    - Supplementation with calcium and vitamin D substantially lowered all-cancer risk in post-menopausal women.<sup>8</sup>



TBM™ Brief:

# Calcium

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Updated 22 May 2015

- External calcium is required for cell proliferation and cell cycle progression in healthy cells. However, cancer cells have no such requirement and can continue proliferation without external calcium.<sup>24</sup>
- Dietary and supplemental calcium intake provides significant risk reduction for colon cancer.<sup>25,26</sup>
- Dairy as well as calcium intake lowered the risk of ovarian cancer.<sup>10</sup>
- *Calcium and Heart Disease*
  - Dairy intake along with calcium intake lowered the risk of hypertension in middle-aged and elderly men and women.<sup>27-29</sup>
  - Dietary calcium, especially from dairy products, was associated with a lowered risk of stroke.<sup>30,31</sup>
  - Increased dietary calcium intake was not associated with increased coronary artery calcification levels.<sup>32</sup>
  - Adverse retinal vascular signs were associated with lower dairy and calcium intake.<sup>33</sup>
  - In one study, increased risk of heart disease and CVD death was shown with “high” calcium intake, defined as >1400mg of dietary calcium plus additional supplementation.<sup>20</sup> Another study showed increased risk of CVD death in men, but not in women.<sup>34</sup> Several other studies, however, show either no increased risk<sup>35-37</sup> or decreased risk.<sup>19</sup> Several recent studies recommend focusing on insuring adequate dietary calcium and utilization of supplemental forms only if dietary levels are insufficient.<sup>5,31,32</sup>
- *Calcium and Metabolic Syndrome*
  - Increased consumption of dairy products was associated with lowered risk of type 2 diabetes.<sup>40-42</sup>
  - Calcium and Vitamin D supplementation had beneficial effects on serum insulin levels, the homeostasis model assessment (HOMA) as relates to insulin resistance, quantitative insulin sensitivity check index (QUICKI), serum triglycerides and VLDL cholesterol levels.<sup>29,43</sup>
  - Low-calcium diets are associated with weight gain, while high-calcium diets are associated with weight loss.<sup>29,44</sup>
  - One proposal of the mechanism for calcium’s beneficial effects on diabetes is that it decreases production of pro-inflammatory chemicals by adipose tissue.<sup>21,22</sup>
- *Calcium and the Renal System*
  - It has long been understood that decreased dietary intake of calcium is associated with an increased risk of kidney stones.<sup>45</sup> More recently, studies have shown that increased dietary calcium from dairy and non-dairy sources decreases the risk of kidney stones.<sup>46-48</sup> Supplemental calcium is not associated with significant increased or decreased risk of kidney stones. However, one study suggests that taking calcium supplements with meals (rather than at a separate



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# Calcium

Kevin S. Millet, D.C and Megan C. Choy, N.D., L.Ac.

Updated 22 May 2015

- time) would show similar effects as dietary calcium, that is, lowering the risk of kidney stones.<sup>48</sup>
- *Calcium and Reproduction*
    - Studies show an inverse relationship between calcium intake and development of PMS symptoms.<sup>49,50</sup>
    - Increased consumption of high fat dairy is associated with a decreased risk of anovulatory infertility.<sup>51</sup>
    - During pregnancy and lactation, calcium absorption is upregulated.<sup>52-54</sup>
  - *Calcium and the Skeletal System*
    - Calcium deficiency directly relates to osteoporosis, and complications due to fractures in osteoporotic patients are among the leading causes of death.<sup>55,56</sup>
  - *Calcium and the Nervous System*
    - Supplemental calcium significantly decreased the number of exacerbations in patients with multiple sclerosis, a correlation that supports the theory that calcium is important in the development, structure and stability of myelin.<sup>57</sup> Another study suggests that a sudden cessation of dairy product consumption during adolescence may increase the risk of later development of multiple sclerosis.<sup>58</sup>
    - Higher reported intakes of calcium, potassium and magnesium reduced the risk of all-cause dementia and, most notably, vascular dementia.<sup>59</sup>
  - *Calcium and Mental/Affective Disorders*<sup>60-63</sup>
    - Several studies show an association between dysregulation of calcium and schizophrenia, depression, suicidality, anxiety and stress perception.<sup>60-66</sup>

## Diet, Testing and Supplementation

- The human diet rarely contains enough calcium to adequately meet the body's need.<sup>67</sup>
- Many humans consume a diet high in calcium anti-nutrients. Research shows that dietary fiber, phytates, and oxalates significantly decrease the bioavailability of dietary calcium. Of greatest concern are grains, legumes and spinach. The first two, especially non-germinated and unfermented, contain high levels of all three previously mentioned calcium anti-nutrients.<sup>68,69</sup> Spinach, particularly when consumed raw, has amongst the highest level of oxalates found in any food source.<sup>70-72</sup> TBM recommends avoiding raw spinach and only consuming germinated and/or fermented and cooked grains and legumes to minimize their calcium anti-nutrient effects.<sup>73</sup>
- In order to obtain adequate calcium solely through the diet, include the following foods (all nutritional data obtained from <http://www.nutritiondata.com>):
  - Cheddar Cheese (721mg calcium/100g) – Most cheeses contain significant amounts of calcium.
    - A general rule: the harder the cheese, the higher the calcium.
    - Fun fact: calcium lactate forms the crystals found in hard cheeses.



TBM™ Brief:

# Calcium

Kevin S. Millet, D.C and Megan C. Choy, N.D., L.Ac.

Updated 22 May 2015

- Sardines (382mg calcium/100g) – Must eat the bones.
- Anchovies (232mg calcium/100g) – Must eat the bones.
- Brazil Nuts (160mg calcium/100g)
- Kale (135mg calcium/100g)
- Whole Milk Plain Yogurt (121mg calcium/100g)
- Walnuts (98mg calcium/100g)
- Pecans (70mg calcium/100g)
- Blood calcium levels do not accurately indicate nutritional status.<sup>74,75</sup> Urine calcium levels remain the best choice for testing.<sup>76,77</sup> Therefore, we recommend TBM practitioners utilize the Sulkowitch Test to assess calcium status. Although the research community questions the validity of this test due to its low degree of correlation with other urinary calcium tests,<sup>78</sup> we have found it useful to monitor overall calcium progress in a cost-effective manner.
- Calcium supplementation is considered standard of care for medical providers.<sup>75</sup>
- **TBM-recommended total calcium intake (dietary plus supplemental):**
  - **Adults: 1200mg**
  - **Athletes: 1800mg**
  - **Professional athletes, pregnant or nursing women: 2400mg**
- Decades of successful clinical implementation as well as current scientific research validate the safety of the TBM-recommended calcium supplementation.<sup>32,65,69</sup>
- We have found that the body responds best when the form of supplemental calcium is changed every 10 to 90 days. This prevents the body from developing a tolerance and, subsequently, an inability to properly utilize supplemental calcium.
- Due to the crucial role calcium plays in physiology, the Calcium test point is included in the TBM Vital Scan. A weak test point typically indicates the need for a different calcium supplement or a change in dosage. However, it may also indicate a need for calcium co-factors (see below), Calcium Utilization, or other corrections to enhance the digestion, assimilation and utilization of calcium.
- In order to promote optimal absorption, do not take more than 300-500mg of calcium at one time.<sup>80,81</sup>
- All forms of calcium support physiologic function. However, due to calcium carbonate's potent capacity to neutralize HCl,<sup>82</sup> we recommend minimizing the use of this form.
- In order to maximize absorption and utilization of calcium, optimize HCl status<sup>83</sup> and check "Need and Use" for the following nutrients:
  - Vitamin D<sup>84,85</sup>
  - Vitamin K<sup>86</sup>
  - Vitamin C<sup>86</sup>
  - Magnesium<sup>86</sup>
  - Boron<sup>86-88</sup>
- If a patient is not in need of HCl supplementation, calcium may be taken at any time. However, if HCl supplementation proves necessary, recommend that calcium be taken with meals.<sup>83</sup>



## TBM™ Brief: Calcium

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Updated 22 May 2015

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## TBM™ Brief: Calcium

Kevin S. Millet, D.C and Megan C. Choy, N.D., L.Ac.

Updated 22 May 2015

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## TBM™ Brief: Calcium

Kevin S. Millet, D.C and Megan C. Choy, N.D., L.Ac.

Updated 22 May 2015

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## TBM™ Brief: Calcium

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Updated 22 May 2015

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