

## **Does the skeleton play a role in acid-base homeostasis? Current evidence: future perspectives**

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With the growing increase in the age of life expectancy, hip fractures are predicted to rise dramatically in the next decade and hence there is an urgent need for the implementation of public health strategies to target prevention of poor skeletal health on a population-wide basis. Nutritional strategies for optimising bone health throughout the lifecycle are extremely important since a dietary approach is more popular amongst osteoporotic sufferers than drug intervention and long-term drug treatment compliance is relatively poor. As an exogenous factor, nutrition is amenable to change and has relevant public health implications.

The role that the skeleton plays in acid-base homeostasis has been gaining increasing prominence in the literature; with theoretical considerations of the role alkaline bone mineral may play in the defence against acidosis dating as far back as the late 19<sup>th</sup> Century. Natural, pathological and experimental states of acid loading/acidosis have been associated with hypercalciuria and negative calcium balance and more recently, the detrimental effects of 'acid' from the diet on bone mineral have been demonstrated. At the cellular level, a reduction in extracellular pH has been shown to have a direct enhancement on osteoclastic activity, with the result of increased resorption pit formation in bone.

A number of observational, experimental, clinical and intervention studies, over the last decade, have suggested a positive link between fruit & vegetable consumption and the skeleton. There is also evidence to show that: (i) the Western diet is acidic; (ii) Fad diets which are increasingly used such as the 'Atkins' diet is also very acidic; (iii) a high vegetable: animal protein ratio is effective in reducing blood pressure and may have a long-term effect on fracture risk. We now urgently need data from randomised controlled trials to determine for certain whether fruit & vegetables are important to the skeleton. A three-month intervention study involving 23-76 year old men and women has shown convincingly that a diet high in fruit and vegetables (the Dietary Approaches to Stopping Hypertension; DASH)) significantly reduces bone turnover.

The positive associations found between fruit and vegetable consumption and bone may not be due to the alkali-excess but instead to some other, identified (such as vitamin K and phytoestrogens) or unidentified 'dietary' component, with the sum being more important than the parts. Vegetables, herbs and salads which are commonly consumed in the human diet have been shown to affect bone resorption in the rat by a mechanism that is not mediated by their base excess but possibly through pharmacologically active compounds.

Currently, we have more questions than we have answers. Future research should focus attention on (i) long-term intervention trials centred specifically on fruit & vegetable intake/alkali administration as the supplementation vehicle and assessing a wide range of bone health indices (including fracture risk); (ii) experimental studies (at both the cellular, animal and human level) to determine whether there are other aspects of fruit & vegetables which are beneficial to bone metabolism and under what mechanisms.

If these questions can be answered, a 'fruit & veg' approach may provide a very sensible (and natural) alternative therapy for osteoporosis treatment, which is likely to have numerous additional health-related benefits. However, our biggest challenge remains how to persuade our Western populations to increase their fruit and vegetable consumption.

**Key Words:** Skeletal health, acid-base balance, systemic acidosis, potential renal acid load (PRAL), vegetarianism, fruit & vegetables, bone metabolism, dietary potassium