

Vitamins and minerals on the ketogenic diet



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Do we need to supplement vitamins and minerals on the ketogenic diet?

Historically, ketogenic diets were not always fully supplemented with vitamins and minerals. However early reports of problems in unsupplemented children date back to 1979. During this year there were two published papers about nutritional deficiency while on the ketogenic diet; the first reported two patients who presented with optic neuropathy caused by thiamine deficiency (Hoyt & Billson, 1979), and the second reported reduced bone mass due to vitamin D deficiency in five patients (Hahn et al, 1979).

Since that time there have been other reports of problems. Selenium deficiency was found in nine children on the diet, including one who developed cardiomyopathy (Bergqvist et al, 2003). This group have also reported poor vitamin D status in children on the diet (Bergqvist et al, 2007 and 2008) this can compromise bone health because of the resulting loss of bone mineral content. There has even been a recent case report of a nine year old girl who developed scurvy due to vitamin C deficiency while on the ketogenic diet (Willmott & Bryan, 2008).

So it is clear from the literature that there is a risk of nutritional deficiency while on the ketogenic diet. How much of this is due to the prescribed diet itself, and how much is due to a previous poor normal diet in a child with severe disability, or the effects of multiple anticonvulsant drugs, is not clear, however the restrictive nature of any type of ketogenic diet makes it necessary to be fully nutritionally supplemented. Although the medium chain triglyceride (MCT) version and the modified Atkins or low glycaemic index versions are much less restrictive, it is still essential that all children using any of these diets are fully assessed by a trained dietitian who can advise on their nutritional adequacy and recommend the necessary supplementation based on a child's nutritional requirements.

What are nutritional requirements?

The UK guidelines on nutritional requirements of children aged between 0-18 years are based on the report of the COMA Panel on Dietary Reference Values (DRVs), Department of Health Report on Health and Social Subjects No 41, published in 1991. These recommendations refer to groups, and any individual is likely to have requirements which fall within a range of recommended intakes for their age group. For this reason, an upper and lower value for requirements is given for each nutrient, these are termed reference nutrient intake (RNI) and lower reference nutrient intake (LRNI) respectively. The RNI of a nutrient would be considered the amount that would meet the requirements of nearly all of the people in a group. Many nutrients also have a value given for estimated average requirement (EAR), about half a group of people would be expected to have a requirement above this level, and about half below. If there is limited information on requirements for a particular nutrient, a value for safe intake may be used. So, when assessing vitamin and mineral requirements, most dietitians would want to be sure that a child's diet met the RNI for their age wherever possible for as many nutrients as possible. In children who are very small for their age, perhaps due to cerebral palsy or other disability, it may be more appropriate to use the requirements for their height age, rather than actual age. This would be assessed on an individual basis by the dietitian.

Many dietitians will want a child on the ketogenic diet to do a regular diet history, that is a record of intake over a few days, so that the provision of vitamins and minerals from the food can be assessed, and the prescribed supplementation checked, to ensure that all requirements are met, and no nutrient is being given in unnecessary excess. Centres will have differing views on how often this should be done, but ideally once a year should be the minimum. It is recommended that the checking of requirements should always be done by a qualified and experienced dietitian, not by families themselves.

What supplements do we use?

In the UK, there are limited vitamin and minerals supplements that are available to be prescribed for children on a ketogenic diet. The most nutritionally complete is called Phlexy-vits (SHS International). This is in the form of sachets of powder that can be added to foods or drink; it does have quite a distinct taste! The amount needed each day by a child would be calculated by a dietitian. A tablet form could be used in older children. Other types of supplement can be bought over the counter and may be more palatable, however must be carbohydrate free and discussed with the dietitian as will probably not provide the full supplementation a child needs. Most will not contain calcium or phosphate, so a child will need calcium supplements as well, in a sugar free form, the most commonly used is Sandocal 400 (Novartis Consumer Health UK Limited). Calcium supplements may not be necessary for a child on an MCT diet if they are consuming adequate amounts of milk as part

of their prescription, but this should be individually assessed by the dietitian. Children who are on a ketogenic diet for a length of time, and not using Phlexy-vits, may also need magnesium and phosphate supplements to ensure requirements are met, this will depend on food intake, and should be individually assessed.

It is important that the dose of supplements is calculated by a dietitian to avoid risk of either under- or over supplementation of any nutrient. Whereas vitamins and minerals do have a vital role in the body, and we must ensure children on the diet are not deficient, it must be noted that adding in further supplements additional to those recommended by the dietitian could in fact prove harmful. Any other supplements should therefore always be discussed with the dietitian/medical team. Children who show deficiencies of particular nutrients on blood monitoring will often need supplementation of that nutrient, an example is vitamin D, as mentioned earlier (although requirements of this vitamin will vary with the seasons, as it is synthesised in the body when exposed to sunlight).

All supplements should be sugar free wherever possible.

How and when should children be monitored?

It is important that children on a ketogenic diet have regular blood monitoring done to check for any nutritional deficiencies. Although each centre will have their own protocol for monitoring, most guidelines are similar and a suggestion is summarised below. Some tests will be essential; others, although recommended, can be more optional depending on resources. Medical teams may wish to monitor more frequently in some cases if there are particular concerns. If any results are abnormal, they should be repeated more frequently, it may be wise to redo them as soon as possible in case there was an error in the actual collection of the specimen. If a supplement has been prescribed following a low level, repeat tests should be done after 3 months.

Urine should be tested for haematuria ideally monthly (can be done at a local GP practice if necessary). At every clinic appointment (three to six monthly) a urine sample needs to be sent to the laboratory for a calcium-creatinine ratio measurement.

Blood investigation		Frequency of monitoring
Essential		
Full blood count including platelets		Baseline, after 3months, 6months, then every 6 months
Renal profile (includes sodium, potassium, urea, creatinine, bicarbonate and albumin)		Baseline, after 3months, 6months, then every 6 months
Liver profile		Baseline, after 3months, 6months, then every 6 months
Calcium, phosphate		Baseline, after 3months, 6months, then every 6 months
Magnesium		Baseline, after 3months, 6months, then every 6 months
Glucose		Baseline, after 3months, 6months, then every 6 months
Cholesterol and triglycerides (the latter preferably fasting)		Baseline, after 3months, 6months, then every 6 months
Free carnitine		Baseline, after 3months, 6months, then every 6 months
Vitamins A, D, E		Baseline, after 3months, 6months, then every 6 months
Zinc, selenium		Baseline, after 3months, 6months, then every 6 months
Recommended		
Further lipid profile – LDL and HDL		Baseline, after 3months, 6months, then every 6 months
Blood ketones and free fatty acids		Baseline, after 3months, 6months, then every 6 months
Uric acid		Baseline, after 3months, 6months, then every 6 months
Full acylcarnitine profile		Baseline, after 3months, 6months, then every 6 months
Optional		
Vitamin C		Baseline, 6months, then every 12months
Copper		Baseline, 6months, then every 12months
Vitamin B12, folate		Baseline, 6months, then every 12months
Ferritin		Baseline, 6months, then every 12months
Clotting screen		Baseline, 6months, then every 12months

References

Bergquist AGC, Chee CM, Lutchka L, Rychik J, Stallings VA (2003). Selenium deficiency associated with cardiomyopathy: a complication of the ketogenic diet. *Epilepsia* **44** (4):618-620.

Bergqvist AG, Schall JI, Stallings VA (2007). Vitamin D status in children with intractable epilepsy, and impact of the ketogenic diet. *Epilepsia* **48** (1):66-71.

Bergqvist AG, Schall JI, Stallings VA, Zemel BS (2008). Progressive bone mineral content loss in children with intractable epilepsy treated with the ketogenic diet. *Am J Clin Nutr.* **88** (6):1678-84.

Hahn T, Halstead L, DeVivo D. (1979), Disordered mineral metabolism produced by ketogenic diet therapy, *Calcified Tissue International* **28**, 17-22.

Hoyt CS, Billson FA (1979). Optic neuropathy in ketogenic diet. *British J Ophthalmol* **63** (3), 191-4.

Willmott NS, Bryan RA (2008). Case report: scurvy in an epileptic child on a ketogenic diet with oral complications. *Eur Arch Paediatr Dent* **9** (3):148-52.