

Fortified Milk

Its Role in Modern Day Health

The Irish Nutrition and Dietetic Institute (INDI) symposium, entitled, 'Fortified Milk, its role in modern Irish Health', heard compelling evidence about the inadequate intakes of vital nutrients in the Irish diet. **Marie-Catherine Mousseau** reports on some of the key points raised by speakers at the symposium.



Fortified Milk, a low fat milk that is enriched with extra calcium, folic acid plus vitamins A, B2, D and E, can play a leading role in the battle to improve the nutrient intake of the Irish population.

● Optimal nutrition

The evidence behind the vital role of calcium, vitamin D and protein

Marie-Catherine Mousseau reports that nutrition is a more powerful tool than currently recognised by medicine

'The gap between what we know and what we don't know is much less than the gap between what we know and what we do.'

– Don Berwick

This sentence quoted by Joanne Corbette, Consultant Dietitian from Nutritionwise and member of the Irish Nutrition and Dietetic Institute (INDI), when speaking at the INDI Symposium organised in Dublin by Super Milk (Glanbia Consumer Foods), gives in a nutshell the core message of the conference:

The evidence that a number of basic nutrients such as calcium, iron, and vitamins including vitamins D, A and B (riboflavin and folate), are critical to our everyday well being and health throughout life is overwhelming. These help prevent chronic diseases inherent in our modern society including osteoporosis, cardiovascular diseases and cancer.

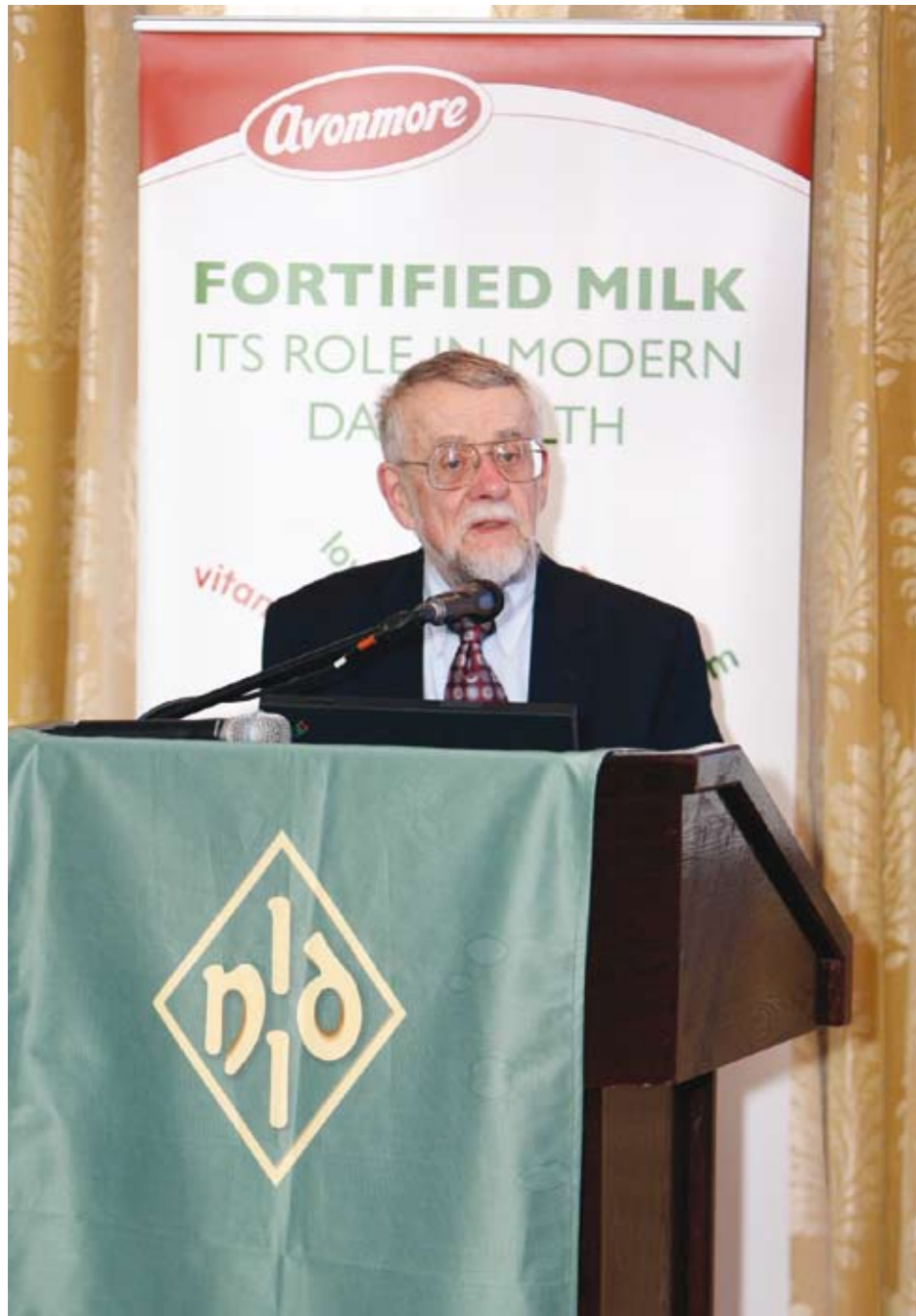
They can be made available easily through an appropriate diet. However, a large proportion of people still have inadequate intakes and thus put themselves at risk of serious health consequences. Fortified milk has a role to play in addressing some of these inadequacies.

Bones Calcium

Calcium and its essential correlate, vitamin D, provide an excellent example. The evidence behind the critical importance of adequate calcium levels in our diet was underscored by a world leading expert in the area of osteoporosis, vitamin D and calcium physiology, **Prof Robert Heaney** from Creighton University in Nebraska.

Prof Heaney, who has worked for more than 50 years in the study of osteoporosis and bone physiology, introduced the Symposium by presenting an impressive accumulation of data highlighting the key role of calcium in bone health and beyond.

Prof Heaney explained that calcium effects upon bones are two fold. First calcium is essential to the development and maintenance of bone mass, but not only that. "Because the body does not conserve calcium very well, and the bone is consistently being turned over, we have a lifelong requirement for calcium in our diet", Prof Heaney said. "And if we don't



Prof Robert Heaney, speaking at the Irish Nutrition and Dietetic Institute (INDI) symposium

get enough calcium from food sources, we begin to tear down our own skeleton in order to access the calcium we need for other body functions". He added: "This is the key point. Calcium in sufficient amount enables us to minimise unnecessary bone remodelling".

"Excessive remodelling makes the bones fragile, and of course decreased bone mass makes it fragile as well," Prof Heaney continued. "So the two different effects of calcium are both pointing in the same direction".

As he put it, the totality of the evidence is overwhelming. Of more than 75 randomised controlled trials designed to assess the skeletal effects of calcium in our diet, 95% showed positive results, including 15 which used dairy foods as a calcium

source. The positive effects of calcium-enriched diet are particularly obvious in relation to hip fractures. A study showed that a cohort of more than 3000 French women aged 84 years on average given 1700mg/day of calcium and 800 IU of vitamin D₃ as compared to a standard (insufficient) diet providing 500mg Ca/day resulted in a 43 percent reduction of hip fractures after just 18 months. "This is a massive effect", commented Prof Heaney (1).

"If you show such an effect for a drug, you will make a billion dollars". A later study even showed that the reduction in the risk of nonvertebral fractures following an appropriate calcium-vitamin D supplementation can reach up to 55% after three years (2). "The take home point is, if you have enough cal-

cium in the diet, you don't need to tear down your skeleton", Prof Heaney concluded.

Proteins

However, Prof Heaney stressed that calcium does not operate on its own. It can only play its structural role if it is made available together with appropriate levels of another key nutrient, namely proteins. "Protein is important for bones in a number of ways", Prof Heaney explained.

First of all it affects the skeleton by optimising IGF1 levels – a growth hormone important for the stimulation of muscle mass and bone mass whose circulating levels tend to be increased by milk – but also it provides the bulk constituent of bones; as he pointed out, bones are actually 50 per-

cent proteins by volume. Thus, as Prof Heaney put it, "protein is as important for bones as is calcium, and higher protein intake means better bone maintenance".

A study actually showed that the clinical outcome of elderly patients with femoral neck fracture can be significantly improved by once daily dietary oral supplementation including 20g of proteins (3).

Clinical outcome during the stay in the convalescent hospital was found significantly better in the supplemented group (56% favourable course vs. 13% in controls), with a median hospital stay of 24 days versus 40 days in the non-supplemented group. The rates of complications and deaths were also shown significantly lower in supplemented patients (44% vs. 87%) – a benefit that was sustained up to 6 months after the fracture (40% vs. 74%).

The good news is that bone mass does not have to be age related; in most case it might be diet-related. "Not enough attention is being given to the nutrition of hip fracture patients", Prof Heaney concluded. "This is such a simple thing we could do for them".

Synergy

In fact, studies clearly show that calcium and proteins need to work together in synergy. "Proteins interact constructively with calcium," Prof Heaney said. "A calcium source providing the needed proteins is clearly to be preferred to a mononutrient calcium source".

But neither calcium with protein is sufficient. Vitamin D is a third key parameter to take in the equation. As Prof Heaney explained, you have to have both calcium and vitamin D in order to get a useful quantity of calcium absorbed from a typical diet. "Vitamin D inadequacy leads to a stepwise deterioration of the ability to absorb calcium". Indeed, several randomised trials have confirmed that vitamin D supplementation can produce a substantial reduction in the risk of falling – a quick and easy way to reduce the fracture risks in our fragile elderly population, as Prof Heaney put it. "The bottom line here is that in the absence of vitamin D, not enough calcium can be absorbed".

The general rule, as emphasised by Prof Heaney, is that the skeletal effects of one nutrient may be blunted or obscured if the others are at inadequate levels. "To sum up calcium, proteins, and vitamin D interact constructively on bones so long as the intake for each is adequate – we need them all,

we cannot focus on just one", he concluded. One solution is the fortification of commonly consumed foods which already contain all these nutrients. Dairy products, especially when fortified, are rich in calcium, proteins and vitamin D. What's more "dairy proteins are the richest food source of branched-chained amino-acid in the diet," Prof Heaney underlined.

Beyond bones

There is growing evidence that dairy products not only participate in the maintenance of bone health; they might also have some role to play in the fight against hypertension and heart disease.

Results from the recent Dietary Approaches to Stop Hypertension (DASH) trial provide the latest evidence concerning the effects of dietary patterns on blood pressure (4). Conducted in 459 adults, the trial showed that a diet rich in fruits and vegetables reduced systolic blood pressure by 2.8 mm Hg more (P<0.001) and diastolic blood pressure by 1.1 mm Hg more than the control diet (P=0.07).

Interestingly, a "combination" diet rich in fruits, vegetables, but also rich in low-fat dairy products reduced systolic and diastolic blood pressure even further (by 5.5 and 3.0 mm Hg more, respectively, than the control diet, P<0.001 for each). Among the 133 subjects with hypertension, the combination diet containing low-fat dairy products reduced systolic and diastolic blood pressure by 11.4 and 5.5 mm Hg more, respectively, than the control diet (P<0.001 for each).

Further results from DASH II (5) pointed out that a lower sodium intake can produce a similar blood pressure lowering effect. However, Prof Heaney pointed out that the combination diet containing low-fat dairy products in DASH showed as much of a reduction in blood pressure without reducing sodium at all. And as he put it, "adding low fat dairy to a diet is easier than putting salt out of it".

Vitamin D multiple role

The vitamin D component of such a diet seems to play a particular role in cardiovascular protection. Few people think of vitamin D in connection with the heart. However, vitamin D receptors have a broad tissue distribution that includes vascular smooth muscle, endothelium, and cardiomyocytes and a growing body of evidence suggests that vitamin D deficiency may adversely affect

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Vitamin D

Mechanism of action

According to Prof Heaney, we have a pretty good idea of what vitamin D's action mechanism is. "Most cells need to go into their DNA library to get the plans to make the proteins they need to respond to specific challenges. We only recently realised that the nucleus is consistently having its plans opened up so that the cell can make the protein equipment that it needs. Vitamin D is one of the key elements that opens up the genome so that the correct gene can be copied", he explained. "Whenever the cell has to go into the genome to get the plans to produce new proteins, it needs vitamin D".

Because different tissues have different functions the role of vitamin D will be different from tissue to tissue. "A macrophage engulfs while an epithelial cell duplicates itself; so in macrophages vitamin D is necessary for synthesising the protein to attack bacteria. In epithelial cells it is important to control the differentiation and cell division that occurs in response to hormones".

This means that the malfunction resulting from vitamin D deficiency will be different depending on the tissue considered. In smooth muscle cells in the lining of the arteries, vitamin D will be important for muscle contraction, and this probably explains the association between vitamin D deficiency and hypertension.

"There are vitamin D receptors in almost all tissues in the body, and we now know that there are over 200 human genes with a vitamin D response element. And very few of those have anything to do with calcium or bone".

Optimal levels

Prof Heaney pointed out that the amount of vitamin D required would not necessarily be the same for all functions, "but we don't know what the optimal levels are", he said. "What we've seen is that all functions are getting better up to 80 to 100 nmol/L". Indeed, according to a review of studies analysing a number of health outcomes - bone mineral density, lower-extremity function, dental health, risk of falls, fractures, and colorectal cancer -, the most advantageous serum vitamin D concentrations begin at 75 nmol/L, and the best are between 90 and 100 nmol/L (10).

These levels are actually much higher than the current recommendations. What's more, while beyond that we don't have enough population data to know for sure, what we do know is that an outdoor summer worker would commonly achieve a value of 150nmol/L - a level which is entirely physiological. In fact, Prof Heaney explained that 80nmol/L would be the very minimum for the maintenance of the body functions. "This means that the requirements are way too low", he stated. And to achieve a vitamin D level of 80nmol/L it takes an intake of 4000 IU a day - that is 100 mcg a day. "So we have to get it from supplement or from fortification; that is the only feasible way", he concluded.

Availability

According to Prof Heaney, evidence shows no difference in terms of availability between vitamin D in fortified food or in supplement. Additionally, even though vitamin D3 is the one which is produced physiologically, both vitamin D2 and vitamin D3 are efficient.

Intoxication

It is possible to get intoxicated by vitamin D. But as Prof Heaney put it, "the good news is that it is not easy". He explained that vitamin D intake has been shown to be safe up to at least 10,000 IU per day, and no case of intoxication has been reported below 30,000 IU.

the cardiovascular system. A study including 1739 participants showed that vitamin D deficiency of < 15 ng/mL and < 10 ng/mL is associated with a 50 percent and 80 percent increase in the risk of developing cardiovascular disease respectively (6).

"This shows a huge increase in the risk of having a major cardiovascular event if you're also vitamin D deficient", said Prof Heaney.

Prof Heaney also highlighted further evidence showing that vitamin D deficiency leads to a three fold increased risk of developing hypertension (7). Conversely, vitamin D plus calcium supplementation have been shown to result in a substantial decrease in blood pressure in elderly women (8). "These are simple means that are inexpensive - cost

a lot less than any hypertensive drug", Prof Heaney commented, "something we need to be thinking of". Finally, Prof Heaney also pointed out the existing association between vitamin D deficiency and cancer risks. Interestingly, evidence has shown that improving calcium and vitamin D nutritional status substantially reduces all-cancer risk in postmenopausal women (9) (see box).

"Again a very powerful effect", Prof Heaney commented. According to him, cancers for which a vitamin D effect has been identified would be colon, breast, prostate, lung cancers and lymphoma.

Thus, it now seems clear that vitamin D has multiple effects on multiple body functions. "Vitamin D is like an iceberg", Prof Heaney said. "Part of what we have been seeing

for the last 80 years is linked to calcium economy - vitamin D is necessary for calcium absorption and its deficiency leads to rickets. But the bottom part of the iceberg is cell cycle and immune regulation. That really accounts for about 85 percent of the metabolism of vitamin D everyday in our body". "We're looking at a potentially very powerful agent here", he enthused (see box on vitamin D).

Taking a more general stance, Prof Heaney made the point that optimal nutrition promises to alleviate the burden of chronic diseases. "In the nutrition and dietetic business I don't know if we take ourselves as seriously as we should", he remarked. "Nutrition is a more powerful tool than medicine currently recognises".

Inadequate intakes of key nutrients in the Irish population

Dr Mairead Kiely from the Department of Food and Science UCC and Dietician Joanne Corbett followed Prof Heaney's talk by highlighting the current inadequacy of the Irish diet in terms of vital nutrients and its health consequences, and presenting the current Irish practice and perception of milk and dairy products.

A recent survey showed that milk and dairy foods are underutilised. Irish Universities Nutrition Alliance (IUNA) North South Ireland Food Consumption Survey (NSIFCS) found that men and women have a daily intake of 2.5 and 1.5 servings of dairy foods respectively (11) falling short of the DoHC Food Pyramid guidelines of 3 servings daily (1 serving = 200mls milk, 125g yoghurt or 28g (1oz) hard cheese). "Girls in particular seem to avoid fresh meat and dairy products in fear of excess body fat mass", Dr Kiely said.

"A lot could be done in terms of education, profile awareness, even marketing, to convince young people that fresh food products were never associated with excess storage of body fat. There is absolutely no reason why there should be this association in their mind between dairy products and fatness and maybe more could be done in this area".

At the same time, food consumption survey data in children, adolescents and adults indicates a high prevalence of inadequacy of micronutrients, including calcium, vitamin A, folate and vitamin B2 (riboflavin), all of which are found in milk and dairy products.

As pointed out by Dr Kiely, 28% of boys and 37% of girls aged 5 to 12 years old have inadequate intakes of calcium while folate intake is insufficient in 21% of boys and 36% of girls (Fig. 1-3). More than one in 10 women aged 18-35 years have intake of folate less than 140 mcg. "And a 140 mcg level is just at the level to prevent deficiency - to maintain red blood cell folate level; it does not take prevention of neuronal tube defects into consideration", said Dr Kiely.

Vitamin A also has quite a low intake in Ireland. According to Dr Kiely, this is related to the vegetable intake, green leafy vegetable intake in particular, which is very low in the Irish population.

Finally, ongoing research is highlighting widespread sub-optimal and deficient vitamin D status in all subsets of the Irish population (12). All these micronutrient inadequacies have a number of preoccupying adverse health effects. Among the most important are Neural Tube Defects (NTDs), re-emergence of rickets and osteoporosis.

Folate and Neural Tube Defects

Each speaker reminded us that Ireland still has one of the highest rates of incidence of NTDs in Europe (0.8 - 1.5 cases per 1,000 births). While this high prevalence is partly due to a genetic predisposition in this country for the development of NTDs (13), peri-conceptual supplementation with folic acid has been shown to prevent up to 70% of NTDs.

However, advice to take 400µg supplemental folic acid before conception and for the first 12 weeks of pregnancy has had little impact on reducing NTD incidence due to poor uptake.

Dr Kiely underlined that, according to the NSIFCS, only 2% of women aged 18-35 years and 5% of women aged 36-50 years actually achieved daily intakes to cover their RDA for folate plus the additional 400µg supplement (14). These are alarming figures. "The results are here to show that the women that are the most at risk are the least likely to take the supplement to comply with the recommendations - the advice is largely ignored", she commented.

As pointed out by Joanne Corbett, 50 percent of pregnancies are unplanned and when women discover they are pregnant it is already too late. To address this issue, the National Committee on Folic

Acid Fortification recommends that all sexually active women of childbearing age should take 400µg folic acid as a supplement (15). "Folate is not easy to get and is destroyed in cooking", Joanne noted. "Since 2006, mandatory fortification of flour with folic acid is recommended", she added. She also explained that folate deficiency can lead to anaemia, cognitive impairment and depression.

Rickets and Vitamin D

Rickets, a manifestation of severe vitamin D deficiency that was thought to have been eradicated 60 years ago, has begun to re-emerge in infants and toddlers in Ireland.

Research is also highlighting a concerning picture of widespread sub-optimal and deficient vitamin D status in older children, adolescents, adults and the elderly living in this country, particularly in late winter/early spring months.

Table 1. Nutritional composition of a glass of Super Milk (200mls) compared with standard whole milk

Average values per 200ml	Super Milk	Standard Whole Milk
Energy (kJ/kcal)	410kJ/98kcal	128kJ/128kcal
Protein (g)	6.8	6.6
Carbohydrate (g)	10.4	9.8
Of which sugars (g)	10.4	9.8
Fat (g)	3.0	7.0
Of which saturates (g)	1.8	4.4
Calcium (mg)	332	236
Vitamin A (µg)	240	104
Vitamin B2 (mg)	0.48	0.34
Vitamin B12 (µg)	0.8	0.8
Folic Acid (µg)	140	12
Vitamin D (µg)	2.0	0.06
Vitamin E (mg)	3.0	0.18

● Optimal nutrition



Robert Jordan (Glanbia Consumer Foods); Joanne Corbett (Consultant Dietitian); Prof Robert Heaney (Creighton University, Nebraska) Dr Mairead Kiely (Department of Food and Nutritional Sciences, University College Cork); and Emma Stapleton (Glanbia Consumer Foods)

This does not come as a surprise. As Dr Kiely noted, at Ireland's latitude of 51-55°N the sun does not penetrate sufficiently to ensure adequate levels of vitamin D body synthesis during 7 months of the year.

"What's more, most of us work indoors during the day and very few see daytime sunshine", she said. "And even if they do most carry protection factors".

All these factors contribute to inadequate vitamin D body storage, especially in dark-skinned people.

Importance of diet

"My point is that with our leisure habits, with our climate, with our lifestyle, the opportunities to vitamin D even during the summer months when we do get some sun are extremely limited; what that means is that we're extremely reliant on diet in this country".

And as she put it, "the relative importance of diet increases as sun exposure decreases; but how many times did we have fatty fish liver in the last year, or egg yolks, or poultry fed a vitamin D enriched diet?". Indeed, there are very few naturally rich dietary sources of vitamin D (e.g. oily fish, liver, egg yolk).

While overt vitamin D deficiency results in rickets in children and osteomalacia in adults, less severe vitamin D deficiency is associated with osteoporosis.

Other serious diseases

Osteoporosis is one of the most serious diseases facing our ageing population, and prevention of this disease should be lifelong. However, again results of the NSIFCS show that there is apparent widespread inadequate intakes in key nutrients for bone health in this country, especially in the most crucial bone forming years during childhood and adolescence (Fig. 1-3).

Joanne Corbett also underlined the particular status of patients in hospital. For many different reasons (e.g. bowel disease, difficulty of swallowing...), these patients may require more micronutrients and end up undernourished and deficient in key nutrients such as calcium and vitamin D.

Even conditions not directly affecting dietary intakes such as chronic renal failure may affect Ca and vitamin D requirements as it is associated with bone remodelling.

Finally, she also reminded the audience how a number of medications can alter nutrient requirements. For instance, folic acid interferes with methotrexate and anti-convulsants which both are antifolate agents.

Good quality milk

Ireland may have little sun, but it has plenty of rain, which means it can grow grass for longer every year than any other country in Europe. Irish cows

therefore spend more time outside than any other cows, and cows eating grass produce tastier, creamier milk. Because we have such great quality milk we have the second highest consumption per capita of milk in the world after Finland. "Milk and dairy products are a fundamental part of our diet in this country", Joanne Corbett said. "One third calcium intake comes from dairy"

And while we are still mainly a 'whole milk nation' (whole milk accounts for 65% of the milk market volume in Ireland), we are slowly adopting fortified milk, a milk that is low in fat and enriched with extra calcium, folic acid and vitamins A, B, D and E. The Irish population would greatly benefit from consuming fortified milk as it can contribute to improved dietary intakes of a number of micronutrients that have been shown to be widely inadequate in children, teens and adults in this country.

In spite of this, Joanne Corbett warned us that milk consumption is starting to reduce. "As we grow older we tend to change our perception of milk. Milk is not seen as a beverage anymore; adults tend to see it as a vehicle or something to add to tea - as if it wasn't a food in its own right". She stressed that dieticians should keep this in mind when advising their patients on dairy intake recommendations.

Going back to the US expert

statement quoted above, Prof Heaney reinforced the message that "the gap between what we know and its application in the community remains large and needs to be closed".

He added: "one solution, that always makes best sense to me, is optimal fortification of commonly consumed foods". According to him, the best and most economical source of essential nutrients in most of our diet is dairy products.

"Diet poor in dairy products tend to be poor in other nutrients as well, and supplements cannot fill the gap", he said. Fortified milk such as Super Milk has a 41% increase in the amount of calcium, a substantially augmented amount of vitamin D, a useful addition in the amount of riboflavin and about a 10 times addition in the amount of folic acid.

"Fortified milk improves an already good food and, if widely utilised, promises to improve general diets substantially", Prof Heaney concluded.

The symposium heard news that Avonmore Super Milk are planning to supply Super Milk into schools in September which will help to address the inadequate intakes of Vitamin A, B2, D, folic acid and calcium in Irish Children. Avonmore also plan to supply Super Milk to hospitals around the country for patients who require additional vitamins and minerals on top of the recommended daily allowance to aid recovery.

DEBUNKING MYTHS ABOUT FORTIFICATION

Dr Mairead Kiely insisted at debunking some of the most persistent myths about fortified food.

- **First myth:** Fortified food makes no difference to nutrient intake; if your diet is well balanced it won't have any impact. Dr Kiely presented the results of a study that they published last year showing that the contribution of fortified food in nutrient intake is between 11 to 21 per cent, while its contribution in energy intake is less than 5 per cent. "For a tiny addition to energy fortified food allows us to boost our micronutrient intakes", she said.
- **Second myth:** if people consumed fortified food their intake of vitamin would be too high and they would poison themselves. Current evidence has not pointed to any risk of excessive intake. "What you can see is that fortified food does not contribute in any way to an increase risk of adverse effect from an excessive intake of any nutrients", she said.
- **Third myth:** people who take fortified food think that this is sufficient and consequently do not pay attention to the rest of their diet. What was found in adults, however, is that this is actually the contrary. Evidence showed that the increased consumption of fortified food was associated with a more micronutrient dense diet for a better quality diet overall. "Diet is one part of an overall lifestyle choice", Dr Kiely commented.

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Figures 1-3: Percentage of Irish people with inadequate intakes of micronutrients.

