

The importance of fortification of flour with calcium and the sources of Ca in the diet of 375 English adolescents

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1. The contribution of the fortification of flour with calcium carbonate to the Ca intake of 375, 11-14-year-old Northumbrian children has been calculated.
2. Mean Ca intakes were above those currently recommended for children of this age. The fortification of flour supplied 16% of the total Ca intakes.
3. Without the fortification, the percentage of these children with intakes below the recommended intake would be more than double. This would include the majority of girls (particularly those of social classes III, IV and V).
4. The recommendation to stop fortifying flour with calcium carbonate should be reviewed.

With the progressive increase in life expectancy (Anon., 1982) osteoporosis and its consequences in the elderly are making increasing demands upon National Health Service resources. Any measures therefore, including nutritional ones, which may help reduce the incidence of such bone disease merit very serious consideration.

Bone is progressively lost from the skeleton from the fourth decade onwards (Robinson, 1983) and the major factors which determine the susceptibility of an individual to fracture are the rate of bone loss and the mass of bone existing at the onset of bone loss (Newton-John & Morgan, 1968). There is evidence, in caucasian subjects at least (Mathovic *et al.* 1979), that an inadequate dietary intake leads to a significantly reduced bone mineral mass at maturity. It is particularly during the adolescent growth spurt with its increased calcium requirement (Garn, 1981) that the dietary supply of Ca may become limiting. Estimates of requirement at this important stage of development are as high as 1.4 g/d (Albanese, 1977) and if this is not satisfied, a lower skeletal mass at maturity may result with the attendant consequences in terms of fracture liability in later life.

Since 1942, all wheat flour except wholemeal has been fortified with calcium carbonate, which at present contributes between 0.94-1.54 g Ca/kg flour (Department of Health and Social Security, 1981 *a*) and is a significant source of dietary Ca. The reasons for this addition were: the likely scarcity of milk and cheese and the increase in the proportion of bran in flour for bread-making during wartime, the desire to maintain the Ca intakes of infants following the lowering of the vitamin D content of some foods and, finally, the possibility that a relatively high Ca intake may protect against cardiovascular disease (Department of Health and Social Security, 1981 *a*). The expert panel of the Committee on Medical Aspects of Food Policy considered these reasons no longer valid (Department of Health and Social Security, 1981 *a*). They also stated that there was no evidence that the removal of the fortification would cause the intake of population groups to fall below the current recommendations.

This paper reports a recent survey of the Ca intake of a group of adolescents at the time of their growth spurt, in South Northumberland, calculated both with and without the contribution from the fortification.

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Table 1. *Average calcium intake, by sex and social class, calculated with and without the contribution from fortification, and percentage of subjects below current recommendations**

(Mean values and standard deviations)

Sex	Social class†	n	Daily Ca intake (mg)		Daily Ca intake (mg/MJ)		Daily Ca intake (mg) less fortification		Fortification as percentage of total intake		Percentage of subjects below recommended intake	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	With fortification	Without fortification
Boys	I+II	46	953	229	101	19	815	216	15	13	35	
	III	86	864	235	92	715	228	17	26	52		
	IV+V	52	871	186	92	731	184	16	17	40		
Girls	I+II	39	836	211	98	9	706	197	15	28	54	
	III	86	780	197	94	659	186	16	34	64		
	IV+V	66	742	179	87	615	158	17	42	71		

* Boys and girls (11-14 years) = 700 mg/d (Department of Health and Social Security, 1979).

† Registrar General (1970).

Table 2. The percentage contribution (and weight) of the three largest contributing groups of food (milk, fortified flour and cheese) to the total daily calcium intake of 11–14-year-old children, by sex and social class

Food	Sex	Social class*					
		I+II		III		IV+V	
		%	mg	%	mg	%	mg
Milk	M	53	502	48	411	49	424
	F	43	363	46	36	42	315
Fortified flour†	M	16	155	19	167	18	158
	F	18	147	17	135	19	143
Cheese	M	7	67	6	55	5	47
	F	11	95	9	69	6	42

* Registrar General (1970).

† Includes the small amount of Ca which occurs naturally.

SUBJECTS AND METHODS

Between September 1979 and July 1981, 405 children from seven South Northumberland middle schools each completed five dietary records of three consecutive days (15 d total record per child) (Hackett *et al.* 1983). The children were initially aged 11–12 years and were asked to record all foods and drinks taken, indicating the amount consumed in household measures. On the 4th day all the children were individually interviewed, by the same nutritionist, to verify and enlarge upon the recorded information which was converted to Ca intake using food tables (Paul & Southgate, 1978). The total daily Ca intake per child, including water, and the weight and percentage of Ca from various groups of foods, were calculated. Foods containing wholemeal flour and self-raising flour were grouped separately from foods containing other flour, since wholemeal flour is not fortified with Ca and self-raising flour is fortified to a variable extent depending upon the raising agent used. By modifying the food tables, the weight of Ca consumed which originated from the fortification of flour (which was mandatory throughout the survey) was calculated: a figure of 1.35 g Ca/kg fortified white flour (Paul & Southgate, 1978) was used and allowance was made for all other Ca sources in each recipe as appropriate. The occupation of each child's father was coded as social class (Registrar General, 1970).

RESULTS

Only 375 out of the 405 children were classified into social classes I to V, and further analyses were limited to these children. The mean daily Ca intake ranged from 953 mg/d for boys in the social classes I+II to 742 mg/d for girls in the social classes IV+V (Table 1). The boys' Ca intake was higher than the girls' ($P < 0.01$) and, for both sexes, social classes I+II had higher intakes than social classes IV+V ($P < 0.05$). Although the total energy intakes of boys were consistently higher than those of girls, no difference was observed between social classes ($P > 0.05$). Differences were, however, observed in the daily Ca intake per unit of energy between social classes, with the boys in the social classes I+II having higher intakes than those in social classes III, IV and V ($P < 0.05$), and girls in the social classes IV+V having lower intakes than those in social classes I+II and III ($P < 0.05$). The percentage of the total daily Ca intake due to fortification was similar between the groups and ranged from 15 to 17%. Without the fortification, the percentage of children with daily Ca intakes

less than the recommended level (700 mg Ca (Department of Health and Social Security, 1979)) more than doubled. This increase was from 13 to 35% for the boys in the social classes I + II, but was more marked (from 42 to 71%) for the girls in the social classes IV + V. The mean Ca intake of the girls of social classes III, IV and V would have fallen below the recommendation.

Milk, fortified flour and cheese provided nearly three-quarters of the total daily Ca intake for these children (Table 2). Other foods (e.g. wholemeal and self-raising flour, confectionery, potatoes, eggs, soups, baked beans, meat and fish, green vegetables and breakfast cereals) were found, individually, to contribute only a small proportion of the total daily Ca intake. Milk provided nearly half the Ca intake. No differences between sexes and social classes in the percentage contribution of fortified flour (including the naturally occurring Ca) to daily Ca intake were observed. Small differences between sexes and social classes were observed in the contribution of cheese to the total daily Ca intake, with girls in the social classes I + II (11% or 95 mg/d) having twice the intake of those of the social classes IV + V (6% or 42 mg/d) ($P < 0.001$).

DISCUSSION

Although milk intake has been falling for several decades (Angel & Hurdle, 1978), the results from the present survey confirm that milk is still the major dietary source of Ca. The nutritional significance of the reduction in the milk intake is somewhat reduced by the fact that cheese intake has risen progressively since the end of food rationing (Angel & Hurdle, 1978). Flour, however, is the second most important source, but the Ca in white flour is largely (90%) the result of fortification. The Ca intakes recorded in the present survey were similar to those reported in several other surveys of adolescents (Darke *et al.* 1980; Darke & Disselduff, 1981). However, none of these studies considered the contribution of the fortification of flour to Ca intake.

This study shows that even with the modest dietary Ca requirement of 700 mg/d for children of 11–14 years, some 13–26% of male subjects and 28–42% of female subjects fall beneath the recommended level. Furthermore, much higher Ca intakes have been recommended (Albanese, 1977; Marcus, 1982). More importantly, the study also shows that removal of the Ca added to flour (which comprised about 16% of Ca intake) would increase the proportion falling below the recommended intake to between 35 and 40% of males and 54 and 71% of females. Removing the Ca fortification from white flour would significantly reduce the mean dietary Ca intakes of the groups of children studied. Contrary to the views of the expert panel, the mean Ca intakes of an important population group (the girls of social classes III, IV and V) would fall below current recommendations.

The panel have argued that there was no evidence of Ca deficiency in countries where Ca intakes were 'considerably less' than in Britain, implying that present recommendations may be too high. However, the studies on low Ca intakes in other countries (Nordin, 1976) were carried out on populations of non-caucasian extraction, usually negro, and it is known (Nordin, 1976; Garn, 1981) that their bone metabolism is significantly different from that of caucasians and such extrapolations may therefore be invalid. For such studies to be meaningful they should be true longitudinal studies.

The energy intake of children has been falling for several decades (Whitehead *et al.* 1982), therefore there is a need for the consumption of a diet of higher quality (nutrient/MJ) if requirements are still to be met. Fortification is perhaps one way of achieving this. This is particularly true of the lower social class girls who consume diets of the poorest quality (mg Ca/MJ).

The consequence of the inadequate Ca intake at this critical stage of skeletal development is likely to be less dense bone on maturity, with the prospect of an increased likelihood of

skeletal fractures in later life. One of the preferred choices (Robinson, 1983) in the treatment of demineralizing disorders, such as osteoporosis, is supplemental Ca; vitamin D and its metabolites, and anabolic sex hormones being the other major therapeutic agents employed. Since, particularly in the elderly, such treatment with Ca may be effective and inhibit (if not reverse) the progressive loss of bone, reducing the dietary supply of Ca, by removing the fortification of flour, may require increased prescribing of expensive Ca supplements. However, Stevenson & Whitehead (1982) have suggested that Ca supplements alone give only small benefits, although these authors emphasise the importance of a diet adequate in Ca. Stevenson & Whitehead (1982) also describe the cost (£48 million in 1981) of fracture of the neck of the femur, which they suggest is largely due to post-menopausal osteoporosis. A proportion of these costs may be saved by maintaining the fortification of flour with Ca.

Implementation of the expert panel's recommendations not to fortify flour would lead to a 16% reduction in Ca intake; this appears to be contrary to the current emphasis on preventive medicine (Department of Health and Social Security, 1981 *b*). Therefore it is suggested that this recommendation is re-examined.

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