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Small changes in snacking behaviour: the potential impact on CVD mortality

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Abstract

Objective: To examine the potential public health impact on CHD and stroke mortality of replacing one 'unhealthy' snack with one 'healthy' snack per person, per day, across the UK population.
Methods: Nutritional information was obtained for different 'unhealthy' (such as crisps, chocolate bars, cakes and pastries) and 'healthy' snack products (such as fresh fruit, dried fruit, unsalted nuts or seeds). Expected changes in dietary intake were calculated. The mean change in total blood cholesterol levels was estimated using the Keys equation. The effect of changing cholesterol and salt levels on CHD deaths and on stroke deaths was calculated using the appropriate equations from the Law and He meta-analyses. The estimated reductions in cardiovascular deaths were then tested in a sensitivity analysis.
Results: Substituting one 'healthy' snack would reduce saturated fat intake by approximately 4·4 g per person per day, resulting in approximately 2400 fewer CHD deaths and 425 fewer stroke deaths per year. The associated 500 mg decrease in salt intake would result in approximately 1790 fewer CHD deaths and 1330 fewer stroke deaths.
Conclusions: Simply replacing one unhealthy snack with one healthy snack per day might prevent approximately 6000 cardiovascular deaths every year in the UK.

Keywords
Snacks
Cardiovascular disease
Mortality
Diet

Most chocolate bars, crisps, cakes, pastries and other 'unhealthy' snacks have a high content of saturated fat, salt and refined sugars. These dietary factors can then elevate total cholesterol, blood pressure and body weight, the major risk factors for CHD, stroke and diabetes. CVD and diabetes cause over 170 000 deaths in the UK every year[1].

People are therefore putting themselves at risk by snacking on unhealthy foods that are high in salt, saturated fats and sugar. In 2004, a large study found that nine out of every ten people snacked between meals, with 43% snacking on chocolate, 41% on crisps, 34% favouring cakes and pastries, and 21% consuming pies and sausage rolls[2]. In 2005, there were approximately 25 billion snacking occasions in the UK. This represented over 410 snacks per person per year. Furthermore, approximately 6·2 billion snacking occasions each year featured a chocolate bar, sugar confectionary product, bag of crisps or another type of salted snack[3]. This commercial market totals over £820 million per annum, and the associated advertising is both extensive and intensive[3].

According to the National Dietary and Nutrition Survey[4], most adults in the UK have a saturated fat intake well above the recommended 10% of energy intake[4]. If current unhealthy snacking (on chocolate and crisps and other unhealthy snacks) could be partially replaced by dried fruit, fresh fruit, natural nuts and seeds, it might substantially decrease total fat intake, perhaps by as much as 10 g/d (equivalent to one small packet of crisps). This could potentially reduce total energy from saturated fats to 10% or less. Furthermore, if sources of nuts and seeds were chosen wisely (walnuts, brazil nuts, pine nuts, pumpkin seeds or flaxseed), this would also result in a valuable increase in the omega 3 and 6 fat consumption[4]. The omega fats have several well-documented health effects, most importantly lowering blood cholesterol levels[5].

However, research into the potential public health effects of changing snack behaviour is scarce. A UK study of habitual snackers found that while total daily energy intake did not vary between high- and low-fat snack consumption, percentage of total daily energy intake from fat increased significantly with high-fat snacks from 37% to 41%; conversely, low-fat snacks reduced daily fat intake to 33·5%[6]. A US study examined the impact of replacing unhealthy snacks with healthy snacks in vending machines in schools. Initial findings suggest positive reactions to the changes; however, data relating to changes in diet quality are yet to be published[7].

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We therefore examined the potential public health impact on CHD and stroke mortality of replacing one 'unhealthy' snack with one 'healthy' snack per person, per day, across the UK population.

Methods

In the present study, 'unhealthy' snacks were defined as chocolate bars, crisps, pies and sausage rolls, cakes and pastries; 'healthy' snacks were defined as dried fruit, unsalted nuts, seeds and fresh fruit such as apples, oranges and bananas. Nutritional information (saturated fat, salt, sugar and energy) for different healthy and unhealthy snack products was obtained from McCance & Widdowson's Food Composition Tables[8] and from the manufacturer's information (Appendix A). The nutritional values were then transformed from nutritional value per 100 g into average nutritional values per portion (Appendix B).

The expected changes in dietary intake were then calculated, based on one average 'healthy' snack replacing one 'unhealthy snack', per person, per day, across the whole UK population. The subsequent mean change in total blood cholesterol levels in the general population was estimated using the Keys equation[9]. Keys' predictive equation enables quantification of the effects of fatty acids and dietary cholesterol on plasma cholesterol concentrations, showing that total cholesterol and LDL-cholesterol are increased by saturated fat and decreased by polyunsaturated fat. The Keys equation is: change in serum cholesterol concentration (mmol/l) $= 0{\cdot}031 \times (2D_{SAT} - D_{PUFA}) + 1{\cdot}50\sqrt{D_{CHOL}}$, where D_{SAT} is the change in the percentage of dietary energy derived from saturates, D_{PUFA} is the change in the percentage of dietary energy derived from polyunsaturates and D_{CHOL} is the change in the dietary cholesterol intake.

The effect of changing cholesterol and salt levels on CHD deaths was then calculated using the equations provided by the Law and He meta-analyses, respectively[10,11]. The quoted reduction (95% confidence interval) in CHD mortality per 0·6 mmol/l reduction in total cholesterol was 25% (15%, 35%) for randomised trials and 27% (23%, 32%) for long-term cohort studies[10]. For stroke deaths, we used a conservative estimate of an overall reduction of 13% (6%, 19%) per 1·0 mmol/l reduction in total cholesterol[12]. The risk ratio for fatal and non-fatal events was very similar[13]. A 3 g reduction in daily salt intake would reduce coronary deaths by approximately 11% and stroke deaths by 13%[11].

The estimated reductions in cardiovascular deaths were then tested in a sensitivity analysis[14]. Values for deaths were rounded to the nearest zero or five.

Results

Portions of 'unhealthy' snacks typically contained 1·0 to 9·1 g of saturated fat (average 5·1 g) and 0·1 to 1·4 g of salt (average 0·56 g). Portions of 'healthy' snacks typically contained 0 to 2·5 g of saturated fat (average 0·69 g) and 0 to 0·15 g of salt (average 0·05 g).

The replacement of one 'unhealthy' snack a day with one 'healthy' snack would result in an average reduction of approximately 4·41 g saturated fat and 0·51 g salt intake per person per day. This would represent a decrease of approximately 11·7% and 6·7% in average daily intake, respectively (Table 1).

Baseline situation

In 2004, 105 845 CHD deaths and 60 458 stroke deaths were reported in the UK.

Ideal scenario, fat intake: If one unhealthy snack was replaced by one healthy snack, the 4·41 g reduction in saturated fat consumption would lead to a reduction in blood cholesterol levels of approximately 0·054 mmol/l. This 0·054 mmol/l decrease would result in approximately 2400 fewer deaths from CHD per year (minimum estimate 1435, maximum estimate 3355) and 425 fewer stroke deaths (minimum estimate 195, maximum estimate 625) (Table 2).

Ideal scenario, salt intake: If one unhealthy snack was replaced by one healthy snack, the 510 mg decrease in salt intake would result in approximately 1790 fewer coronary deaths (minimum estimate 1155, maximum estimate 2505) and 1330 fewer deaths from strokes (minimum estimate 860, maximum estimate 25501) (Table 3).

Table 1 Change in dietary intake: replacing one 'unhealthy' snack with one 'healthy' snack

	Total fat (g)	Saturated fat (g)	Salt (g)	Sugar (g)	Dietary fibre (g)	Energy (kcal)	Monounsaturated fat (g)	Polyunsaturated fat (g)**
'Unhealthy snacks' average values per portion	11·60	5·10	0·56	15·10	0·81	230·22		
'Healthy snacks' average values per portion	5·83	0·69	0·05	10·40	1·51	110·08		
Change in dietary intake (g)	−5·77	−4·41	−0·51	−4·70	+0·70	−120·14	−0·90	−0·45
Average daily total intake* (g)	(96·2)	(37·6)	(7·6)	(65·0)	(13·9)	(1972·5)	(19·5)	(39·0)
% change in daily intake†	−5·9	−11·7	−6·7				−4·6	−1·1

*Source: Office for National Statistics (2005) *Expenditure and Food Survey 2003/04*. London: The Stationery Office.
*Source of data for sugar, fibre & energy: FSA (2003) *The National Diet and Nutrition Survey: Adults Aged 19–64 Years*. vol. 2. London: The Stationery Office.
†Assuming 2:1 monounsaturated:polyunsaturated split.

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Table 2 Reduction in serum cholesterol concentration, and hence in CHD and stroke mortality, with an 11·7 % decrease in saturated fat intake

Fat and CHD			
Applying the Keys equation Change in serum cholesterol concentration (in mmol/l) $= 0{\cdot}031 \times (2D_{SAT} - D_{PUFA}) + 1{\cdot}5 \times \sqrt{D_{CHOL}}$			
	Actual snacks		
D_{SAT} = change in percentage of dietary energy from saturated fats	11·7 %		
D_{PUFA} = change in percentage of dietary energy from polyunsaturated fats	1·1 %		
D_{CHOL} = change in dietary cholesterol intake	(assume) 0·01 %		
Square root of D_{CHOL} = change in dietary cholesterol intake	0·3 %		
Change in serum cholesterol concentration, using the Keys equation, therefore	0·054 mmol/l		
Change in CHD death rate	Best estimate	Minimum estimate	Maximum estimate
Fall per 1·0 mmol/l decrease in cholesterol[10]	42 %	25 %	58 %
Change in CHD death rate for predicted fall in cholesterol	2·3 %	1·4 %	3·2 %
UK CHD deaths per year in 2004	105 845		
Therefore, 2·3 % fewer CHD deaths if 0·054 mmol/l cholesterol fall =	2400	1435	3355
Fat and stroke			
Change in serum cholesterol concentration, using the Keys equation	0·054 mmol/l		
	Best estimate	Minimum estimate	Maximum estimate
Change in stroke death rate, if reduction of 1 mmol/l total cholesterol[13]	13 %	6 %	19 %
Change in stroke death rate for predicted fall in cholesterol	0·702 %	0·3 %	0·10 %
UK Stroke deaths per year	60 458		
Therefore, −0·702 % fewer stroke deaths if 0·054 mmol/l cholesterol fall=	425	195	625

Table 3 Reduction in CHD and stroke with a 0·51 g decrease in dietary salt intake

Salt and CHD Change in dietary intake of salt	0·510 g		
Change in CHD death rate	Best estimate	Minimum estimate	Maximum estimate
Reduction of 1 g/d would reduce CHD by 3·33 %[11]	3·33 %	2·1 %	4·6 %
Therefore, change in CHD death rate for 0·510 g fall in salt	1·7 %	1·1 %	2·4 %
UK CHD deaths per year in 2004	105 845		
Therefore, fewer CHD deaths if 0·510 g fall in salt	1790	1155	2505
Total fewer CHD deaths if cholesterol & salt reduction	4185	2595	5860
Salt and stroke Change in dietary intake of salt	0·510 g		
Change in stroke death rate	Best estimate	Minimum estimate	Maximum estimate
Reduction of 1 g/d would reduce strokes by 4·33 %[11]	4·33 %	2·8 %	6·0 %
Therefore change in stroke death rate for 0·510 g fall in salt	2·2 %	1·4 %	4·2 %
UK stroke deaths per year	60 458		
Fewer stroke deaths if salt reduction	1330	860	2550
Total fewer stroke deaths if both cholesterol & salt reduction	1755	1055	1930
Total fewer CHD & stroke deaths if both cholesterol & salt reduction	5945	3650	7785

In total, approximately 6000 cardiovascular deaths a year could be prevented from this minor change to diet (minimum estimate 3650, maximum estimate 7785).

Discussion

Simply replacing one unhealthy snack with one healthy snack per day might prevent approximately 6000 cardiovascular deaths every year. The corresponding reductions in cardiovascular morbidity, obesity and diabetes would also be valuable, particularly given the recent alarming trends[15]. These are not trivial benefits. In the USA, the Baltimore Longitudinal Study of Aging recently reported that CHD mortality was approximately 75 % lower among men with both low saturated fat and high fruit and vegetable intake (compared with those with low fruit and vegetable consumption and high saturated fat intake); furthermore, this combination was considerably more protective than either behaviour alone[16].

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Cholesterol remains the major reversible risk factor for CVD[1,5,10,12]. In Finland, a logical combination of national policies and local interventions reduced the population average total cholesterol by over 1 mmol/l, cardiovascular deaths subsequently fell by over 70 %[17].

Furthermore, He and McGregor[11] recently estimated major reductions in CHD and stroke mortality in the UK population simply by decreasing dietary salt. A conservative estimate of salt intake reduction by 3 g/d (from 12 to 9 g/d) could potentially prevent approximately 7800 stroke deaths and 11 500 CHD deaths per year. If salt intake was reduced from the current average intake of 12 to 3 g/d (as in the successful DASH Trial level), this might prevent approximately 20 500 stroke deaths and 31 400 CHD deaths every year[11].

Yet, persuading large numbers of UK citizens to switch from unhealthy to healthy snacks may not be realistic using health education alone. Such information is easily buried by the immense volume of food industry advertising with an annual budget now exceeding £700 million[18]. However, simple legislation may be much more effective; for instance, banning TV junk food adverts prior to 21.00 hours[19].

This first, simple analysis of a complex dietary phenomenon has obvious limitations. Data quality was imperfect. Furthermore, the methodology would clearly benefit from future refinement; for instance, modelling of separate age, sex and socio-economic categories. Consideration might also be given to quantifying the beneficial effect of these same modest dietary changes on obesity, diabetes and relevant cancers. However, having acknowledged these limitations, we would emphasise that these calculations used conservative estimates, because individuals might well change by more than one snack per day. Also, the true population benefit could be even greater, not least because of the additional unquantified harm from *trans* fats. In conclusion, even small changes to diet (such as choosing healthy snacks) could lead to potentially large reductions in cardiovascular deaths.

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Appendix A

Nutritional value (average value per 100 g) of typical 'unhealthy' and 'healthy' snacks

Food	Total fat (g)	Saturated fat (g)	Salt (g)	Sugar (g)	Dietary fibre (g)	Energy (kJ)	Energy (kcal)	Average portion size (g)
'Unhealthy' snacks								
Mars bar	19·0	10·3	0·4	66·2	0·4	1980	473	57
Snickers bar	19·0	10·9	1·0	47·5	1·7	2081	497	57
Kit Kat	26·0	16·2	0·3	50·1	0	2093	500	42
Walkers ready salted crisps	34·0	11·0	1·5	0·5	4·0	2219	530	34·5
Walkers salt & vinegar crisps	33·0	10·0	3·0	0·5	4·0	2198	525	34·5
Walkers cheese & onion crisps	33·0	10·0	1·8	2·0	4·0	2198	525	34·5
Madeira cake	15·1	8·4	0·9	36·5	0·9	1578	377	40
Chocolate fudge cake	14·3	4·6	0·6	44·4	0·9	1499	358	98
Battenburg cake	16·8	3·4	1·0	36·8	0·9	1562	373	32
Sponge cake with cream and jam	10·9	7·0	0·5	25·3	0·7	1172	280	60
Chocolate muffin	18·2	10·7	0·6	28·4	1·6	1612	385	72
Danish pastry	14·1	8·6	0·5	28·5	1·6	1432	342	60
Cornish pasty	16·3	5·9	1·0	0·9	0·9	1118	267	155
Sausage roll	27·6	11·2	1·4	0·9	1·0	1604	383	60
Average value per 100 g	21·24	9·16	1·04	26·32	1·61	1739·02	415·36	59·75
'Healthy' snacks								
Dried apricots	1·0	0	0·3	53·0	7·0	1009	241	50
Dried raisins	0	0·1	0·3	59·0	3·7	1252	299	43
Unsalted peanuts	46·0	7·0	0·05	6·2	6·9	2357	563	28
Unsalted almonds	55·8	4·4	0·35	4·2	7·4	2562	612	28
Walnuts	65·8	5·6	0·03	2·6	3·5	2881	688	30
Sunflower seeds	47·5	4·5	0·08	1·7	6·0	2433	581	16
Pumpkin seeds	46·0	9·0	0·45	1·0	4·0	2265	541	28
Apple	0·1	0	0·01	11·8	1·8	197	47	112
Banana	0·3	0·1	0·00	20·9	1·1	398	95	100
Pear	0·1	0	0·01	10·0	2·2	167	40	150
Orange	0·1	0	0·01	8·5	1·7	155	37	160
Satsuma	0·1	0	0·01	8·5	1·3	151	36	70
Average value per 100 g	21·90	2·56	0·13	15·62	2·65	1318·84	315·00	67·92

Appendix B

Nutritional value (average values per portion) of typical 'unhealthy' and 'healthy' snacks

Food	Total fat (g)	Saturated fat (g)	Na (mg)	Salt (g)	Sugar (g)	Dietary fibre (g)	Energy (kJ)	Energy (kcal)
'Unhealthy' snacks								
Mars bar	10·83	5·87	85·50	0·228	37·73	0·29	1128·80	269·61
Snickers bar	10·83	6·21	153·90	0·570	27·08	0·97	1186·08	283·29
Kit Kat	10·92	6·80	50·40	0·126	21·04	0	879·23	210·00
Walkers ready salted crisps	11·73	3·80	207·00	0·518	0·17	1·38	765·56	182·85
Walkers salt & vinegar crisps	11·385	3·45	414·00	1·035	0·17	1·38	758·36	181·13
Walkers cheese & onion crisps	11·385	3·45	241·50	0·621	0·69	1·38	758·36	181·13
Madeira cake	6·04	3·36	152·00	0·365	14·60	0·36	631·37	150·80
Chocolate fudge cake	14·01	4·51	259·70	0·623	43·51	0·88	1468·90	350·84
Battenburg cake	5·38	1·09	138·56	0·333	11·78	0·29	499·74	119·36
Sponge cake with cream and jam	6·54	4·2	130·80	0·314	15·18	0·42	703·38	168·00
Chocolate muffin	13·10	7·70	182·88	0·439	20·45	1·15	1160·58	277·20
Danish pastry	8·46	5·16	114·00	0·274	17·10	0·96	859·13	205·20
Cornish pasty	25·27	9·15	620·00	1·488	1·40	1·40	1732·71	413·85
Sausage roll	16·56	6·72	360·00	0·864	0·54	0·60	962·13	229·80
Average value per portion	11·60	5·10	222·16	0·560	15·10	0·81	963·89	230·22
'Healthy' snacks								
Dried apricots	0·50	0	5·00	0·150	26·50	3·50	504·51	120·50
Dried raisins	0	0·04	4·73	0·129	25·37	1·59	538·30	128·57
Unsalted peanuts	12·88	1·96	0·56	0·014	1·74	1·93	660·01	157·64
Unsalted almonds	15·62	1·23	3·92	0·100	1·18	2·07	717·45	171·36
Walnuts	19·74	1·68	2·10	0·010	0·78	1·05	864·16	206·40
Sunflower seeds	7·60	0·72	0·48	0·013	0·27	0·96	389·20	92·96
Pumpkin seeds	12·88	2·52	5·04	0·126	0·28	1·12	634·22	151·48
Apple	0·11	0	3·36	0·008	13·22	2·02	220·39	52·64
Banana	0·30	0·10	1·00	0·002	20·90	1·10	397·75	95·00
Pear	0·15	0	4·50	0·011	15·00	3·30	251·21	60·00
Orange	0·16	0	8·00	0·019	13·6	2·72	247·86	59·20
Satsuma	0·07	0	2·80	0·007	5·95	0·91	105·51	25·20
Average value per portion	5·83	0·69	3·46	0·050	10·40	1·51	460·88	110·08