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Received 14 December 2011; accepted in revised form 23 February 2012

Age and Ageing 2012; **41:** 776–784
doi: 10.1093/ageing/afs052

Childhood milk consumption is associated with better physical performance in old age

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Abstract

Background: studies have shown that milk and dairy consumption in adulthood have beneficial effects on health.
Methods: we examined the impact of childhood and adult diet on physical performance at age 63–86 years. The Boyd Orr cohort ($n = 405$) is a 65-year prospective study of children who took part in a 1930's survey; the Caerphilly Prospective Study (CaPS; $n = 1{,}195$) provides data from mid-life to old age. We hypothesised that higher intakes of childhood and adult milk, calcium, protein, fat and energy would be associated with a better performance.
Results: in fully adjusted models, a standard deviation (SD) increase in natural log-transformed childhood milk intake was associated with 5% faster walking times from the get-up and go test in Boyd Orr (95% CI: 1 to 9) and 25% lower odds of poor balance (OR: 0.75; 0.55 to 1.02). Childhood calcium intake was positively associated with walking times (4% faster per SD; 0 to 8) and a higher protein intake was associated with lower odds of poor balance (OR: 0.71; 0.54 to 0.92). In adulthood, protein intake was positively associated with walking times (2% faster per SD; 1 to 3; Boyd Orr and CaPS pooled data).
Conclusion: this is the first study to show positive associations of childhood milk intake with physical performance in old age.

Keywords: *diet, physical performance, walking speed, standing balance, older people*

Introduction

The ability to undertake physical tasks of everyday living is important for successful ageing, but knowledge of potentially modifiable lifestyle factors that may enhance later-life physical performance is largely limited to exposures in middle-life to old age (e.g. smoking [1], alcohol [2], physical activity [3], exercise resistance [4] and diet [5, 6]), rather than factors operating early in life, such as socio-economic adversity [7] and growth in childhood [8].

We previously reported that people from more deprived childhood circumstances had slower walking times and reduced balance ability in old age [9], using objective assessments of physical performance that are markers of current health and predictors disability and mortality in older people [10, 11]. We have hypothesised that diet, and specifically milk intake, may mediate this association, since milk and dairy consumption in both childhood [12] and adulthood [13, 14] have been associated with other health outcomes, such as reduced risk of cardiovascular disease. The present analysis examines the impact of aspects of both childhood and later life diet on physical performance in old age using the Boyd Orr cohort [15] and the Caerphilly Prospective Study (CaPS) [16]. The Boyd Orr cohort is a 65-year prospective study of children who took part in a survey of diet and health in 1930s; CaPS provides data from mid-life to old age. Our hypotheses are that higher intakes of milk and components of milk (calcium, protein, fat and energy) are associated with improved measures of physical performance in old age and that childhood diet is a possible mechanism linking childhood socio-economic circumstances with physical function in old age in Boyd Orr [9].

Methods

Participants

The Boyd Orr study is an historical cohort based on the Carnegie (Boyd Orr) Survey of Diet and Health in Pre-War Britain, 1937–39 [15, 17]. A total of 4,999 children aged 0–19 years in 16 centres across the UK underwent physical measurements, a week-long dietary inventory was completed for each family and detailed assessments of socio-economic environment were made. In 1997, a follow-up study re-established contact with 1,648 individuals from the original sample, who completed a detailed health, diet and lifestyle questionnaire. In 2002, all 732 surviving study members who lived near research clinics in Bristol, London, Wisbech, Aberdeen and Dundee, and had previously consented to the clinical follow-up, were contacted; of these 405 (55%) agreed to take part in a detailed clinical examination. Responders to the 1997 questionnaire were more likely to come from more affluent childhood social backgrounds [18], but participants who did not attend the clinic had similar backgrounds to those who did [19].

The CaPS recruited 2,512 men aged 45–59 years between 1979 and 1983 from the town of Caerphilly, South Wales and the adjacent villages [16]. For the second examination (phase II 1984–88), the original cohort was supplemented with 447 men of a similar age who had moved into the defined area; however, 561 men were lost from the cohort giving a total of 2,398 men who participated in phase II. Since then the men have been examined on three further occasions: phases III (1989–93), IV (1993–96) and V (2002–04). At each phase, the men have completed diet and lifestyle questionnaires. Men that continued to attend the follow-up clinics were more likely to come from a non-manual social class [19]. A total of 1,195 men attended the phase V clinic (or had a home visit) where physical performance was tested.

Physical performance

Walking times were measured using the get-up and go test [20]. Participants were timed while they rose from a chair, walked three metres, turned, walked back to the chair and sat down. Standing balance was measured using the flamingo test of postural stability. Participants were timed for how long subjects could lift one leg, while the other leg remained straight, with their eyes open. The position was held for as long as possible, for a maximum of 30 s. Because of constraints on the length of time we could run the research clinics, which also included many other measures, we made a pragmatic decision to restrict the physical performance assessment to these two measures.

Diet

In Boyd Orr, childhood diet data were obtained from a 7-day household inventory, carried out for the original Carnegie survey [17, 21]. Per capita food and nutrient intake were calculated by dividing daily total intake by the number of household members [17]. Daily intakes of milk [and milk products; in grams (g)], total calcium [in milligrams (mg)], protein (g), fat (g) and energy [in kilocalories (kcal)] were estimated. Adult diet was measured by food-frequency questionnaires. To reduce measurement error, responses were averaged from the 1997 and 2002 questionnaires in Boyd Orr; and from phases I to III in CaPS. Daily intakes of total calcium (mg), protein (g), fat (g) and energy (kcal) were estimated and converted into standardised z-scores. Daily milk intake did not form a continuous distribution, so the mean amounts were split into four groups ranging from lowest to highest milk intake: none, ½ imperial pint (284 g) or less, ½ pint to one pint (568 g) and more than one pint.

Potential confounders

In Boyd Orr, childhood socio-economic position was determined from the occupation of the male head of the household. Weekly household income and food expenditure in childhood was calculated per head per week in shillings. For Boyd Orr men, adult social class corresponded to their main occupation during their working lives. For women, the social class of their spouse or partner was used, if available, otherwise their own occupation was used. In CaPS, social class in adulthood was based on participants' present or last job at phase II (1984–88). Information on major co-morbidities was collected (stroke, cancer, diabetes and angina) and the adult body mass index (BMI) was derived from height and weight measurements [weight (kg)/height (m)^2].

Statistical methods

Analyses were performed in Stata version 11. Normality of variables was assessed and transformed as appropriate. The dietary variables were converted to standardised z-scores to enable comparison for an equivalent one SD change in each dietary measure. Energy-adjusted variables were computed using the residuals method [22]. Linear regression models investigated associations of diet with log-transformed get-up and go times. Regression coefficients were multiplied by 100 to represent the percentage change in walk time [23]. A *negative* estimate of percentage change represents a *faster* walking time per unit increase in dietary variable and a *positive* coefficient of percentage change represents a *slower* walking time. Over a third of participants achieved the maximum balance of 30 s; therefore, the flamingo test was dichotomised at the lowest 20% of performers, using a cut-point of 5 s. The flamingo test was modelled using logistic regression, with the outcome being unable to balance for 5 s (termed 'poor balance' in the text). Non-linear associations were investigated by including quadratic terms in the models. In Boyd Orr, robust standard errors were calculated to account for clustering of siblings within families. Fully adjusted models controlled for: age, sex, centre, socio-economic circumstances, energy intake, adult BMI and co-morbidities. Model diagnostics were carried out by viewing plots of residuals from the regression models. When there was no evidence of an interaction between cohorts ($P > 0.1$) data were across studies pooled.

Results

In Boyd Orr, the physical performance tests were carried out when the men and women were a mean age of 70.7 years (range 63–83 years) (Table 1). CaPS men were slightly older at the time of the physical performance tests (mean age of 75.3; range 66–86 years). Childhood total energy intake was positively correlated with all the other aspects of childhood diet (Pearson correlation coefficients $r = 0.51$ with milk, 0.69 with calcium, 0.92 with protein and 0.77 with fat; see the Supplementary data available in *Age and Ageing* online, Appendix, Table S1). Childhood milk consumption was positively correlated with total protein, calcium and fat intakes ($r = 0.58$, 0.87 and 0.40, respectively). Components of diet in childhood compared with diet in adulthood were only weakly correlated with each other (Supplementary data are available in *Age and Ageing* online, Table S2). Adult consumptions of milk, calcium, protein, fat and total energy consumption were positively correlated with each other (Supplementary data are available in *Age and Ageing* online, Table S3). There were patterns consistent with dose-response associations for all the standardised components of childhood diet by childhood social factors (Supplementary data are available in *Age and Ageing* online, Table S4): families from higher occupational social classes, those with higher family incomes and those with higher expenditure on food consumed more milk, calcium, protein, fat and calories (all $P < 0.01$).

Childhood diet and walking times

In the fully adjusted model, a higher childhood milk intake was associated with 5% faster walking times (95% CI: 1 to 9 faster; $P = 0.02$) per SD increase in natural log of milk consumption (Table 2). When three influential observations

Table 1. Characteristics of study members

	Mean (SD); median (quartiles)[a]; or %			
	n	Boyd Orr	*n*	CaPS
Outcomes				
Get-up and go test (s)[a]	405	9.3 (8.2, 10.8)	1,114	10.3 (9.0, 12.2)
Flamingo test (balance <5 s)	81	20%	290	26%
Exposures				
Childhood diet (per head per day)				
Milk (g)[a]	403	277 (179, 429)		
Calcium (mg)[a]	403	597 (449, 786)		
Protein (g)[a]	403	64 (53, 76)		
Fat (g)	403	86 (27)		
Total energy (kcal)[a]	403	2,259 (1,868, 2,651)		
Adult diet				
Calcium (mg)	405	1,135 (370)	1,190	926 (219)
Protein (g)	405	90 (24)	1,193	72 (14)
Fat (g)	405	78 (29)	1,192	87 (22)
Total energy (kcal)	402	2,235 (648)	1,190	2,109 (452)
Milk group: none	11	3%	130	11%
Less than half a pint	101	25%	621	52%
Half a pint to a pint	226	56%	398	33%
More than a pint	67	17%	44	4%
Potential confounders				
Age at performance tests (years)	405	70.7 (4.3)	1,195	75.3 (4.3)
Sex (male)	182	45%	1,195	100%
Research centre				
Aberdeen	88	22%		
Dundee	84	21%		
London and Bristol	190	47%		
Wisbech	43	11%		
Location				
Clinic	392	97%	1,053	88%
Home visit	13	3%	142	12%
Childhood social class				
High (I, II and III)	125	31%		
Low (IV, V, other[b], unemployed)	280	69%		
Childhood family income[c]				
<10 shillings	245	61%		
10 to <15 shillings	96	24%		
15 to <20 shillings	31	8%		
≥20 shillings	29	7%		
Childhood family food expenditure[c]				
<5 shillings	179	44%		
5 to <7 shillings	126	31%		
7 to <9 shillings	60	15%		
≥9 shillings	39	10%		
Adult occupational social class				
I/II	28	7%	77	8%
III NM[d]	}97	24%	55	6%
III M[d]			591	64%
IV/V/other[b]	192	48%	166	18%
Unemployed	82	21%	39	4%
Adult body mass index	405	27.5 (4.4)	1,178	27.8 (4.1)
Stroke	22	5.5%	131	11.9%
Cancer	58	14.3%	150	13.6%
Diabetes	39	9.7%	158	14.4%
Angina	75	18.7%	236	21.7%

Sample sizes vary due to missing data. SD, standard deviation.

[a] Median and quartiles are presented, due to skewed distributions.

[b] Armed forces or unclassifiable.

[c] Family income and food expenditure per head per week in shillings.

[d] Data are not available to distinguish between the adult occupational social classes III manual (M) and III non-manual (NM) in Boyd Orr.

Table 2. Associations of standardised aspects of childhood diet and physical performance in old age, results from the Boyd Orr cohort

Diet (per SD)[a]	Get-up and go test ($n = 394$)			Flamingo test ($n = 399$)		
	%[b]	95% CI	*P*-value	OR	95% CI	*P*-value
Controlling for age and sex						
Milk	−4	(−7 to −1)	0.02	0.86	(0.65 to 1.13)	0.3
Calcium	−3	(−6 to 0)	0.07	0.92	(0.68 to 1.24)	0.6
Protein	0	(−3 to 3)	1.0	0.88	(0.66 to 1.17)	0.4
Fat	−3	(−5 to 0)	0.05	0.87	(0.66 to 1.15)	0.3
Energy	0	(−2 to 3)	0.9	0.93	(0.70 to 1.24)	0.6
Additionally controlling for research centre and childhood socio-economic circumstances[c]						
Milk	−4	(−9 to 0)	0.07	0.77	(0.54 to 1.10)	0.2
Calcium	−2	(−6 to 2)	0.3	0.86	(0.57 to 1.28)	0.5
Protein	3	(−1 to 6)	0.1	0.81	(0.55 to 1.19)	0.3
Fat	0	(−4 to 4)	1.0	1.05	(0.66 to 1.67)	0.8
Energy	3	(−1 to 6)	0.1	0.95	(0.62 to 1.45)	0.8
Additionally controlling for energy						
Milk	−5	(−9 to −1)	0.02	0.79	(0.60 to 1.05)	0.1
Calcium	−4	(−8 to 0)	0.06	0.87	(0.64 to 1.17)	0.4
Protein	1	(−2 to 3)	0.7	0.73	(0.55 to 0.96)	0.02
Fat	−3	(−7 to 0)	0.07	1.14	(0.80 to 1.62)	0.5
Additionally controlling for adult BMI and co-morbidities						
Milk	−5	(−9 to −1)	0.02	0.75	(0.55 to 1.02)	0.07
Calcium	−4	(−8 to 0)	0.03	0.81	(0.58 to 1.12)	0.2
Protein	0	(−3 to 3)	0.8	0.71	(0.54 to 0.92)	0.01
Fat	−3	(−6 to 0)	0.05	1.10	(0.78 to 1.57)	0.6

[a] The values of SDs were 215 g for milk; 273 mg for calcium; 17 g for protein; 27 g for fat and 562 kcal for energy, although these should be interpreted with caution as milk, calcium, protein and energy were natural log-transformed before standardisation.

[b] The natural log transformation was used on the get-up and go test. Coefficients are interpreted as % change in walk time per SD change in the diet variable; a positive % change indicates a slower walk time; a negative % change indicates a faster walk time.

[c] Childhood social class, childhood family income and childhood family food expenditure.

from individual subjects were removed, evidence of a positive association remained (coefficient: 3%; 0 to 5). There was no evidence of a non-linear effect of milk on the get-up and go test (*P* for quadratic term = 0.2). Putting these effect sizes into context, the median time to complete the get-up and go test for people in the bottom third of childhood milk consumption was 9.7 s; those in the top third of milk consumption were on average half a second faster, with a median time of 9.2 s.

In fully adjusted models, the childhood calcium intake (4% faster; 0 to 8; $P = 0.03$) and fat intake (3% faster; 0 to 6; $P = 0.05$) were weakly associated with a better performance in the get-up and go test, but there was no association for protein intake.

Childhood diet and balance ability

In the minimally adjusted model, the odds ratio for poor balance per SD increase in natural log of the childhood milk intake was 0.86 (0.65 to 1.13; $P = 0.3$; Table 2), representing a 14% reduction in risk (95% CI: 36% reduction, 13% increase) of being unable to balance for 5 s per SD. When controlling for childhood socio-economic circumstances, research centre, energy intake, adult BMI and co-morbidities, the inverse association with poor balance became stronger (0.75; 0.55 to 1.02; $P = 0.07$). There was no evidence of a non-linear effect of milk on the flamingo test (*P* for quadratic term = 0.2). There was no association between childhood calcium, fat or total energy consumption and old age balance ability in any of the models. A 1 SD increase in the childhood protein intake was associated with 29% lower odds of poor balance (OR: 0.71; 0.54 to 0.92; $P = 0.01$), in the fully adjusted model.

Adult diet and walking times

There was no evidence that associations of adult dietary variables with the get-up and go test differed between cohorts (Boyd Orr and CaPS) (*P* for interaction ranged from 0.2 to 0.9), hence the data were pooled across studies (Table 3). There was no evidence of associations of milk, calcium or fat intake in adulthood with walking times. In fully adjusted models, a 1 SD increase in adult protein intake was associated with 2% faster walking times (1 to 3; $P = 0.008$).

Adult diet and balance ability

In CaPS, each increase in the milk group (increase of half a pint milk/day) was associated with 21% lower odds of poor balance (OR in fully adjusted model 0.79; 0.62 to 1.01; $P = 0.06$). The odds ratio in Boyd Orr, however, was in the opposite direction (1.19; 0.76 to 1.90; $P = 0.4$). There was evidence of heterogeneity between studies ($P = 0.02$), hence data were not pooled for this exposure. There was no evidence of associations of calcium or protein intake in adulthood with balance ability in either cohort, or when data were pooled across the cohorts (Table 3). In Boyd Orr, fat intake was associated with higher odds of poor balance in fully adjusted models (OR: 1.37; 1.00 to 1.86; $P = 0.05$), but the odds ratio in CaPS was in the opposite direction (0.83; 0.67 to 1.03; $P = 0.09$). There was evidence of heterogeneity between studies ($P = 0.08$), hence data were not pooled.

Childhood socio-economic circumstances and physical performance in old age, controlling for childhood milk intake

A previous analysis of the Boyd Orr and CaPS showed that people from more deprived childhood circumstances had slower walking times and reduced balance ability in old age [9].

These associations were attenuated when childhood milk consumption was included in models (Supplementary data are available in *Age and Ageing* online, Table S5). For example, people from a non-manual childhood social class

Table 3. Associations between adult diet and physical performance in old age, results from Boyd Orr and CaPS

Diet, per SD or milk group	Get-up and go test									Flamingo test								
	Boyd Orr (*n* = 392)			CaPS (*n* = 973)			Combined (*n* = 1,365)			Boyd Orr (*n* = 395)			CaPS (*n* = 979)			Combined[a] (*n* = 1,374)		
	%[b]	95% CI	*P*-value	%[b]	95% CI	*P*-value	%[b]	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Controlling for age and sex																		
Milk[c]	2	(−2 to 6)	0.3	−1	(−3 to 1)	0.3	−1	(−2 to 1)	0.4	1.20	(0.80 to 1.81)	0.4	0.80	(0.64 to 1.00)	0.05	[a]		
Calcium	1	(−2 to 3)	0.7	1	(−1 to 2)	0.4	1	(−1 to 2)	0.4	1.04	(0.83 to 1.31)	0.7	0.92	(0.79 to 1.07)	0.3	0.94	(0.82 to 1.09)	0.3
Protein	0	(−2 to 3)	0.9	0	(−1 to 2)	0.6	0	(−1 to 2)	0.6	1.05	(0.81 to 1.35)	0.7	0.92	(0.79 to 1.08)	0.3	0.95	(0.83 to 1.08)	0.4
Fat	2	(−1 to 5)	0.14	1	(−1 to 2)	0.5	1	(0 to 2)	0.14	1.15	(0.86 to 1.52)	0.3	0.87	(0.74 to 1.03)	0.1	[a]		
Energy	1	(−2 to 4)	0.4	2	(0 to 3)	0.05	1	(0 to 3)	0.04	1.05	(0.81 to 1.36)	0.7	0.93	(0.79 to 1.09)	0.4	0.95	(0.83 to 1.09)	0.5
Additionally controlling for research centre and adult socio-economic position																		
Milk[c]	2	(−2 to 6)	0.3	−1	(−3 to 1)	0.3	0	(−2 to 1)	0.6	1.20	(0.80 to 1.81)	0.4	0.81	(0.64 to 1.01)	0.06	[a]		
Calcium	1	(−2 to 3)	0.7	0	(−1 to 2)	0.8	0	(−1 to 2)	0.7	1.00	(0.80 to 1.26)	1.0	0.92	(0.78 to 1.08)	0.3	0.92	(0.81 to 1.06)	0.2
Protein	0	(−2 to 3)	0.8	0	(−1 to 2)	0.9	0	(−1 to 1)	0.8	1.02	(0.80 to 1.31)	0.8	0.93	(0.79 to 1.09)	0.4	0.94	(0.82 to 1.07)	0.3
Fat	2	(−1 to 5)	0.10	0	(−2 to 2)	0.9	1	(−1 to 2)	0.2	1.13	(0.85 to 1.51)	0.4	0.89	(0.75 to 1.05)	0.2	[a]		
Energy	1	(−1 to 4)	0.3	1	(−1 to 3)	0.3	1	(0 to 2)	0.1	1.02	(0.78 to 1.33)	0.9	0.94	(0.79 to 1.11)	0.4	0.97	(0.85 to 1.12)	0.7
Additionally controlling for energy intake																		
Milk[c]	1	(−2 to 5)	0.5	−2	(−4 to 0)	0.13	−1	(−3 to 1)	0.3	1.19	(0.77 to 1.84)	0.4	0.81	(0.64 to 1.03)	0.08	[a]		
Calcium	−1	(−3 to 2)	0.6	0	(−2 to 1)	0.7	−1	(−2 to 1)	0.3	0.98	(0.77 to 1.24)	0.8	0.93	(0.79 to 1.10)	0.4	0.94	(0.82 to 1.08)	0.4
Protein	−2	(−4 to 0)	0.09	−1	(−3 to 1)	0.2	−1	(−3 to 0)	0.06	1.00	(0.77 to 1.30)	1.0	0.94	(0.78 to 1.14)	0.5	0.97	(0.83 to 1.13)	0.7
Fat	3	(0 to 6)	0.05	−1	(−3 to 1)	0.2	0	(−1 to 2)	0.9	1.28	(0.96 to 1.72)	0.09	0.87	(0.70 to 1.07)	0.2	[a]		
Additionally controlling for adult BMI and co-morbidities																		
Milk[c]	1	(−2 to 5)	0.4	−1	(−3 to 1)	0.2	0	(−2 to 1)	0.6	1.19	(0.76 to 1.90)	0.4	0.79	(0.62 to 1.01)	0.06	[a]		
Calcium	−1	(−3 to 2)	0.5	0	(−2 to 1)	0.5	−1	(−2 to 1)	0.3	0.94	(0.73 to 1.22)	0.7	0.91	(0.76 to 1.08)	0.3	0.92	(0.80 to 1.07)	0.3
Protein	−2	(−5 to 0)	0.04	−2	(−3 to 0)	0.07	−2	(−3 to −1)	0.008	0.97	(0.75 to 1.27)	0.8	0.86	(0.71 to 1.06)	0.2	0.92	(0.79 to 1.08)	0.3
Fat	3	(0 to 5)	0.04	−2	(−3 to 0)	0.1	0	(−1 to 1)	1.0	1.37	(1.00 to 1.86)	0.05	0.83	(0.67 to 1.03)	0.09	[a]		

[a] Data were combined when there was no evidence that associations differed between cohorts (*P* interaction > 0.1), *P* for interaction for the flamingo test outcome: milk intake = 0.02, fat = 0.08 intake.

[b] The natural log transformation was used on the get-up and go test. Coefficients are interpreted as % change in time per SD change in the diet variable, except for: milk, where trend per increase in the group of consumption is presented; a positive % change indicates a slower walk time; a negative % change indicates a faster walk time. OR = odds ratios for poor balance.

[c] Milk groups range from lowest to highest intake, this was: none, ½ pint or less (284 g), ½ pint to one pint (568 g), more than one pint. The values of SDs were 373 mg for calcium; 25 g for protein; 30 g for fat and 697 kcal for energy in Boyd Orr and 219 mg for calcium; 14 g for protein; 22 g for fat and 452 kcal for energy in CaPS.

had walking times that were 5% faster than manual childhood social class (95% CI: 1 slower to 10% faster); the coefficient was attenuated to 2% faster (95% CI: 4 slower to 8% faster) when additionally controlling for childhood milk intake.

Discussion

This is the first study to show a positive association of childhood milk intake with physical performance in old age. A 1 SD increase in log transformed childhood milk intake was associated with 5% faster walking times from the get-up and go test. Childhood milk consumption partially attenuated previously reported associations of childhood social class with physical performance [9]. Higher intakes of calcium in childhood were associated with faster times to complete the get-up and go test, and higher intakes of protein in childhood were associated with lower odds of poor balance. In adulthood, higher levels of protein intake were associated with faster walking times, in fully adjusted models. Adult milk consumption was associated with lower odds of poor balance in the prospective Caerphilly cohort, but not in the cross-sectional Boyd Orr data.

To our knowledge, no other studies have examined childhood diet with objective measures of physical performance in old age. Associations of childhood milk with improved physical performance could be mediated through peak bone mineral density. Childhood milk intake was associated with a better bone mineral density in adulthood [24, 25], which in turn was associated with the get-up and go test [26]. Alternatively, milk intake could promote brain development, and lifetime cognitive performance has been positively related to physical performance in mid-life [27].

A study examining adult diet measured at the same time as other health outcomes showed insufficient dietary protein and energy were associated with frailty [28], where the definition of frailty included an aspect of muscle strength and walking speed. A cross-sectional study found that muscle strength was positively related to protein intakes in women and to the protein density of the diet in men and women [6]. Percentage energy from protein was also associated with faster 3-m walking times [5]. In line with our findings in the prospective Caerphilly cohort, increased protein intake in mid-life was associated with faster walking times in old age. In a large prospective study, protein intake was associated with a self-reported measure of frailty after 3 years' follow-up [29]. Adult dietary protein intake may preserve both muscle mass and bone mass in older people [30].

A key strength of this study is that childhood diet in Boyd Orr was measured long before the occurrence of physical function outcomes in old age, thus avoiding the problem of recall bias. The estimates of childhood milk consumption were reliable: the intra-class correlation coefficient for milk intake was 0.85 in a substudy [31]. It is important to interpret the results in light of the study limitations. Childhood diet was based on household rather than individual consumption. It is likely that milk intake, more so than other foods, were consumed by the children of the families and misclassification resulting from imprecise diet measurements would probably have been non-systematic, attenuating rather than explaining the associations observed. Despite this limitation, findings for childhood diet in this cohort have been observed with cancer risk [32] and cardiovascular mortality [12]. Since the 1930s there has been a shift away from the consumption of whole-fat, to semi-skimmed and skimmed, milk. It is not known whether reduced-fat milk and milk products provide the same advantage as the consumption of whole milk. We did not always observe consistent findings between cohorts, e.g. in Boyd Orr, adult fat intake was associated with higher odds of poor balance but the odds ratio in CaPS was in the opposite direction. This could be due to the timing of measurement: in CaPS adult diet was measured prospectively (phases I–III), a couple of decades prior to the assessment of physical performance, whereas in Boyd Orr diet was measured at the same time as physical performance (cross sectionally). Alternatively associations may have arisen by chance, although we restricted the diet measures to milk and components of milk to avoid excessive multiple testing.

Our study suggests that a benefit of milk consumption on health in old age may be extended to intake in childhood. However, any potential public health advice should also consider suggested harmful effects of milk, such as a possible positive associations of calcium with prostate cancer [33]. The effect sizes appear small, but subtle differences in physical ability could greatly impact on activities in daily life, e.g. whether older people have enough time to cross a road at a timed pedestrian crossing.

Conclusion

If these findings are replicated, they suggest a public health benefit of childhood milk intake on physical function in old age, although any interventions would need to carefully assess potentially harmful effects of milk on some outcomes (such as prostate cancer).

Key points

- This is the first study to show a positive association of childhood milk intake with physical performance in old age.
- Childhood milk consumption partially attenuated associations of childhood social class with physical performance.
- In adulthood, higher levels of protein intake were associated with faster walking times.

Acknowledgements

We are very grateful to all cohort members who participated in the studies. The current analysis was funded by a Research into Ageing PhD studentship to K.B. (reference: 302). The Caerphilly Prospective Study (CaPS) was undertaken by the former MRC Epidemiology Unit (South Wales) and the School of Social and Community Medicine, University of Bristol, acts as the data custodian. CaPS phase 5 follow-up was funded by a grant from the Alzheimer's Society. The Boyd Orr cohort has received funding from the Medical Research Council, the World Cancer Research Fund, Research into Ageing, United Kingdom Survivors, the Economic and Social Research Council, the Wellcome Trust, and the British Heart Foundation. The Boyd Orr follow-up clinics in 2002 were funded within a Wellcome Research Training Fellowship in Clinical Epidemiology to R.M.M. (GR063779FR). D.G. is an NIHR senior investigator.

Conflicts of interest

None declared.

Ethical approval

Ethical approval was obtained from the Multicenter Research Ethics Committee for Scotland (Boyd Orr) and the Ethics Committee of the Division of Medicine of the former South Glamorgan Area Health Authority (CaPS).

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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Received 14 December 2011; accepted in revised form 23 February 2012

Age and Ageing 2012; **41:** 784–789
doi: 10.1093/ageing/afs073

Predicting readmissions: poor performance of the LACE index in an older UK population

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Abstract

Introduction: interventions to prevent hospital readmission depend on the identification of patients at risk. The LACE index predicts readmission (and death) and is in clinical use internationally. The LACE index was investigated in an older UK population.

Methods: randomly selected alive-discharge episodes were reviewed. A LACE score was calculated for each patient and assessed using receiver operator characteristic (ROC) curves. A logistic regression model was constructed, compared with the LACE and validated in a separate population.

Results: a total of 507 patients were included with a mean (SD) age of 85 (6.5) years; 17.8% were readmitted and 4.5% died within 30 days. The median LACE score of those readmitted compared with those who were not was 12.5 versus 12 ($P = 0.13$). The Lace index was only a fair predictor of both 30-day readmission and death with *c*-statistics of 0.55 and 0.70, respectively. Only the emergency department visit was an independent predictor of readmission, with a *c*-statistic of 0.61 for readmission. In a validation cohort of 507 cases, the *c*-statistic of the regression model was 0.57.