

Nutrition and lifestyle in relation to bowel movement frequency: a cross-sectional study of 20 630 men and women in EPIC–Oxford

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Abstract

Objective: To investigate the relationships between nutritional and lifestyle factors and bowel movement frequency.

Design: Cross-sectional analysis using data from a prospective study. Mean numbers of bowel movements were calculated in relation to a range of factors. In addition, individuals were categorised according to frequency of bowel movements: fewer than 7 per week ('less than daily') versus 7 or more per week ('daily'), and odds ratios were calculated from logistic regression models. Results for each factor were adjusted for the other factors under consideration.

Setting: The European Prospective Investigation into Cancer and Nutrition, Oxford cohort (EPIC–Oxford), UK.

Participants: In total, 20 630 men and women aged 22–97 years at recruitment. Thirty per cent of the subjects were vegetarians or vegans.

Results: Women had fewer bowel movements on average than men, and were less likely to have daily bowel movements. Mean bowel movement frequency was higher in vegetarians (10.5 in men, 9.1 in women) and especially in vegans (11.6 in men, 10.5 in women) compared with participants who ate meat (9.5 in men, 8.2 in women). There were also significant positive associations between bowel movement frequency and body mass index (BMI), intakes of dietary fibre and non-alcoholic fluids, for both men and women. Vigorous exercise was positively associated with bowel movement frequency in women although results for men were less clear. Alcohol intake was positively associated with bowel movement frequency in men but not in women.

Conclusion: Being vegetarian and especially vegan is strongly associated with a higher frequency of bowel movements. Moreover, having a high intake of dietary fibre and fluids and a high BMI are associated with an increase in frequency of bowel movements.

Keywords
Constipation
Bowel movements
Risk factors
Lifestyle
Nutrition

Constipation is a common condition, especially in Western countries^{1,2}, that might be a risk factor for colorectal cancer^{3,4}. A low bowel movement frequency is one of the criteria for diagnosing constipation⁵. However, the determinants of bowel movement frequency are not well understood. The aim of the present study was to investigate nutritional and lifestyle factors that are associated with bowel movement frequency, using cross-sectional data from a prospective study in the UK that includes a large number of vegetarians and vegans.

Participants and methods

Participants

EPIC–Oxford is a cohort study forming part of the European Prospective Investigation into Cancer and Nutrition (EPIC)^{6,7}. Between 1993 and 1999, 65 429 men

and women aged 20 to 97 years were recruited from across the UK into EPIC–Oxford through general practice surgeries, vegetarian and health food magazines, the Vegetarian Society, the Vegan Society, and from friends and relatives of the participants. Baseline characteristics of the participants have been described elsewhere⁸.

The follow-up questionnaire

The information used for this analysis was derived from a short follow-up questionnaire, mailed to participants approximately five years after recruitment, which collected information on various aspects of lifestyle and nutrition that may be related to cancer risk and that may change over time. The questionnaire also included two questions relating to bowel movements: 'About how many bowel movements do you have each week?' and 'How often do you take laxatives?'

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Statistical analysis

We used two separate outcome variables in the analysis: the number of bowel movements per week, and a dichotomous variable defined so as to compare participants having 7 or more bowel movements per week with those having fewer than 7 bowel movements per week. The dichotomous variable is subsequently referred to as 'daily bowel movements'.

Analysis of variance and logistic regression were used to investigate the association between selected nutritional and lifestyle factors and bowel movement frequency, and daily bowel movements, respectively. The factors investigated were: diet group, body mass index (BMI), fibre intake, non-alcoholic fluid intake, amount of vigorous exercise, employment status, smoking, alcohol consumption and, for women only, menopausal status and current use of hormone replacement therapy (HRT). Dietary fibre intake was estimated as non-starch polysaccharides (NSP)⁹ from the intake of fibre-containing foods listed on the follow-up questionnaire. Portion sizes for these foods were derived from the Ministry of Agriculture, Fisheries and Food¹⁰ and NSP content from the fifth edition of *McCance & Widdowson's The Composition of Foods*¹¹.

Participants taking laxatives and/or other drugs that could influence the frequency of bowel movements were excluded from the analysis, as were those who reported having none or more than 21 bowel movements per week. The analysis was further restricted to participants with complete information for each of the variables of interest, leaving data for 20 630 individuals. All analyses were performed using Stata software¹².

Results

Figure 1 shows the distribution of the number of bowel movements per week among the 4654 men and 15 976 women included in the analysis. The distribution is clearly non-normal, with a distinct peak at 7 per week containing more than 40% of the population, and smaller peaks at 10 and 14 per week.

Characteristics of the participants are given in Table 1. Median age was 51.7 years for men and 48.3 years for

Table 1 Characteristics of the study participants

Characteristic	Men (n = 4654)	Women (n = 15 976)
Median age (years)	51.7	48.3
Mean BMI (kg m ⁻²)	25.1	25.6
Diet group (%)		
Meat-eater	53.7	53.8
Fish-eater	12.3	16.9
Vegetarian	27.0	25.9
Vegan	7.0	3.3
Mean fibre intake (g day ⁻¹)	17.3	15.9
Mean fluid* intake (l day ⁻¹)	0.7	0.8
Mean alcohol intake (g day ⁻¹)	14.8	8.4
Hours per week of vigorous exercise (%)		
None	20.4	27.1
1–3	48.9	47.8
4–6	18.5	15.3
7 or more	12.2	9.8
Employment status (%)		
Full-time employment	59.5	37.5
Part-time employment	10.5	30.7
None	30.0	31.8
Current smoker (%)	12.5	12.7
Menopausal status (%)		
Premenopausal	–	48.5
Postmenopausal	–	43.2
Unsure	–	8.2
Current use of HRT (%)	–	13.8
Mean number of bowel movements per week	9.9	8.6
Daily bowel movements (%)	93.1	83.2

BMI – body mass index; HRT – hormone replacement therapy.

*Water and pure fruit juices (excludes milk, tea, coffee, soft drinks and alcoholic drinks).

women. Fifty-four per cent of women were meat-eaters, 17% reported eating fish but not meat, 26% were vegetarians and 3% were vegans. Among men, the proportions in the four diet groups were broadly similar, except that the proportion of vegans was higher (7% vs. 3%).

The mean number of bowel movements per week was 9.9 for men and 8.6 for women, and 93% of men and 83% of women reported having daily bowel movements (Table 1). These differences between men and women were highly statistically significant ($P < 0.001$) after adjusting for age, although there was some evidence that the differences became less marked with increasing age (results not shown).

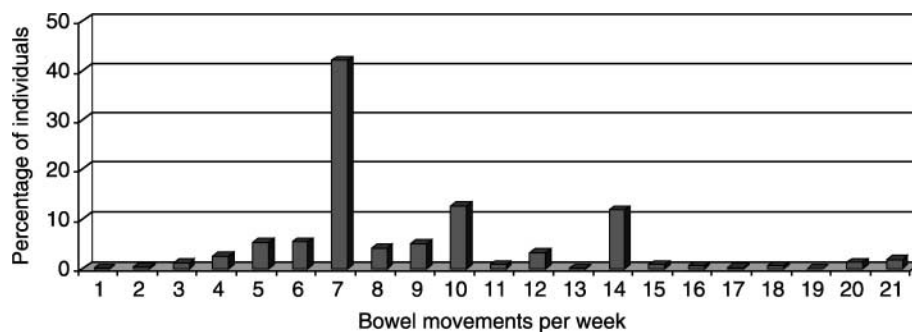


Fig. 1 Distribution of the number of bowel movements per week in the study population

Table 2 gives the mean number of bowel movements per week for men and women in each category of nutritional and lifestyle factors included in the analysis, adjusted for each other factor. Analogously, Table 3 presents the odds ratios (ORs) for having daily bowel movements in each category of the nutritional and lifestyle factors, again adjusted for each other factor.

Age

There were no differences in either the mean number of weekly bowel movements or the odds of having daily bowel movements by age group for men. However, both the mean number of weekly bowel movements and the odds of having daily bowel movements increased steadily with age for women ($P < 0.05$). Compared with women aged 20–29 years, the OR for daily bowel movements in women aged > 70 years was 2.22 (95% confidence interval (CI): 1.68–2.93). Extreme values of bowel movement frequency (< 4 or > 12 times per week) became less common with increasing age, with an increasing proportion of people reporting 7 bowel movements per week (results not shown).

BMI

There was a positive association between BMI and the mean number of weekly bowel movements for both men and women ($P < 0.001$ for trend for both sexes). However, there was no clear association between BMI and having daily bowel movements.

Diet group

There were clear and highly significant differences in bowel movement frequency between the four diet groups for both men and women, with vegetarians and especially vegans having more frequent bowel movements than meat-eaters and fish-eaters. In men, the adjusted mean number of weekly bowel movements increased from 9.5 in meat-eaters to 11.6 in vegans, and in women the mean increased from 8.2 in meat-eaters to 10.5 in vegans. The odds of having daily bowel movements for vegans compared with meat-eaters was 2.49 (95% CI: 1.33–4.64) for men and 3.59 (95% CI: 2.50–5.16) for women.

Fibre intake

There was a steady increase in the mean number of bowel movements per week with increasing intake of dietary fibre for both men and women ($P < 0.001$ for trend for both sexes). The odds of having daily bowel movements also increased with increasing fibre intake for both men and women, with an OR in the highest compared with the lowest intake category of 2.00 (95% CI: 1.38–2.90) in men and 1.43 (95% CI: 1.24–1.64) in women.

Fluid intake

There was a steady increase in the mean number of bowel movements per week with increasing intake of water and

juices for both men and women ($P < 0.001$ for trend for both sexes), and a corresponding increase in the odds of having daily bowel movements. In men, the OR in the highest compared with the lowest fluid intake category was 2.59 (95% CI: 1.31–5.14) whereas in women it was 1.70 (95% CI: 1.41–2.05).

Alcohol intake

There was a positive association between alcohol intake and bowel movement frequency in men ($P = 0.004$ for trend) but not in women. The odds of having daily bowel movements increased with increasing alcohol intake in men ($P < 0.001$ for trend); the OR for men consuming 20 g or more of ethanol per day compared with men consuming no alcohol was 1.94 (95% CI: 1.36–2.76). No significant association was observed in women.

Physical activity

There was a positive association between the amount of vigorous physical exercise and the mean number of bowel movements per week ($P < 0.001$ for both sexes). The odds of having daily bowel movements was noticeably higher among women who exercised vigorously for 7 h or more per week compared with women who did not exercise vigorously at all (OR 1.70, 95% CI: 1.42–2.03). However no significant association was observed in men.

Employment status

There was a weak association between employment status and the mean number of weekly bowel movements for both men and women ($P < 0.05$ for heterogeneity for both sexes). However, the differences in the means were relatively small, and the direction of the association was different between the two genders. There were no differences in the odds of having daily bowel movements for men, although women not having a paid job and those in part-time employment were significantly more likely to have daily bowel movements than full-time employees.

Smoking

There was no association between smoking and either the mean number of bowel movements per week or the odds of having daily bowel movements, for either sex.

Menopausal status and current HRT use

There was no association between menopausal status and either the mean number of bowel movements per week or the odds of having daily bowel movements. With regard to current HRT use, there was no association with the mean number of bowel movements per week, although the odds of having daily bowel movements was slightly lower in women who were currently using HRT (OR 0.88, 95% CI: 0.77–1.00).

Table 2 Mean number of bowel movements per week in relation to selected nutritional and lifestyle factors

	Men			Women		
	<i>n</i>	Adjusted mean*	95% CI	<i>n</i>	Adjusted mean*	95% CI
Age (years)						
20–39	739	10.0	9.7–10.3	3648	8.4	8.3–8.6
40–49	1209	9.8	9.5–10.0	4300	8.5	8.3–8.6
50–59	1256	9.9	9.7–10.1	4536	8.7	8.6–8.8
60–69	825	9.9	9.6–10.2	2395	8.8	8.6–9.0
> 70	625	10.2	9.8–10.5	1097	8.8	8.5–9.0
<i>P</i> for trend		0.573			0.039	
BMI (kg m ⁻²)						
< 20	273	9.5	9.0–10.0	1676	8.4	8.3–8.6
20.0–22.4	994	9.5	9.3–9.8	4512	8.4	8.3–8.5
22.5–24.9	1494	9.9	9.7–10.1	4059	8.5	8.4–8.6
25.0–29.9	1489	10.2	10.0–10.4	3490	8.8	8.7–8.9
> 30	404	10.5	10.1–10.9	2239	8.9	8.7–9.0
<i>P</i> for trend		<0.001			<0.001	
Diet group						
Meat-eater	2500	9.5	9.3–9.6	8598	8.2	8.1–8.3
Fish-eater	572	9.8	9.5–10.1	2707	8.7	8.6–8.8
Vegetarian	1257	10.5	10.2–10.7	4139	9.1	8.9–9.2
Vegan	325	11.6	11.2–12.1	532	10.5	10.2–10.8
<i>P</i> for heterogeneity		<0.001			<0.001	
Fibre intake (g day ⁻¹)						
< 11.3	786	9.6	9.3–9.9	3333	8.4	8.3–8.5
11.3–14.3	824	9.8	9.5–10.0	3300	8.5	8.4–8.7
14.4–17.1	835	9.8	9.5–10.1	3294	8.7	8.6–8.8
17.2–20.9	958	10.2	9.9–10.4	3171	8.6	8.5–8.8
> 20.9	1251	10.2	9.9–10.4	2878	8.7	8.6–8.8
<i>P</i> for trend		<0.001			<0.001	
Fluid intake† (l day ⁻¹)						
< 0.3	924	9.7	9.5–10.0	2153	8.3	8.2–8.4
0.3–0.6	1951	9.8	9.7–10.0	5956	8.4	8.3–8.5
0.7–1.4	1459	10.0	9.8–10.2	6305	8.7	8.6–8.8
> 1.4	320	10.8	10.4–11.2	1562	9.3	9.1–9.5
<i>P</i> for trend		<0.001			<0.001	
Alcohol intake (g day ⁻¹)						
None	847	9.8	9.5–10.1	3773	8.9	8.7–9.0
1–9	1357	9.7	9.5–10.0	6963	8.4	8.4–8.5
10–19	1075	9.9	9.7–10.2	3456	8.5	8.4–8.6
> 20	1375	10.2	10.0–10.4	1784	8.8	8.6–8.9
<i>P</i> for trend		0.004			0.096	
Vigorous exercise (h week ⁻¹)						
None	949	9.6	9.3–9.8	4334	8.4	8.3–8.5
1–3	2275	10.0	9.8–10.1	7633	8.6	8.5–8.7
4–6	861	10.0	9.8–10.3	2448	8.7	8.6–8.9
7 or more	569	10.3	10.0–10.7	1561	9.0	8.8–9.1
<i>P</i> for trend		<0.001			<0.001	
Employment status						
Full-time	2769	10.1	9.9–10.3	5992	8.5	8.4–8.6
Part-time	489	9.9	9.6–10.3	4904	8.6	8.6–8.7
None	1396	9.6	9.3–9.8	5080	8.7	8.5–8.8
<i>P</i> for heterogeneity		0.018			0.022	
Current smoker						
No	4073	9.9	9.8–10.0	13 946	8.6	8.4–8.7
Yes	581	10.0	9.7–10.3	2030	8.6	8.5–8.7
<i>P</i> for heterogeneity		0.598			0.698	
Menopausal status						
Premenopausal	–	–	–	7767	8.5	8.4–8.6
Postmenopausal	–	–	–	6902	8.6	8.5–8.7
Unsure	–	–	–	1307	8.8	8.6–9.0
<i>P</i> for heterogeneity					0.141	
Current use of HRT						
No	–	–	–	13 777	8.6	8.5–8.7
Yes	–	–	–	2199	8.6	8.4–8.7
<i>P</i> for heterogeneity					0.368	

CI confidence interval; BMI – body mass index; HRT – hormone replacement therapy.

*Mean adjusted for age, diet group, BMI, fibre intake, fluid intake, vigorous exercise, employment status, smoking, alcohol intake and, for women only, menopausal status and current HRT use.

†Water and pure fruit juices (excludes milk, tea, coffee, soft drinks and alcoholic drinks).

Table 3 Odds ratios for having 7 or more bowel movements per week in relation to selected nutritional and life-style factors

	Men			Women		
	<i>n</i>	Multivariate OR*	95% CI	<i>n</i>	Multivariate OR*	95% CI
Age (years)						
20–39	739	1.00		3648	1.00	
40–49	1209	0.99	0.68–1.43	4300	1.23	1.09–1.39
50–59	1256	1.26	0.86–1.86	4536	1.45	1.22–1.73
60–69	825	1.35	0.83–2.21	2395	1.59	1.27–1.99
> 70	625	1.14	0.66–1.96	1097	2.22	1.68–2.93
<i>P</i> for trend		0.285			< 0.001	
BMI (kg m ⁻²)						
< 20	273	1.00		1676	1.00	
20.0–22.4	994	0.93	0.55–1.57	4512	0.91	0.78–1.07
22.5–24.9	1494	0.94	0.57–1.57	4059	0.96	0.82–1.13
25.0–29.9	1489	1.18	0.71–2.00	3490	1.00	0.85–1.18
> 30	404	1.77	0.91–3.47	2239	1.09	0.91–1.30
<i>P</i> for trend		0.019			0.056	
Diet group						
Meat-eater	2500	1.00		8598	1.00	
Fish-eater	572	1.23	0.85–1.78	2707	1.41	1.25–1.60
Vegetarian	1257	1.59	1.17–2.16	4139	1.60	1.43–1.78
Vegan	325	2.49	1.33–4.64	532	3.59	2.50–5.16
<i>P</i> for heterogeneity		0.002			< 0.001	
Fibre intake (g day ⁻¹)						
< 11.3	786	1.00		3333	1.00	
11.3–14.3	824	1.31	0.92–1.87	3300	1.19	1.05–1.34
14.4–17.1	835	1.29	0.90–1.85	3294	1.37	1.21–1.56
17.2–20.9	958	1.40	0.98–2.00	3171	1.39	1.22–1.59
> 20.9	1251	2.00	1.38–2.90	2878	1.43	1.24–1.64
<i>P</i> for trend		0.001			< 0.001	
Fluid intake† (l day ⁻¹)						
< 0.3	924	1.00		2153	1.00	
0.3–0.6	1951	1.18	0.90–1.62	5956	1.18	1.04–1.34
0.7–1.4	1459	1.29	0.92–1.73	6305	1.29	1.14–1.47
> 1.4	320	2.59	1.31–5.14	1562	1.70	1.41–2.05
<i>P</i> for trend		0.014			< 0.001	
Alcohol intake (g day ⁻¹)						
None	847	1.00		3773	1.00	
1–9	1357	1.17	0.85–1.62	6963	0.86	0.77–0.97
10–19	1075	1.74	1.21–2.51	3456	0.94	0.82–1.07
> 20	1375	1.94	1.36–2.76	1784	1.12	0.96–1.32
<i>P</i> for trend		< 0.001			0.173	
Vigorous exercise (h week ⁻¹)						
None	949	1.00		4334	1.00	
1–3	2275	1.07	0.80–1.45	7633	1.15	1.04–1.27
4–6	861	1.40	0.95–2.06	2448	1.18	1.03–1.35
7 or more	569	1.04	0.69–1.57	1561	1.70	1.42–2.03
<i>P</i> for trend		0.378			< 0.001	
Employment status						
Full-time	2769	1.00		5992	1.00	
Part-time	489	1.59	0.99–2.55	4904	1.17	1.05–1.29
None	1396	0.99	0.68–1.45	5080	1.20	1.06–1.36
<i>P</i> for heterogeneity		0.100			0.003	
Current smoker						
No	4073	1.00		13 946	1.00	
Yes	581	1.20	0.83–1.73	2030	0.97	0.85–1.10
<i>P</i> for heterogeneity		0.100			0.003	
Menopausal status						
Premenopausal	–	–	–	7767	1.00	
Postmenopausal	–	–	–	6902	0.99	0.84–1.17
Unsure	–	–	–	1307	0.93	0.85–1.23
<i>P</i> for heterogeneity					0.937	
Current use of HRT						
No	–	–	–	13 777	1.00	
Yes	–	–	–	2199	0.88	0.77–1.00
<i>P</i> for heterogeneity					0.052	

OR – odds ratio; CI – confidence interval; BMI – body mass index; HRT – hormone replacement therapy.
 *Odds ratio adjusted for age, diet group, BMI, fibre intake, fluid intake, vigorous exercise, employment status, smoking, alcohol intake and, for women only, menopausal status and current HRT use.
 † Water and pure fruit juices (excluding milk, tea, coffee, soft drinks and alcoholic drinks).

Discussion

The major strengths of our study are the large sample size, the large proportion of vegetarians and vegans, the availability of information on several factors thought to be associated with bowel movement frequency, and the fact that the outcome was determined from the reported frequency of bowel movements instead of a subjective assessment of constipation. However, this self-reported frequency has not been validated and the distribution shows a clear preference for the value 7. Although the large number of observations implies considerable robustness for the comparisons of the means, the standard errors of the means might be underestimates the true variation, thus exaggerating the significance of the differences.

Our study showed that the mean number of bowel movements per week was 9.9 in men and 8.6 in women. Ninety-three per cent of men and 83% of women had 7 or more bowel movements per week. These results are similar to those seen at baseline in a UK-based randomised cross-over trial¹³ and in a nation-wide random sample of US households¹⁴.

We found a positive association between age and bowel movement frequency in women but not in men. This association between age and bowel movement frequency has been found in some studies¹⁵ but not in others^{2,16,17}.

Men reported more frequent bowel movements than did women. It is well documented that women suffer more often from constipation than men, especially at younger ages^{2,14,17}. It has also been reported that men tend to have shorter colonic transit times than do women at all ages¹⁸, and it has been proposed that sex hormones, in particular progesterone, may contribute to this¹⁹. It has been suggested that higher fibre intakes in men than in women might contribute to the difference²⁰, but in our study fibre intake did not confound the association, and the differences in bowel movement frequency between men and women were not explained by the other factors examined.

That non meat-eaters have a higher frequency of defecation is well documented²¹. A higher intake of dietary fibre decreases intestinal transit time²². In the present study, fibre intake accounted for part of the difference in bowel movement frequency between diet groups but it could not explain the overall association. The estimate of fibre intake in this study has not been validated, is based on a limited number of foods, and probably underestimates the true values. Therefore, we did not attempt to explore the association of dietary fibre with bowel movement frequency in greater detail. Our finding of a very clear trend towards an increasing number of bowel movements with a more rigorous degree of vegetarianism could be a field for further investigation.

In our study, there was a positive association between the amount of vigorous exercise and the mean number of

weekly bowel movements. Transit time has been found to be reduced by increasing exercise in some studies²³, but not in others²⁴. The mechanisms by which transit time is reduced by exercise are unclear.

Both men and women had more bowel movements with increasing intakes of fluid. This positive association was also found in a randomised controlled trial with water supplementation involving 117 patients suffering from chronic functional constipation²⁵.

In conclusion, we have identified several nutritional and lifestyle factors that were associated with the frequency of bowel movements. The strongest associations were seen with having a vegetarian or vegan diet, dietary fibre intake, fluid intake and vigorous exercise.

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