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ORIGINAL CONTRIBUTION

Relationship between lifestyle factors and defecation in a Japanese population

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Summary *Background* There is a paucity of accurate data regarding any association in the general population between defecation and lifestyle factors such as diet, exercise, physique, and childbirth. *Aims of the study* To evaluate the effects of such lifestyle factors on defecation among regional residents of Japan. *Methods* Residents (n = 1,699) of northern Japan, aged over 40 years, were surveyed in 1995 using a questionnaire to assess their lifestyle factors (diet, beverage consumption, exercise, physique, and childbirth), and examining their defecation status. We evaluated the relationship between these lifestyle factors and defecation using logistic regression analysis. The authors used four measures (defecation frequency, subjective defecation state, subjective fecal properties, and fecal consistency) and assigned the subjects to a group defined by their defecatory status: constipation, diarrhea, or normal, depending on the responses of the subjects to all four criteria. *Results* The tendency for constipation correlated positively with age in males ($p = 0.130$), although this trend was not observed in females ($p = 0.641$). Of the dietary factors examined, only rice, which accounts for the largest proportion of daily dietary fiber intake in Japan, demonstrated a preventive effect on constipation in both sexes ($p = 0.050$ in males and 0.003 in females). Walking was a preventive factor for constipation among males ($p = 0.049$), and alcohol also inhibited constipation among males ($p = 0.007$). *Conclusions* These results suggest that exercise, such as walking, and a high intake of dietary fiber, such as rice, were useful in the maintenance of defecation.

Key words defecation – walking – dietary factors – rice

Introduction

Defecation status and fecal characteristics are a major concern in peoples' daily lives, and their association with many colorectal diseases, such as cancer and diverticular disease, has been suggested [1–4]. However, there are few data on defecation and fecal properties in general population [5–11]. Consequently, there are few studies examining the association of lifestyle factors with defecation.

To clarify whether lifestyle factors, including dietary habits, have an influence on defecation, we analyzed the association between lifestyle factors and defecation among regional residents of Japan. We used "subjective fecal properties" and "fecal consistency" as survey terms as well as "defecation frequency", because defecation frequency, while easy to access, is a poor indicator of colonic function and bears little relation to intestinal transit time or daily fecal weight [12–15]. In contrast, fecal form and consistency are well correlated with transit

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time and fecal output [12–15]. This is the first study to analyze the association between lifestyle factors and defecation among regional residents of Japan.

Subjects and Methods

Subjects

Subjects were aged over 40 years and residents of Iwate Prefecture in northern Japan, which is located in a mainly agricultural area, with a population of 4,765 in 1995. In the evaluation of subjective fecal properties and fecal consistency, subjects using laxatives were excluded from the study.

Survey of dietary habits and defecation and fecal properties

A questionnaire survey of the dietary habits used an interview technique, querying dietary habit with emphasis on the frequency of food intake (30 main foods) as an average over the previous three years. The dates of survey were in August 1995. Defecation status and fecal properties, including fecal consistency, were investigated simultaneously. Each question addressed the state of defecation and fecal properties as follows. Defecation frequency: once or more per day, once per two days, once per three days, or once or less per four days; subjective defecation state: normal, marked constipation, constipation, slight constipation, alternating diarrhea/constipation disorder and diarrhea; and subjective fecal properties: watery, semisolid, mushy, plump and soft, small and hard, hard, or unknown. In the survey, subjects were asked to express their dietary habits, defecation status, and fecal properties as an average of the previous three years. Furthermore, we measured fecal consistency in all subjects by Nakaji's method [16]. This method was developed by modification of the Exton-Smith method [17]. In the Exton-Smith, each fecal sample was placed in a Petri dish (depth: 10 mm, diameter: 10 cm), flattened to a uniform height using a spatula, and placed on the dish of an even balance. After the Petri dish containing the fecal sample descended, a penetrometer (Marubishi Co. Ltd., Tokyo, Japan) (tip area 1 cm^2) was placed above the dish. A distance between the penetrometer tip and the fecal surface was 10 mm. The other side of the balance was lifted and a 500 g weight placed on it, held and released. The weight descended at a constant rate as the fecal sample ascended at a constant rate, colliding with the penetrometer tip. The maximum penetrometer tip length inserted into the fecal sample after collision was 4 mm. The maximum restitution shown on the penetrometer at collision was used as an index of fecal consistency (g/cm^2).

We simultaneously enquired about the time spent walking on a daily basis by both sexes, and the number of childbirths each woman had experienced. Body weight and height were also measured, and body mass index (BMI) was calculated (weight/height^2).

Statistical analysis

Simple logistic regression was used separately for both sexes to analyze the association between constipation and the lifestyle factors and age. Next, a regression model was selected using a stepwise approach, with the age category always included. For stepwise selection, significance levels for entry and removal were set at 0.05 and 0.10, respectively. The statistical significance of the explanatory variable of the model was tested with the Wald test. All statistical tests were two-sided. A value of $P < 0.05$ was considered statistically significant. Statistical analyses were performed with Stata ver. 7.0 [18].

All lifestyle factors (explanatory variables) were divided into two groups. Food intake was classified into high or low ingestion frequencies by 50 % percentile. The criteria for the high ingestion frequency for each food were: rice, three times or more per day; bread, once or more per day; miso soup, twice or more per day; and other foods, three times or more per week; coffee, three times or more per week; and Japanese green tea, once or more per day. Frequencies below these values were classified as low ingestion frequencies. The consumption of alcoholic beverages and cigarettes was classified into two categories: use or non-use. Other factors were divided into two groups as follows: BMI > 24 or ≤ 24 for males, and > 25 or ≤ 25 for females; time spent walking daily, > 4 h or ≤ 4 h; and number of childbirths, ≤ 1 or ≥ 2.

Defecation-related items were first classified into three groups, "normal", "constipation" or "diarrhea" as follows: defecation frequency, "once or twice per one or two days" and "once or less per three days" and "three or more times per day"; subjective defecation state, "normal", "constipation", or "diarrhea"; subjective fecal properties, "plump and soft", "hard, or small and hard", or "watery, or mushy"; and fecal consistency, "200–399 g/cm^3", "400 g/cm^3 or more", or "199 g/cm^3 or less". We then assigned subjects to one of the three groups, on the basis that they matched exactly all four of the above criteria. Data for diarrhea were not analyzed for either sex because too few cases were reported.

Results

Response rate

The questionnaire was completed in the interview style by 3,100 residents, with a response rate of 53.8 %, con-

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sisting of 1,699 individuals (696 males and 1003 females) (Table 1). The mean age of the residents who responded to the questionnaire was 59.1 years.

Odds ratio for each food in the prevention of constipation

Multiple regression analysis of constipation revealed that walking, and the intakes of rice and alcohol helped prevent constipation in males (P = 0.049, 0.050, and 0.007, respectively), and that intake of rice and eggs helped prevent constipation in females (P = 0.003 and 0.021, respectively) (Table 2).

The tendency to constipation correlated with age in males (P = 0.130), although this trend was not observed in females (P = 0.641).

Discussion

As mentioned above, an objective and precise evaluation of defecation status is very difficult, which increases the difficulty in examining the relationship between defecation and other factors. To evaluate defecation precisely and objectively, the authors used four measures (defecation frequency, subjective defecation state, subjective fecal properties, and fecal consistency) and assigned the subjects to groups defined by defecatory state, namely "constipation", "diarrhea" or "normal", depending on the responses of the subjects to all four criteria. It was particularly advantageous in this study to use fecal consistency as an objective criterion.

Our results show that a tendency to suffer from constipation depends on advancing age in men, as described previously [6, 11]. Two reasons postulated to explain this are a) developing dysfunction of the large intestine with age induces constipation, and b) constipation in the elderly may be caused by low energy intake that reflects low dietary intake. Low dietary intake leads to reduced fecal volume and weight, which may lead to constipation [6, 19]. On the other hand, there was no statistically significant association between aging and constipation in females. One reason for this may be that the menstrual cycle and menstrual disorders, especially menopause, are confounding factors [20, 21].

Of the dietary factors examined, only rice helped prevent constipation in both sexes. Rice is the staple food in Japan. Furthermore, the rice intake strongly correlates with dietary fiber intake, although rice is not such a fiber-rich food, which includes resistant starch, because the proportion of rice intake to total amount of intake is the largest [22]. Therefore, rice is the largest resource of dietary fiber for Japanese; the proportion of dietary fiber from rice vs. total fiber intake is 20.5 % in 1991 [23]. Therefore, this result may reinforce the argument that dietary fiber exerts a preventive effect on constipation, as reported previously [24–26]. It is unknown why egg had a preventive effect on constipation in females. The author could not find any reports which showed same evidence previously. In the present study, there were unexpectedly few dietary factors that correlated significantly with defecation. This may be due to the fact that the average age of the subjects in this study was relatively high. The majority of subjects had already lost some normal function of the large intestine over a long period, and dietary factors may not improve this.

Table 1 Age and sex distribution of the subjects

Age	Men	Women	Total
40–49	160 (23.0)[a]	214 (21.3)	374 (22.0)
50–59	203 (29.2)	314 (31.3)	517 (30.4)
60–69	216 (31.0)	321 (32.0)	537 (31.6)
70–79	96 (13.8)	127 (12.7)	223 (13.1)
80–	21 (3.0)	27 (2.7)	48 (2.8)
Total	696 (100)	1003 (100)	1699 (100)

[a] percentage

Table 2 Result of multiple logistic regression analysis

	– male –		
	Category	OR (95 % CI)	*p* value
Age	–49	1.0	
	50–59	0.56 (0.18–1.76)	
	60–69	1.25 (0.42–3.71)	0.130
	70+	1.82 (0.55–6.08)	
Walking Habit	Little–4 h/day	1.0	
	> 4 h/day	0.46 (0.23–1.05)	0.049
Rice	1–2/day	1.0	
	3/day	0.42 (0.12–1.39)	
	4/day	1.19 (0.31–4.49)	0.050
	5/day	0.33 (0.07–1.48)	
	6+/day	0.24 (0.07–0.88)	
Alcohol	No + Past	1.0	
	Current	0.32 (0.14–0.73)	0.007
	– female –		
	Category	OR (95 % CI)	*p* value
Age	–49	1.0	
	50–59	1.07 (0.57–1.99)	
	60–69	0.58 (0.30–1.13)	0.641
	70+	1.32 (0.57–3.03)	
Rice	1–2/day	1.0	
	3/day	0.36 (0.18–0.70)	
	4/day	0.18 (0.07–0.47)	0.003
	5/day	0.70 (0.28–1.77)	
	6+/day	0.13 (0.05–0.36)	
Egg	Little–4/week	1.0	
	Almost daily	0.56 (0.34–0.91)	0.021

Alcoholic liquors had a preventive effect on constipation in this study, but they showed a promotive effect on diarrhea as well as a preventive effect on constipation in our previous study [16]. Therefore, we did not conclude that alcoholic liquors have a favorable effect on defecation and fecal properties.

In the current study, apart from the dietary factors studied, only the amount of walking performed daily appeared to help prevent constipation. This result suggests that exercise, including walking, can maintain good bowel function in men. Walking, running, and strength training have generally been found to reduce gastrointestinal transit time [27–31]. As mentioned above, our results suggest that dietary factors have little influence on defecation in this population because of the stability of large bowel function in the over–40s age group. Therefore, exercise may be more useful in preventing constipation in the over–40s. Physical activity is also thought to be an important factor in the prevention of colorectal cancer, especially colon cancer [32–41]. The proposed biological mechanisms underlying the association between physical activity and cancer include the effects of exercise on the transit time of digestion [32, 33], hormone levels [34], and body fat [34]. Walking is an appropriate representative exercise for the general population, especially in such an agricultural area.

Overweight has been reported to induce constipation [42] and to increase the risk of colon cancer [43–45]. However, in this study, no statistically significant association was observed between defecation and BMI.

The limitation of this study is that this survey was performed in a rural area. The same survey for an urban area is required.

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