Dietary intake habits and the prevalence of nocturia in Japanese patients with type 2 diabetes mellitus

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Keywords
Dietary behavior, Nocturia, Vegetable

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J Diabetes Investig 2018; 9: 279–285
doi: 10.1111/jdi.12709

INTRODUCTION
Nocturia, one type of voiding dysfunction, negatively affects nocturnal sleep, daytime sleepiness and quality of life. Nocturia is common among patients with diabetes mellitus. Among Japanese patients with type 2 diabetes mellitus, nocturia was significantly positively associated with erectile dysfunction 1, diabetic neuropathy 2 and depressive symptoms 3.

ABSTRACT
Aims/Introduction: No reports have been published on the association between dietary intake habits and nocturia in the diabetes population. We therefore evaluated this issue among Japanese patients with diabetes mellitus.

Materials and Methods: Study participants in the present study were 785 Japanese patients with type 2 diabetes mellitus. Self-administered questionnaires were used to assess each type of dietary intake habit. Vegetable intake habit was assessed by the following question: “Do you have vegetables or seaweed every day?” We used the following two outcomes: (i) nocturia: ≥2 voids per night; and (ii) severe nocturia: ≥3 voids per night. Adjustment was made for age, sex, body mass index, glycated hemoglobin, hypertension, dyslipidemia, smoking, drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy.

Results: The prevalence of nocturia, severe nocturia, and vegetable intake habit was 39.9%, 14.4% and 67.3%, respectively. After adjusting for confounding factors, vegetable intake habit was independently inversely associated with nocturia and severe nocturia: the adjusted odds ratios were 0.67 (95% confidence interval [CI] 0.48–0.94) and 0.46 (95% CI 0.30–0.71), respectively. Among male patients, vegetable intake habit was independently inversely associated with severe nocturia, but not nocturia: the adjusted OR was 0.51 (95% CI 0.29–0.88). Among female patients, vegetable intake habit was independently inversely associated with nocturia and severe nocturia: the adjusted ORs were 0.44 (95% CI 0.24–0.79) and 0.34 (95% CI 0.15–0.78), respectively.

Conclusions: We found an inverse association between vegetable intake habit and nocturia in Japanese patients with type 2 diabetes mellitus.
isoflavones and citrus juice were significantly inversely associated with LUTS, whereas a significant positive relationship between total energy intake and LUTS was found. Inverse associations between the intake of vegetables, bread and chicken and OAB were observed. Intake levels of vitamin D, protein and potassium, as well as beer intake, were significantly inversely associated with the onset of OAB. Intake levels of vegetables and vegetable fat were significantly inversely associated with BPH.

No data regarding the association between dietary intake and nocturia are available among patients with type 2 diabetes mellitus. The importance of research into the possible role of dietary factors in voiding dysfunction is emphasized by the fact that diet is modifiable. The aim of the present study was to evaluate the association between dietary intake habits and nocturia among Japanese patients with type 2 diabetes mellitus.

METHODS

Study population

The Dogo Study is an ongoing multicenter prospective cohort study of patients with diabetes. All 1051 Japanese patients with type 2 diabetes mellitus who gave informed consent were enrolled from the participating local base hospitals in Ehime prefecture. The patients in this cohort study were recruited from 2009 to 2014. The final analysis sample in this study consisted of 785 patients, as 266 patients were excluded due to incomplete data. The present study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institutional review board of the Ehime University Graduate School of Medicine.

Measurements

Each participant completed a self-administered questionnaire, which collected data on the variables. Information on medication was based on admission records, medical records and/or a questionnaire. Exercise habit was defined as positive if the study participants reported exercising 60 min or more per week during leisure time, regardless of the exercise intensity. The definitions of variables were previously described in detail. The definitions of microvascular diseases were based on the Classification of Diabetic Nephropathy 2014, the Fukuda standard and the abbreviated diagnosis of diabetic nephropathy.

Assessment of dietary intake habits

We used a self-administered questionnaire to estimate dietary intake using the following questions: (i) “Do you have fried food every day?”; (ii) “Do you have one or more eggs every day?”; (iii) “Do you have meat more than twice a week?”; (iv) “Do you have fish or shellfish more than twice a week?”; (v) “Do you have salty pickles more than twice a week?”; (vi) “Do you have vegetables or seaweed every day?”; (vii) “Do you have fruit every day?”; (viii) “Do you have soy products every day?”; and (ix) “Do you consume dairy products every day?”. Patients answered either “yes” or “no”.

Assessment of nocturia

The definition of nocturia was based on a questionnaire regarding the numbers of voids. We used the following outcomes: (i) nocturia was defined as ≥2 voids per night; and (ii) severe nocturia was defined as ≥3 voids per night.

Statistical analysis

We selected age, sex, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy as a priori as potential confounding factors. Logistic regression analyses were carried out to estimate crude odds ratios (ORs) and their 95% confidence intervals (CIs) for nocturia according to dietary intake habits. Additionally, multiple logistic regression analysis was carried out to adjust for confounding factors. All computations were carried out using SAS software package version 9.4 (SAS Institute Inc., Cary, NC, USA).

Table 1: Clinical characteristics of the 785 study participants

| Variable                                      | n (%)   |
|-----------------------------------------------|---------|
| Age, years (mean ± SD)                        | 61.7 ± 11.2 |
| Male (%)                                      | 489 (62.3) |
| BMI, kg/m2 (mean ± SD)                       | 25.2 ± 4.8 |
| HbA1c, % (mean ± SD)                         | 7.89 ± 1.83 |
| Duration of type 2 diabetes mellitus, years (mean ± SD) | 11.0 ± 10.2 |
| Current drinking (%)                         | 323 (41.2) |
| Current smoking (%)                          | 144 (18.3) |
| Exercise habit                                | 258 (32.9) |
| Use of diuretics                              | 89 (11.3) |
| Hypertension (%)                              | 551 (70.2) |
| Dyslipidemia (%)                              | 585 (74.5) |
| Diabetic neuropathy (%)                       | 483 (61.5) |
| Diabetic retinopathy (%)                      | 231 (29.4) |
| Diabetic nephropathy (%)                      | 80 (10.2) |
| Stroke (%)                                    | 53 (6.8) |
| Ischemic heart disease (%)                    | 89 (11.3) |
| Nocturia                                      | 313 (39.9) |
| Severe nocturia, ≥3 voids per night (%)       | 113 (14.4) |

Dietary intake habits

- Fried foods (%): 174 (24.7)
- Eggs (%): 329 (41.9)
- Fatty meat (%): 238 (30.3)
- Seafood (%): 553 (70.5)
- Pickles (%): 248 (31.6)
- Vegetables (%): 528 (67.3)
- Fruit (%): 432 (55.0)
- Soy products (%): 473 (60.3)
- Dairy products (%): 460 (58.6)

BMI: body mass index; HbA1c, glycated hemoglobin; SD, standard deviation.
RESULTS

Characteristics of the 785 patients are listed in Table 1. The prevalence of nocturia and severe nocturia was 39.9% and 14.4%, respectively. Dietary intake habits of fried foods, eggs, fatty meat, seafood, pickles, vegetables, fruit, soy products, and dairy products were reported at 24.7%, 41.9%, 30.3%, 70.5%, 31.6%, 67.3%, 55.0%, 60.3% and 58.6% of study participants, respectively. The percentage intake of fish, fruit, soy products and dairy products among patients with vegetable intake habit was significantly low among all patients (data not shown). Table 2 shows the crude and adjusted ORs and 95% CIs for nocturia in relation to dietary intake habits among all patients. In the crude analysis, seafood, fruit and dairy products intake habits were positively associated with nocturia. The association between seafood, fruit, and dairy products and nocturia completely disappeared after adjusting for age, sex, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habits, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy. After adjustment, vegetable intake habit was independently inversely associated with nocturia: the adjusted OR was 0.51 (95% CI 0.29–0.88). Table 3 shows the crude and adjusted ORs and 95% CIs for severe nocturia in relation to dietary intake habits. In crude analysis, fruit and daily products intake habits were positively associated with severe nocturia, whereas vegetable intake was inversely associated with severe nocturia. After adjustment, vegetable intake habit was independently inversely associated with severe nocturia: the adjusted OR was 0.46 (95% CI 0.30–0.71). Among male patients, vegetable intake habit was independently inversely associated with severe nocturia, but not nocturia: the adjusted OR was 0.51 (95% CI 0.29–0.88; Table 4). Among female patients, vegetable intake habit was independently inversely associated with nocturia and severe nocturia: the adjusted ORs

### Table 2 | Crude and adjusted odds ratios and 95% confidence intervals for nocturia in relation to dietary intake habits among all patients

| Variable        | Prevalence (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-----------------|----------------|------------------|----------------------|
| Nocturia        |                |                  |                      |
| Fried foods (%) |                |                  |                      |
| No              | 242/5,941 (41.0) | 1.00             | 1.00                 |
| Yes             | 71/194 (36.6)   | 0.83 (0.59–1.16) | 1.12 (0.77–1.61)     |
| Eggs (%)        |                |                  |                      |
| No              | 185/456 (40.6)  | 1.00             | 1.00                 |
| Yes             | 128/329 (38.9)  | 0.93 (0.70–1.25) | 1.03 (0.76–1.40)     |
| Fatty meat (%)  |                |                  |                      |
| No              | 217/547 (39.7)  | 1.00             | 1.00                 |
| Yes             | 96/238 (40.3)   | 1.03 (0.75–1.40) | 1.33 (0.94–1.87)     |
| Seafood (%)     |                |                  |                      |
| No              | 74/232 (31.9)   | 1.00             | 1.00                 |
| Yes             | 239/553 (43.2)  | 1.63 (1.18–2.25) | 1.22 (0.86–1.73)     |
| Pickles (%)     |                |                  |                      |
| No              | 202/537 (37.6)  | 1.00             | 1.00                 |
| Yes             | 111/248 (44.8)  | 1.34 (0.99–1.82) | 1.11 (0.79–1.54)     |
| Vegetables (%)  |                |                  |                      |
| No              | 110/257 (42.8)  | 1.00             | 1.00                 |
| Yes             | 203/528 (38.5)  | 0.84 (0.62–1.13) | 0.67 (0.48–0.94)     |
| Fruit (%)       |                |                  |                      |
| No              | 121/353 (34.3)  | 1.00             | 1.00                 |
| Yes             | 192/432 (44.4)  | 1.53 (1.15–2.05) | 1.08 (0.78–1.50)     |
| Soy products (%)|                |                  |                      |
| No              | 122/312 (39.1)  | 1.00             | 1.00                 |
| Yes             | 191/473 (40.4)  | 1.06 (0.79–1.41) | 0.95 (0.69–1.30)     |
| Dairy products (%)|            |                  |                      |
| No              | 113/325 (34.8)  | 1.00             | 1.00                 |
| Yes             | 200/460 (43.5)  | 1.44 (1.08–1.94) | 1.25 (0.91–1.71)     |

Odds ratios (OR) were adjusted for age, sex, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy. CI, confidence interval.

### Table 3 | Crude and adjusted odds ratios and 95% confidence intervals for severe nocturia in relation to dietary intake habits among all patients

| Variable        | Prevalence (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-----------------|----------------|------------------|----------------------|
| Severe nocturia |                |                  |                      |
| Fried foods (%) |                |                  |                      |
| No              | 88/591 (14.9)  | 1.00             | 1.00                 |
| Yes             | 25/194 (12.9)  | 0.85 (0.52–1.34) | 0.99 (0.58–1.65)     |
| Eggs (%)        |                |                  |                      |
| No              | 71/456 (15.6)  | 1.00             | 1.00                 |
| Yes             | 42/329 (12.8)  | 0.79 (0.52–1.19) | 0.87 (0.56–1.33)     |
| Fatty meat (%)  |                |                  |                      |
| No              | 79/547 (14.4)  | 1.00             | 1.00                 |
| Yes             | 34/234 (14.3)  | 0.99 (0.63–1.51) | 1.16 (0.72–1.84)     |
| Seafood (%)     |                |                  |                      |
| No              | 26/232 (11.2)  | 1.00             | 1.00                 |
| Yes             | 87/553 (15.7)  | 1.48 (0.94–2.40) | 1.09 (0.72–1.84)     |
| Pickles (%)     |                |                  |                      |
| No              | 202/537 (37.6) | 1.00             | 1.00                 |
| Yes             | 111/248 (44.8) | 1.22 (0.78–1.85) | 1.05 (0.67–1.64)     |
| Vegetables (%)  |                |                  |                      |
| No              | 51/257 (19.8)  | 1.00             | 1.00                 |
| Yes             | 62/528 (11.7)  | 0.54 (0.36–0.81) | 0.46 (0.30–0.71)     |
| Fruit (%)       |                |                  |                      |
| No              | 39/353 (11.1)  | 1.00             | 1.00                 |
| Yes             | 74/432 (17.1)  | 1.66 (1.10–2.54) | 1.31 (0.83–2.09)     |
| Soy products (%)|                |                  |                      |
| No              | 122/312 (39.1) | 1.00             | 1.00                 |
| Yes             | 191/473 (40.4) | 1.00 (0.67–1.50) | 0.99 (0.64–1.54)     |
| Dairy products (%)|            |                  |                      |
| No              | 41/325 (12.6)  | 1.00             | 1.00                 |
| Yes             | 72/460 (15.7)  | 1.29 (0.86–1.96) | 1.11 (0.72–1.73)     |

Odds ratios (OR) were adjusted for age, sex, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy. CI, confidence interval.
Table 4 | Crude and adjusted odds ratios and 95% confidence intervals for severe nocturia in relation to dietary intake among male patients

| Variable          | Prevalence (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-------------------|----------------|------------------|----------------------|
| Nocturia          |                |                  |                      |
| Fried foods (%)   |                |                  |                      |
| No               | 151/350 (43.1) | 1.00             | 1.00                 |
| Yes              | 55/139 (39.6)  | 0.86 (0.58–1.29) | 1.26 (0.80–1.99)     |
| Eggs (%)         |                |                  |                      |
| No               | 122/273 (44.7) | 1.00             | 1.00                 |
| Yes              | 84/216 (38.9)  | 0.79 (0.55–1.13) | 0.93 (0.63–1.38)     |
| Fatty meat (%)   |                |                  |                      |
| No               | 143/344 (41.6) | 1.00             | 1.00                 |
| Yes              | 63/145 (43.5)  | 1.08 (0.73–1.60) | 1.46 (0.93–2.30)     |
| Seafood (%)      |                |                  |                      |
| No               | 49/145 (33.8)  | 1.00             | 1.00                 |
| Yes              | 157/344 (45.6) | 1.65 (1.10–2.48) | 1.16 (0.75–1.81)     |
| Pickles (%)      |                |                  |                      |
| No               | 132/336 (39.3) | 1.00             | 1.00                 |
| Yes              | 74/153 (48.4)  | 1.45 (0.98–2.13) | 1.20 (0.79–1.83)     |
| Vegetables (%)   |                |                  |                      |
| No               | 74/178 (41.6)  | 1.00             | 1.00                 |
| Yes              | 132/311 (42.4) | 1.04 (0.71–1.51) | 0.81 (0.53–1.23)     |
| Fruit (%)        |                |                  |                      |
| No               | 90/241 (37.3)  | 1.00             | 1.00                 |
| Yes              | 116/248 (46.8) | 1.47 (1.03–2.12) | 0.93 (0.61–1.40)     |
| Soy products (%) |                |                  |                      |
| No               | 88/212 (41.5)  | 1.00             | 1.00                 |
| Yes              | 118/277 (42.6) | 1.05 (0.73–1.50) | 0.91 (0.61–1.35)     |
| Dairy products (%)|               |                  |                      |
| No               | 82/219 (37.4)  | 1.00             | 1.00                 |
| Yes              | 124/270 (45.9) | 1.42 (0.99–2.05) | 1.12 (0.75–1.66)     |
| Severe nocturia  |                |                  |                      |
| Fried foods (%)  |                |                  |                      |
| No               | 51/336 (15.2)  | 1.00             | 1.00                 |
| Yes              | 28/153 (18.3)  | 0.71 (0.39–1.22) | 0.83 (0.43–1.55)     |
| Eggs (%)        |                |                  |                      |
| No               | 50/273 (18.3)  | 1.00             | 1.00                 |
| Yes              | 29/216 (13.4)  | 0.69 (0.42–1.13) | 0.83 (0.48–1.40)     |
| Fatty meat (%)  |                |                  |                      |
| No               | 54/344 (15.7)  | 1.00             | 1.00                 |
| Yes              | 25/145 (17.2)  | 1.22 (0.66–1.86) | 1.19 (0.65–2.14)     |
| Seafood (%)      |                |                  |                      |
| No               | 17/145 (11.7)  | 1.00             | 1.00                 |
| Yes              | 62/344 (18.0)  | 1.66 (0.95–3.02) | 1.14 (0.62–2.17)     |
| Pickles (%)      |                |                  |                      |
| No               | 51/336 (15.2)  | 1.00             | 1.00                 |
| Yes              | 28/153 (18.3)  | 1.25 (0.74–2.06) | 1.15 (0.65–2.00)     |
| Vegetables (%)   |                |                  |                      |
| No               | 36/178 (20.2)  | 1.00             | 1.00                 |
| Yes              | 43/311 (13.8)  | 0.63 (0.39–1.03) | 0.51 (0.29–0.88)     |
| Fruit (%)        |                |                  |                      |
| No               | 32/241 (13.3)  | 1.00             | 1.00                 |
| Yes              | 47/248 (19.0)  | 1.53 (0.94–2.51) | 0.98 (0.56–1.72)     |

Odds ratios (OR) were adjusted for age, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy. CI, confidence interval.

DISCUSSION

To our knowledge, the present study is the first to show a significant inverse association between vegetable intake habit and nocturia and severe nocturia among Japanese patients with type 2 diabetes mellitus.

In the general population, some evidence of the association between intake of vegetables and voiding dysfunction exists. Vegetable intake was significantly inversely associated with LUTS in a Chinese study of 1,564 men, in a Finnish study of 3,143 men, in a Chinese study of 2,000 men and in three USA studies. Similarly, in a USA study of 7,043 women, intake of bread and chicken was not associated with BPH, but intake of vegetables was significantly inversely associated with OAB. In a USA study of 51,529 men, in a Finnish study of 7,043 women, intake of bread and chicken was partially consistent with those of the previous studies regarding vegetable intake habit and BPH was reported. In contrast, in a Greek study of 430 men, vegetable intake was not associated with BPH. The present results are partially consistent with those of the previous studies regarding voiding dysfunction. The discrepancies among these studies might be explained, at least in part, by differences in sample size; the definition of voiding dysfunction; characteristics, such as age, sex, race, body mass index, prevalence of stroke and hypertension; and other confounding factors.

The associations between several types of dietary intake excluding vegetables and voiding dysfunction were observed. In a UK study of 7,043 women, intake of bread and chicken was significantly inversely associated with the onset of OAB. In a USA study of 1,545 men aged 30–79 years, intake of total energy and sodium were significantly positively associated with...
Table 5 | Crude and adjusted odds ratios and 95% confidence intervals for severe nocturia in relation to dietary intake among female patients

| Variable | Prevalence (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|----------|----------------|-------------------|----------------------|
| Nocturia |                |                   |                      |
| Fried foods (%) | |                   |                      |
| No | 91/241 (37.8) | 1.00              | 1.00                 |
| Yes | 16/55 (29.1)  | 0.68 (0.35–1.26)  | 0.86 (0.43–1.67)     |
| Eggs (%) | |                   |                      |
| No | 63/183 (34.4) | 1.00              | 1.00                 |
| Yes | 44/113 (38.9) | 1.22 (0.75–1.97)  | 1.29 (0.77–2.17)     |
| Fatty meat (%) | |                   |                      |
| No | 74/203 (36.5) | 1.00              | 1.00                 |
| Yes | 33/93 (35.5)  | 0.96 (0.57–1.59)  | 1.13 (0.65–1.95)     |
| Seafood (%) | |                   |                      |
| No | 28/87 (28.7)  | 1.00              | 1.00                 |
| Yes | 82/209 (39.2) | 1.60 (0.94–2.79)  | 1.31 (0.73–2.39)     |
| Pickles (%) | |                   |                      |
| No | 70/201 (34.8) | 1.00              | 1.00                 |
| Yes | 37/95 (39.0)  | 1.19 (0.72–1.97)  | 0.97 (0.56–1.65)     |
| Vegetables (%) | |                   |                      |
| No | 36/79 (45.6)  | 1.00              | 1.00                 |
| Yes | 71/217 (32.7) | 0.58 (0.34–0.99)  | 0.44 (0.24–0.79)     |
| Fruit (%) | |                   |                      |
| No | 31/112 (27.7) | 1.00              | 1.00                 |
| Yes | 76/184 (41.3) | 1.84 (1.11–3.08)  | 1.33 (0.75–2.35)     |
| Soy products (%) | |                   |                      |
| No | 34/100 (34.0) | 1.00              | 1.00                 |
| Yes | 73/296 (37.2) | 1.15 (0.70–1.92)  | 1.03 (0.60–1.79)     |
| Dairy products (%) | |                   |                      |
| No | 31/106 (29.3) | 1.00              | 1.00                 |
| Yes | 76/190 (40.0) | 1.61 (0.98–2.71)  | 1.63 (0.96–2.82)     |
| Severe nocturia | |                   |                      |
| Fried foods (%) | |                   |                      |
| No | 27/241 (11.2) | 1.00              | 1.00                 |
| Yes | 7/55 (2.7)    | 1.16 (0.44–2.68)  | 1.35 (0.49–3.33)     |
| Eggs (%) | |                   |                      |
| No | 21/183 (11.5) | 1.00              | 1.00                 |
| Yes | 13/113 (11.5) | 1.00 (0.47–2.07)  | 1.00 (0.45–2.13)     |
| Fatty meat (%) | |                   |                      |
| No | 25/203 (12.3) | 1.00              | 1.00                 |
| Yes | 9/93 (9.7)    | 0.76 (0.32–1.65)  | 0.77 (0.32–1.74)     |
| Seafood (%) | |                   |                      |
| No | 9/87 (10.3)   | 1.00              | 1.00                 |
| Yes | 25/209 (12.0) | 1.18 (0.54–2.77)  | 0.98 (0.42–2.45)     |
| Pickles (%) | |                   |                      |
| No | 22/201 (11.0) | 1.00              | 1.00                 |
| Yes | 12/95 (12.6)  | 1.18 (0.54–2.45)  | 0.88 (0.39–1.92)     |
| Vegetables (%) | |                   |                      |
| No | 15/79 (19.0)  | 1.00              | 1.00                 |
| Yes | 19/217 (8.8)  | 0.41 (0.20–0.86)  | 0.34 (0.15–0.78)     |
| Fruit (%) | |                   |                      |
| No | 7/112 (6.3)   | 1.00              | 1.00                 |
| Yes | 27/184 (14.7) | 2.58 (1.14–6.63)  | 2.20 (0.88–6.11)     |

Table 5 (Continued)

| Variable | Prevalence (%) | Crude OR (95% CI) | Adjusted OR (95% CI) |
|----------|----------------|-------------------|----------------------|
| Soy products (%) | |                   |                      |
| No | 13/100 (13.0) | 1.00              | 1.00                 |
| Yes | 21/196 (10.7) | 0.80 (0.39–1.72)  | 0.80 (0.37–1.80)     |
| Dairy products (%) | |                   |                      |
| No | 11/106 (10.4) | 1.00              | 1.00                 |
| Yes | 23/190 (12.1) | 1.19 (0.57–2.64)  | 1.13 (0.51–2.59)     |

Odds ratios (OR) were adjusted for age, body mass index, glycated hemoglobin, hypertension, dyslipidemia, current smoking, current drinking, exercise habit, stroke, ischemic artery disease, diabetic nephropathy, diabetic neuropathy and diabetic retinopathy. CI, confidence interval.

LUTS9. Dietary isoflavone intake was significantly inversely associated with LUTS in a Chinese study of 2,000 men7. Intake of citrus juice was significantly inversely associated with LUTS in a USA study of 4,144 participants8. Beer intake was significantly inversely associated with the onset of OAB in a UK study of men12.

No evidence regarding the association between dietary intake and nocturia exists. Nocturia is a storage symptom. In the general population, citrus juice intake was significantly inversely associated with storage symptoms in men, but not women; coffee intake was significantly positively associated with storage symptoms only in men, while soda intake was significantly positively associated with storage symptoms only in women5.

The mechanism linking vegetable intake habit and nocturia is not well understood. Vegetables are high in anti-oxidants, fibers, minerals and vitamins24. Vegetable intake might reduce post-prandial hyperglycemia25. Among patients with diabetes, post-prandial hyperglycemia is associated with increased oxidative stress and inflammation26,27. Vegetable intake might beneficially affect the prostate and bladder by inhibiting inflammation and oxidative damage.

The present study had several limitations that must be acknowledged. First, we used a cross-sectional analysis to assess the association between dietary intake habits and nocturia. Second, we used a “yes”/“no” response format partially validated questionnaire to assess dietary intake habits. A previous study using the same “yes”/“no” response format partially validated questionnaire found that the participants who reported eating something frequently had a higher intake than the other participants22. In previous epidemiological studies, the participants with a high vegetable intake were older, and showed a lower prevalence of hypertension and current smoking8,25. In the present study, similar characteristics as previous studies were observed among patients with vegetable intake habit. Therefore, we might assess the vegetable intake habit by this questionnaire. A “yes”/“no” response format questionnaire should be used only to assess vegetable intake habits. As consuming vegetables is thought to be a

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Nocturia habit, thus we should consider the possibility of misclassification. However, the possibility of non-differential outcome misclassification might have biased the magnitude of the observed associations toward the null. The questionnaire in the present study was inadequate to evaluate total energy intake, nutrient intake, and the dose–response association between eating vegetables and nocturia. Thus, further research based on a validated food frequency questionnaire is required to confirm the association between intake of vegetables and nocturia. Third, we used a questionnaire to survey nocturia. We could not carry out a urological test for nocturia, nor could we estimate BPH or bladder function. In a previous study, the overestimation of nocturia was reported. Among previous epidemiological studies, however, the definition of nocturia was based on a questionnaire and/or interview. Fourth, many of the patients might have opted to consume vegetables to control their hyperglycemia. Fifth, in a previous study, the intake of salt and water affected nocturia, but we could not estimate the intake of salt and water in the present study. Nocturia is likely a multifactorial disorder, and we could not rule out residual confounding factors. Finally, we could not control for the patients’ socioeconomic status.

In conclusion, we found an inverse association between vegetable intake habits and nocturia in Japanese patients with type 2 diabetes mellitus. Further studies are required to show the beneficial intake of vegetables for nocturia among patients with type 2 diabetes mellitus.

ACKNOWLEDGMENTS

This study was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI Grants (21790583 and 23790697). We thank Morikazu Onji from Saiseikai Imabari Hospital, Eriko Kawanumoto from the University of the Ryukyus, Keiko Kikuchi and Tomo Kogama from Ehime University, and Eri Furukawa from the Furukawa Clinic.

DISCLOSURE

The authors declare no conflict of interest.

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