

Original Article

How do health behaviours relate to dietary practice patterns among Japanese adults?

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Background and Objectives: To identify dietary practice patterns for Japanese adults and investigate the links between health behaviours and these patterns. **Methods and Study Design:** A random sample, stratified according to area, sex, and age, of 4570 adults aged 20-80 years completed a survey conducted in 2011 in a city, in Yamagata Prefecture, Northeast Japan. **Results:** Cluster analysis of 16 dietary practice items revealed four patterns labelled as: *low fat, sugar, or salt; emphasis on nutrition; regular breakfast and staples;* and *meals not snacks*. Findings from multiple linear regression analyses showed that those not engaged in habitual physical exercise had lower scores on *low fat, sugar, or salt* (beta coefficient -0.22; 95% confidence intervals -0.30, -0.14); *emphasis on nutrition* (-0.17: -0.25, -0.09); *meals not snacks*; (-0.38: -0.46, -0.3) that other participants. Current smokers had lower scores than never smokers on *low fat, sugar, or salt* (-0.23: -0.32, -0.14); *emphasis on nutrition* (-0.28: -0.37, -0.19); *regular breakfast and staples* (-0.42: -0.51, -0.33) patterns. Compared with non-drinkers, those who had reduced their consumption of alcohol had higher scores on *low fat, sugar, or salt* (0.19: 0.09, 0.29) and *emphasis on nutrition* (0.17: 0.07, 0.27). These relationships were adjusted for other dietary practice patterns, sociodemographic factors, body mass index, and the presence of major illness or pain. **Conclusions:** Findings support an integrated and targeted approach as part of public health policy by considering links between dietary practices and other health behaviours, such as habitual exercise and smoking behaviour that may facilitate changes in dietary practices.

Key Words: dietary practice patterns, habitual physical exercise, health behaviours, Japan, smoking

INTRODUCTION

In Japan, as in other nations such as the UK,¹ there has been considerable recognition that public health policy needs to adopt an integrated approach to modify lifestyle and behavior for prevention and management of chronic diseases. For instance, Japanese guidelines for the prevention of atherosclerotic cardiovascular diseases emphasizes a combination of health behaviours, including increased physical activity, dietary changes, and cessation of smoking.² This integrated approach is highlighted in "Healthy Japan 21", a national public health policy initiative established in 2000 and ushered into its second term in 2013 by the Japan Ministry of Health, Labour and Welfare, which among its broad set of objectives includes specific targets for improvements in nutrition and dietary habits, including increased fruit and vegetables intake.³ Moreover, with the aim of extending 'healthy life expectancy', the government has promoted the Smart Life Project since 2011, which focuses on "proper exercise", "appropriate dietary habits", and "smoking cessation" (with medical checks and screening added as a fourth component in 2014).^{4,5} To support the on-going development of such broad initiatives, however, further evidence is need-

ed to understand the relationships between different aspects of lifestyle and dietary practices in Japan.

Over the last decade, increasing evidence has pointed to associations between health behaviours and dietary patterns. For instance, a US study of students found that those with low physical activity were more likely to have lower consumption of fruit and vegetables and to be current smokers, among a range of other poor health behaviours.⁶ Another study showed that sedentary behaviour among French adults was associated with poorer diet, including the consumption of smaller amounts of foods and nutrients considered to be healthful, such as fruit and vegetables, and fibre, and higher amounts of nutrients considered harmful, such as trans-fats.⁷ Findings from a

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Manuscript received 16 February 2015. Initial review completed 23 September 2015. Revision accepted 10 November 2015.

doi: 10.6133/apjcn.022016.01

nationally representative survey in Japan indicated that men in lower occupational categories (such as 'service work', 'transport', and 'labour') were more likely to engage in risky health behaviours, including excessive drinking, cigarette smoking, and poor dietary habits.⁸ Results from intervention studies have also highlighted the benefits of a more integrated approach, for instance a study of Japanese women showed that the combination of regular exercise and nutritional guidance lowered both BMI and adiposity, as well as providing general improvements in health related quality of life, especially mental health components.⁹ These findings highlight the way that concepts of 'healthy eating' in Japan include aspects of lifestyle around traditional dietary practices, such as the enjoyment of eating meals with friends or family, that are additional to considerations of food content as the key characteristic of a healthy diet.¹⁰ This may also reflect that Japan has formally referenced the role of quality of life as part of its national dietary guidelines since 1985.¹¹

Given this cultural and policy context, a more detailed understanding of the links between lifestyle and dietary practices in Japan is needed. This study uses data from a population-based survey conducted in Northeast Japan in 2011 to identify dietary practices across socioeconomic groups and to quantify the relationships between specific health behaviours and dietary practices.

MATERIALS AND METHODS

Study population

In collaboration with the local health authority, a cross-sectional survey was administered on samples of residents aged 20-80 years living in Tsuruoka City, in Yamagata Prefecture, Northeast Japan. The survey was conducted in November 2011, after the eastern Japan disaster, with the samples selected using a stratified random sampling method according to area, sex, and age strata based on data from the Basic Resident Register on October 1, 2010. The data collection procedures, which included survey staff delivering and collecting the self-administered questionnaire, followed protocols approved by the Ethical Committee of the Graduate School of Medicine, The University of Tokyo (ID: 1568). The sample for this study comprised 5,002 residents (5% of the population) with 4,570 respondents (91.4% response rate).

Measures

Participants were presented with sixteen statements developed and standardised by the Ministry of Health Labour and Welfare^{3,12} on their daily dietary practices, with the response option coded as 0 (no) or 1 (yes): *I always have breakfast, I have staple food, i.e., rice, cereal, bread, or noodle, as part of every meal, I have a nutritionally balanced diet, I have calcium-rich food, i.e. milk or small fish including the bones, I have vegetables as part of every meal, I don't overeat, I don't have snacks, I don't have meals after dinner, I pay attention to the nutritional information on food when buying food or eating out, I have meals low in fat, I have meals low in salt, I don't have much sugar, I know the nutritional content and amount appropriate for my diet, My eating speed is not fast, I don't eat while doing other things, I don't have dinner*

before bedtime more than three times a week.

Age was categorised according to life stages into four groups: 20-24 years, 25-44 years, 45-64, and 65-80 years, while living arrangements was classified as living together, living alone (divorced or widowed), and single. Markers of socioeconomic position were: education level with <12 years of schooling (elementary schools, middle school, high school, vocational school), 12 years (senior high school), and 14 or more years (university, and graduate school); employment status was categorised as currently employed (including those employed in agriculture, forestry, fishery, and self-employed), not in paid employment, students, and full-time housewives.

Participants were asked if they had taken part in sports or exercise all year round, and the duration of activity on each occasion and the frequency of activity per week. Habitual exercise was defined as doing exercise or sports at least 30 minutes at one time with a frequency of more than twice a week.³ Other health behaviours were: cigarette smoking (as never smoker, past smoker, or current smoker); alcohol intake (non-drinker, past drinker, those who reported that they had reduced their amount of drinking, current drinker). BMI (kg/m^2) was classified as <18.5, 18.5-24.9, ≥ 25 . The presence of major illness or pain, that could change the dietary practice of the participants were indicative by an affirmative response to any of the following health conditions: hypertension, diabetes, dyslipidemia, gout and/or hyperuricemia, angina pectoris, myocardial infarction, stroke, digestive disorders, hepatitis and/or cirrhosis, low back pain, knee joint pain, osteoporosis, asthma, tooth decay and/or periodontal diseases, or the others.

Statistical analysis

Dietary practice patterns for all participants were derived using cluster analysis on data from the 16 dietary practices items using the VARCLUS procedure in SAS 9.3.¹³ This method places variables into distinct clusters on the basis of principal components, starting with one cluster and then splitting clusters until all clusters have at most one eigenvalue >1. Standardised component scores for each cluster were then computed using the Score procedure. Four patterns were selected based on having an eigenvalue >1 and the interpretability of the clusters. A higher standardised component score represented a higher number of affirmative responses to items in that dietary practice cluster.

Associations between standardised component scores from each of the dietary practice patterns and each of the sociodemographic factors and health behaviours were investigated using linear regression models. To examine the effect of habitual exercise on the standardised component scores for each dietary practice pattern, a series of adjustments were made to the linear regression models: initially adjusting for all socio-demographic variables that were significant in the linear regression analyses above (p -value <0.05), for the presence of major illness or pain, and BMI; then for the full model it was adjusted for the other health behaviours (in this case cigarette smoking and alcohol intake). The equivalent process was repeated for the effect of cigarette smoking and for alcohol intake on the standardised component scores for each dietary

practice pattern.

RESULTS

Cluster analysis of survey responses for the 16 items on daily dietary practices produced four distinct patterns (Table 1) labelled as: *low fat, sugar, or salt; emphasis on nutrition; regular breakfast and staples*; and *meals not snacks*. The four patterns explained 44% of the total variance in the daily dietary practice.

Marked differences were evident in the associations with the four dietary practice patterns according to socio-demographic characteristics and health behaviours (Table 2). For example, males had lower scores than females on all dietary practice patterns, except for *meals not snacks* where no sex difference was evident. Older Japanese (aged 65 to 80 years) had higher scores than other age groups on all four dietary practice patterns. Compared with those with 14 years of education or more, those with less than 12 years of education had lower scores on *emphasis on nutrition* but higher scores on *regular breakfast and staples* and *meals not snacks*. Housewives had higher scores in all the four dietary practice patterns compared with those in paid employment. With respect to BMI, participants in the underweight and obese categories had lower scores for the *low fat, sugar, or salt* and the *regular breakfast and staples* pattern than those in with normal BMI. Participants in the obese category also had lower scores on the *emphasis on nutrition* pattern.

In terms of health behaviours, habitual exercise was associated with all the four dietary practice patterns while cigarette smoking and alcohol intake were associated with all except *meals not snacks* pattern. In the fully adjusted model (Table 3), which accounts for age, sex, BMI category, and recent health services use (as an indicator of illness) and mutual adjustment of health behaviours, in almost all cases the relationships of health behaviours with the dietary practice patterns remained significant.

Those who reported not undertaking habitual exercise had a lower score on the dietary practice patterns that correspond with the *low fat, sugar, or salt; emphasis on nutrition*; and *meals not snacks* patterns. The association of habitual exercise with the *regular breakfast and staples* pattern, however, was attenuated when smoking status was added into the model (results not shown). Current smokers had lower scores than never smokers on all dietary practice patterns, except with respect to the *meals not snacks* pattern where no difference was evident. The associations for current drinkers were attenuated in the full model, but those who reported reduced intake had lower scores on the *low fat, sugar, or salt* and *emphasis on nutrition* patterns than non-drinkers.

DISCUSSION

As far as we are aware, this study provides unprecedented detail on the relationships of health behaviours with dietary practice patterns among Japanese adults. We found that their dietary practices formed four distinct patterns: *low fat, sugar, or salt; emphasis on nutrition; regular breakfast and staples*; and *meals not snacks*.

Our findings indicated that even after adjusting for other factors, including BMI category, those who reported not engaging in habitual exercise had lower scores on all patterns, except the *regular breakfast and staples* pattern. Similar findings were evident for past and current smokers compared with non-smokers (except with respect to *meals not snacks*). The relationship of alcohol intake with dietary practice patterns was more nuanced, with participants who reported they had reduced their alcohol intake having higher scores on the *low fat, sugar, or salt* and *emphasis on nutrition* patterns than non-drinkers. This may indicate that their reported reduction in alcohol intake was part of a broader change in lifestyle.

Findings in this study are consistent with previous research that have identified poor dietary practices among

Table 1. Dietary practice patterns from cluster analysis, using data from the 2011 survey

Dietary practices	Percentage who reported "yes" to the dietary behaviour (n/N)	Standardized scoring coefficients
Cluster 1: "Low fat/sugar/salt"		
I have meals low in fat.	67.3 (2951/4387)	0.343
I don't have much sugar	63.1 (2765/4385)	0.339
I have meals low in salt	67.4 (2961/4395)	0.333
I don't overeat	73.9 (3245/4393)	0.270
Cluster 2: "Emphasis on nutrition"		
I have the nutritionally balanced diet	67.6 (2951/4366)	0.396
I have calcium-rich food	60.2 (2628/4365)	0.336
I have vegetables in every meal	72.6 (3190/4395)	0.332
I know the nutritional proper content and amount for my diet	52.6 (2296/4367)	0.285
I pay attention to the nutritional information	22.2 (968/4363)	0.237
Cluster 3: "Regular breakfast and staples"		
I have breakfast always	83.5 (3682/4410)	0.613
I have staple food e.g. rice in every meals	89.5 (3929/4389)	0.613
Cluster 4: "Meals not snacks"		
I don't have snacks	47.6 (2088/4384)	0.489
I don't have meals after dinner	74.7 (3273/4384)	0.433
I don't eat while doing other things	69.6 (3001/4311)	0.351
I don't have dinner before bedtime more than three times a week	72.6 (3183/4387)	0.310
My eating speed is not fast	48.6 (2130/4381)	0.112
Total percentage of variances explained		44.1%

Table 2. Beta coefficients and 95% confidence intervals from multiple regression analysis using standardised component scores for each dietary practice patterns[†]

Characteristics	% (n)	Low fat, sugar, and salt	<i>p</i> -value	Emphasis on nutrition	<i>p</i> -value	Regular breakfast and staples	<i>p</i> -value	Meals not snacks	<i>p</i> -value
Sex			<0.0001		<0.0001		0.013		0.29
Men	48.8 (2168)	-0.33 (-0.40, -0.27)		-0.43 (-0.49, -0.36)		-0.08 (-0.15, -0.02)		0.03 (-0.03, 0.10)	
Women	51.2 (2277)	Reference		Reference		Reference		Reference	
Age groups			<0.0001		<0.0001		<0.0001		<0.0001
20-24	4.8 (213)	-0.44 (-0.61, -0.27)		-0.65 (-0.82, -0.48)		-0.68 (-0.84, -0.51)		-0.67 (-0.84, -0.51)	
25-44	27.3 (1221)	-0.55 (-0.65, -0.45)		-0.52 (-0.62, -0.42)		-0.54 (-0.64, -0.45)		-0.74 (-0.83, -0.64)	
45-64	40.8 (1823)	-0.20 (-0.28, -0.12)		-0.31 (-0.39, -0.22)		-0.27 (-0.35, -0.19)		-0.38 (-0.46, -0.29)	
65-80	27.1 (1209)	Reference		Reference		Reference		Reference	
Living arrangements			<0.0001		<0.0001		<0.0001		<0.0001
Living alone	13.2 (565)	0.09 (-0.01, 0.19)		-0.02 (-0.11, 0.08)		-0.06 (-0.15, 0.04)		0.03 (-0.07, 0.12)	
Never married	15.5 (663)	-0.26 (-0.35, -0.17)		-0.41 (-0.50, -0.32)		-0.41 (-0.50, -0.32)		-0.27 (-0.36, -0.18)	
Living together	71.3 (3050)	Reference		Reference		Reference		Reference	
Education level			0.026		<0.0001		<0.0001		<0.0001
<12 years	20.7 (870)	0.08 (-0.02, 0.18)		-0.10 (-0.20, 0.00)		0.24 (0.14, 0.34)		0.37 (0.27, 0.47)	
12 years	51.4 (2156)	-0.04 (-0.12, 0.03)		-0.17 (-0.24, -0.10)		0.03 (-0.05, 0.10)		0.12 (0.05, 0.20)	
≥14 years	27.9 (1169)	Reference		Reference		Reference		Reference	
Employment status			<0.0001		<0.0001		<0.0001		<0.0001
Housewife	8.6 (375)	0.43 (0.31, 0.54)		0.53 (0.41, 0.64)		0.25 (0.13, 0.36)		0.29 (0.17, 0.40)	
Not in paid employment	21.8 (956)	0.24 (0.15, 0.32)		0.21 (0.12, 0.29)		0.13 (0.05, 0.22)		0.40 (0.31, 0.48)	
Students	0.9 (41)	0.07 (-0.27, 0.41)		-0.16 (-0.49, 0.17)		-0.52 (-0.86, -0.18)		-0.23 (-0.56, 0.11)	
Paid employment	68.7 (3011)	Reference		Reference		Reference		Reference	
Habitual exercise			<0.001		<0.0001		0.0028		<0.0001
No	82.2 (3672)	-0.26 (-0.35, -0.18)		-0.4 (-0.49, -0.32)		-0.13 (-0.21, -0.04)		-0.27 (-0.36, -0.19)	
Yes	17.8 (794)	Reference		Reference		Reference		Reference	
Cigarette smoking			<0.0001		<0.0001		<0.0001		0.32
Past smoker	25.3 (1107)	-0.17 (-0.24, -0.09)		-0.25 (-0.33, -0.18)		-0.16 (-0.24, -0.08)		0.03 (-0.05, 0.11)	
Current smoker	24.0 (1050)	-0.43 (-0.51, -0.35)		-0.55 (-0.63, -0.47)		-0.43 (-0.51, -0.35)		-0.04 (-0.12, 0.04)	
Never smoker	50.7 (2222)	Reference		Reference		Reference		Reference	
Alcohol intake			<0.001		<0.0001		0.0003		0.36
Past drinker	6.4 (279)	0.09 (-0.06, 0.23)		-0.04 (-0.18, 0.10)		0.12 (-0.02, 0.27)		0.08 (-0.06, 0.23)	
Reduced amount	12.4 (539)	0.07 (-0.03, 0.17)		0.03 (-0.07, 0.14)		-0.04 (-0.15, 0.06)		0.04 (-0.07, 0.14)	
Current drinker	37.7 (1636)	-0.21 (-0.28, -0.14)		-0.24 (-0.31, -0.17)		-0.13 (-0.2, -0.06)		-0.03 (-0.10, 0.04)	
Non-drinker	43.5 (1890)	Reference		Reference		Reference		Reference	
Body mass index (kg/m ²)			<0.0001		0.014		0.13		<0.001
<18.5	7.0 (302)	-0.20 (-0.32, -0.07)		-0.05 (-0.18, 0.08)		-0.13 (-0.26, 0.00)		-0.16 (-0.28, -0.03)	
≥25	23.3 (999)	-0.15 (-0.23, -0.07)		-0.12 (-0.19, -0.04)		-0.03 (-0.10, 0.05)		-0.13 (-0.21, -0.05)	
18.5-24.9	69.7 (2995)	Reference		Reference		Reference		Reference	

[†]Adjusted for the presence of major illness or pain. N varies due to missing values.

Table 3. Beta coefficients and 95% confidence intervals from multiple regression analysis using standardised component scores for each dietary practice pattern[†]

Characteristics	Low fat, sugar, and salt (n=3922)	<i>p</i> -value	Emphasis on nutrition (n=3615)	<i>p</i> -value	Regular breakfast and staples (n=3864)	<i>p</i> -value	Meals not snacks (n=3862)	<i>p</i> -value
Habitual exercise								
No	-0.22 (-0.30, -0.14)	<0.0001	-0.38 (-0.46, -0.30)	<0.0001	-0.07 (-0.15, 0.01)	0.096	-0.17 (-0.25, -0.09)	<0.0001
Yes	Reference		Reference		Reference		Reference	
Cigarette smoking		<0.0001		<0.0001		<0.0001		0.50
Past smoker	-0.04 (-0.12, 0.05)		-0.12 (-0.20, -0.03)		-0.22 (-0.30, -0.13)		0.03 (-0.06, 0.11)	
Current smoker	-0.23 (-0.32, -0.14)		-0.28 (-0.37, -0.19)		-0.42 (-0.51, -0.33)		0.05 (-0.03, 0.14)	
Never smoker	Reference		Reference		Reference		Reference	
Alcohol intake		<0.0001		0.0002		0.31		0.80
Past drinker	0.17 (0.04, 0.30)		0.05 (-0.08, 0.19)		0.08 (-0.06, 0.21)		0.06 (-0.08, 0.19)	
Reduced amount	0.19 (0.09, 0.29)		0.17 (0.07, 0.27)		0.01 (-0.10, 0.11)		0.02 (-0.08, 0.12)	
Current drinker	-0.02 (-0.09, 0.05)		-0.02 (-0.09, 0.06)		-0.04 (-0.12, 0.03)		-0.01 (-0.08, 0.07)	
Non-drinker	Reference		Reference		Reference		Reference	

[†]Models contained all variables listed above, age, sex, BMI and the presence of major illness or pain. *Low fat, sugar, and salt* pattern was also adjusted for employment status, *Emphasis on nutrition* pattern for living arrangements and education level, *Regular breakfast and staples* and *Meals not snacks* patterns for living arrangements. N varies due to missing values.

the overweight and obese.¹⁴ The low scores for those not engaged with habitual exercise across three of the four dietary practice patterns adds to the evidence reported in a recent international systematic review for clear associations between sedentary behaviour and less healthful diet among young people, but with less conclusive results for adults.¹⁵ Further, our finding that older Japanese were more likely to have practices corresponding with the four dietary practice groups, as was also the case for housewives but not for those in paid employment, is consistent with evidence from previous research that suggested issues of work-life balance and a lack of time were the primary reason identified for a large discordance in the realities of breakfast consumption compared with the 'ideal' Japanese breakfast, rather than a lack of nutritional knowledge.¹⁶

The study has a number of implications for the development of public health policies aimed at improving dietary habits. Findings suggest specific segments of the population for targeted health messages, such as males and those in paid employment. Some dietary practice patterns appear to apply more broadly across the population, for instance fewer relationships were identified for the *meals not snacks* patterns than others, including no evidence of sex differences. By identifying clear associations between health behaviours, including habitual exercise and smoking, and dietary practice patterns the study supports the integrated approach to health behaviours, such as used in the Smart Japan Project.^{4,5} For example, encouraging the cessation of smoking and the practice of habitual exercise alongside dietary changes may facilitate the shift towards or maintenance of recommended dietary practices.

This study has both strengths and limitations. The findings use reported dietary practices from a self-completed survey with only binary responses. The survey statements were developed by the Ministry of Health Labour and Welfare with the intention of identifying healthful or unhealthful dietary practises,^{3,12} but the health implications do not necessarily apply to all population segments. For instance the consumption of snacks, which are usually linked with consumption of fast foods and unhealthful diets for most age groups, may be beneficial for the elderly in maintaining nutrient intakes.¹⁷ Further, the question on reduction in alcohol intake did not distinguish between reductions in frequency or the amount of alcohol intake. Another limitation was that while information was gathered on whether anyone in the household was pregnant, the pregnancy status of the respondent was not recorded. Nonetheless, reported dietary practices from this large survey of Japanese adults provides information on perceived patterns of dietary intakes and hence can give insights for interventions to influence dietary practices. While it is not possible to infer causal pathways from cross-sectional analysis of the dietary practice patterns, the strength of the key associations for habitual exercise and smoking status remained in the fully adjusted model and suggests an underlying relationship.

Conclusions

This study highlights the relationships between health behaviours and dietary practices in Japanese adults. Most

notably, the lack of habitual exercise was linked with poor dietary practices. Findings are consistent with an integrated approach to health policy that links dietary practices with habitual exercise behaviours and smoking cessation and additionally suggest targeting specific groups, such as males and those in paid employment. Further research is needed to determine if such relationships are replicated across Japan.

ACKNOWLEDGEMENTS

This study was supported by the Grant-in Aid for Scientific Research from the Japan Ministry of Education, Culture, Sports, Science and Technology (JSPS KAKENHI, Grant Numbers: 202463 and 25242063). The Japan Ministry of Education, Culture, Sports, Science and Technology had no role in the design, analysis or writing on this article.

AUTHOR DISCLOSURES

The authors have no conflict of interest to declare.

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