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REGULAR ARTICLE

The associations between lifestyles and mental health using the General Health Questionnaire 12-items are different dependently on age and sex: a population-based cross-sectional study in Kanazawa, Japan

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Abstract

Objectives The aim of this study was to examine potential differences of the associations between mental health and lifestyle factors across a wide range of age.

Methods In August/September 2011, data were collected from 4693 males (age 51.6 ± 19.5) and 5678 females (age 52.4 ± 19.4) living in Kanazawa, Japan. A cross-sectional community-based survey was conducted with self-administered questionnaire including the General Health Questionnaire (GHQ) 12-item version, sociodemographic, and lifestyle factors. Associations between the GHQ scores and other variables were examined using two-way analysis of variance (ANOVA) followed by multiple comparisons and logistic regression stratified by age and gender.

Results Multiple comparisons indicated that people aged 20–39 or 40–64 had higher GHQ scores than older aged. The two-way ANOVA revealed significant interaction between body mass index and age group, and between exercise and age group. Overweight or underweight males aged 40–64 had poorer mental health than those at normal weight. In the elderly, being underweight was significantly associated with poor mental health. There were no significant effects of exercise on mental health for young adults. The logistic regression showed significant negative effects of short-time sleep in adults.

Conclusions The associations between mental health and lifestyles differ across age groups. Further study is needed to reveal effects of aging on lifestyle and mental health with a longitudinal design.

Keywords Aging · Cross sectional · Lifestyle · The General Health Questionnaire · Mental health

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Introduction

Mental health is now a major public health problem in the world. As in other countries, mental disorders are spreading in Japan. It has been reported that a prevalence of common mental disorders in Japan was 8.8 % [1]. From the aspect of prevention of depression and suicide, health behaviors attract attentions. Individual lifestyles, including body mass index (BMI), smoking, alcohol consumption, sleeping, exercise, and dietary habits, are well known to be associated with health status, such as morbidity and mortality [2–5]. Observational epidemiologic studies have proved that lifestyles are significantly associated with mental health as well as physical health in adults [6–8] and adolescents [9]. Previous cross-sectional study on psychological problems in male middle-aged workers suggests that low frequency of exercise, high-smoking frequency,

and high BMI significantly contributed to high GHQ-12 score [10, 11]. Those studies, however, had some limitations. The problem seems to lie in the fact that the subjects were confined to a certain age group or sex. Also, there is a lack of consensus on whether the relationship varies across age groups. Until now, mental health among healthy community dwelling people has not been well documented. In aging society at an unprecedented rate, it is necessary to clarify potential differences of the associations between mental health and lifestyle factors across a wide range of age.

We hypothesized that the role of lifestyle on mental health differs across age groups or sex. The purpose of this study was to further explore and disentangle the associations between a variety of lifestyles, aging, and mental health (measured using the General Health Questionnaire-12: GHQ-12), in a large Japanese population-based study.

Materials and methods

Subjects and sampling

Our cross-sectional study was conducted in the city of Kanazawa, Ishikawa prefecture, Japan. Kanazawa is a central city of the Hokuriku area with a total population about 462,500 in 2010. Kanaiwa and Togashi school districts in which the total population was 12,868 were selected to study. Kanaiwa is a port town facing the Sea of Japan. Togashi is an inland residential area near the city center. Almost all the residents are Japanese. In Japan, an elementary school district is defined as the primary residential spatial unit of people where neighborhood associations are organized within each district. Neighborhood associations are determined as local community of citizens which contribute to building and maintaining social solidarity [12]. The residents participate in them on household basis.

We held an orientation meeting with the representatives of the neighborhood associations, instructing to follow the guidelines for conducting the survey. The questionnaires and envelopes were distributed among the householders. Each family member aged 12 years or over responded a self-administered questionnaire. The self-administered questionnaire included questions concerning mental health, sociodemographic factors, and lifestyles. After filling in the anonymous questionnaire, each householder sealed the questionnaires of family members in the provided envelope with an adhesive flap and sent back to Kanazawa University. The survey period was from August to September 2011.

12,253 questionnaires were collected, and thus, the participation rate was 95.2 % (12,253/12,868). Of the collected questionnaires, 1882 were excluded, because age or sex was not specified or the answers for the GHQ-12 were incomplete. The data for the remaining 10,371 questionnaires, including 4693 males [age 51.6 ± 19.5 years, (mean ± SD)] and 5678 females [age 52.4 ± 19.4 years, (mean ± SD)] were analyzed. The oldest subject was 103 years old. This resulted in the valid response rate of 80.6 % (10,371/12,868). We first compared the differences in characteristics between the present study subjects and those excluded from the analyses. Since most of subjects were excluded due to the lack of relevant personal data, such as age or sex, we could not examine these differences between the two groups. Nevertheless, the differences in lifestyles and the GHQ scores were examined between the two groups. There were no significant differences between the two groups in the GHQ-12 scores or most lifestyle factors in general.

Measurement of mental health

We used the Japanese version of the GHQ-12 to evaluate mental health status [13, 14]. The GHQ-12 is a widely used, self-administered questionnaire that was originally designed as a screening tool for mental illness. The GHQ is also used in primary health care screening in the general population survey [14]. The GHQ-12 score was first applied to adults and then validated for adolescents as well [15]. Every item on the GHQ-12 describes a symptom and has four possible responses: the two answers which indicate the absence of the symptom are given a score of 0, and the other two which indicate the presence of the symptom receive a score of 1. The overall score on the scale will fall into a range of 0–12, with higher scores indicating more psychological distress. Good mental health was defined as a GHQ-12 score <4 and poor mental health as a score ≥ 4 [16].

Measurement of other variables

The sociodemographic factors derived from personal data were sex, age, height, weight, employment status, and the number of family members. Age was divided into four groups: 12–19, 20–39, 40–64, and 65 years old or over. In japan, when people reach 20 years of age, they are permitted to smoke cigarette and drink alcohol. They retire on age of 65 generally. The national pension system starts providing a pension when people reach 60–65 years old. BMI, a measure of relative weight, was calculated from self-reported weight and height as weight divided by height squared (kg/m^2). BMI was categorized into underweight ($<$18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), and overweight ($\geq$25.0 kg/m^2) [17]. We omitted the criteria that defines obesity when BMI $\geq$ 30.0 kg/m^2, because the

participants had extremely small proportion of BMI $\geq$ 30.0 kg/m^2. For the participants under 18 years old, international age- and sex-specific cutoff points for BMI were used to define underweight, normal weight, and overweight [18–20]. These cutoff points are linked to the adult cutoff points of 18.5 kg/m^2 (underweight), and 25.0 kg/m^2 (overweight). Employment status was dichotomized into: self-employed/employed = "employed" and "self-employed," and others = "unemployed," "house worker," and "student." The number of family members was dichotomized into: living with others and living alone.

Lifestyles included the following five: smoking status, alcohol consumption, sleep duration, exercise frequency, and breakfast habit. Smoking status was categorized as never-smoker, ex-smoker, or current smoker. Alcohol consumption was assessed by the question: "How often do you drink?" The answering alternatives were categorized into the following scale: rarely = "No, I don't drink"; occasionally = "1–3 days a month", "1–2 days a week", and "3–5 days a week"; daily = "almost every day". Sleep duration was elicited by posing the question, ''How many hours of sleep do you have on average?" To create comparable categories of sleep duration, response categories were collapsed into three groups: $\geq$9, 7–9, and $<$7 h. This classification was consistent with that used in the majority of studies on the health effects of habitual sleep duration [4, 21]. Exercise frequency was asked by the question: "How many days do you exercise in an ordinary week?" The answering alternatives were categorized into the following: active = "every day" and "5–6 days"; moderate = "3–4 days", and "1–2 days"; inactive = "less than 1 day". We regarded light physical activity (e.g., walking or yoga) as exercise, because the associations between physical activity and mental health were always positive regardless of activity intensity [22]. Breakfast habit was asked by the question: "How often do you eat breakfast in an ordinary week?" The answering alternatives were the following: regularly = "almost every day"; sometimes = "one to four times"; rarely = "less than once".

Statistical analysis

The differences of the GHQ cutoff point, sociodemographic factors, and lifestyle factors between males and females were analyzed by Chi-square test. The differences in the total GHQ score among response categories of each of demographic and lifestyle factors were analyzed by a two-way analysis of variance (ANOVA) with main factors of age class and each category, followed by post hoc Bonferroni test for multiple comparisons. To clarify which lifestyle factors are significantly associated with mental health status after controlling for the other factors, multiple logistic regression analyses were performed in which the dependent variable was dichotomized value of the GHQ-12, and the independent variables were five lifestyles and the other variables: age, employment status, living arrangements, and BMI. We excluded variables of living arrangement, smoking, and drinking in the analysis for non-adult. The analyses were performed for males and females separately, because the prevalence of poor mental health and related lifestyle has been shown to differ between genders [23, 24]. All statistical tests were two-tailed. *P* values less than 0.05 were regarded as indicating statistical significance. SPSS (Ver. 22) was used for all statistical analyses.

Ethical approval

This study was approved by the Ethics Committee of Kanazawa University Graduate School of Medicine, Japan (reference number 513). We considered the return of the self-administered questionnaires filled out by the subjects to imply their consent to participate in the study.

Results

Table 1 shows the sex-specific distribution of variables. We recognized significant differences in the ratio of the corresponding categories of all variables between males and females. Females had higher GHQ cutoff category (i.e., poor mental health), higher average age, lower BMI, shorter sleep duration, less frequency of smoke, less frequency of drink, less frequency of exercise, and less frequency of breakfast skipping. Those results were statistically significant.

Table 2 shows the mean value of the GHQ-12 by age and sex. An ANOVA was conducted to determine whether psychological distress significantly differed across age groups and sex. The analysis revealed a significant main effect for age group and sex. Post hoc Bonfferoni tests confirmed that males and females aged 20–39 or 40–64 years had poorer mental health than the older. Females reported significantly higher levels of distress relative to males in all age groups.

The mean scores and standard deviation of the GHQ-12 by categories of each lifestyle factor and age group are presented in Table 3. The two-way ANOVA in males revealed significant main effects of BMI, alcohol consumption, sleep duration, exercise frequency, and breakfast habit. On the other hand, the result in females clarified significant main effects of smoking status, sleep duration, exercise frequency, and breakfast habit. Of both genders, we further detected significant interactive effects of age group and two variables: BMI and exercise frequency. The

Table 1 Descriptive characteristics of the subjects stratified by gender

Variables	Male, $N = 4693$ (%)	Female, $N = 5678$ (%)	P value[a]
GHQ-12 score			
≥4	1136 (24.2)	1816 (32.0)	<0.001
<4	3557 (75.8)	3862 (68.0)	
Age group			
12–19	396 (8.4)	391 (6.9)	0.016
20–39	919 (19.6)	1155 (20.3)	
40–64	2045 (43.6)	2451 (43.2)	
65 or over	1333 (28.4)	1681 (29.6)	
BMI			
Underweight	256 (5.7)	715 (13.5)	<0.001
Normal weight	3208 (70.8)	3857 (72.9)	
Overweight	1065 (23.5)	721 (13.6)	
Employment status			
Self/employed	3045 (65.9)	2465 (44.2)	<0.001
Others	1574 (34.1)	3108 (55.8)	
Living arrangements			
With others	4409 (95.8)	4978 (91.7)	<0.001
Alone	195 (4.2)	448 (8.3)	
Smoking status			
Non-smoker	1432 (31.7)	4178 (77.3)	<0.001
Ex-smoker	1731 (38.3)	690 (12.8)	
Current smoker	1354 (30.0)	537 (9.9)	
Alcohol consumption			
Rarely	1492 (33.1)	3125 (58.0)	<0.001
Occasionally	1365 (30.2)	1628 (30.2)	
Daily	1657 (36.7)	633 (11.8)	
Sleep duration			
>9 h	222 (4.8)	193 (3.5)	<0.001
7–9 h	2016 (43.5)	2212 (39.6)	
<7 h	2395 (51.7)	3186 (57.0)	
Exercise frequency			
Active	1084 (23.5)	950 (17.4)	<0.001
Moderate	1566 (34.0)	1775 (32.5)	
Inactive	1957 (42.5)	2741 (50.1)	
Breakfast habit			
Regularly	3646 (79.2)	4794 (85.6)	<0.001
Sometimes	478 (10.4)	473 (8.4)	
Rarely	482 (10.5)	333 (5.9)	

GHQ general health questionnaire, *BMI* body mass index

[a] Chi-square test

post hoc Bonfferoni multiple comparisons showed that males aged 40–64 who were underweight or overweight had significantly poor mental health compared with those at normal weight. Males aged ≥65 who were underweight showed significantly higher GHQ-12 scores than those at normal weight or overweight. Female ex-smokers aged ≥65 had significantly poorer mental health than never smokers. Short-time sleepers of all age groups in both sexes and longer time sleeping older females had significantly poor mental health relative to those who slept 7–9 h. Males and females of all age groups except young adults who exercised inactively reported significantly higher GHQ scores as compared with those who exercised at least once a week. The GHQ scores in males aged ≥65 who had breakfast sometimes were significantly higher than those who had daily. Females aged 20 or over who ate breakfast

Table 2 Mean GHQ scores across age group and gender and *P* values of main and interaction effects

Age group	12–19 years		20–39 years		40–64 years		>65 years		*P* for age group	*P* for gender	*P* for interaction
	N	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD			
Gender											
Male	396	1.82 ± 2.76[a,b,c]	919	2.50 ± 3.17[a,d]	2045	2.34 ± 3.14[a,e]	1333	1.90 ± 2.87[a]	<0.001	<0.001	0.354
Female	391	2.64 ± 3.00	1155	2.90 ± 3.23[d]	2451	2.82 ± 3.33[e]	1681	2.51 ± 3.15			

GHQ general health questionnaire, *SD* standard deviation

[a] Significant difference between males and females, $P < 0.05$

[b] Significant difference between 12–19 and 20–39 years, $P < 0.05$

[c] Significant difference between 12–19 and 40–64 years, $P < 0.05$

[d] Significant difference between 20–39 and ≥65 years, $P < 0.05$

[e] Significant difference between 40–64 and ≥65 years, $P < 0.05$

daily had lower GHQ scores than those who skipped breakfast.

Table 4 shows the result of multiple logistic regression analyses of the participant characteristics associated with having poor mental health by age groups and sex, adjusted for sociodemographic and lifestyle factors. Among males aged 40–64, underweight or overweight persons had higher adjusted odds ratios (AOR) of the GHQ score ≥4 than persons at normal weight (AORs were 1.88 and 1.36, respectively). Current or ex-smokers had higher AORs of poor mental health than non-smokers among females aged ≥65. For females aged 40–64, drinking occasionally was related to decreased risk of poor mental health. Short-time sleep significantly contributed to poor mental health as compared with normal time in adults. The relationship was border significant in teenagers. Males and females aged 40–64 and ≥65 years who exercised actively or moderately had lower AORs of poor mental health than those exercised inactively.

Discussion

One of our main findings was that the relationship between mental health and lifestyle varied across age groups and sex in the general population. The ANOVA followed by post hoc Bonferroni test showed that older adults had lower GHQ-12 scores than young and middle-aged adults did. Unhealthy lifestyle factors that have been shown to be associated with poor mental health in the present, and other studies (such as cigarette smoking, short sleep duration, low frequency of exercise, and breakfast skipping) were less prevalent among the elderly than young and middle-aged adults. The present result supports a number of research on that depression and anxiety symptoms in adult decline across age groups after controlling for major confounders (i.e., sociodemographic and lifestyle factors) [25–27]. One possible explanation for the age difference is a transition of stress across life stage. Honda and Kikuzawa described that working age population in Japan is suffering from multiple stressors: work-related stress, childcare, and care for the aging parents [28, 29]. Although the elderlies have a higher prevalence of chronic diseases and disabilities which ought to result in poorer mental health, aging of the brain could be possibility to explain the mental well-being. It is reported that older adults are less likely to remember negative than positive emotional stimuli [30]. Thus, the issue arises whether the GHQ-12 could be applied with equal validity across wide age range (i.e., from adolescents to the very elderly aged 100 years old and above). This issue deserves more attention for the future epidemiological study.

Interestingly, for males, difference across age groups was found in the pattern of relationships between the GHQ-12 scores and BMI. Our post hoc tests showed that BMI significantly had a U-shape effect on mental health among middle-aged. It was also true in multiple logistic regression analyses; either underweight or overweight was significantly associated with poor mental health. However, in the older age group, the association between underweight and poor mental health persisted, whereas the effect of overweight on poor mental health weakened. Two combined factors would explain the difference. First, overweight males had a higher prevalence of unhealthy lifestyle. Our previous studies had showed unhealthy lifestyle negatively affect mental health [10, 11]. The second factor is a survivorship bias, which our methodology could not avoid. A decline in the ratio of overweight males across 40–64 and ≥65 age groups might reflect the dropout. The present result is in accordance with recent cohort studies that clearly demonstrated the association between weight abnormalities and all-cause mortalities in Japan [31, 32].

Table 3 Mean GHQ scores across age group and variables stratified by gender, and *P* values of main and interaction effects

Age group	12–19 years		20–39 years		40–64 years		>65 years		*P* for age group	*P* for trend	*P* for interaction
Variables	*N*	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD			
Male											
BMI											
Underweight	53	2.00 ± 3.04	60	2.62 ± 2.94	65	3.25 ± 3.56[a]	74	3.02 ± 3.79[a,b]	0.001	0.002	0.030
Normal weight	294	1.79 ± 2.73	637	2.44 ± 3.15	1355	2.15 ± 2.99[c]	927	1.82 ± 2.81			
Overweight	48	1.82 ± 2.76	188	2.83 ± 3.36	572	2.76 ± 3.44	259	1.73 ± 2.54			
Employment status											
Self/employed	20	2.75 ± 3.11	781	2.48 ± 3.18	1853	2.27 ± 3.09[a]	391	1.72 ± 2.56	<0.001	0.649	0.043
Others	363	1.79 ± 2.77	129	2.72 ± 3.18	174	3.12 ± 3.62	908	1.96 ± 2.97			
Living arrangements											
With others	387	1.81 ± 2.74	878	2.48 ± 3.17	1912	2.30 ± 3.11	1232	1.84 ± 2.78[a]	0.062	0.093	0.305
Alone	0		25	2.32 ± 2.79	98	2.84 ± 3.44	72	2.77 ± 3.75			
Smoking status											
Non-smoker	362	1.82 ± 2.77	378	2.63 ± 3.32	409	2.38 ± 3.22	283	1.67 ± 2.76	<0.001	0.136	0.194
Ex-smoker	1	1	172	2.53 ± 3.07	821	2.29 ± 3.15	737	1.92 ± 2.93			
Current smoker	8	4.00 ± 4.38	345	2.34 ± 3.04	754	2.36 ± 3.09	247	2.10 ± 2.91			
Alcohol consumption											
Rarely	358	1.80 ± 2.78[b]	279	2.67 ± 3.29	443	2.36 ± 3.28	412	2.27 ± 3.19[b]	<0.001	0.045	0.005
Occasionally	10	3.10 ± 2.02	416	2.33 ± 3.10	654	2.48 ± 3.29	285	1.77 ± 2.77			
Daily	2	8.00 ± 5.66	206	2.58 ± 3.12	883	2.23 ± 2.95	566	1.67 ± 2.65			
Sleep duration											
>9 h	31	2.06 ± 3.02	18	2.61 ± 3.63	39	1.90 ± 3.14	134	2.16 ± 3.18	0.301	<0.001	0.338
7–9 h	225	1.45 ± 2.44[c]	313	2.07 ± 3.02[c]	809	1.66 ± 2.58[c]	669	1.50 ± 2.45[c]			
<7 h	137	2.34 ± 3.12	577	2.71 ± 3.22	1173	2.83 ± 3.39	508	2.30 ± 3.12			
Exercise frequency											
Active	227	1.52 ± 2.31[b]	140	2.21 ± 3.01	340	1.87 ± 2.85[b]	377	1.36 ± 2.35[b]	0.001	<0.001	0.032
Moderate	96	1.60 ± 2.68[c]	330	2.47 ± 3.24	671	1.93 ± 2.78[c]	469	1.74 ± 2.69[c]			
Inactive	70	3.19 ± 3.73	444	2.62 ± 3.18	1010	2.78 ± 3.39	433	2.52 ± 3.27			
Breakfast habit											
Regularly	315	1.65 ± 2.56	542	2.40 ± 3.07[b]	1571	2.24 ± 3.03	1218	1.79 ± 2.77[a]	0.675	<0.001	0.001
Sometimes	52	2.27 ± 3.21	183	2.03 ± 2.84[c]	203	2.73 ± 3.52	40	3.57 ± 3.73			
Rarely	22	3.05 ± 4.12	180	3.30 ± 3.68	240	2.72 ± 3.43	40	2.90 ± 3.84			
Female											
BMI											

Table 3 continued

Age group	12–19 years		20–39 years		40–64 years		>65 years		*P* for age group	*P* for trend	*P* for interaction
Variables	*N*	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD	*N*	Mean ± SD			
Underweight	82	2.39 ± 2.85	215	2.68 ± 3.13	246	3.03 ± 3.58	161	2.92 ± 3.38[a]	0.207	0.233	0.097
Normal weight	267	2.70 ± 3.03	755	2.93 ± 3.26	1744	2.72 ± 3.21	1102	2.35 ± 3.04			
Overweight	41	2.83 ± 3.13	86	3.44 ± 3.66	317	2.90 ± 3.44	284	2.68 ± 3.20			
Employment status											
Self/employed	15	2.07 ± 2.76	785	3.03 ± 3.31[a]	1469	2.85 ± 3.30	196	2.28 ± 3.06	0.023	0.750	0.153
Others	367	2.68 ± 2.98	359	2.60 ± 3.05	944	2.73 ± 3.33	1438	2.52 ± 3.15			
Living arrangements											
With others	372	2.66 ± 3.00	1082	2.87 ± 3.25	2201	2.79 ± 3.28	1323	2.51 ± 3.17	0.015	0.230	0.301
Alone	0		18	3.72 ± 3.59	126	3.07 ± 3.67	304	2.39 ± 2.97			
Smoking status											
Non-smoker	368	2.61 ± 2.93[a,b]	773	2.79 ± 3.16	1735	2.72 ± 3.27[b]	1302	2.38 ± 3.09[a]	0.005	<0.001	0.003
Ex-smoker	2	8.60 ± 1.98	202	3.06 ± 3.32	347	2.66 ± 3.19[c]	139	3.11 ± 3.37			
Current smoker	4	7.50 ± 4.65	160	3.23 ± 3.49	294	3.57 ± 3.56	79	3.18 ± 3.67			
Alcohol consumption											
Rarely	351	2.62 ± 2.95[a]	491	2.80 ± 3.23	1154	2.90 ± 3.38	1129	2.56 ± 3.22	0.001	0.464	0.028
Occasionally	18	4.17 ± 3.40	547	3.02 ± 3.24	799	2.60 ± 3.15	264	2.14 ± 2.95			
Daily	0		98	2.72 ± 3.22	425	2.95 ± 3.34	110	2.21 ± 2.73			
Sleep duration											
>9 h	45	2.38 ± 2.83	34	2.44 ± 2.94	22	2.08 ± 3.12	92	2.88 ± 3.45[a]	0.795	<0.001	0.153
7–9 h	189	2.32 ± 2.93[c]	515	2.53 ± 2.98[c]	804	1.99 ± 2.77[c]	704	1.94 ± 2.78[c]			
<7 h	151	3.21 ± 3.08	600	3.25 ± 3.41	1605	3.25 ± 3.50	830	2.93 ± 3.32			
Exercise frequency											
Active	160	2.20 ± 2.71[b]	113	2.80 ± 3.06	322	2.32 ± 3.15[b]	355	1.77 ± 2.66[a,b]	0.005	<0.001	0.024
Moderate	125	2.51 ± 2.82[c]	317	2.92 ± 3.30	765	2.59 ± 3.30[c]	568	2.36 ± 3.05[c]			
Inactive	103	3.58 ± 3.43	716	2.93 ± 3.24	1320	3.11 ± 3.37	602	3.05 ± 3.41			
Breakfast habit											
Regularly	325	2.46 ± 2.81	859	2.65 ± 3.02[a,b]	2059	2.70 ± 3.25[a,b]	1551	2.43 ± 3.10[a,b]	0.424	<0.001	0.312
Sometimes	41	3.49 ± 3.80	182	3.70 ± 3.59	198	3.42 ± 3.61	52	3.97 ± 3.56			
Rarely	20	3.80 ± 3.68	106	3.65 ± 3.89	172	3.40 ± 3.55	35	4.39 ± 4.09			

GHQ general health questionnaire, *BUI* body mass index, *SD* standard deviation

[a] Significant difference between the first and second categories of each variable, $P < 0.05$

[b] Significant difference between the first and third categories of each variable, $P < 0.05$

[c] Significant difference between the second and third categories of each variable, $P < 0.05$

Table 4 Logistic regression analysis of the categories associated with poor mental health (GHQ ≥ 4) stratified by age group and gender

Age group	12–19 years[a]				20–39 years[b]				40–64 years[b]				>65 years[b]			
Variables	*N*	AOR	95 % CI	*P* value	*N*	AOR	95 % CI	*P* value	*N*	AOR	95 % CI	*P* value	N	AOR	95 % CI	*P* value
Male, $N = 4153$																
Age	373	1.03	0.88–1.21	0.680	829	1.02	0.9–1.05	0.286	1844	0.98	0.97–1.00	0.015	1107	1.01	0.99–1.04	0.372
BMI																
Underweight	51	1.16	0.55–2.44	0.706	56	1.80	1.00–3.26	0.050	61	1.88	1.07–3.29	0.028	66	1.65	0.92–2.96	0.095
Normal weight	282	1.00			597	1.00			1250	1.00			818	1.00		
Overweight	40	0.80	0.33–1.94	0.613	176	1.14	0.78–1.67	0.490	533	1.36	1.08–1.72	0.010	223	1.00	0.68–1.47	0.999
Employment status																
Self/employed	18	1.00			717	1.00			1690	1.00			341	1.00		
Others	355	0.80	0.26–2.47	0.704	112	1.64	0.98–2.73	0.059	154	1.91	1.29–2.83	0.001	766	1.26	0.88–1.82	0.211
Living arrangements																
With others					808	1.00			1755	1.00			1052	1.00		
Alone					21	0.83	0.29–2.38	0.728	89	1.19	0.74–1.93	0.476	55	1.13	0.58–2.21	0.719
Smoking status																
Non-smoker					355	1.00			378	1.00			241	1.00		
Ex-smoker					162	1.14	0.73–1.78	0.568	762	1.23	0.91–1.67	0.177	653	1.27	0.85–1.90	0.245
Current smoker					312	0.98	0.68–1.43	0.929	704	1.20	0.88–1.64	0.242	213	1.26	0.77–2.07	0.358
Alcohol consumption																
Rarely					255	1.00			396	1.00			341	1.00		
Occasionally					389	0.93	0.65–1.34	0.704	616	1.15	0.85–1.55	0.371	251	0.83	0.55–1.27	0.400
Daily					185	1.09	0.70–1.71	0.702	832	1.18	0.88–1.57	0.272	515	0.79	0.55–1.12	0.184
Sleep duration																
>9 h	29	1.11	0.38–3.25	0.847	15	1.06	0.31–3.56	0.929	35	0.63	0.23–1.71	0.366	110	1.65	0.99–2.75	0.054
7–9 h	212	1.00			288	1.00			740	1.00			561	1.00		
<7 h	132	1.78	0.99–3.19	0.053	526	1.44	1.03–2.02	0.032	1069	2.31	1.82–2.93	<0.001	436	1.92	1.38–2.66	<0.001
Exercise frequency																
Active	213	0.45	0.22–0.95	0.035	128	0.78	0.48–1.25	0.300	304	0.68	0.50–0.94	0.020	333	0.46	0.31–0.68	<0.001
Moderate	93	0.37	0.17–0.81	0.013	307	0.97	0.69–1.36	0.849	622	0.71	0.55–0.91	0.006	418	0.59	0.42–0.85	0.004
Inactive	67	1.00			394	1.00			918	1.00			356	1.00		
Breakfast habit																
Regularly	302	1.00			496	1.00			1445	1.00			1040	1.00		
Sometimes	50	1.37	0.64–2.93	0.418	173	0.80	0.52–1.21	0.288	179	1.17	0.81–1.67	0.402	33	4.58	2.17–9.65	<0.001
Rarely	21	2.01	0.72–5.58	0.182	160	1.54	1.03–2.29	0.035	220	1.03	0.73–1.44	0.878	34	1.48	0.66–3.31	0.339
Female, $N = 4574$																
Age	371	1.26	1.10–1.44	0.001	971	0.99	0.96–1.01	0.295	2059	1.00	0.99–1.02	0.577	1173	1.03	1.01–1.05	0.011

Table 4 continued

Age group	12–19 years[a]				20–39 years[b]				40–64 years[b]				>65 years[b]			
Variables	*N*	AOR	95 % CI	*P* value	*N*	AOR	95 % CI	*P* value	*N*	AOR	95 % CI	*P* value	N	AOR	95 % CI	*P* value
BMI																
Underweight	80	0.76	0.42–1.35	0.347	199	0.75	0.53–1.07	0.113	219	1.12	0.83–1.52	0.459	118	1.13	0.74–1.74	0.571
Normal weight	259	1.00			697	1.00			1557	1.00			852	1.00		
Overweight	32	1.65	0.74–3.66	0.224	75	1.06	0.64–1.76	0.822	283	1.04	0.79–1.37	0.781	203	1.14	0.80–1.60	0.470
Employment status																
Self/employed	13	1.00			671	1.00			1265	1.00			139	1.00		
Others	358	3.20	0.88–11.60	0.077	300	0.99	0.73–1.35	0.967	794	1.03	0.84–1.26	0.804	1034	1.08	0.71–1.64	0.715
Living arrangements																
With others					956	1.00			1956	1.00			976	1.00		
Alone					15	1.44	0.50–4.16	0.502	103	0.91	0.58–1.42	0.670	197	0.92	0.64–1.31	0.635
Smoking status																
Non-smoker					665	1.00			1496	1.00			1008	1.00		
Ex-smoker					171	1.31	0.91–1.89	0.150	305	0.92	0.70–1.22	0.569	104	2.19	1.42–3.37	<0.001
Current smoker					135	1.37	0.90–2.08	0.143	258	1.26	0.94–1.70	0.122	61	2.08	1.19–3.64	0.011
Alcohol consumption																
Rarely					417	1.00			985	1.00			875	1.00		
Occasionally					471	1.05	0.79–1.40	0.741	698	0.80	0.65–1.00	0.047	209	0.89	0.62–1.27	0.510
Daily					83	0.90	0.53–1.53	0.693	376	1.09	0.83–1.42	0.536	89	0.62	0.36–1.07	0.084
Sleep duration																
>9 h	45	1.12	0.52–2.40	0.781	29	0.82	0.35–1.93	0.647	17	1.00	0.32–3.14	0.999	55	0.69	0.34–1.38	0.291
7–9 h	178	1.00			438	1.00			688	1.00			522	1.00		
<7 h	148	1.57	0.94–2.62	0.088	504	1.41	1.07–1.87	0.016	1354	2.08	1.68–2.58	<0.001	596	1.78	1.35–2.34	<0.001
Exercise frequency																
Active	154	0.68	0.37–1.24	0.676	99	1.10	0.70–1.74	0.678	278	0.53	0.39–0.73	<0.001	285	0.61	0.43–0.87	0.006
Moderate	118	0.61	0.34–1.10	0.613	270	1.07	0.78–1.46	0.689	659	0.79	0.63–0.97	0.027	450	0.72	0.54–0.98	0.036
Inactive	99	1.00			602	1.00			1122	1.00			438	1.00		
Breakfast habit																
Regularly	313	1.00			723	1.00			1742	1.00			1114	1.00		
Sometimes	39	1.39	0.68–2.84	0.373	160	1.56	1.08–2.25	0.018	168	1.35	0.96–1.90	0.084	37	2.66	1.33–5.30	0.006
Rarely	19	1.24	0.46–3.38	0.672	88	1.35	0.83–2.20	0.223	149	1.19	0.82–1.72	0.350	22	2.62	1.07–6.43	0.035

GHQ general health questionnaire, *BMI* body mass index, *CI* confidence interval, *AOR* adjusted odds ratio

[a] Adjusted for age, BMI, employment status, sleep duration, exercise frequency, and breakfast habit

[b] Adjusted for age, BMI, employment status, living arrangements, smoking status, alcohol consumption, sleep duration, exercise frequency, and breakfast habit

On the contrary, Ul-Haq pointed out inconsistent result in their meta-analysis in which the selected samples were from Western countries: there is a significant positive association between overweight and mental well being, and only class 3 obesity reduced mental quality of life [33]. The disagreement could be explained by racial differences in BMI distributions. A majority of studies exploring the association between mental health and BMI is from the US or Europe. We should be cautious when construed the result from Western countries, because an average BMI is relatively low in Japan [34]. Future research is needed to investigate more thoroughly how underweight or overweight affect for heightened psychological distress in Japanese population.

It is noteworthy that the predominant factor for poor mental health was short sleep duration. In other words, shorter sleeping hours are associated with poor mental health, independently of age group, BMI, employment status, living arrangements, and other lifestyle factors. The results of our current study corroborate several studies that have verified short sleep duration is associated with an increased risk of depression [35], as well as overall mortality [4, 21, 36]. Another finding from the post hoc test was that, specifically for older females, individual who sleep more than 9 h had significantly higher GHQ score compared with those sleep 7–9 h. However, the relationships were not significant in our multiple logistic regression analyses. We interpret that the higher GHQ-12 scores reported by the participants were due to their higher rates of other unhealthy lifestyles. For example, long sleep duration is known to be associated with low physical activity, current smoking, and binge drank [35]. It is also reported that, biological rhythms and sleep efficacy deteriorate with aging, and as a result, sleeping time (time in bed) lengthens [37]. Although the relationship between mental health and sleep duration is clear, it should be noted that the GHQ-12 contains one query about sleep. Therefore, the association between mental health and sleep duration looked stronger than the actual result.

In teenagers and middle aged to elderly, the association between low GHQ scores and exercise is consistent with results from prospective cohort studies that have generally showed inverse associations between physical activity and incident depression [38–40]. One unexpected finding was that there were significant interactions between exercise and age group, which means that we could not detect a protective effect for mental health among young adults. Some researchers found that regular exercise was not associated with less anxiety and depression in adolescents [41]. Although underlying mechanisms are not fully corroborated, the effects of physical activity on mental health might be explained as a complex neurobiological system, which result in higher resilience against mental disorders [42]. We assumed that aging influenced a biological homeostasis and effects of exercise. Further characterization and randomized intervention studies are needed before concluding that exercising is a promising target preventing the onset of specific mental disorders.

The main strengths of this survey are the sampling technique that is representative of all 12–103 years in Japan, its large sample size, and high response rate using the validated measures of mental health. To the best of our knowledge, no other studies have realized subjects with such a wide range of age and high response rate using the GHQ-12 at the same time. Another strength of our study is a control of important factors, such as sex and age group. Although the present sample is older than the national population (mean age; 44.9 years old in 2011) by more than 5 years, we tested for interaction with age group stratified by sex, demonstrating associations between mental health and lifestyle by each sex and different age group. Most of the published studies have examined only overall association and not reported properly stratified results.

The limitations of the present study should be recognized. First, since this was a cross-sectional study, we cannot exclude the possibility that the present results are explained by reverse causality. A longitudinal study is required in the future. Second, the items in our questionnaire did not include all the factors known to affect mental wellbeing. For example, house income, educational level, medical comorbidity, stress from job, social capital, and life event are all possible factors that could be confounding factors between age, lifestyle, and mental health. We could not include them in the questionnaire because of space limitations. These items will need to be examined in the future. Third, there were fewer people who were overweight, smoker, or drinker among teenagers, so our statistical power to detect differences of GHQ-12 scores in the group is small. Teenagers might be non-cooperative in responding to the survey, because they are prohibited from smoking and drinking alcohol. Forth, due to some missing values, the number of analyzed participants decreased in the logistic model. Participants who were reluctant to answer the queries or who had cognitive impairments might be excluded in the analysis. Other limitation of this study is the use of self-report measures. Because of the self-reporting bias, the prevalence of categories, such as overweight, might be underestimated [43, 44].

Conclusion

In summary, our study on general residents suggests that aging and good health practices are associated with mental well being. The role of BMI for mental health varies across

age groups. Short-time sleepers reported a higher psychological distress in almost all subgroups. There were no significant positive effects of exercise on mental health among young adults. This study further supports the need to consider age variations in future studies of lifestyle and mental health with a longitudinal design.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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