Combined impact of lifestyle factors on low back pain: A cross-sectional study of over 400,000 Japanese adults

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Abstract

Background: Many epidemiological studies have indicated the association between low back pain (LBP) and lifestyle factors, such as physical activity, smoking, weight gain, diet, and sleep problems. However, the combined effect of lifestyle factors on LBP has not been adequately investigated. Thus, we aimed to investigate the association between a cluster of unhealthy lifestyle behaviors and LBP using a large cohort of Japanese adults.

Methods: We included 419,003 adults aged over 20 years who underwent an annual health checkup between April 2013 and March 2014 in Japan. Information on the following lifestyle factors were collected using the standardized questionnaire recommended by the Ministry of Health, Labour and Welfare in Japan: smoking, alcohol intake, exercise, physical activity, walking speed, weight control, eating habits, and sleep. Each factor was evaluated as a dichotomous variable (1: health risk, 0: no health risk). A lifestyle risk score was calculated by summing the score of each lifestyle factor (range: 0-12) and was categorized into three groups (low, moderate, high). LBP was defined as self-reported LBP under treatment. Logistic regression analysis was conducted to calculate the odds ratio (OR) and 95% confidence interval (CI) for LBP.

Results: In multivariate logistic regression analysis, the OR for LBP was significantly higher in the moderate risk score group (adjusted OR: 1.33 [95% CI: 1.23-1.44] in men; 1.40 [95% CI: 1.27-1.54] in women) and the high risk score group (adjusted OR: 1.54 [95% CI: 1.43-1.67] in men; 1.83 [95% CI: 1.64-2.03] in women) than in the low risk score group. A trend of higher risk of LBP associated with higher lifestyle risk score was observed in both sexes (p for trend < 0.001). These results were similar even in subgroup analysis by age (20-39, 40-59, and ≥ 60 years) and body mass index (BMI) (< 18.5, 18.5-24.9, and ≥ 25 kg/m^2).

Background

Low back pain (LBP) is one of the primary causes of disability and remains a major health problem worldwide [1]. LBP has an enormous economic burden including direct and indirect costs such as loss of work productivity [2]. Previous epidemiological studies have indicated a number of multidimensional risk factors for LBP [3]. Among these, lifestyle factors are a particularly important domain as they are potentially modifiable. In fact, targeting lifestyle as part of the management of LBP has been recommended [4, 5].

The impact of lifestyle factors such as smoking, physical activity, alcohol, and diet on health outcome has been extensively studied. This impact, mainly on cardiovascular disease [6], diabetes [7], cancer [8], and mortality [9], has been shown to be especially greater when the factors were accumulated. Therefore, evaluating the cluster of lifestyle factors is considered important to prevent the negative effects on health.

The development and chronicity of LBP have been considered to be linked to lifestyle factors. A population-based study using data from National Health and Nutrition Examination Survey indicated that smoking, physical activity, and obesity were associated with LBP [10]. Similarly, many studies investigated the association of LBP with each lifestyle factor such as smoking, physical inactivity, alcohol consumption, and sleep disturbance [11-14]. However, the combined effects of lifestyle risk factors on LBP have not been adequately investigated. Elucidating the effect of the accumulation of lifestyle factors on LBP may help to demonstrate the importance of lifestyle modification for the prevention or management of LBP. Therefore, we aimed to investigate the combined effects of multiple lifestyle factors on LBP using a large-scale data in Japan. We hypothesized that the accumulation of unhealthy lifestyle factors is associated with increased LBP because lifestyle behaviors consist of multiple dimensions that coexist and are mutually related in many cases [15, 16].

Methods

Study population

This was a cross-sectional study that used health checkup data. The check-up was conducted by the All Japan Labor Welfare Foundation, a health checkup center in Japan. Subjects in the present study were adults aged over 20 years who underwent the annual health checkup between April 2013 and March 2014. Of the 552,005 subjects, 551,871 subjects consented to participate in this study. Of these, we excluded 132,868 subjects with missing data on any variables used in the present study. Thus, 419,003 participants were included in the analysis. Written informed consent for the use of personal health checkup data in this study was obtained from each participant. This study protocol was approved by the Ethics Committee of the All Japan Labor Welfare Foundation (Approval No. 9-1-0007) and the medical ethics committee of Showa University School of Medicine (Approval No. 2407).

Study measures

Data on age, sex, lifestyle behaviors, medical history, and current use of medications were collected using a self-administered questionnaire. Trained staff measured height to the nearest 0.1 cm using a stadiometer and weight to the nearest 0.1 kg using a scale. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m). Blood pressure was measured in the sitting position using an automated sphygmomanometer (HEM-907, Omron, Kyoto, Japan). LBP was defined as self-reported LBP under treatment (i.e., a “yes” answer to the question “Do you have LBP under treatment including follow-up?”) [17].

Blood samples were collected and stored in a cooler at 4°C for transporting to an external laboratory (SRL, Tokyo, Japan). Triglyceride levels were measured using an enzymatic method (AU5400; Beckman Coulter, Tokyo, Japan), while low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) were measured using a direct method (AU5400; Beckman Coulter, Tokyo, Japan). Hemoglobin A1c (HbA1c) level was determined using latex agglutination turbidimetry (JCA-BM9130, JEOL, Tokyo, Japan).

Hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or medication use for hypertension [18]. Diabetes was defined as HbA1c (National Glycohemoglobin Standardization Program) ≥ 6.5% or medication use for diabetes [19]. Dyslipidemia was defined as triglyceride ≥ 150 mg/dL, HDL-C < 40 mg/dL, LDL-C ≥ 140 mg/dL, or medication use for dyslipidemia [20].

Assessment of lifestyle risk score

Questionnaire items on lifestyle behaviors were based on the standardized questionnaire used for the National Health Promotion Program [21, 22], which started in Japan in 2008 and aimed to prevent lifestyle-related diseases (e.g., metabolic syndrome and cardiovascular disease). The following 12 items related to lifestyle behaviors were used in the present study: 1) smoking habits (current, former, none), 2) alcohol intake (everyday, sometimes, none), 3) exercise ≥ 30 min/day, ≥ twice a week, and ≥ 1 year (yes, no), 4) physical activity equal to walking ≥ 60 min/day (yes, no), 5) walking faster than others in the same generation (yes, no), 6) weight gain ≥ 10 kg since age 20 years (yes, no), 7) body weight change ≥ 3 kg during the preceding 1 year (yes, no), 8) eating speed (fast, normal, slow), 9) eating dinner within 2 hours before bed ≥ three times per week (yes, no), 10) having a snack after dinner ≥ three times per week (yes, no), 11) skipping breakfast ≥ three times per week (yes, no), and 12) adequate sleeping (yes, no).

For each lifestyle factor, we created a binary variable; 1 represented health risk (unhealthy) and 0 showed no health risk. The criteria of health risk were determined with reference to the recommended guideline or current health-related studies [7, 23-29]. Specifically, we assigned a score of 1 for each item as follows: 1) current smoking, 2) drinking alcohol every day, 3-5) a response of no, 6-7) yes, 8) eating fast, 9-11) yes, and 12) no response. A lifestyle risk score was calculated by combining the scores of the 12 lifestyle factors (range: 0-12) [19] and was categorized into the following three groups by tertile of the total score; low (score: 0-3), moderate (4-5), and high risk (6-12).

Statistical analysis

Data on the participants' characteristics are presented as n (%) or median (25th, 75th percentile). Characteristics of the study participants with and without LBP were compared using chi-squared test for categorical variables or Wilcoxon rank-sum test for continuous variables.

To evaluate the association between LBP and lifestyle risk levels, a logistic regression analysis was performed to calculate the odds ratio (OR) and 95% confidence interval (CI) for LBP. Model 1 was a crude model, and model 2 was adjusted for age and BMI. Model 3 was further adjusted for hypertension, diabetes, and dyslipidemia. We then examined the association between LBP and lifestyle risk score stratified by age (20-39, 40-59, and ≥ 60 years) and BMI (underweight: < 18.5, normal weight: 18.5-24.9, and overweight/obesity: ≥ 25 kg/m^2) categories in model 3. Test for trend was conducted with the lifestyle risk score groups considered as continuous variables. All statistical analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). A p value < 0.05 was considered statistically significant.

Results

The median age (25th, 75th percentile) of the study participants was 45 (range, 36, 55) years, and 67.1% of the participants were men. Comparison of the participants' characteristics according to LBP is shown in Table 1 for men and Table 2 for women. Individuals with LBP were older, had higher BMI, and were more likely to have hypertension, diabetes, and dyslipidemia than those without LBP in both sexes.

Table 3 shows the association between lifestyle risk score (low, moderate, and high) and LBP by sex. In both sexes, the age- and BMI-adjusted OR for LBP were higher in the moderate risk score group (OR: 1.32 [95% CI: 1.22-1.43] in men; OR: 1.39 [95% CI: 1.27-1.54] in women) and the high risk score group (OR: 1.53 [95% CI: 1.42-1.65] in men; OR: 1.81 [95% CI: 1.63-2.02] in women) compared with those in the low risk score group. Further adjustment for hypertension, diabetes, and dyslipidemia did not markedly change the association of LBP with the lifestyle risk score.

Table 4 shows the association between LBP and lifestyle risk score by age groups. In all age categories, compared to individuals with low risk score, the ORs for LBP in the moderate and the high risk score groups were significantly increased. A trend of higher risk of LBP associated with higher lifestyle risk score was observed in both sexes and all age groups (p for trend < 0.001 in all).

We also performed BMI-stratified analysis for the association between lifestyle risk score and LBP (Table 5). Among underweight men, only the high risk score group showed higher OR for LBP (adjusted OR: 1.66 [95% CI: 1.15-2.38]). Meanwhile, among underweight women, higher ORs for LBP were observed in the moderate risk score group (adjusted OR: 1.43 [95% CI: 1.05-1.95]) and the high risk score group (adjusted OR: 1.68 [95% CI: 1.13-2.50]). Among subjects with normal weight or overweight/obesity, LBP was significantly associated with lifestyle risk score in the moderate risk score group and the high risk score group. There were significant dose-response relationships between the level of lifestyle risk score and LBP in all BMI strata (p for trend < 0.01 in all).

Discussion

Our study investigated the combined effects of multiple unhealthy lifestyle behaviors on LBP using a large-scale health checkup data in Japan. We found that a combination of unhealthy lifestyle behaviors was dose-dependently associated with increased LBP in both sexes. These associations were observed regardless of age and BMI status. To our knowledge, this is the first study demonstrating the influence of unhealthy lifestyle clustering, which included multifaceted lifestyle factors, on LBP in Japanese adults.

Many epidemiological studies have investigated the association between LBP and each lifestyle risk factor such as physical inactivity [13], smoking [14], exercise [30], alcohol [12], and sleep disturbance [31]. Focusing on the clustering of multiple lifestyle risk factors, we evaluated unhealthy lifestyle factors using 12 questionnaire items that have been recommended for use by the National Health Promotion Program in Japan [21, 22]. These factors included Breslow's health habits including smoking, alcohol drinking, physical activity, weight control, breakfast, snacking, and sleep [32]. Previous studies that investigated the relationship between healthy lifestyle behaviors and LBP [33-35] indicated that health lifestyle behaviors may decrease the risk of developing LBP, although there may be sex- or age-related differences in the effects. It is difficult to directly compare our results with previous findings because the definition of health lifestyle behaviors varies by studies. For example, a previous study defined health behavior using information on BMI, physical exercise, and smoking [34]. However, our findings were consistent with those of previous studies. Our results that clustering of unhealthy lifestyles could negatively influence LBP may have important implications for the prevention and management of LBP both in a public health and a clinical perspective.

Age is one of the common risk factors for LBP. A previous systematic review has demonstrated that the prevalence of severe LBP increases with age [36]. Although several lifestyle behaviors were also expected to vary depending on age, our age-stratified analyses indicated the dose-response relationship between accumulation of unhealthy lifestyle risk and LBP regardless of age groups (20-39, 40-59, and ≥ 60 years). These findings suggest the importance of education related to healthy lifestyle for preventing LBP throughout the adult population.

Previous systematic reviews with meta-analysis have shown that overweight and obesity increased the risk of LBP [37, 38]. Moreover, many of the unhealthy lifestyle factors included in the present study have been considered to be associated with overweight/obesity [23, 24, 26, 28]. Therefore, to eliminate the effects of BMI status on LBP, we analyzed the association of LBP with lifestyle risk according to BMI strata (underweight, normal, and overweight/obesity). This stratified analysis showed that moderate and high lifestyle risk scores were significantly associated with LBP among all individuals except for underweight men. Moreover, regardless of BMI status, the accumulation of unhealthy lifestyle risk factors resulted in a significantly higher OR for LBP (p for trend < 0.01). These results imply that improving unhealthy lifestyle behaviors may prevent the development of LBP even in non-overweight individuals.

No simple explanation can be given with regard to the potential mechanism behind the association of unhealthy lifestyle clustering with LBP. Unhealthy lifestyle may affect LBP through biological processes such as vascular degeneration or inflammation. For example, metabolic disturbance caused by unhealthy lifestyle could induce the atherosclerotic change in the artery, which may lead to the degeneration of the lumbar intervertebral disc [39]. Even individuals without obesity have been indicated to readily develop metabolic disturbances [40], which might support our results in the BMI-stratified analysis. Furthermore, it has been indicated that systemic inflammation, assessed according to C-reactive protein levels, is associated with the number of unfavorable lifestyle factors [41]. The other possible explanation is that individuals with healthier lifestyle might be potentially conscious of their decreased risk of chronic diseases or can cope with symptoms including pain. Psychological factors such as self-esteem may also affect the association of unhealthy lifestyle with pain [42]. Further, high levels of health literacy have been indicated to be associated with healthy lifestyle [43]. A previous study has emphasized the importance of addressing the health literacy in the self-management for LBP [44]. Further investigations are needed with regard to these points.

The strength of this study was the large-scale sample size that helped reduce the random error and could permit exploring the risk along multidimensional aspects of lifestyle factors. However, the present study also has several limitations. First, the determination of LBP relied on self-reports and was not based on clinical examinations. Differentiating LBP type (e.g., acute pain or chronic pain, or localized pain or radicular pain, disease-specific) might have been helpful to explore the associations found here in more detail. Second, we cannot rule out the effects of unmeasured confounders (e.g., occupation type, contents of diet, education level, or psychological status [3]). Third, we evaluated information on lifestyle factors using a self-reported questionnaire, which is prone to social desirability bias. This could lead to misclassification of exposure; the misclassification is considered non-differential in its nature, which may have resulted in dilution of a true association. Finally, we could not determine a causal relationship due to the cross-sectional nature of the study.

Conclusions

In summary, we investigated the combined effects of multiple unhealthy lifestyle behaviors on LBP among more than 400,000 Japanese adults. Our results indicated that the accumulation of unhealthy lifestyle factors was associated with increased LBP, and this was consistent across age and BMI status. These findings may provide important implications for the better prevention and management of LBP considering modifiable lifestyle factors.

Abbreviations

BMI: body mass index; CI: confidence interval; HbA1c: hemoglobin A1c; HDL-C: high-density lipoprotein cholesterol; LBP: low back pain; LDL-C: low-density lipoprotein cholesterol; OR: odds ratio

Declarations

Ethics approval and consent to participate

The present study was approved by the medical ethics committee of Showa University School of Medicine (Approval No. 2407) and the Ethics Committee of the All Japan Labor Welfare Foundation (Approval No. 9-1-0007). Written informed consent was obtained from each subject.

Consent for publication

Not applicable

Availability of data and materials

The data used in the current study are available on reasonable request and with permission of the Ethics Committee of the All Japan Labor Welfare Foundation.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

TY, HO, and TS contributed to the study design, data interpretation. TY conducted the statistical analysis and drafted the manuscript. SN contributed to the acquisition of data. AU and JM contributed to the interpretation of the results and supported drafting the manuscript. AK made substantial contributions to the conception of the study and the revision of the manuscript. All authors have read and approved the final manuscript.

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Tables

Table 1. Characteristics of the study participants by low back pain in men

	Low back pain (+) (n = 5,486)	Low back pain (−) (n = 275,622)	*p*-value
Age, years	51 (41, 61)	45 (36, 55)	< 0.001
Body mass index, kg/m^2	23.7 (21.6, 26.0)	23.2 (21.1, 25.6)	< 0.001
Current smoker, n (%)	2,431 (44.3)	129,977 (47.2)	< 0.001
Daily drinker, n (%)	2,257 (41.1)	99,315 (36.0)	< 0.001
Weight gain (≥ 10 kg since age 20 years), n (%)	2,474 (45.1)	106,931 (38.8)	< 0.001
Exercise (≥ 30 min/day, ≥ twice/ week), n (%)	1,320 (24.1)	64,772 (23.5)	0.332
Physical activity (≥ 1 hr/day), n (%)	2,066 (37.7)	108,597 (39.4)	0.009
Walking faster, n (%)	2,289 (41.7)	125,111 (45.4)	< 0.001
Body weight change (≥ 3 kg/year), n (%)	2,102 (38.3)	93,583 (34.0)	< 0.001
Eating fast, n (%)	1,773 (32.3)	83,972 (30.5)	0.003
Eating dinner within 2 hours before bedtime (≥ 3 times/week), n (%)	2294 (41.8)	117,739 (42.7)	0.181
Having a snack after dinner (≥ 3 times/week), n (%)	857 (15.6)	42,229 (15.3)	0.541
Skipping breakfast (≥ 3 times/week), n (%)	1,215 (22.2)	79,135 (28.7)	< 0.001
Adequate sleep, n (%)	2,850 (52.0)	169,996 (61.7)	< 0.001
Hypertension, n (%)	1,892 (34.5)	88,180 (32.0)	< 0.001
Diabetes, n (%)	488 (8.9)	18,511 (6.7)	< 0.001
Dyslipidemia, n (%)	2,790 (50.9)	136,124 (49.4)	0.031

Values are presented as median (25th, 75th percentile), except where indicated as n (%).

Table 2. Characteristics of the study participants by low back pain in women

	Low back pain (+) (n = 2,575)	Low back pain (−) (n = 135,320)	*p*-value
Age, years	54 (44, 61)	46 (36, 55)	< 0.001
Body mass index, kg/m^2	22.6 (20.4, 25.4)	21.5 (19.5, 24.1)	< 0.001
Current smoker, n (%)	552 (21.4)	26,429 (19.5)	0.016
Daily drinker, n (%)	384 (14.9)	18,211 (13.5)	0.032
Weight gain (≥ 10 kg since age 20 years), n (%)	880 (34.2)	32,141 (23.8)	< 0.001
Exercise (≥ 30 min/day, ≥ twice/week), n (%)	494 (19.2)	20,391 (15.1)	< 0.001
Physical activity (≥ 1 hr/day), n (%)	928 (36.0)	44,201 (32.7)	< 0.001
Walking faster, n (%)	926 (36.0)	52,711 (39.0)	0.002
Body weight change (≥ 3 kg/year), n (%)	907 (35.2)	39,699 (29.3)	< 0.001
Eating fast, n (%)	687 (26.7)	30,257 (22.4)	< 0.001
Eating dinner within 2 hours before bedtime (≥ 3 times/week), n (%)	690 (26.8)	33,694 (24.9)	0.028
Having a snack after dinner (≥ 3 times/week), n (%)	511 (19.8)	25,981 (19.2)	0.411
Skipping breakfast (≥ 3 times/week), n (%)	464 (18.0)	25,878 (19.1)	0.158
Adequate sleep, n (%)	1,191 (46.3)	80,161 (59.2)	< 0.001
Hypertension, n (%)	689 (26.8)	29,679 (21.9)	< 0.001
Diabetes, n (%)	134 (5.2)	4,453 (3.3)	< 0.001
Dyslipidemia, n (%)	1,027 (39.9)	45,872 (33.9)	< 0.001

Values are presented as median (25th, 75th percentile), except where indicated as n (%).

Table 3. Association between lifestyle risk score and low back pain by sex

		Total	LBP	Model 1
		N	n (%)	OR (95% CI)
Men				
Lifestyle risk score	Low (0-3)	63,022	986 (1.56)	1.00
	Moderate (4-5)	105,120	2,080 (1.98)	1.27 (1.18-1.37)
	High (6-12)	112,966	2,420 (2.14)	1.38 (1.28-1.48)
	p for trend			< 0.001
Women				
Lifestyle risk score	Low (0-3)	49,179	735 (1.49)	1.00
	Moderate (4-5)	55,757	1,054 (1.89)	1.27 (1.15-1.40)
	High (6-12)	32,959	786 (2.38)	1.61 (1.45-1.78)
	p for trend			< 0.001

OR: odds ratio, CI: confidence interval, LBP: low back pain

Model 1: Crude model

Model 2: Adjusted for age and body mass index

Model 3: Adjusted for age, body mass index, hypertension, diabetes, and dyslipidemia

Table 4. Association between lifestyle risk score and low back pain stratified by age group

	Age: 20-39 years			Age: 40-59 years		
	Total N	LBP n (%)	Adjusted OR (95% CI)	Total N	LBP n (%)	Adjusted OR (95% CI)
Men						
Lifestyle risk score						
Low (0-3)	20,831	166 (0.80)	1.00	27,222	406 (1.49)	1.00
Moderate (4-5)	33,946	383 (1.13)	1.33 (1.11-1.60)	52,474	1,043 (1.99)	1.33 (1.19-1.50)
High (6-12)	39,307	558 (1.42)	1.56 (1.30-1.86)	61,866	1,348 (2.18)	1.47 (1.31-1.65)
p for trend			< 0.001			< 0.001
Women						
Lifestyle risk score						
Low (0-3)	13,652	87 (0.64)	1.00	25,086	346 (1.38)	1.00
Moderate (4-5)	18,182	158 (0.87)	1.31 (1.01-1.71)	29,938	573 (1.91)	1.37 (1.20-1.57)
High (6-12)	11,475	155 (1.35)	1.89 (1.44-2.48)	18,404	481 (2.61)	1.84 (1.59-2.13)
p for trend			< 0.001			< 0.001

OR: odds ratio, CI: confidence interval, LBP: low back pain
Adjusted for age, body mass index, hypertension, diabetes, and dyslipidemia.

Table 5. Association between lifestyle risk score and low back pain stratified by BMI status

	Underweight (BMI < 18.5 kg/m^2)			Normal (18.5-24.9 kg/m^2)			
	Total N	LBP n (%)	Adjusted OR (95% CI)	Total N	LBP n (%)	Adjusted OR (95% CI)	
Men							
Lifestyle risk score							
Low (0-3)	3,833	49 (1.28)	1.00	47,712	728 (1.53)	1.00	1
Moderate (4-5)	5,470	74 (1.35)	1.07 (0.75-1.55)	71,131	1,336 (1.88)	1.32 (1.21-1.45)	2
High (6-12)	3,824	78 (2.04)	1.66 (1.15-2.38)	63,763	1,311 (2.06)	1.60 (1.45-1.75)	4
p for trend			0.004			< 0.001	
Women							
Lifestyle risk score							
Low (0-3)	7,561	77 (1.02)	1.00	36,415	559 (1.54)	1.00	
Moderate (4-5)	7,391	90 (1.22)	1.43 (1.05-1.95)	37,478	635 (1.69)	1.28 (1.14-1.44)	1
High (6-12)	2,939	38 (1.29)	1.68 (1.13-2.50)	19,357	449 (2.32)	1.95 (1.71-2.22)	1
p for trend			0.005			< 0.001	

OR: odds ratio, CI: confidence interval, LBP: low back pain, BMI: body mass index

Adjusted for age, body mass index, hypertension, diabetes, and dyslipidemia.