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Lifestyle and subjective musculoskeletal symptoms in young male Japanese workers: A 16-year retrospective cohort study

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ABSTRACT

This longitudinal study was conducted from 2002 to 2018 and aimed to investigate predictive lifestyle factors for the occurrence of subjective musculoskeletal symptoms. The participants came from several employers in Japan. Setting 2002 as the baseline, we performed logistic regression analyses using lifestyle questionnaire items as explanatory variables and Stiff neck/shoulders (SN/S) and Lower back pain (LBP) as objective variables (n = 16,748). Workers who responded positively to good lifestyle items with an odds ratio < 1.0 and those who did not were classified in the Good (GL) and Poor lifestyle groups (PL), respectively. The survival period between the groups was compared using the log-rank test and Cox hazard regression analysis with propensity score matching (n = 3,593). Based on the Cox hazard regression analysis results, the risk of SN/S was about 2.54 (95% confidence interval [CI]: 1.80–3.59) times higher for PL than for GL ($p < 0.001$). Similarly, after propensity score matching, the risk was about 2.33 (95% CI: 1.07–5.10) times higher for PL than for GL ($p < 0.05$). Further, LBP risk was about 2.45 (95% CI: 1.67–3.58) times higher for PL than for GL ($p < 0.001$). Similarly, after propensity score matching, the risk was about 3.50 (95% CI: 1.60–7.68) times higher for PL than for GL ($p < 0.01$). This study highlighted that workers with four good lifestyle factors (life satisfaction, hours of sleep, exercise habits, and physical fitness) presented reduced risk of subjective musculoskeletal symptom occurrence. To prevent musculoskeletal symptoms, physicians and occupational health staff should advise on workers' individual lifestyle.

1. Introduction

Work-related musculoskeletal symptoms, especially neck and low back pain, have been studied worldwide for many years and their risk factors have been reported from various perspectives. Particularly, physical and work environment factors have been reported to increase such pain risk in workers. Important factors include: awkward posture (Björck-van et al., 2008; Costa and Vieira, 2010; Flodin et al., 2018), computer monitor location (Ye et al., 2017), heavy lifting/physical work (Bernard, 1997; Costa and Vieira, 2010; Kawaguchi et al., 2017), high job strain (Morken et al., 2003; Hannan et al., 2005), and physically heavy workload (Xu et al., 1997; Costa and Vieira, 2010). Moreover, mental and physical stress (Mäkelä et al., 1991) and computer use at work [e.g., mouse-use (Jensen, 2003) and typing duration and speed (Tittiranonda et al., 1999)] are considered factors for neck pain. Furthermore, physical inactivity (Ebara et al., 2015) and psychological distress (Power et al., 2001) have been reported as risk factors for low back pain in workers. Such pain lead to reduce productivity (Lötters et al., 2005; Boström et al., 2008) and could cause compensated work injury (Fujii and Matsudaira, 2013). Additionally, at age > 40–45 years, the risk of low back pain increases due to physical decline associated with aging (World Health Organization, 1993; Yoshimura et al., 2010); thus, it seems important to facilitate to prevent neck and back pain in the future, starting from a young worker generation.

According to the Comprehensive Survey of Living Conditions conducted by the Ministry of Health, Labour, and Welfare in Japan, the complaint rate for stiff shoulders was 57.0/1,000 and 117.5/1,000 people for adult men and women, respectively. Furthermore, low back

Abbreviations: BMI, body mass index; GL, good lifestyle; PL, poor lifestyle; SN/S, stiff neck/shoulders; LBP, lower back pain; CI, confidence interval; OR, odds ratio; SD, standard deviation; VIF, variance inflation factor

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pain was the main complaint for both sexes, with complaint rates of 91.8/1,000 and 115.5/1,000 for men and women, respectively (Ministry of Health, Labour, and Welfare of Japan, 2017); therefore, many workers complained of stiff shoulders and back pain simultaneously. A study that examined neck and low back pain reported computer position as a risk factor (Ye et al., 2017). Recently, a high correlation between neck and back pain and the importance of genetic factors for the occurrence of such pain has been reported (Dunn et al., 2013). Perhaps, there are other common acquired risk factors for neck and low back pain occurrence. However, the most previous studies have investigated neck pain/stiffness and low back pain separately; as only limited studies have examined them simultaneously, further research is needed.

Apart from the physical and work environment each individual's lifestyle is recognized as an important risk factor for neck and low back pain (Ferreira et al., 2013; Deokhoon et al., 2017; Clark and Horton, 2018). Indeed, smoking (Power et al., 2001; Costa and Vieira, 2010; Iizuka et al., 2017) and obesity (Mäntyselkä et al., 2010; Shiri et al., 2010) are representative examples. Interestingly, lifestyle has been defined as performing discretionary activities, which are a regular part of an individual's daily pattern of living (Wiley and Camacho, 1980). Tracking changes in individual lifestyle status over time is necessary to clarify the relationship between worker lifestyle and musculoskeletal symptom occurrence. However, few studies have investigated the correlation of lifestyle, with musculoskeletal symptoms as outcomes (Dean and Söderlund, 2015). Previous longitudinal studies on lifestyle and health status have reported regular meals, adequate sleep, near average weight, physical activity, smoking avoidance, and limited alcohol consumption as good health habits (Belloc and Breslow, 1972). However, the studies have examined the relationship between health practices and physical health status, but not the musculoskeletal symptom outcome. Recently, changing patterns of daily life activities into a healthy lifestyle (e.g., achieve a healthy body weight, increase physical activity, develop healthy eating habits, quit smoking) has been used in interventions for low back pain (Robson et al., 2019). However, it was not clarified which lifestyle changes should be prioritized. Moreover, a recent study clarified the relationship between lifestyle behaviors (e.g., intensity of physical activity, smoking daily or not, alcohol, fruit, and vegetable intake) and neck or low back pain (Skillgate et al., 2017). However, the studies have not examined lifestyle factors common to the neck and low back pain. Additionally, it has been reported that unmeasured or residual confounding of lifestyle may exist. Recently, a study in Denmark reported that lifestyle behavior factors (physical activity and smoking) were common risk factors for stiff shoulders and low back pain; nevertheless, it was a cross-sectional study indicating the possibility of reverse causation (Kirsch et al., 2019). In Japan, body mass index (BMI) was reported as a common risk factor by a cross-sectional population-based study that simultaneously investigated stiff shoulders and low back pain (Kumagai et al., 2018); however, this survey provided limited information on participant lifestyle. Additionally, as the study was conducted in a community population rather than young workers, the participants' average age was high (mean age ± standard deviation [SD] in men, 52.6 ± 15.5). Therefore, more evidence is needed on what the lifestyle behaviors would prevent. Especially, an exploratory and longitudinal study of "positive lifestyle predictors" contributing to the onset prevention of neck and low back pain in young workers is needed.

According to the Industrial Safety and Health Act by the Ministry of Health, Labour, and Welfare in Japan, employers are obliged to provide health check-ups to workers (Ministry of Health, Labour, and Welfare of Japan, 1972). Hence, most Japanese workers undergo an annual health check-up at hospitals and/or occupational health institutes, which have accumulated abundant longitudinal data. Information obtained from these data could help to clarify the relationship between individual lifestyles and common risks for neck pain/stiffness and low back pain, contributing to those pain preventions. We aimed to estimate risk factors common in neck pain/stiffness and low back pain and examine the lifestyle factors that positively affect and predict (i.e., positive lifestyle predictors) subjective symptom occurrence of neck and low back pain in young male workers.

2. Materials and methods

2.1. Study population

This was a retrospective cohort study using 16-year longitudinal data. The participants came from several employers in Japan. Data were collected at clinics (Tokyo, Osaka, Nagoya, and Fukuoka) and on-site health check-up services owned by the Association for Preventive Medicine of Japan. The study sample initially consisted of 351,997 male workers among 522,912 who underwent health check-up and completed a lifestyle questionnaire at the Association for Preventive Medicine of Japan in 2002. We extracted information from 18,635 male workers with sufficient data among those who continued to undergo health check-ups (e.g., height, weight, liver function, blood lipid, and chest radiography) and completed the lifestyle questionnaire from April 1, 2002 until March 31, 2018. Moreover, as the World Health Organization defines workers aged > 45 years as old (World Health Organization, 1993), we selected 16,748 young workers aged 18–44 years. Additionally, we performed descriptive statistical analysis to clarify their basic information (Fig. 1). We calculated the average and SD of age, BMI, and the prevalence for "Stiff neck/shoulders (SN/S)" and "Lower back pain (LBP)" in 2002 and 2018. Further, we calculated the prevalence for those who complained of SN/S and LBP.

The ethical committee of the Association for Preventive Medicine of Japan (Approval Number, 2019001) approved this study. All participants provided written informed consent at enrollment.

2.2. Health check-up lifestyle questionnaires

The lifestyle questionnaire was developed in 1994 based on the opinions of physicians and experts involved in health check-up, being an important examination tool. We ex-post analyzed the lifestyle questionnaire. Between 2002 and 2018, baseline and follow-up data were collected using annual health check-up lifestyle questionnaires. The respondents were asked to evaluate their medical history and whether their subjective symptoms within the past month were as follows: SN/S and LBP (Applicable or Inapplicable). Furthermore, the respondents were asked to assess their lifestyle. This lifestyle questionnaire included items related to dietary habits and daily living activities, in addition to the good health habits (Belloc and Breslow, 1972), as shown in Table 1. The respondents evaluated whether these lifestyles were "Applicable" or "Inapplicable." In addition, we interpreted as follows: "Yes" and "No" for "Applicable" and "Inapplicable," respectively.

2.3. Statistical analysis

First, we compared the prevalence for SN/S and LBP of 2002 with that of 2018 using the Wilcoxon signed-rank test. Then, setting the baseline in 2002 values, we investigated the association between the SN/S or LBP from the 16,748 workers as objective variables and 35 lifestyle questionnaire items as explanatory variables, and estimated the odds ratio (OR) and 95% confidence interval (CI) using a univariate logistic regression analysis model. Additionally, we conducted multivariate logistic regression analysis adjusted for age and BMI. Further, the variance inflation factor (VIF) was calculated to confirm the interaction between the items. The logistic regression model results showed four items with OR < 1.0 common for SN/S and LBP. We defined these items as the "four positive predictors." Subsequently, survival and Cox hazard regression analyses were performed to consider the impact of time of four positive predictors against SN/S and LBP. We performed

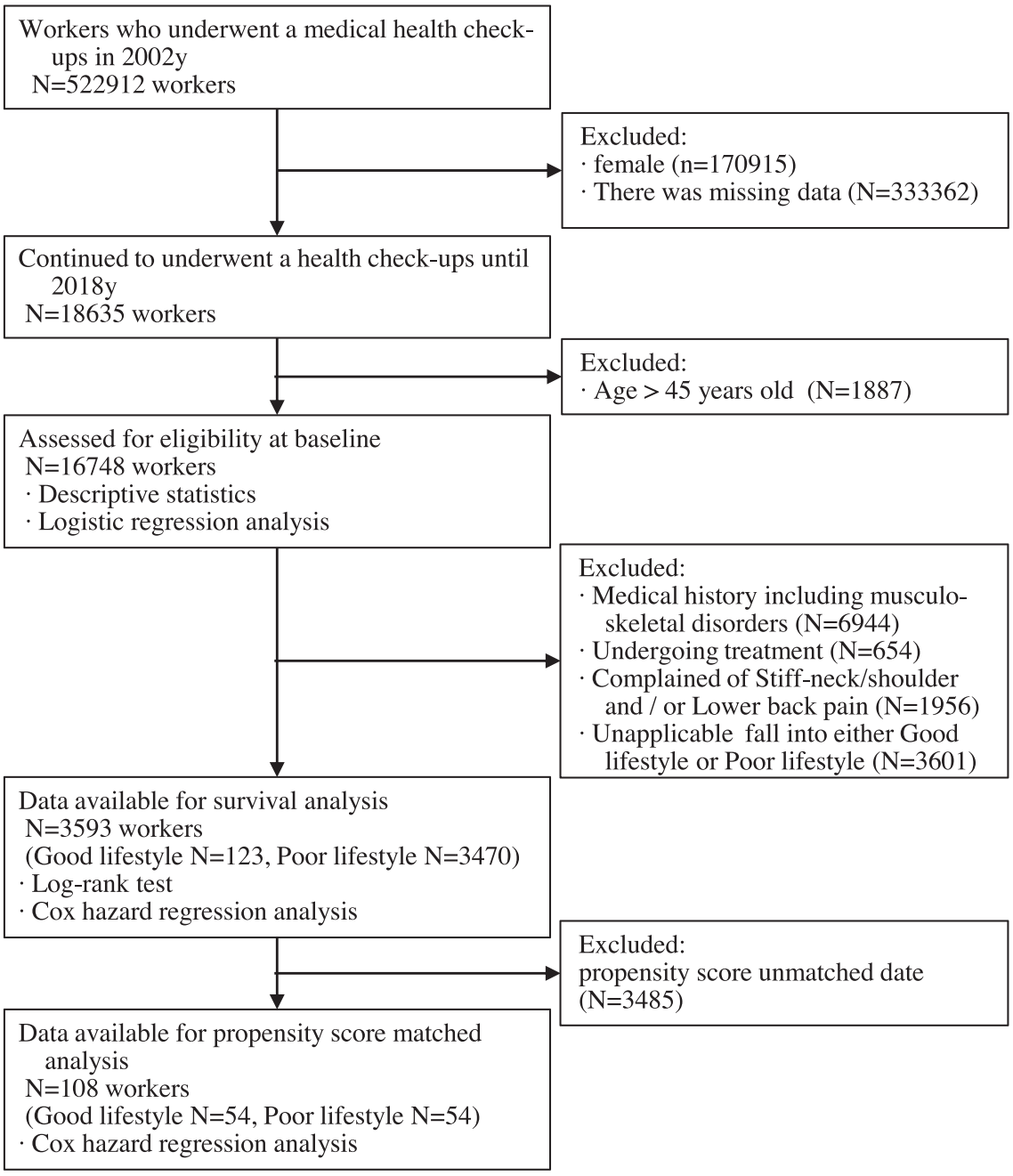

Fig. 1. Flowchart for identification of the study population.

the following procedure to select individuals for the survival and Cox hazard regression analyses among the 16,748 workers: we extracted those who did not correspond to SN/S and LBP based on the questionnaires, had no medical history, and were not undergoing treatment; we defined and classified workers who responded applicable and inapplicable to all the positive predictors in the "Good lifestyle" (GL: n = 123) and "Poor lifestyle" (PL: n = 3,470) group, respectively; we excluded workers who did not fall in the GL or PL group. The remaining 3,593 workers were included in the survival analysis, 108 of whom matched with the propensity score in the Cox hazard regression analysis.

Between 2002 and 2018, the survival period between the two groups (n = 3,593) was compared using the log-rank test. The occurred events were SN/S or LBP. Cumulative complaint rates for SN/S and LBP were tested using the Kaplan–Meier survival curves. Furthermore, the hazard ratio (HR) and 95% CI estimated for the two groups were analyzed using the Cox hazard regression analysis adjusted for age and BMI. We used years as the time variable to define the time until the SN/S or LBP occurred and SN/S or LBP cases as the outcome variable in regression analyses (model 1). Subsequently, we used propensity score matching to strictly adjust for differences in baseline characteristics to reduce the effects of selection bias and potential confounders in this study. A logistic regression model was used to determine the propensity score. The explanatory variables used were baseline age, BMI, and the lifestyle questionnaire items excluding the four positive predictors. We extracted data from 108 individuals that matched with the propensity score and classified the participants into the GL (n = 54) and PL (n = 54) groups; additionally, the HR and 95% CI were compared by the Cox hazard regression analysis (model 2). The follow-up time was assessed as years from the baseline in 2002 until the date of

Table 1
The items of questionnaire at health check-up.

item[a]
Symptoms within the past month
Stiff neck/shoulders
Lower back pain
Lifestyle questionnaire
Good health habits
Are you a current regular smoker?
Are you a drinker?
Exercise at least twice a week
Have three meals almost at the same time every day
Sleep for 7–8 h
Dietary habits
Aware of balanced diet
Eat protein dishes with every meal
Eat rice, bread, or noodles with every meal
Eat slowly chewing well
Eat two or more kinds (packs) of Western or Japanese confectioneries or snacks on average a day
Finish eating at least two hours before bedtime
Frequently eat deep-fried food, such as fried dishes and pork cutlets
Frequently eat heavy meat dishes
Frequently eat salty food
Frequently eat seaweed and small fish
Frequently have dairy products (milk, yogurt, or cheese)
Frequently have instant food or processed food
Have breakfast almost every day
Have juice or canned coffee two bottles (two cups) or more on average a day
Regularly eat dark green and deep yellow vegetables
Regularly eat fruits
Regularly have snacks or late-night meals
Daily living and activities
Belonged to a sports club while in school
Can walk for about one hour non-stop without getting tired
Doing sports in free time at least one time a month
Have a moderate level of stress
Have worse condition than six months ago
Prefer to spend time out in nature such as the mountains, sea, and river
Regularly go outside
Regularly move around at work or housework
Regularly walk
Satisfied with everyday life
Walk at least one time for ten minutes per time every day
Walk or bike when commuting
Work for less than nine hours

[a] All items were responded as “Applicable” or “Inapplicable”.

complaining of subjective musculoskeletal symptoms (cases) or until the end of follow-up (non-cases) in 2018, whichever came first. All analyses were performed using the EZR (Kanda, 2013), which is a graphical user interface for R (R Foundation for Statistical Computing, Vienna, Austria). The statistical significance level set at $p < 0.05$.

3. Results

We evaluated the prevalence for SN/S and LBP symptoms in 2002 and 2018. At study enrollment in 2002, 3,344/16,748 workers (20.0%) experienced SN/S, and 2,314/16,748 (13.8%) experienced LBP. At the end of the follow-up period in 2018, 4,878/16,748 workers (29.1%) experienced SN/S, and 3,479/16,748 workers (20.8%) experienced LBP. There was a significant difference in symptom prevalence of 2002 and that of 2018 ($p < 0.001$). Therefore, the proportion of SN/S and LBP increased with age. The same tendency was found in workers who experienced SN/S and LBP (7.9% in 2002 and 14.3% in 2018, $p < 0.001$).

Table 2 shows the relationship between SN/S and LBP and the lifestyle questionnaire items. As a result of the logistic regression analysis with the SN/S as the objective variable, there were significant differences in 20 items in both analyses. Moreover, there were significant differences in 20 items in both analyses obtained from the logistic regression analysis with the LBP as the objective variable. There was no distortion due to multicollinearity, as each item’s VIF calculated by logistic regression analysis was approximately 1.5. Between the logistic regression analysis adjusted for confounding factors, there were items whose OR and p-values changed. Additionally, the logistic regression model results indicated that there were 11 items whose OR were > 1.0 between the SN/S and LBP groups: “Age,” “Have worse condition than 6 months ago,” “Frequently have instant food or processed food,” “Have juice or canned coffee two bottles (two cups) or more on average every day,” “Have a moderate level of stress,” “Frequently eat deep-fried food, such as fried dishes and pork cutlets,” “Are you a drinker?,” “Frequently eat salty food,” “Regularly have snacks or late-night meals,” “Frequently have dairy products,” and “Eat rice, bread, or noodles with every meal.” Furthermore, there were four items (positive predictors) whose OR were < 1.0 between the SN/S and LBP groups: “Satisfied with everyday life,” “Sleep for 7–8 h,” “Exercise at least twice a week,” and “Can walk for about 1 h non-stop without getting tired.”

Survival analysis and Cox hazard regression analysis were performed on 3,593 individuals aged 18–44 years (mean age $\pm$ SD, 30.8 $\pm$ 6.1). Based on the logistic regression analysis results, we classified 123 and 3,470 workers who responded applicable to all the positive predictors or not, as GL or PL, respectively. During the 16-year follow up, the mean follow-up periods for SN/S and LBP were 10.12 (36,350 person-years in total) and 11.53 years (41,437 person-years in total), respectively. Moreover, 1,946 and 1,606 workers complained of the corresponding subjective symptoms, respectively (complaint rate: 54/1,000 and 39/1,000 person-years, respectively). In classification, GL newly occurred in 33 and 27 workers with SN/S and LBP complaints, respectively (complaint rate: 20/1,000 and 16/1,000 person-years, respectively). In PL, 1,913 and 1,579 workers newly complained of SN/S and LBP, respectively (complaint rate: 55/1,000 and 40/1,000 person-years, respectively).

Fig. 2 shows the Kaplan–Meier survival curves for the survival rate comparison between the two groups. Fig. 2A shows the survival curves for SN/S, demonstrating a significant difference in the survival rates between the two groups. Similarly, Fig. 2B shows the survival curves for LBP, demonstrating a significant difference between the two groups. Significant differences were observed between GL and PL at SN/S and LBP (log-rank test, all $p < 0.001$), respectively. Additionally, the cumulative complaint rate of SN/S was 28.6% for GL (median: not reached; 95% CI: not reached) and 58.5% for PL (median: 11 years; 95% CI: 10–12). Similarly, the cumulative complaint rate of LBP was 21.1% and 46.2% for GL and PL, respectively (both: median: not reached; 95% CI: not reached). The PL group showed a lower survival rate than the GL group.

Then, we compared the HR between the GL and PL groups using Cox hazard regression analysis before and after propensity score matching. After propensity score matching, the two groups were not significantly different regarding age, BMI, and lifestyle questionnaire items excluding the four positive predictors (Table 3). Table 4 shows the results of the Cox hazard regression analysis before and after propensity score matching. Based on the results before propensity score matching, the HR of SN/S was about 2.54 (95% CI: 1.80–3.59) times higher in the PL than in the GL group ($p < 0.001$); furthermore, the HR was about 0.99 (95% CI: 0.98–0.99) times regarding the age ($p < 0.01$). Additionally, based on the results after propensity score matching, the HR of SN/S was about 2.33 (95% CI: 1.07–5.10) times higher in the PL than in the GL group ($p < 0.05$). According to the results before propensity score matching, the HR of LBP was about 2.45 (95% CI: 1.67–3.58) times higher in the PL than in the GL group ($p < 0.001$); similarly, the HR was about 3.50 (95% CI: 1.60–7.68) times higher in the PL than in the GL group after propensity score matching ($p < 0.01$).

4. Discussion

We aimed to clarify whether the young male Japanese worker

Table 2
Odds ratios confidence intervals for Stiff neck/shoulders and Lower back pain versus lifestyle questionnaire at baseline, Japan (n = 16,748). [cOR, crude odds ratio; OR, odds ratio; CI, confidence interval; BMI, body mass index].

	Stiff neck/shoulders						Lower back pain					
	Model 1[a]			Model 2[b]			Model 1[a]			Model 2[b]		
	cOR	95% CI	p-value	OR	95% CI	p-value	cOR	95% CI	p-value	OR	95% CI	p-value
Age	1.03	1.03–1.04	< 0.001	1.04	1.03–1.05	< 0.001	1.02	1.02–1.03	< 0.001	1.03	1.02–1.04	< 0.001
BMI	0.97	0.96–0.98	< 0.001	0.99	0.98–1.01	0.375	1.01	1.00–1.02	0.208	1.00	0.99–1.02	0.609
Lifestyle questionnaire [c]												
Good health habits												
Are you a current regular smoker?	1.05	0.97–1.13	0.207	0.97	0.89–1.06	0.510	1.32	1.21–1.44	< 0.001	1.16	1.05–1.28	0.004
Are you a drinker?	1.39	1.28–1.50	< 0.001	1.25	1.15–1.36	< 0.001	1.29	1.18–1.42	< 0.001	1.17	1.06–1.29	0.002
Exercise at least twice a week	0.64	0.57–0.72	< 0.001	0.66	0.58–0.76	< 0.001	0.80	0.70–0.91	0.001	0.83	0.71–0.97	0.019
Have three meals almost at the same time every day	0.91	0.84–0.99	0.031	0.90	0.81–1.00	0.042	0.90	0.82–0.99	0.025	0.89	0.79–1.01	0.066
Sleep for 7–8 h	0.71	0.65–0.78	< 0.001	0.75	0.68–0.83	< 0.001	0.85	0.77–0.94	0.002	0.88	0.79–0.98	0.023
Dietary habits												
Aware of balanced diet	1.05	0.96–1.14	0.271	1.04	0.93–1.16	0.497	0.93	0.84–1.03	0.151	0.97	0.86–1.10	0.638
Eat protein dishes with every meal	1.12	1.02–1.22	0.016	1.02	0.92–1.13	0.714	1.11	1.00–1.23	0.058	1.00	0.89–1.13	0.986
Eat rice, bread, or noodles with every meal	1.38	1.26–1.51	< 0.001	1.24	1.12–1.38	< 0.001	1.31	1.18–1.46	< 0.001	1.17	1.04–1.32	0.009
Eat slowly chewing well	0.94	0.83–1.06	0.339	0.97	0.85–1.10	0.636	0.98	0.85–1.13	0.786	1.05	0.90–1.21	0.563
Eat two or more kinds (packs) of Western or Japanese confectioneries or snacks on average a day	1.52	1.28–1.8	< 0.001	1.21	1.00–1.46	0.046	1.55	1.28–1.88	< 0.001	1.20	0.97–1.48	0.086
Finish eating at least two hours before bedtime	0.86	0.79–0.94	< 0.001	1.00	0.91–1.11	0.991	0.90	0.81–0.99	0.034	0.99	0.88–1.11	0.849
Frequently eat deep-fried food, such as fried dishes and pork cutlets	1.38	1.27–1.50	< 0.001	1.15	1.04–1.27	0.007	1.55	1.41–1.70	< 0.001	1.15	1.03–1.29	0.014
Frequently eat heavy meat dishes	1.32	1.21–1.44	< 0.001	1.11	1.00–1.24	0.054	1.60	1.45–1.77	< 0.001	1.21	1.07–1.37	0.002
Frequently eat salty food	1.40	1.28–1.53	< 0.001	1.11	1.01–1.22	0.039	1.65	1.50–1.82	< 0.001	1.22	1.09–1.36	< 0.001
Frequently eat seaweed and small fish	1.05	0.95–1.16	0.352	0.91	0.81–1.03	0.131	1.16	1.03–1.30	0.014	1.03	0.90–1.18	0.630
Frequently have dairy products (milk, yogurt, or cheese)	1.23	1.14–1.33	< 0.001	1.20	1.10–1.31	< 0.001	1.17	1.07–1.28	0.001	1.17	1.06–1.30	0.002
Frequently have instant food or processed food	1.40	1.29–1.53	< 0.001	1.20	1.09–1.32	< 0.001	1.55	1.41–1.70	< 0.001	1.19	1.06–1.32	0.002
Have breakfast almost every day	1.16	1.07–1.25	< 0.001	1.13	1.03–1.25	0.014	1.08	0.99–1.18	0.090	1.14	1.02–1.28	0.021
Have juice or canned coffee two bottles (two cups) or more on average a day	1.32	1.22–1.42	< 0.001	1.20	1.10–1.31	< 0.001	1.46	1.34–1.59	< 0.001	1.16	1.05–1.28	0.002
Regularly eat dark green and deep yellow vegetables	1.15	1.06–1.25	0.001	1.11	0.99–1.23	0.066	1.11	1.01–1.23	0.036	1.09	0.97–1.24	0.160
Regularly eat fruits	1.06	0.96–1.17	0.288	0.98	0.87–1.10	0.749	0.93	0.82–1.05	0.227	0.86	0.75–0.99	0.036
Regularly have snacks or late-night meals	1.50	1.35–1.66	< 0.001	1.23	1.09–1.38	< 0.001	1.52	1.35–1.71	< 0.001	1.18	1.03–1.35	0.014
Daily living and activities												
Belonged to a sports club while in school	1.12	1.04–1.21	0.003	1.09	1.00–1.18	0.063	1.26	1.15–1.37	< 0.001	1.16	1.05–1.28	0.005
Can walk for about one hour non-stop without getting tired	0.76	0.69–0.84	< 0.001	0.73	0.65–0.82	< 0.001	0.73	0.65–0.82	< 0.001	0.72	0.63–0.83	< 0.001
Doing sports in free time at least one time a month	0.87	0.80–0.95	< 0.001	0.97	0.88–1.08	0.593	0.91	0.83–1.00	0.062	0.92	0.82–1.03	0.149
Have a moderate level of stress	1.36	1.26–1.47	< 0.001	1.24	1.14–1.34	< 0.001	1.32	1.21–1.44	< 0.001	1.18	1.08–1.30	< 0.001
Have worse condition than six months ago	2.91	2.60–3.25	< 0.001	2.52	2.25–2.83	< 0.001	2.98	2.64–3.36	< 0.001	2.54	2.24–2.87	< 0.001
Prefer to spend time out in nature such as the mountains, sea, and river	1.18	1.09–1.27	< 0.001	1.12	1.02–1.23	0.015	1.18	1.08–1.30	< 0.001	1.07	0.96–1.19	0.217
Regularly go outside	1.09	1.00–1.18	0.046	1.07	0.97–1.18	0.165	1.23	1.12–1.35	< 0.001	1.12	1.00–1.24	0.042
Regularly move around at work or housework	0.96	0.88–1.04	0.331	0.94	0.85–1.04	0.204	1.35	1.22–1.48	< 0.001	1.30	1.16–1.45	< 0.001
Regularly walk	1.05	0.96–1.15	0.315	1.07	0.96–1.20	0.230	0.89	0.80–0.99	0.037	0.95	0.83–1.08	0.400
Satisfied with everyday life	0.65	0.59–0.72	< 0.001	0.69	0.61–0.77	< 0.001	0.65	0.57–0.73	< 0.001	0.65	0.57–0.75	< 0.001
Walk at least one time for ten minutes per time every day	1.11	1.03–1.20	0.007	1.05	0.96–1.15	0.249	1.05	0.97–1.15	0.239	1.00	0.9–1.1.00	0.919
Walk or bike when commuting	1.15	1.06–1.25	< 0.001	1.11	1.01–1.21	0.030	0.99	0.90–1.09	0.856	1.00	0.90–1.11	0.956
Work for less than nine hours	0.84	0.77–0.92	< 0.001	0.97	0.88–1.07	0.590	1.02	0.92–1.12	0.734	1.10	0.99–1.23	0.078

[a] Univariate logistic regression analysis.
[b] Multivariate logistic regression analysis, adjusted for Age and BMI.
[c] "Inapplicable" were defined as reference.

lifestyle is related to subjective symptom occurrence of SN/S and LBP. Therefore, we did not just clarify the neck and low back pain risk factors, as shown in a previous study, but we examined "positive lifestyle factors" to prevent subjective symptom occurrence of SN/S and LBP. Therefore, in logistic regression analyses, there were four items extracted with OR < 1.0 as follows: "Satisfied with everyday life (life satisfaction)," "Sleep for 7–8 h (hours of sleep)," "Exercise at least twice a week (exercise habits)," and "Can walk for about 1 h non-stop without getting tired (physical fitness)." Moreover, to consider the time effect, we compared the survival period between the GL and PL groups using the log-rank test and the Cox hazard regression analysis with the propensity score method. Consequently, significant differences in risk were observed in survival analysis, suggesting that it could predict SN/S and LBP symptom occurrence in workers during long-time follow-up depending on the existence of these four positive predictors. Survival analysis results did not change before and after propensity score matching.

The employment status, health state, income, family, and education, physical, and social activity levels are factors that may affect life satisfaction (Gopalakrishnan and David, 2008; McNamee and Mendolia, 2014; Senay et al., 2018). In our study, "Satisfied with everyday life" was considered a positive lifestyle factor that could represent daily life satisfaction including the workplace and home and leisure times. Previous studies in Japan have reported an association between the psychosocial factors in the workplace and neck and low back pain occurrence (Matsudaira et al., 2011; Matsudaira et al., 2012; Fujimoto et al.,

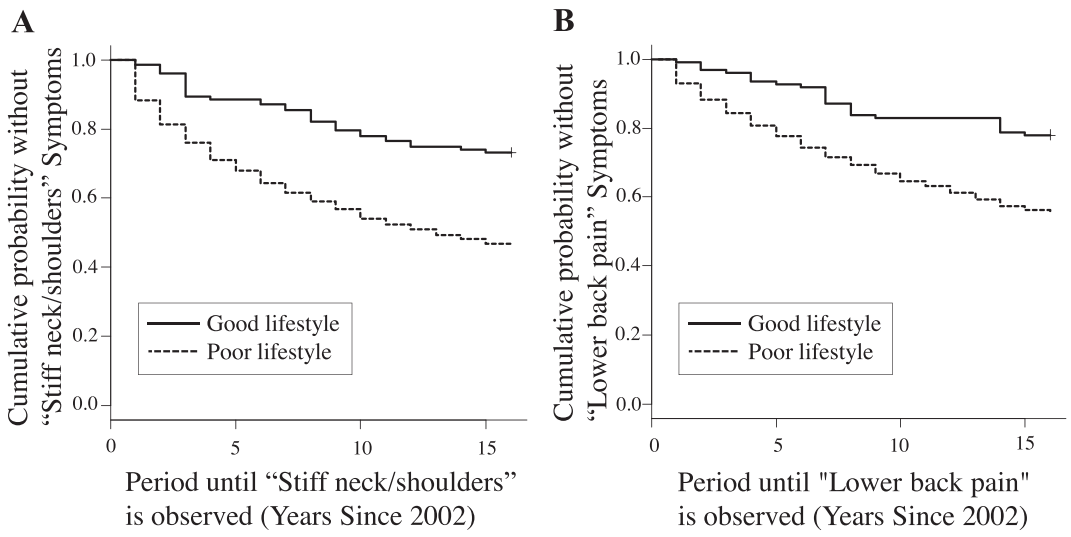

Fig. 2. Comparison between groups of Good (n = 123) and Poor lifestyle (n = 3,470) on complaining their "Stiff neck/shoulders (A)" and "Lower back pain (B)".

2018), highlighting that high life satisfaction might be a factor contributing to SN/S and LBP prevention. Moreover, previous studies have suggested a relationship between neck/shoulders and low back pain and sleep (Moldofsky, 2001; Mork et al., 2014). Further, it has been reported that longer sleeping duration on workdays increase life satisfaction (Pagan, 2017). Additionally, 7–9 h of sleep for adults was recommended by a national survey that investigated the relationship between sleep time and several diseases (Hirshkowitz et al., 2015). Similarly, our findings suggested a relationship between sleep time and subjective symptoms of SN/S and LBP, and sleep time seems an important factor in preventing symptom development. Furthermore, previous studies have reported that lower physical activity during leisure time and exercise habits reduce neck and low back pain risk (Hartvigsen and Christensen, 2007; Björck-van et al., 2008; Skillgate et al., 2017; Kirsch et al., 2019). Similarly, our findings suggested a relationship between exercise habits and subjective symptoms of SN/S and LBP. Additionally, a relationship with physical fitness was suggested. Other previous studies have reported that the relationship between trunk muscles and low back pain is inconclusive (Hamberg-van et al., 2007; Heneweer et al., 2012). Rather, it has been reported that physical activity, such as aerobic and muscular endurance, is important for preventing low back pain (Suni et al., 1998; Verbunt et al., 2003; Heneweer et al., 2012). Likewise, the physical fitness importance in addition to muscle strengthening has been highlighted as an efficient neck pain exercise treatment (Yalcinkaya et al., 2017). Based on the literature and our results, exercise habits and physical fitness are possibly more related to the prevention of subjective symptoms of SN/S and LBP than to specific muscle strength.

Most importantly, positive lifestyle factors are probably bidirectionally involved and suggest that biopsychosocial framework (Waddell, 1992; Foster et al., 2018) can be applied to the prevention of SN/S and LBP. Especially, it may be desirable to examine four lifestyle factors at the same time, instead of each independent lifestyle. Additionally, positive lifestyle factor is probably a central element of the management of SN/S and LBP occurrence. Hence, the following should be recommended to young male workers: create a satisfying life environment; sleep 7–8 h; exercise two times/week for > 30 min; try not to feel tired when walking for about an hour. Consequently, the four positive predictors are likely to increase the threshold for subjective symptoms of SN/S and LBP. Especially, it is likely to reduce the neck and low back pain occurrence by acquiring four positive lifestyle behaviors simultaneously. Our findings have an important clinical implication. Namely, facilitating changes in these four lifestyle behaviors may prevent neck and low back pain in young male workers and improve the patient's symptoms of neck and low back pain during multidisciplinary treatment for return to work.

4.1. Study limitations and strengths

Our study's strengths were the long follow-up period, sample size, and implementation of extensive lifestyle questionnaires including items on dietary habits, daily living, and activities. Moreover, our major findings were the four positive predictors common for SN/S and LBP. However, the following limitations should be noted: it only considered aspects of individual lifestyle and physical factors (e.g., work stress and load), and psychosocial factors were not considered; items extracted by the logistic regression model probably because the outcome was set as subjective symptoms of neck and low back pain; the industry type was unknown; we examined subjective symptoms of SN/S and LBP and not diagnosed musculoskeletal disorders; the self-reported annual lifestyle questionnaire data possibly affected by recall bias; the self-reported lifestyle questionnaire could be a limitation; changes in lifestyle during the follow-up period and the interaction among the four positive predictors were not considered. Furthermore, the following points should be noted regarding this study's generalizability: the study only included male workers; dietary and exercise habits vary by country; healthy-worker effect by extracting workers who underwent annual health check-up.

5. Conclusions

The PL group was associated with a significantly increased risk of developing subjective musculoskeletal symptoms compared to the GL group. Thus, adopting lifestyle interventions from a young age may reduce the risk of SN/S and LBP newly occurrence. However, changes in four positive predictors during the follow-up period were not considered. In future studies further analysis of the changes and interactions among the four positive predictors is needed.

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Table 3
Characteristic of the young worker before and after Propensity Score matching in 2002, Japan. [BMI, body mass index; SD, standard deviation; PS, Propensity Score].

	Before PS matching									After PS matching								
	Good lifestyle groups (n = 123)				Poor lifestyle groups (n = 3,470)					Good lifestyle groups (n = 54)				Poor lifestyle groups (n = 54)				
	n[c]	%	mean	SD	n[c]	%	mean	SD	p-value[a]	n[c]	%	mean	SD	n[c]	%	mean	SD	p-value[a]
Age(years)			31.1	6.94			30.8	6.06	0.606[b]			30.7	6.75			30.3	6.31	0.735[b]
BMI(kg/m^2)			22.9	2.76			22.9	3.30	0.868[b]			22.8	2.58			22.6	2.79	0.762[b]
Lifestyle questionnaire [d]																		
Good health habits																		
Are you a current regular smoker?	48	39.0			1,918	55.3			< 0.001	23	42.6			24	44.4			1.000
Are you a drinker?	82	66.7			1,823	52.5			0.002	37	68.5			30	55.6			0.234
Have three meals almost at the same time every day	92	74.8			533	15.4			< 0.001	32	59.3			30	55.6			0.846
Dietary habits																		
Aware of balanced diet	91	74.0			402	11.6			< 0.001	27	50.0			24	44.4			0.700
Eat protein dishes with every meal	82	66.7			326	9.40			< 0.001	25	46.3			29	53.7			0.564
Eat rice, bread, or noodles with every meal	117	95.1			1,837	52.9			< 0.001	48	88.9			48	88.9			1.000
Eat slowly chewing well	40	32.5			205	5.90			< 0.001	11	20.4			11	20.4			1.000
Eat two or more kinds (packs) of Western or Japanese confectioneries or snacks on average a day	8	6.50			95	2.70			0.024	5	9.30			3	5.60			0.716
Finish eating at least two hours before bedtime	86	69.9			445	12.8			< 0.001	30	55.6			32	59.3			0.846
Frequently eat deep-fried food, such as fried dishes and pork cutlets	40	32.5			804	23.2			0.022	19	35.2			21	38.9			0.842
Frequently eat heavy meat dishes	34	27.6			589	17.0			0.003	16	29.6			15	27.8			1.000
Frequently eat salty food	30	24.4			574	16.5			0.027	16	29.6			14	25.9			0.830
Frequently eat seaweed and small fish	70	56.9			236	6.80			< 0.001	17	31.5			17	31.5			1.000
Frequently have dairy products (milk, yogurt, or cheese)	87	70.7			751	21.6			< 0.001	30	55.6			31	57.4			1.000
Frequently have instant food or processed food	26	21.1			750	21.6			1.000	16	29.6			12	22.2			0.511
Have breakfast almost every day	106	86.2			1,353	39.0			< 0.001	40	74.1			40	74.1			1.000
Have juice or canned coffee two bottles (two cups) or more on average a day	47	38.2			1,414	40.7			0.641	19	35.2			21	38.9			0.842
Regularly eat dark green and deep yellow vegetables	77	62.6			430	12.4			< 0.001	22	40.7			22	40.7			1.000
Regularly eat fruits	58	47.2			292	8.40			< 0.001	19	35.2			12	22.2			0.201
Regularly have snacks or late-night meals	9	7.30			406	11.7			0.152	6	11.1			6	11.1			1.000
Daily living and activities																		
Belonged to a sports club while in school	105	85.4			1,271	36.6			< 0.001	44	81.5			43	79.6			1.000
Doing sports in free time at least one time a month	112	91.1			515	14.8			< 0.001	45	83.3			42	77.8			0.628
Have a moderate level of stress	73	59.3			945	27.2			< 0.001	32	59.3			32	59.3			1.000
Have worse condition than six months ago	6	4.90			175	5.00			1.000	2	3.70			1	1.90			1.000
Prefer to spend time out in nature such as the mountains, sea, and river	97	78.9			717	20.7			< 0.001	35	64.8			34	63.0			1.000
Regularly go outside	83	67.5			657	18.9			< 0.001	31	57.4			32	59.3			1.000
Regularly move around at work or housework	85	69.1			498	14.4			< 0.001	30	55.6			33	61.1			0.696
Regularly walk	80	65.0			289	8.30			< 0.001	23	42.6			18	33.3			0.428
Walk at least one time for ten minutes per time every day	98	79.7			975	28.1			< 0.001	39	72.2			37	68.5			0.833
Walk or bike when commuting	64	52.0			733	21.1			< 0.001	25	46.3			21	38.9			0.560
Work for less than nine hours	74	60.2			482	13.9			< 0.001	26	48.1			20	37.0			0.331

[a] Chi-square test or Fisher's exact test
[b] Unpaired T-test
[c] The number of Applicable
[d] Lifestyle questionnaire items excluded the four positive predictors

Table 4
Associations between the lifestyle groups and Stiff neck/shoulders and Lower back pain symptoms, 2002–2018, Japan: Hazard ratios confidence intervals for Good lifestyle versus Poor lifestyle. [HR, hazard ratio; CI, confidence interval; BMI, body mass index]

variables	Model 1[a] (n = 3,593)			Model 2[b] (n = 108)		
	HR	95%CI	p-value	HR	95%CI	p-value
Stiff neck/shoulders						
Age	0.99	0.98–0.99	0.009			
BMI	1.01	0.99–1.02	0.381			
Groups						
Good lifestyle	1.00	reference		1.00	reference	
Poor lifestyle	2.54	1.80–3.59	< 0.001	2.33	1.07–5.10	0.033
Lower back pain						
Age	0.99	0.99–1.00	0.228			
BMI	1.01	0.99–1.02	0.275			
Groups						
Good lifestyle	1.00	reference		1.00	reference	
Poor lifestyle	2.45	1.67–3.58	< 0.001	3.50	1.60–7.68	0.002

[a] Cox proportional hazards analysis model, adjusted for Age and BMI.
[b] Cox proportional hazards analysis model for after propensity score matched.

CRediT authorship contribution statement

Naomichi Tani: Conceptualization, Investigation, Formal analysis, Methodology, Data curation, Writing - original draft. **Masanori Ohta:** Conceptualization, Methodology, Writing - review & editing. **Yoshiyuki Higuchi:** Conceptualization, Formal analysis, Methodology. **Junichi Akatsu:** Funding acquisition, Writing - review & editing. **Masaharu Kumashiro:** Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors Tani and Akatsu are employees of the Association for Preventive Medicine of Japan. The other authors have no conflicts of interest to report.

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