

The Risk Factor of Worsening Low Back Pain in Older Adults Living in a Local Area of Japan: The GAINA Study

Shinji Tanishima,* Hiroshi Hagino,† Hiromi Matsumoto,‡ Chika Tanimura§ and Hideki Nagashima*

*Division of Orthopedic Surgery, Department of Sensory of Motor Organs, School of Medicine, Faculty of Medicine, Tottori University, Yonago 683-8504, Japan, †Department of Fundamental Nursing, School of Health Science, Faculty of Medicine, Tottori University, Yonago 683-8503, Japan, ‡Department of Physical Therapy, Faculty of Rehabilitation, Kawasaki University of Medical Welfare, Kurashiki 701-0193, and §Department of Adult and Elderly Nursing, School of Health Science, Faculty of Medicine, Tottori University, Yonago 683-8503, Japan

ABSTRACT

Background Several factors, particularly osteoporosis, obesity, and a lack of exercise, contribute to low back pain (LBP). This observational longitudinal cohort study to identify the risk factors for worsening low back pain.

Methods We sent a self-administered questionnaire and a consent form for this study to 1,450 subjects aged > 40 years in Hino, Japan. Baseline assessments of 273 individuals undergoing medical check-ups were conducted from 2014 to 2016. The subjects were divided into Group A (no change or improvement in LBP) and Group B (worsening LBP). LBP was assessed using a visual analog scale; body mass index (BMI), bone mineral density, skeletal muscle index (SMI), standing posture, and habitual exercise frequency were also evaluated. We defined, habitual exercise as nontherapeutic exercise (e.g. swimming, walking, physical exercise and work out).

Results Overall, 81.2% subjects performed habitual exercise in Group A, a greater number of subjects than the 40.8% in Group B. BMI, SMI, and bone mineral density (BMD) were not significantly different between the two groups. Lack of exercise was a significant risk factor for worsening of LBP. On the other hand, the lack of osteoporosis treatment was significantly different between subjects with worsening LBP despite habitual exercise and those who did not perform habitual exercise.

Conclusion Although habitual exercise is useful to prevent LBP, it may not necessarily be useful for those with a lack of osteoporosis treatment. Although exercise is typically posited to prevent LBP, it may not be effective in preventing LBP associated with osteoporosis.

Key words bone mineral density; elderly; exercise; low back pain; osteoporosis

Low back pain (LBP) is a common complaint in clinical settings and the fifth most common cause of visits to clinics in the USA.¹ Several factors, particularly osteoporosis, obesity, sarcopenia, and a lack of exercise,

contribute to low back pain (LBP).^{2, 3} In a systematic review, Itz et al. investigated the natural history of non-specific low back pain, and the results demonstrated that only 33% of people who experienced it found pain relief within 3 months. Sixty-five percent of people experienced low back pain for one year after experiencing non-specific low back pain.⁴ Recovering from it is very difficult; consequently, many treatment options exist. Various conservative therapies, including exercise, medication, the use of braces, and several injections according to patient's condition, were investigated thus far. Among these, exercise is strongly recommended as a conservative therapy,¹ owing to its advantages of safety and low risk of adverse events. Exercise using a therapist's guidance, acupuncture, massage therapy, spinal manipulation, yoga, cognitive-behavioral therapy, or progressive relaxation are useful not only for treatment but also for prevention of LBP.

Previous papers have reported making a habit of exercising might demonstrate an important role in the prognosis of LBP.⁵ However, the long-term effects of exercise remain unclear,⁶ although the efficacy of various types of muscle strengthening exercises for treating LBP was reported.^{7, 8} Most studies reported on short-term exercise under a therapist.⁷ Rasmussen et al. reported that low physical capacity doubled the risk of developing persistent LBP among health care workers without LBP 2 years earlier.⁹ The implementation of an exercise routine by a physical therapist can help the patient to efficiently perform exercises as well as to maintain a schedule.¹⁰ However, we posit that maintaining a therapist-guided exercise schedule for a long duration

Corresponding author: Shinji Tanishima, MD, PhD

shinjit@tottori-u.ac.jp

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Abbreviations: BMD, bone mineral density; BIA, bioelectrical impedance analysis; GAINA, Good Ageing and Intervention Against Nursing Care and Activity Decline; LBP, low back pain; ODI, Oswestry Disability Index; QUS, quantitative ultrasound; %YAM, the mean percentage for young adults; SMI, skeletal muscle index; VAS, visual analogue scale

is rather difficult. So, we hypothesized that it would be better to get patients to create a habit of exercising. Conversely, few studies assess the efficacy of habitual exercise for LBP² and the association between lack of exercise and deterioration from low back pain are still unclear.

Therefore, the aim of this study was to assess the risk factor of worsening low back pain to determine the association between habitual exercise and LBP in individuals.

SUBJECTS AND METHODS

Study design

This was an observational longitudinal cohort study.

Subjects

This study is based on the results obtained in a prospective cohort of subjects enrolled in the Good Ageing and Intervention Against Nursing Care and Activity Decline (GAINA) study. The GAINA study, which began in 2014, is a population-based cohort study of 3,352 subjects from Hino, Tottori Prefecture, Japan, who received annual town-sponsored medical check-ups. The proportion of elderly individuals in this population was approximately 45%. A self-administered questionnaire, a consent form for the GAINA study, and a medical check-up form were mailed to 1,450 subjects aged > 40 years who were eligible to receive a town-sponsored medical check-up. Enrollment in the present study was open to all subjects who agreed to participate in the GAINA study from 2014 to 2016, and attendance during the study period was voluntary. Baseline assessments of 273 individuals receiving medical check-ups were conducted between May and June 2014. The inclusion criteria for the present study were as follows: 1) lived independently, 2) able to walk to the survey location, and 3) agreed to provide self-reported data. In total, 57 subjects were excluded because of the lack of data in their medical check-up forms. In total, 216 subjects (79 men and 137 women) were included for baseline assessment in 2014. Each year, we performed the GAINA study between May and June. We enrolled ninety-six subjects (34 men and 62 women; average age, 73.9 years; age range, 52–97 years) participating in the general medical examination scheme who had low back pain in their ordinary life and the GAINA study each year from 2014 to 2016.

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Tottori University (approval no. 2354), and all subjects provided written informed consent.

Baseline characteristics and questionnaire

The baseline characteristics of age, sex, height, body weight, and body mass index (BMI) were recorded for each subject. We used the questionnaire to investigate the prevalence of LBP, intensity of LBP, and lifestyle. Subjects who answered “yes” to the question “Have you lately experienced LBP in your daily life?” were regarded as experiencing LBP. Each subject indicated intensity of LBP by drawing a vertical mark on a 100-mm horizontal visual analog scale (VAS). The questionnaire also inquired about habitual exercise in terms of the frequency of exercise per week, length of time per session, and the type of exercise. Exercising at least two times per week was considered habitual exercise. We also asked about their smoking habit.

Content of exercise

We divided the content of habitual exercises into three groups: work out, physical exercise and aerobic exercise (swimming and working).

Body function and structure measurements

Muscle mass was measured by bioelectrical impedance analysis (BIA) with an MC-780A Body Composition Analyzer (Tanita Co., Tokyo, Japan). The BIA method requires the subjects to step onto a platform and remain in the standing position for approximately 30 s. Skeletal mass index (SMI) was calculated by dividing the limb muscle mass (kg) by height squared (m²). Quantitative ultrasound (QUS) was used to assess the calcaneal bone mass.^{11, 12} The speed of sound through the calcaneus was evaluated using a CM-200 sonometer (Furuno Co., Nishinomiya City, Japan). Subjects were seated and asked to place their right heel on the QUS device. To facilitate the transmission of ultrasound to the skeletal site being examined, a coupling gel was applied to the heel. As a result of QUS methods, we used %Young Adult Mean (%YAM) to explain bone mineral density. To clarify the risk factors that make low back pain worse, we divided participants in this study into the following two groups on the basis of self-reported VAS scores from 2014 to 2016: Group A ($n = 73$, 26 men and 47 women), which included subjects who reported no change or improvement by measuring VAS of LBP from 2014 to 2016 during the study period, and Group B ($n = 23$, 8 men and 15 women), which included subjects who reported a worsening decrease of 20 mm by measuring VAS of LBP from 2014 to 2016. We considered the possibility that some residents experienced deteriorating LBP in spite of regular exercise from 2014 to 2016.

We also divided Group A and B into A1 ($n = 22$) and A2 ($n = 51$) or B1 ($n = 17$) and B2 ($n = 6$), according

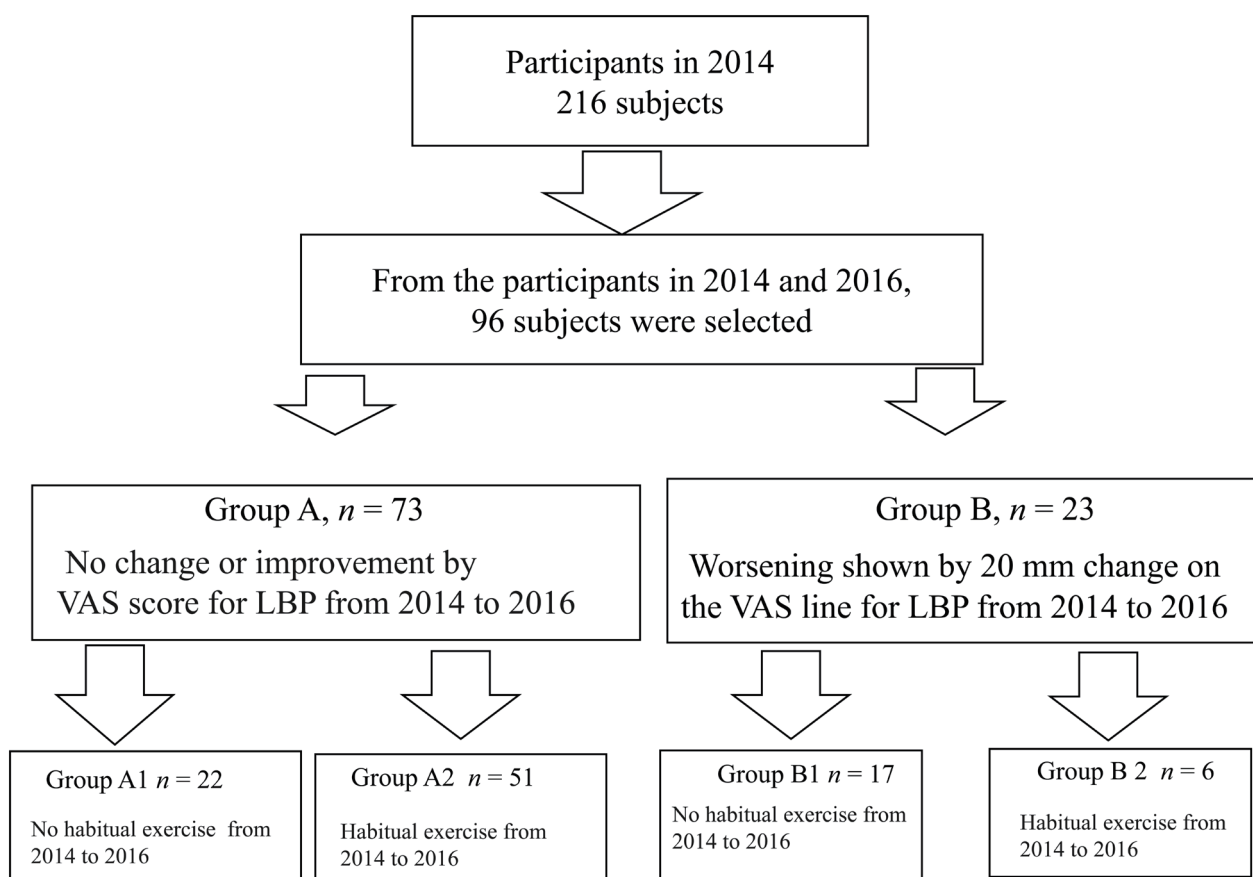


Fig. 1. Flow diagram of this study.

to those who proceeded with or without habitual exercise. (Fig. 1).

Statistical analysis

All numerical data are presented as the mean \pm standard deviation. Differences in subject demographics, age, BMI, SMI, habitual exercise, BMD, osteoporosis therapy, habitual smoking, and VAS scores of LBP in 2014 between the Group A and Group B were examined using the Mann–Whitney *U*-test and chi-square test. Fisher’s exact test was applied when the expected cell size was < 5 . The survey items that may have demonstrated any influence according to previous research, sex, and age were used in logistic regression analysis, to assess the risk factor of worsening LBP.¹³ We also used the Chi-square test, $m \times n$ contingency table, Kruskal–Wallis test and Fisher’s exact test to evaluate differences among A1, A2, B1 and B2 groups for sub-analysis. We added the Bonferroni test to compare the differences with each group after the Kruskal–Wallis test. We also added adjusted residual analysis, when the differences existed after the Chi-square test, $m \times n$ contingency

table and Fisher’s exact test to detect which groups had significant differences. When the adjusted residual was less than -1.96 or greater than 1.96 , we concluded there were significant differences at the 5% level. The content of exercise between Group A and B was analyzed by the Chi-square test, and $m \times n$ contingency table. Statistical significance was set to $P < 0.05$. All data analyses were conducted using SPSS 27.0 software (SPSS, Chicago, IL).

RESULTS

Comparison of demographic data at baseline in 2014

The ratio of subjects who performed habitual exercise at least twice a week is greater in Group A than in Group B (69.9% vs. 26.1%; $P < 0.01$; chi-square test). The frequency of exercise in Group A and Group B are shown in Fig. 1. No significant differences were found between the two groups, in terms of age, sex ratio, VAS for LBP, SMI, bone mineral density [BMD; as determined by the percentage of the young adult mean of lumbar BMD (%YAM)], the ratio of patients receiving osteoporosis

Table 1. Comparison of demographic data at baseline in 2014

	Group A	Group B	<i>P</i> value
Number of subjects	73	23	
Age (years)	73.9 ± 7.5	74.7 ± 7.5	0.51*
Gender (men/women)	26/47	8/15	0.94†
VAS of LBP	20.0 ± 26.0	21.5 ± 19.4	0.22*
SMI (kg/m ²)	2.81 ± 0.34	2.76 ± 0.33	0.29*
BMI (kg/m ²)	21.9 ± 2.8	22.4 ± 2.0	0.43*
BMD (%YAM)	80.2 ± 14.0	77.6 ± 7.5	0.70*
Osteoporosis treatment	10/63 (15.9%)	1/22 (4.54%)	0.22‡
Smoking	4/73 (5.5%)	2/23 (8.7%)	0.57‡
Habitual exercise	51/73 (69.9%)	6/23 (26.1%)	< 0.01†
Content of exercise			
Walking/Swimming	25	3	
Physical exercise	22	2	0.74§
Work out	4	1	

The prevalence of performing regular exercise was higher in Group A than in Group B. *Mann-Whitney *U* test, †Chi-square test, 2 × 2 contingency table, ‡Fisher's exact probability test, §Chi-square test, m × n contingency table. BMD, bone mineral density; BMI, body mass index; BIA, bioelectrical impedance analysis; LBP, low back pain; %YAM, the percentage of young adults' mean; SMI, skeletal muscle index; VAS, visual analogue scale.

Table 2. Association factors for the worsening of LBP

	Odds ratio	95% confidence interval	<i>P</i> value
Sex	1.541	0.549–4.326	0.412
Age (years)	1.012	0.949–1.079	0.717
SMI (kg/m ²)	1.014	0.566–1.815	0.964
%YAM	1.028	0.983–1.076	0.225
Habitual exercise	5.526	1.961–15.574	< 0.001

Habitual exercise was associated with significantly less worsening of LBP. LBP, low back pain; %YAM, the percentage of young adults' mean; SMI, skeletal muscle index.

treatment, and habitual smoking. The content of exercise was not significantly different between two groups. (Table 1).

Association factors for the worsening of LBP

Compared with other factors, habitual exercise was associated with significantly less worsening of LBP ($P < 0.01$, 95% confidence interval, 1.961–15.574 odds ratio, 5.526) (Table 2).

Association between habitual exercise and LBP

There were significant differences among the four groups with a prevalence of treatment for osteoporosis ($P = 0.03$), (Table 3). Adjusted residual analysis revealed that only the A1 group had a significant higher prevalence of osteoporosis treatment (Table 4).

DISCUSSION

In this study, the effects of habitual exercise on LBP in local residents are reported. Rainville et al.¹¹ performed a cohort study, to compare the treatment frequencies in patients with chronic LBP in order to determine whether aggressive spine rehabilitation was more efficacious at two or three times per week for 12 months. Their results demonstrated that no significant difference was found regarding the efficacy of rehabilitation performed at two or three times per week.¹⁴ The treatment protocol of their study included the strengthening of the trunk muscles, stretching, and aerobic exercise.

Nelson et al.^{15, 16} reported the advantages of resistance training for the strengthening of the back muscles. Moreover, Frost et al.¹⁷ investigated the benefits of attending a fitness class two times per week on chronic LBP, the Oswestry disability index, and walking

Table 3. Association between habitual exercise and LBP

	Group A1	Group A2	Group B1	Group B2	P value
Number of subjects	22	51	17	6	
Age (years)	72.3 ± 8.7	74.3 ± 6.9	73.4 ± 7.8	78.1 ± 5.5	0.55*
Gender (man/woman)	7/15	19/32	6/11	2/4	0.98†
VAS of LBP	27.3 ± 31.4	16.9 ± 22.9	18.4 ± 18.5	30.5 ± 20.5	0.28*
SMI (kg/m ²)	6.84 ± 1.11	6.62 ± 0.91	6.81 ± 0.89	6.42 ± 0.48	0.76*
BMI (kg/m ²)	21.8 ± 2.7	21.9 ± 2.8	22.3 ± 2.1	22.7 ± 1.6	0.85*
BMD (%YAM)	76.1 ± 10.5	75.4 ± 14.5	74.8 ± 7.8	71.5 ± 7.3	0.75*
Treatment of osteoporosis (%)	7.3	7.8	0.0	0.2	0.03‡
Smoking (%)	27.3	7.8	11.8	0.0	0.44†

Prevalence of osteoporosis treatment in Group A1 was higher than other groups. *Kruskal-Wallis test, †Chi-square test, m × n contingency table, ‡Fisher's exact test. BMD, bone mineral density; BMI, body mass index; LBP, low back pain; SMI, skeletal muscle index; VAS, visual analogue scale; %YAM, the mean percentage for young adults.

Table 4. Adjusted residual analysis with treatment for osteoporosis among the four groups

	Treatment for osteoporosis (-)	Treatment for osteoporosis (+)
Group A1	-2.6	2.6
Group A2	1.2	-1.2
Group B1	1.6	-1.6
Group B2	-0.6	0.6

distance. The findings of these reports were similar in that therapeutic exercise at least two times per week was useful to alleviate chronic LBP.

In a review article, Rainville et al.¹⁸ reported the effect of exercise on chronic LBP, and they found that the observed efficacy was similar to that reported in several previous studies. In addition, van der Veldle and Mierau¹⁹ investigated changes in aerobic capacity after a 6-week exercise schedule in patients with chronic LBP, and they reported that aerobic capacity and musculoskeletal function improved, while pain and disability scores significantly decreased. Several previous studies also noted that musculoskeletal dysfunction was associated with trunk strength,^{20,21} flexibility,²² and the endurance of pain.¹⁹

Many studies regarding the efficacy of exercise for alleviating LBP^{21,23} reported that exercise, particularly stretching, improved trunk flexibility and pain relief. However, most subjects in these reports were of working age or younger. Therefore, the present study focused on the effect of exercise habit on LBP in an elderly Japanese population.

We posit that participating in a daily exercise program under the guidance of a physical therapist is difficult for many elderly individuals, as reported by

Liddle et al.¹⁰ Therefore, we investigated the association between habitual exercise and LBP. Most of the subjects who engaged in regular exercise (e.g., jogging, stretching, strength training, and others) did not experience the worsening of LBP symptoms, as reflected by their VAS scores, indicating that exercise is beneficial for LBP.

In the present study, the subjects were encouraged to perform exercises at home. The study results showed that a daily exercise habit was associated with pain relief in elderly subjects with LBP. Therefore, exercise should be recommended for patients with LBP.

In some subjects, VAS scores decreased in spite of regular exercise habits. The results of the present study showed that subjects who did not change or make improvement without habitual exercise ended up receiving osteoporosis therapy.

Most subjects who participated in this study were elderly and had a low bone mineral density of under 80% in %YAM. Mattia et al.²⁴ mentioned that osteoporotic bone contains a greater volume of sensory nerve fibers around the periosteum. We thought that low back pain of these residents might be related to osteoporosis.

Therefore, osteoporosis therapy might contribute to improve the quality of vertebral bone and reduce low back pain. Residents in Group B2 deteriorated low back

pain in spite of habitual exercise. They had low %YAM compared with other groups. Although there were no significant differences among all groups because of the small sample size, we could not ignore the influence of low mineral density.

We believe the best ways to prevent deterioration of low back pain are habitual exercise and osteoporosis therapy. This study demonstrated several limitations that should be addressed. First, using only the VAS to assess LBP may be ineffective; the possible causes of LBP, such as disc herniation, lumbar spinal stenosis, and spinal deformity, were not investigated using X-ray, magnetic resonance imaging, or other imaging techniques. Second, selection bias may be present because the subjects voluntarily participated in the medical check-ups. Third, we didn't investigate the possibility of other musculoskeletal diseases (e.g. osteoarthritis of the knee or hip joint.) and how they might affect habitual exercise. Fourth, although the residents participating in this study were relative healthy, because they could participate in medical check-up by themselves, we didn't investigate how their comorbidities might affect their physical condition. Fifth, we didn't receive information regarding the activities of their daily life (e.g. occupation and housework) besides habitual exercise, and these might have potentially confounded the results according to their responses. Finally, the sample size was relatively small. Therefore, future large-scale investigations that incorporate imaging studies and consideration of the other factors mentioned above are warranted.

In conclusion, we posit that habitual exercise is useful in the prevention and treatment of LBP. And although habitual exercise is useful in preventing LBP, it may not necessarily be useful for those who do not undergo osteoporosis treatment.

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cal Co., Ltd., Asahi Kasei Pharma Co., Kaken Pharmaceutical Co., Ltd., Pfizer Japan Inc., Nippon Zoki Pharmaceutical Co., Ltd., Shionogi & Co., Ltd., Eisai Co., Ltd., Astellas Pharma Inc., Takeda Pharmaceutical Co., Ltd., Teijin Pharma Limited, Ono Pharmaceutical Co., Ltd., AOSpine, Daiichi Sankyo Co., Ltd., and Eli Lilly Japan K. K.

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