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Physical Function and Low Back Pain in Leek Farmers: A Comparison with Non-Farmers

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ABSTRACT

Background The purpose of this study was to investigate the low back pain (LBP) and physical function of young to middle aged farmers of leeks in western Tottori Prefecture.

Methods Fifteen farmers (55 years old or younger) cultivating leeks in western Tottori Prefecture were recruited as the subjects, and 14 non-farmers matching the age and sex of the subjects were recruited as the control group. A questionnaire survey was conducted to determine the presence or absence of LBP, smoking, and alcohol consumption. Physical functions were measured by anthropometry (body fat percentage and muscle mass), Finger-Floor distance (FFD), back muscle strength, and upper body bending, and lumbar muscle cross-sectional area (CSA) was evaluated by magnetic resonance imaging (MRI).

Results Weight, BMI, body fat percentage, upper body bending, back muscle strength, and L3/4 iliocostalis lumborum CSA, current LBP were significantly higher in the leek farmer group. One-way analysis of variance showed significant differences in upper body bending, and history of LBP.

Conclusion LBP was more common among leek farmers. The characteristics of leek farmers with LBP were history of LBP.

Key words agriculture; body fat percentage; leek farmer; low back pain; upper body bending

Low back pain (LBP) is a symptom that afflicts many people, from the young to the elderly, and has a high lifetime prevalence of 80%, making it prone to recurrence.[1, 2] In addition, continuous management of LBP is very important because of its social impact and high medical cost.[3, 4]

Occupational LBP has been reported to be associated with decreased productivity.[5] This is because studies in various occupations have shown that occupational LBP is associated with health-related quality of life and social health care costs. The loss of productivity due to LBP is something that both workers and managers want to avoid in their work. In Japan, the occupations with the highest incidence of LBP were reported to be nurses and transportation workers.[6] In Finland, LBP was reported to be more common in the construction, agriculture, transportation, and medical industries.[7] The causes of occupational LBP are various, including physical and environmental factors. In terms of work posture, lifting,[8–10] standing,[8, 11] and bending[12] are reported to be associated with LBP. Therefore, various occupations are reviewing their work methods and work environments, and efforts are being made to reduce physical burden.

Common causes of LBP include lower extremity flexibility,[13–15] back muscle strength,[16] body weight,[16] body mass index (BMI),[16, 17] smoking,[18] alcohol consumption,[18] stress,[19] and history of LBP.[20] There are few studies on the relationship between occupational LBP and physical function. A study on postal workers reported a relationship between LBP and back muscle strength.[21] The relationship between occupational LBP and physical function may be influenced by the content of work. It is difficult to clarify the characteristics of more individualized occupational LBP without considering the occupation and work content and selecting the subjects.

In a previous study on LBP in agricultural workers, it was reported that the incidence of LBP was higher in agricultural workers than other occupations.[22–24] In addition, LBP is related to work area[24] and lifting.[23] It is difficult to obtain a definite opinion on the relationship between agriculture and LBP in Japan, because most of the previous studies are from overseas and there are differences in crops, work characteristics, and work area among countries. Agricultural work is associated with

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Abbreviations: BMI, body mass index; CSA, cross-sectional area; FFD, Finger-Floor distance; LBP, low back pain; MRI, magnetic resonance imaging

causing LBP because there is a lot of repetitive lifting, standing, and bending. However, there are no reports on the physical characteristics of agricultural workers in Japan. Clarification of the Prevalence of LBP and the physical characteristics of agricultural workers will help to prevent and improve LBP. Therefore, the purpose of this study was to investigate incidence of LBP and physical functions of young to middle aged farmers of leek in western Tottori Prefecture.

MATERIALS AND METHODS

Participants

The Participants consisted of 15 young to middle aged farmers (55 years old or younger) who were cultivating leek in western Tottori Prefecture. The control group consisted of 14 non-farmers who were matched in age and sex to the above subjects. Those who met any of the following criteria were not included in this study: those who suffered from i.) serious spinal diseases; and/or ii.) neurological disorders of the lower limbs; or were iii.) part-time farmers.

Questionnaire survey

We asked the respondents about their current LBP and history of LBP. History of LBP refers to any history of LBP since entering farming and other than current physical condition. LBP was defined as “pain localized from the first lumbar vertebra to the lower buttock, without sciatica (radiating pain)”.[25] As for lifestyle, they were asked about current smoking habits and whether they consumed alcohol more than once a month.[18]

Evaluation of physical function

Body fat percentage and muscle mass were measured using a professional dual-frequency body composition analyzer DC-430A separate type (TANITA Co., Tokyo, Japan). The measurement accuracy of this body composition analyzer was ensured because it is for medical use. Body composition was measured by the bioimpedance method in the barefoot standing position. In addition the subjects were asked to dress as lightly as possible, and the amount of clothing was set at 0.5 kg. The measurement time was standardized to be in the morning. Measurements of muscle mass reflected total body muscle mass, which was divided by body weight.

For Finger Floor Distance (FFD) we used a measuring table with a height of 30 cm, upon which the participants stood for measurement as follows: align the toes with the front edge of the platform, assume a standing posture with the knees straight, and try to touch the floor with both hands. The distance between the fingertips and the floor was measured by bending the trunk forward and extending the hands to the floor. The distance between the fingertips and the floor was set to 0 cm at the top of the table, and if the fingertips passed over the top of the table and approached the floor, the distance was indicated by a minus sign (–). Two trials were performed to obtain the maximum value (in cm).

Back muscle strength was measured according to the method described in the New Japanese Physical Fitness Standard II. For measurement, the subjects stood on the stand of a back-dynamometer (Takei Scientific Instruments Co., Niigata, Japan) with the feet about 15 cm apart, and from a posture in which the upper body was bent forward 30 degrees, the length of the chain of the back-dynamometer was adjusted by grasping and pulling the handles with both hands in a downward motion. The method of operation was instructed to be performed with the knees straight, the hands lowered and the chain accompanying the back-dynamometer being pulled vertically. At that time, we instructed the subjects to gradually increase the muscle strength to reach maximum muscle strength without recoiling from the upper body in consideration of LBP. Two trials were performed to obtain the maximum value (in kg).

Upper body bending was measured using an upper body bending measuring instrument (Takei Scientific Instruments Co., Niigata, Japan). The method was to place both hands on the lumbar in the prone position and measure the distance the upper body as it is bending. Two trials were performed to obtain the maximum value (in cm).

Magnetic resonance imaging (MRI) evaluation

MRI was performed in the supine position accordance with normal medical practice. The MRI system was a Philips 1.5T. The imaging sequence was T2-weighted, and the lumbar to sacral spine (L3/L4-L5/S1) was performed in a horizontal section. The cross-sectional area (CSA) of the analyzed muscles was the iliocostalis lumborum, psoas major, iliacus, multifidus, quadratus lumborum, and longissimus. Muscle CSA was performed to obtain the mean on each side with measurements corrected for BMI.[26]

Data analysis

First, the interval scale was subjected to the Shapiro-Wilk test to confirm normality. The dependent variables in the univariate analysis were leek farmers and non-farmers. The independent variables were basic information, body fat percentage, muscle mass, FFD, back muscle strength, upper body bending, and lumbar muscle CSA; differences were tested using the t-test and Mann-Whitney *U* test. In addition, $\chi 2$ tests were

Table 1. Background of the subjects

	Total (n = 29)
Age (year)	36.7 ± 8.9
Gender (male/female)	(27/2)
Height (cm)	170.6 ± 5.6
Weight (kg)	68.1 ± 9.5
BMI (kg/m^2)	23.4 ± 3.3
Body fat percentage (%)	20.8 ± 7.5
Muscle mass (kg/kg)	2.2 ± 0.3
FFD (cm)	1.4 ± 6.7
Upper body bending (cm)	34.6 ± 9.3
Back muscle Strength (kg)	118.6 ± 29.6

Mean ± SD. BMI, body mass index; FFD, Finger-Floor distance.

conducted for leek farmers, presence of LBP, history of LBP, smoking, and alcohol consumption. Next, leek farmers and LBP were classified into four groups, and $\chi 2$ test, one-way analysis of variance, and Kruskal-Wallis test were conducted, followed by Bonferroni method as a post-hoc test ($P < 0.0083$). Statistical analysis was conducted using SPSS version 26 for Mac (IBM, Chicago, IL). Statistical significance was set to $P < 0.05$.

Ethical considerations

This study is a cross-sectional study, which was reviewed and approved by the Ethics Review Committee of Faculty of Medicine, Tottori University, at the time of the survey (No.18A100).

RESULTS

Background of the subjects

The mean age was 36.7 ± 8.9 years, gender was 27 males and 2 females, BMI was 23.4 ± 3.3 kg/m^2, and body fat percentage was 20.8 ± 7.5% (Table 1).

Leek farmers group and non-farmer group

The leek farmers group had significantly higher averages in body weight (P = 0.04, 1–β error probability = 0.64), BMI (P = 0.04, 1–β error probability = 0.69), body fat percentage (P = 0.01, 1–β error probability = 0.89), upper body bending (P = 0.01, 1–β error probability = 0.98), back muscle strength (P = 0.01, 1–β error probability = 0.95), L3/4 iliocostalis lumborum CSA (P = 0.01, 1–β error probability = 0.97), and current LBP (P = 0.04, 1–β error probability = 0.99) (Table 2).

Comparison of four groups classified by being leek farmers or not and the presence or absence of LBP

Dependent variables were categorized into four groups to clarify the characteristics of Leek farmers and LBP: i) Leek farmers with LBP (farmers + LBP group); ii) Leek farmers without LBP (farmers + no LBP group); iii) non-farmers with LBP (non-farmers + LBP group); and iv) non-farmers without LBP (non-farmers + no LBP group), and a one-way analysis of variance was conducted. Upper body bending was significantly higher in the farmer + no LBP group than in the non-farmer + LBP group or the non-farmer + no LBP group. History of LBP was significantly higher in the farmer + with LBP group than in the farmer + without LBP group (Table 3).

DISCUSSION

The average age of the subjects was 36.7 years, and they were predominantly young males. The average BMI of the subjects was 23.4 kg/m^2, which reflected appropriate body weight overall.

Compared to the non-farmers group, the leek farmers had significantly higher body weight, BMI, body fat percentage, upper body bending, back muscle strength, and current LBP, indicating that they had a good physique and high back muscle strength. Previous studies have reported that there is a relationship between body weight, BMI, and body fat percentage and LBP.[16, 18] Among them, a BMI of 25.0 kg/m^2 or higher was more likely to correlate with LBP.[27] A result of a BMI 25.6 ± 4.1 kg/m^2 in leek farmers with LBP may be related to a tendency towards obesity and LBP. The high values of upper body bending and back muscle strength in the leek farmers can be considered as muscle development due to their work characteristics. However, it can also be viewed as an overuse of back muscle, which may be one of the factors causing LBP. The L3/4 iliocostalis lumborum CSA was higher in the leek farmers. In previous studies, we did not find any previous research that related the lumbar muscle cross-sectional area to occupation or work content. Studies investigating LBP and lumbar muscle CSA have reported an association with atrophy of the multifidus, but not the erector spinae.[28] In this study, there was no relationship between LBP and lumbar muscle CSA. A large iliocostalis muscle CSA was characteristically large for leek farmers. This may have been influenced by agricultural work such as bending and harvesting. LBP was more frequently observed among leek farmers than among non-farmers. Previous studies have shown that LBP is common among agricultural workers. Being a leek farmer (rather than a dairy farmer and working in a dairy[24]) or working in agriculture for more than 10 years[22] have been reported to be associated with LBP. Farmers had more LBP compared to the control group, which was similar

Table 2. Leek farmers group and non-farmers group

	Leek farmers group (*n* = 15)	Non-farmers group (*n* = 14)	*P* value
Age (year)	37.6 ± 9.5	35.8 ± 8.5	0.59
Gender (male/female)	(14/1)	(13/1)	0.96
Height (cm)	170.4 ± 4.9	170.8 ± 6.6	0.87
Weight (kg)	71.4 ± 9.8	64.5 ± 8.1	0.04
BMI (kg/m^2)	24.6 ± 3.5	22.1 ± 2.6	0.04
Body fat percentage (%)	24.3 ± 5.5	17.0 ± 7.7	0.01
Muscle mass (kg/kg)	2.1 ± 0.2	2.3 ± 0.3	0.05
FFD (cm)	1.9 ± 7.9	0.8 ± 5.2	0.69
Upper body bending (cm)	39.8 ± 8.1	29.1 ± 7.2	0.01
Back muscle Strength (kg)	133.9 ± 32.1	102.2 ± 14.6	0.01
L3/4 iliocostalis lumborum (mm^2/BMI)	55.0 ± 11.0	39.1 ± 12.6	0.01
L3/4 multifidus (mm^2/BMI)	26.5 ± 6.4	25.2 ± 6.4	0.57
L3/4 longissimus (mm^2/BMI)	24.2 ± 7.2	24.4 ± 7.0	0.94
L3/4 quadratus lumborum (mm^2/BMI)	27.1 (19.1–33.0)	32.1 (19.6–47.2)	0.19
L3/4 psoas major (mm^2/BMI)	53.2 ± 8.8	53.1 ± 13.6	0.98
L4/5 multifidus (mm^2/BMI)	35.9 ± 7.3	36.2 ± 6.6	0.91
L4/5 longissimus (mm^2/BMI)	57.1 ± 13.5	52.2 ± 10.8	0.28
L4/5 quadratus lumborum (mm^2/BMI)	25.3 ± 7.1	25.8 ± 6.6	0.83
L4/5 psoas major (mm^2/BMI)	68.3 ± 12.3	68.5 ± 15.2	0.96
L5/S1 multifidus (mm^2/BMI)	37.8 ± 8.5	41.0 ± 10.8	0.37
L5/S1 longissimus (mm^2/BMI)	20.6 ± 8.8	37.8 ± 8.5	0.80
L5/S1 psoas major (mm^2/BMI)	58.7 ± 18.6	59.6 ± 17.6	0.89
L5/S1 iliacus (mm^2/BMI)	42.0 ± 16.6	35.8 ± 19.5	0.36
Current of LBP (%)	60	21	0.04
History of LBP (%)	60	57	0.88
Smoking (%)	27	36	0.60
Alcohol consumption (%)	67	36	0.10

Mean ± SD. Median (interquartile range). **t*-test, †Mann-Whitney *U* test, ‡Chi-square test. BMI, body mass index; FFD, Finger-Floor distance.

to previous studies. However, all reports were from overseas, and it may not be relevant to apply some of the same factors associated with LBP to this study, such as working environment, working area, and differences in skeletal muscle because of different body structure according to race.

The characteristics of leek farmers with LBP were body fat percentage and history of LBP. History of LBP[21] related to LBP were considered to be similar to previous studies. If the patient has experienced LBP in the past and the cause has not been resolved, the risk of recurrence is predicted to be high.

In this study, we focused on Japanese agricultural workers and investigated the prevalence of LBP. The results showed that leek farmers had more LBP than non-farmers. The characteristics of leek farmers with LBP were history of LBP, which were similar to the risk factors for LBP. Although not investigated in this study, agriculture is characterized by lifting, standing, and bending activities that put a lot of strain on the lumbar, which may lead to LBP. The Ministry of Health, Labor and Welfare (MHLW) explains that occupational safety can be maintained by limiting the weight of lifting work to 20 kg or less. However, the actual work is more likely to cause LBP, because work efficiency is prioritized over reducing the burden on the body. Therefore, taking measures to prevent LBP may help reduce medical costs, improve productivity, and help farmers stay in

Table 3. Comparison of four groups classified by being leek farmers or not and the presence or absence of LBP

	Farmers + LBP group (*n* = 9)	Farmers + no LBP group (*n* = 6)	Non-farmers + LBP group (*n* = 3)	Non-farmers + no LBP group (*n* = 11)
Age (year)	37.3 ± 11.8	38.0 ± 5.6	29.7 ± 6.1	37.5 ± 8.5
Gender (male/female)	(9/0)	(5/1)	(3/0)	(10/1)
Height (cm)	172.1 ± 4.2	167.9 ± 5.0	172.8 ± 3.8	170.2 ± 7.3
Weight (kg)	75.4 ± 10.4	65.3 ± 4.6	59.5 ± 8.9	65.8 ± 7.7
BMI (kg/m^2)	25.6 ± 4.1	23.2 ± 1.9	19.9 ± 2.2	22.8 ± 2.4
Body fat percentage (%)	24.6 ± 5.4	23.7 ± 6.2	9.9 ± 1.7	18.9 ± 7.6
Muscle mass (kg/kg)	2.1 ± 0.2	2.0 ± 0.3	2.6 ± 0.1	2.2 ± 0.4
FFD (cm)	1.8 ± 10.1	2.0 ± 3.8	7.3 ± 5.5	-0.9 ± 3.7
Upper body bending (cm)	37.0 ± 7.9	44.1 ± 6.9 (a, b)	22.8 ± 4.5 (a)	30.8 ± 7.1 (b)
Back muscle Strength (kg)	131.0 ± 32.4	138.3 ± 34.1	102.8 ± 23.8	102.1 ± 12.8
L3/4 iliocostalis lumborum (mm^2/BMI)	54.0 ± 13.4	56.5 ± 6.5	44.6 ± 12.7	37.7 ± 12.7
L3/4 multifidus (mm^2/BMI)	27.6 ± 7.8	24.9 ± 3.3	24.9 ± 1.6	25.2 ± 7.2
L3/4 longissimus (mm^2/BMI)	22.4 ± 7.5	27.1 ± 6.2	23.3 ± 4.6	24.7 ± 7.6
L3/4 quadratus lumborum (mm^2/BMI)	25.5 (18.3–32.5)	29.3 (24.7–36.7)	31.5 (19.9–69.5)	32.7 (18.9–46.1)
L3/4 psoas major (mm^2/BMI)	51.0 ± 9.1	56.5 ± 7.8	40.3 ± 26.0	51.9 ± 12.2
L4/5 multifidus (mm^2/BMI)	34.2 ± 7.7	38.6 ± 40.0	39.4 ± 3.8	35.4 ± 7.1
L4/5 longissimus (mm^2/BMI)	54.5 ± 14.5	61.1 ± 12.0	51.4 ± 15.5	52.4 ± 10.1
L4/5 quadratus lumborum (mm^2/BMI)	26.1 ± 8.6	24.0 ± 4.4	28.0 ± 6.8	25.2 ± 6.8
L4/5 psoas major (mm^2/BMI)	67.7 ± 12.4	69.2 ± 13.2	79.0 ± 17.3	65.6 ± 14.1
L5/S1 multifidus (mm^2/BMI)	34.6 ± 31.4	42.5 ± 7.0	43.8 ± 10.9	40.3 ± 11.2
L5/S1 longissimus (mm^2/BMI)	21.6 ± 10.3	19.1 ± 6.6	31.1 ± 7.3	18.8 ± 5.8
L5/S1 psoas major (mm^2/BMI)	57.5 ± 22.9	60.4 ± 10.9	69.4 ± 27.2	56.9 ± 14.7
L5/S1 iliacus (mm^2/BMI)	44.3 ± 18.4	38.5 ± 14.2	31.3 ± 15.7	37.3 ± 20.8
History of LBP (%)	100 (c)	0 (c)	100	46
Smoking (%)	33	17	100	18
Alcohol consumption (%)	67	67	33	36

Mean ± SD. Median (interquartile range). For the nominal scale, chi-square test and 4 × 2 contingency table were used, and for other continuous variables, one-way analysis of variance, and Kruskal-Wallis test were conducted, followed by Bonferroni method as post-hoc test. $P < 0.0083$. Significant differences were found between the same alphabets (a, b, c). BMI, body mass index; FFD, Finger-Floor distance.

work longer.

One limitation of this study is that it was difficult to obtain a sufficient number of cases commensurate with the sample size to analyze the LBP factors. Therefore, it may be difficult to assert that this is a characteristic of farmers because of the small number of cases. Therefore, as a post hoc analysis, we calculated the power of the test and examined the validity of the sample size. The evaluation of muscle CSA may have been subject to measurement error due to compression of the dorsal muscle group since the measurement posture was in the supine position. Furthermore, the thickness of subcutaneous fat was not taken into account, which may not represent an accurate value for muscle CSA.

In addition, because this was a cross-sectional study, it was difficult to clarify the causes of LBP. Since this study was conducted on adolescents under the age of 55, it was not possible to state the prevalence of LBP as a trend for all agricultural workers.

However, this is the first study to examine the relationship between physical capacity and low back pain in specific agricultural workers, and we believe that the results of this study will assist in future investigations of back pain specific to agriculture.

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