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Original article

Prevalence of Low Back Pain and Associated Risk Factors among Farmers in Jeju

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ABSTRACT

Background: We aimed to investigate the prevalence of low back pain (LBP) and its associated agricultural work-related, biomechanical factors among this population.
Methods: We analyzed initial survey data from the Safety for Agricultural Injury of Farmers cohort study involving adult farmers in Jeju Island. The prevalence of LBP was calculated with associated factors.
Results: In total, 1,209 participants were included in the analysis. The overall prevalence of LBP was 23.7%. Significant associations for LBP were the type of farming activity, length of farming career, prior agricultural injury within 1 year, and stress levels. Multivariate logistic regression analysis revealed three biomechanical factors significantly related to LBP: repetitive use of particular body parts; the inappropriate posture of the lower back and neck.
Conclusions: Some occupational, and biomechanical risk factors contribute to LBP. Therefore, postural education, injury prevention education, and psychological support will be needed to prevent LBP.

1. Introduction

Due to the nature of agriculture, one person may perform various types of work. Biomechanical factors may vary according to the type of agricultural work [1]. Agricultural work is high tension and involves plenty of repetitive labor. Hence, work-related injuries and musculoskeletal disorders are common among farmers [2,3]. Among them, the most common musculoskeletal disorder is low back pain (LBP) [4,5]. In a 2019 study by Kee et al., the rate of musculoskeletal pain among Korean farmers was very high at 97.2%, of which LBP had contributed 58.7% [6].

LBP has been shown to cause serious socioeconomic losses, physical impairment, and harms to mental health [7–9]. Biomechanical risk factors for causing LBP include inappropriate posture of the lower back, heavy lifting, repetitive work, and whole-body vibrations from agricultural machinery [3,10–12]. Psychological factors, in turn, include stress, anxiety, and depression [13,14]. As age increases, the prevalence of LBP increases with continuous exposure to occupational factors and changes in pain perception [15–17].

Korean agriculture varies by region. Among them, Jeju is the southernmost volcanic island. It is very different from other regions in terms of geological characteristics [18,19]. In Jeju Island, the high water permeability of the land precludes rice farming [18]. In addition, due to the subtropical climate, approximately 64% of Jeju farmers focus on citrus cultivation. The rest grow winter vegetables such as carrots, onions, and cabbage [18,20,21].

According to the 2018 Agriculture, Forestry, and Fisheries Survey, the agricultural population in Jeju Island was 82,751, which was higher at 12.58% than the national agricultural population ratio

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of 4.5%. Among Jeju farmers, the proportion of older adults aged 65 or older was 32.5%. This is lower than the rate of the older farmers nationwide in Korea, at 44.7%. The majority (57%) of Jeju farmers combine farm work with other jobs, and this rate is higher than the national average (43.2%) for multiple employment [20].

The 1-year prevalence of LBP among farmers has been reported to vary from 26.9% to 63.9% [6,11,22]. Since Jeju Island's demography and agricultural environment are markedly different from those of other regions, differences in the prevalence of back pain and its risk factors are expected among farmers. This study aimed to investigate the prevalence of LBP in Jeju farmers and to analyze the risk factors associated with it.

2. Materials and methods

2.1. Study design and data source

We performed a cross-sectional analysis from survey data from the Safety for Agricultural Injury of Farmers (SAIF) cohort study among Jeju Island farmers.

SAIF is a community-based cohort study on occupational and environmental exposures affecting agricultural injuries of farmers in Jeju. A two-stage sampling process was used to select the SAIF cohort participants by selecting primary regional clusters from major agricultural administrative districts of Jeju and selecting sampling populations from a list of all farmers dwelling in the sampled cluster frame. The final SAIF cohort recruited 1,239 adult farmers dwelling in 20 sampled rural villages, who each completed a baseline interview between 2015 and 2019. An interviewer-administered survey was administered using a semi-structured questionnaire by trained personnel of the Center for Farmers' Safety and Health at Jeju National University Hospital.

This retrospective study was approved by the Jeju National University Hospital Institutional Review Board (IRB No. 2020-05-002). Written informed consent was obtained from each farmer prior to enrollment with the SAIF cohort.

2.2. Study participants

All 1,239 farmers of the final SAIF recruitment who were engaged in agricultural work at the time of the baseline survey, including men and women and who were 18 years old or older, were considered eligible for study participation.

A total of 30 participants (1 person with undetermined age, 15 with an undetermined or minor type of farm, 17 with total experience in farming $<$ 1 year) were excluded from the analysis, leaving 1,209 participants (Fig. 1).

2.3. Dependent variable

Our dependent variable was self-reported non-traumatic musculoskeletal pain in the low back area over the past 12 months before the baseline survey. It was assessed using the standard questionnaire for musculoskeletal disorders developed by the Korea Occupational Safety and Health Agency (KOSHA) [23].

Study participants reported the presence of LBP (no/yes), LBP frequency at least once a month (no/yes), LBP pain duration more than one week (no/yes), numeric rating pain severity (0 to 10), self-assessed agricultural work relevance (no/yes) and seeking medical services due to LBP (no/yes) during the past 12 months.

The definition of LBP was satisfied by any of the two following criteria during the past 12 months: (1) the musculoskeletal pain in the low back lasting more than a week or (2) the musculoskeletal pain in the low back occurring at least once a month.

3. Independent variables

3.1. Sociodemographic characteristics

The sociodemographic variables in our analysis included age (years), sex (male/female), marital status (single/married), smoking status (non-smoker, ex-smoker, current), alcohol consumption (no/yes), CAGE scores (0-1, $\geq$2 points), average sleep duration (hours), self-assessed average daily stress level (rarely, occasional, frequent, almost). Variables also included sadness or despair for more than two weeks (no/yes).

3.2. Agricultural work-related conditions

Types of farming work (field, orchard, livestock), the total number of years of farming (1 to 15, 16 to 30, 31 to 45, $\geq$46 years), average months of farming per year, average hours per day of farming, days off work per month (0 to 8, $\geq$9 days), possession of agricultural machines (no/yes), possession of vinyl greenhouse (no/yes), and any agricultural injury within a past year (no/yes) were used as variables of agricultural work-related conditions.

The type of farming included only three categories, excluding rice farming: dry field farming, orchard farming, and livestock

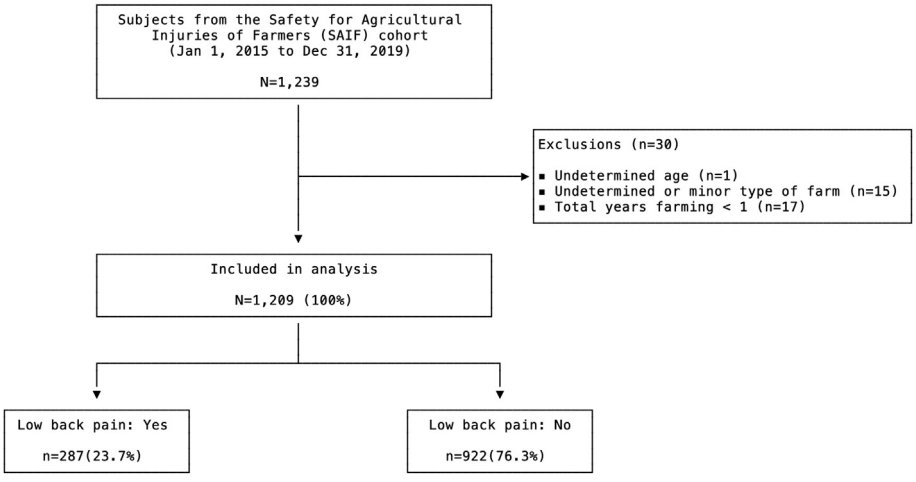

Fig. 1. Flow chart of the study.

Table 1
Distribution of association among sociodemographic characteristics of farmers by LBP

Characteristics	LBP		*p*-value	Unadjusted OR	95% CI
	No ($n = 922$)	Yes ($n = 287$)			
Age in years*	61 (52, 70)	65 (56, 74)	<0.001†		
<50	173 (82.4%)	37 (17.6%)	<0.001‡	1	
50–59	248 (82.9%)	51 (17.1%)		0.962	0.604–1.532
60–69	257 (75.8%)	82 (24.2%)		1.492	0.967–2.301
≥70	244 (67.6%)	117 (32.4%)		2.242	1.476–3.405
Sex			<0.001‡		
Male	646 (79.8%)	164 (20.3%)		1	
Female	276 (69.2%)	123 (30.8%)		1.755	1.336–2.306
Marital status			0.552‡		
Single	14 (82.4%)	3 (17.7%)		1	
Married	908 (76.2%)	284 (23.8%)		1.460	0.416–5.115
Smoking			<0.001‡		
Non-smoker	448 (71.2%)	181 (28.8%)		1	
Ex-smoker	254 (81.7%)	57 (18.3%)		0.555	0.397–0.777
Current	220 (81.8%)	49 (18.2%)		0.551	0.387–0.786
Alcohol drink			0.065‡		
No	229 (72.5%)	87 (27.5%)		1	
Yes	693 (77.6%)	200 (22.4%)		0.760	0.567–1.018
CAGE scores			0.385‡		
0–1 point	815 (75.9%)	259 (24.1%)		1	
≥2 points	107 (79.3%)	28 (20.7%)		0.823	0.531–1.277
Sleep duration* (hours)	7 (6, 8)	6 (5, 7)	0.031†		
Stress level			<0.001‡		
Rarely	336 (83.2%)	68 (16.8%)		1	
Occasional	427 (77.1%)	127 (22.9%)		1.470	1.059–2.039
Frequent	134 (67.0%)	66 (33.0%)		2.434	1.642–3.607
Almost	25 (49.0%)	26 (51.0%)		5.139	2.799–9.436
Sadness or despair (≥2 weeks)			<0.001‡		
No	851 (78.2%)	238 (21.9%)		1	
Yes	71 (59.2%)	49 (40.8%)		2.468	1.669–3.650

LBP, low back pain; OR, odds ratio; CI, confidence interval; CAGE, cut-annoyed-guilty-eye questionnaire.
* Descriptive statistics were presented as medians (25percentile, 75percentile) for continuous variables.
† Wilcoxon rank-sum test.
‡ Chi-square test‡

farming; the proportion of rice farming in our population was small (n = 18) considering the environment of Jeju Island.

3.3. Agricultural work-related biomechanical factors

The biomechanical factors related to agricultural work were investigated using the questionnaire developed by the Korean Rural Development Administration [24]. The questionnaire, composed of 11 items about agricultural work-related biomechanical factors, asked participants about the frequency of the following per day using a 5-point Likert scale corresponding to rarely, sometimes, usually, often, and always:

1. Lifting heavy objects (>10 kg) or pushing and pulling heavy objects (>30 kg)
2. Shoveling, pickaxing, and hammering
3. Using vibrating agricultural machinery such as cultivators, tractors, rotaries, and mowers
4. Repetitive use of particular body parts, such as hand, wrist, elbows, and shoulders
5. Stretching or twisting the forearm
6. Constant elevation of the arm above the head
7. Bending, twisting, or reclining your back more than 30 degrees
8. Neck flexion or neck twisting more than 20 degrees
9. Kneeling and squatting on the ground (e.g., streaming)
10. Using hands or knees to apply impact like a hammer
11. Uncomfortable posture on the ramp

3.4. Statistical analysis

Descriptive statistics, including the prevalence of LBP, were presented as frequencies, and categorical variables were presented as percentages. Continuous variables were presented as means, standard deviations (SD), medians, and interquartile ranges (IQR) depending on the distribution.

We compared baseline sociodemographic characteristics and agricultural work-related conditions between the farmers with or without LBP using Student's t-test, Wilcoxon's rank-sum test, chi-square test, or Fisher's exact test as appropriate.

We also calculated the unadjusted odds ratio (uOR) for the association between LBP and each categorical variable in sociodemographic characteristics and agricultural work-related conditions.

We used univariate analysis for LBP, followed by multivariate logistic regression analysis to identify significant sociodemographic and agricultural work-related factors. The multivariate logistic model was built using stepwise selection, only including sociodemographic and agricultural work-related variables at $p < 0.05$.

Table 2
Distribution of association among agricultural work-related conditions of farmers by LBP

Characteristics	LBP		p-value	Unadjusted OR	95% CI
	No ($n = 922$)	Yes ($n = 287$)			
Type of farming			0.003*		
Field	322 (70.9%)	132 (29.1%)		1	
Orchard	539 (79.3%)	141 (20.7%)		0.638	0.485–0.840
Livestock	61 (81.3%)	14 (18.7%)		0.560	0.303–1.036
Total number of years of farming§	30 (16, 44)	39 (23, 49)	<0.001†		
1–15	226 (82.8%)	47 (17.2%)	0.001‡	1	
16–30	238 (78.6%)	65 (21.5%)		1.313	0.865–1.993
31–45	250 (75.1%)	83 (24.9%)		1.596	1.070–2.383
≥46	208 (69.3%)	92 (30.7%)		2.127	1.428–3.169
Average months of farming per year§	12 (9, 12)	12 (9, 12)	0.810†		
Average hours per day of farming (usual season)§	6 (4, 8)	6 (4, 8)	0.962†		
Average hours per day of farming (busy season)§	10 (8, 11)	10 (8, 12)	0.838†		
Day off work per month			0.848‡		
≤8 days	609 (76.2%)	190 (23.8%)		1	
≥9 days	313 (76.7%)	95 (23.3%)		0.973	0.734–1.289
Agricultural machine			0.024‡		
No	118 (69.4%)	52 (30.6%)		1	
Yes	803 (77.4%)	235 (22.6%)		0.664	0.465–0.949
Vinyl greenhouse			0.236‡		
No	496 (74.9%)	166 (25.1%)		1	
Yes	425 (77.8%)	121 (22.2%)		0.851	0.651–1.112
Agricultural injury within a year			0.007‡		
No	861 (77.2%)	254 (22.8%)		1	
Yes	61 (64.9%)	33 (35.1%)		1.834	1.174–2.865

LBP, low back pain; OR, odds ratio; CI, confidence interval.
* Fisher's exact test.
† Wilcoxon rank-sum test.
‡ Chi-square test.
§ Descriptive statistics were presented as medians (25th percentile, 75th percentile) for continuous variables.

Another multivariate logistic model for LBP was built to compute the adjusted odds ratio (aOR) of each 5-point Likert scale of agricultural work-related biomechanical factors after adjusting for a set of significant sociodemographic and agricultural work-related covariates (total years of farming, sex, stress level, type of farming, agricultural injury within a year). We also tested the overall null hypothesis that the association for LBP is equal among each multidegree of biomechanical factor group after adjusting for a set of significant sociodemographic and agricultural work-related covariates, using the Wald chi-square test. We conducted additional comparisons between each group (sometimes, usually, often, and always) against a reference group (rarely) if the biomechanical factor's overall null hypothesis was rejected. We calculated the margins, which are statistics calculated from predictions of a previously fit model after adjusting for covariates (total years of farming, sex, stress level, type of farming, agricultural injury within a year). The adjusted marginal differences for each group versus the reference group were plotted with 95% confidence intervals for each difference.

All statistical analyses were performed using Stata 14.0 (StataCorp, College Station, TX), utilizing a two-tailed test with a statistical significance level below 0.05.

4. Results

4.1. Distribution of association among sociodemographic characteristics of farmers by LBP (Table 1)

Among the 1,209 respondents who participated in the SAIF cohort from 2015 to 2019, the overall prevalence of LBP was 23.7% (N = 287). Farmers with LBP were older than farmers without LBP (median age 61 vs. 65; $p < 0.001$). The LBP prevalence trend tended to increase with age: 17.6% in those <50 years old, 17.1% among the 50s, 24.2% among the 60s, and 32.4% in those >70 years (p *for trend* < 0.001). LBP was more likely to occur in women than in men (30.8% vs. 20.3%).

The farmers with LBP's sleep duration were significantly shorter than those without LBP (median 6 hours vs. 7 hours; $P = 0.031$). As the stress level in daily life increased, the LBP prevalence also increased [rarely (16.8%), occasional (22.9%), frequent (33.0%), almost (51%)]. The LBP prevalence was higher among farmers who experienced sadness or despair for more than two weeks (40.8% vs. 21.9%; $p < 0.001$).

The uORs between LBP and each sociodemographic categorical variable yielded significance for age group, sex, smoking status, stress level, and sadness or despair for more than two weeks.

4.2. Distribution of association among agricultural work-related conditions of farmers by LBP (Table 2)

The prevalence of LBP was significantly different with the type of farming. Its prevalence, in descending order, is field, orchard, and livestock farming. The total number of years of farming was significantly longer in farmers with LBP than without LBP (median 30 vs. 39; $p < 0.001$), and the trend of LBP prevalence tended to increase with the duration of farming career (P for trend < 0.001). There was no significant difference based on the average number of farming months per year ($p = 0.810$), the average number of farming hours per day ($p = 0.962$), and the number of days off per month ($p = 0.838$).

The LBP prevalence was significantly lower in farmers owning agricultural machinery than those who do not (22.6% vs. 30.6; $p = 0.024$). The difference was not significant based on whether the

Table 3
Association with sociodemographic and agricultural work-related factors with LBP from multivariate logistic regression

	Adjusted OR*	95% CI
Sex		
Male	1	
Female	1.146	0.804–1.634
Smoking		
Non-smoker	1	
Ex-smoker	0.634	0.424–0.946
Current	0.659	0.433–1.003
Alcohol drink		
No	1	
Yes	1.253	0.882–1.780
Sleep duration (hours)	0.955	0.872–1.046
Stress level		
Rarely	1	
Occasional	1.455	1.038–2.040
Frequent	2.118	1.376–3.261
Almost	3.289	1.683–6.430
Sadness or despair (≥2 weeks)		
No	1	
Yes	1.423	0.906–2.235
Type of farming		
Field	1	
Orchard	0.668	0.502–0.890
Livestock	0.568	0.294–1.098
Total number of years of farming		
1–15	1	
16–30	1.316	0.856–2.025
31–45	1.592	1.042–2.430
≥46	1.934	1.246–3.000
Agricultural machine		
No	1	
Yes	0.871	0.576–1.315
Agricultural injury within a year		
No	1	
Yes	1.861	1.160–2.988

LBP, low back pain; OR, odds ratio.
* Adjusted for the total number of years of farming, type of farming, sex, smoking, stress level, agricultural machine, and agricultural injury within a year.

farmer owns a vinyl greenhouse (22.2% vs. 25.1%; $p = 0.236$). LBP was significantly more prevalent among farmers who sustained occupational injuries within the last year than those who did not (35.1% vs. 22.8; $p = 0.007$).

The uORs between LBP and each categorical variable for agricultural work-related conditions indicated that the type of farming, the total duration of the farming career, the possession of agricultural machinery, and a recent prior history of agricultural injury, within a year, were significant.

4.3. Association with sociodemographic and agricultural work-related factors with LBP from multivariate logistic regression analysis (Table 3)

Our multivariate logistic analysis revealed that LBP prevalence was significantly higher with increasing stress levels in daily life (occasional: aOR, 1.455; 95% CI, 1.038 to 2.040; frequent: aOR, 2.118; 95% CI, 1.376 to 3.261; almost: aOR, 3.289, 95% CI; 1.683 to 6.430). The same holds true for increasing total duration of farming career (31 to 45: aOR, 1.592; 95% CI, 1.042 to 2.430; ≥46: aOR, 1.934; 95% CI, 1.246 to 3.000), and whether the worker had recent prior occupational injury (aOR, 1.861; 95% CI, 1.160 to 2.988).

4.4. Agricultural work-related biomechanical factors with LBP from multivariate logistic regression analysis (Table 4)

Table 4 shows the aORs and *p*-values for the overall null hypothesis test (Wald chi-square test) for LBP against each of the Likert scales for agricultural work-related biomechanical factors, adjusting for a set of significant sociodemographic and agricultural work-related covariates (total years of farming, sex, stress level, type of farming, agricultural injury within a year).

The results of the multivariate analysis indicated that three agricultural work-related biomechanical factors were significantly associated with LBP: 1) repetitive use of body parts, such as hands, wrists, elbows, and shoulders ($p = 0.002$), 2) bending, twisting, or reclining the lower back by more than 30 degrees ($p = 0.003$) and 3) neck flexion or neck rotation by more than 20 degrees ($p = 0.049$).

Fig. 2 illustrates an overview of the adjusted marginal differences for each group versus the reference group (rarely) with 95% confidence intervals for each difference.

The contrasts of adjusted marginal prediction for the always group versus the rare group in (1) "repetitive use of particular body parts, such as hand, wrist, elbow, and shoulder" and (2) "bending, twisting, or reclining the lower back by more than 30 degrees" is 0.076 (95% CI; 0.003 to 0.149, $p = 0.001$) and 0.078 (95% CI; 0.005 to 0.151, $p = 0.037$), respectively. The 95% confidence excludes zero, indicating that this difference from the reference group (rarely) is significant at the 5% level (Fig. 2) (Supplementary Table A).

5. Discussion

This cross-sectional study was conducted to identify the overall prevalence of LBP and the sociodemographic and occupational risk factors using the SAIF cohort data.

Table 4
Adjusted OR* for LBP using the 5-point Likert scale of agricultural work-related biomechanical factors in multivariate logistic regression analysis

		Rarely (0–24%)	Sometimes (25–49%)	Usually (50%)	Often (51–74%)	Always (75–100%)	*p*-value†
1	Lifting or pushing and pulling heavy objects	1	0.963 (0.647–1.433)	1.243 (0.803–1.925)	1.259 (0.831–1.907)	1.288 (0.846–1.960)	0.509
2	Shoveling, pickaxing, and hammering	1	1.045 (0.733–1.489)	0.670 (0.377–1.188)	1.174 (0.700–2.970)	1.422 (0.837–2.417)	0.363
3	Using vibrating agricultural machinery	1	0.800 (0.530–1.207)	1.114 (0.707–1.755)	0.949 (0.589–1.528)	1.130 (0.712–1.793)	0.692
4	Repetitive use of particular body parts	1	0.650 (0.388–1.087)	0.840 (0.523–1.351)	1.400 (0.932–2.104)	1.515 (1.012–2.267)	0.002
5	Stretching or twisting the forearm	1	0.899 (0568–1.425)	1.345 (0.890–2.035)	1.066 (0.696–1.632)	1.667 (1.112–2.498)	0.053
6	Constant elevation of the arm above the head	1	0.877 (0.566–1.361)	1.400 (0.914–2.144)	1.297 (0.841–1.999)	1.337 (0.891–2.007)	0.214
7	Bending, twisting, or reclining your back	1	0.607 (0.366–1.007)	1.246 (0.798–1.945)	1.103 (0.713–1.707)	1.527 (1.020–2.288)	0.003
8	Neck flexion or neck twisting	1	0.669 (0.417–1.073)	1.075 (0.704–1.641)	1.199 (0.789–1.823)	1.374 (0.931–2.028)	0.049
9	Kneeling and squatting on the ground	1	1.175 (0.771–1.791)	1.312 (0.850–2.026)	1.048 (0.676–1.625)	1.551 (1.045–2.300)	0.218
10	Using hands or knees to apply impact like a hammer	1	0.830 (0.563–1.223)	1.306 (0.819–2.083)	0.825 (0.439–1.551)	0.699 (0.340–1.436)	0.432
11	Uncomfortable posture on the ramp	1	0.762 (0.506–1.148)	1.099 (0.726–1.663)	1.028 (0.618–1.709)	0.955 (0.542–1.684)	0.693

OR, odds ratio; LBP; low back pain.
* Multivariate logistic model was used to compute the adjusted odds ratio of each 5-point Likert level of agricultural work-related biomechanical factors after adjusting for a set of covariates (total years of farming, gender, stress level, type of farming, agricultural injury within a year).
† Wald chi-square test.

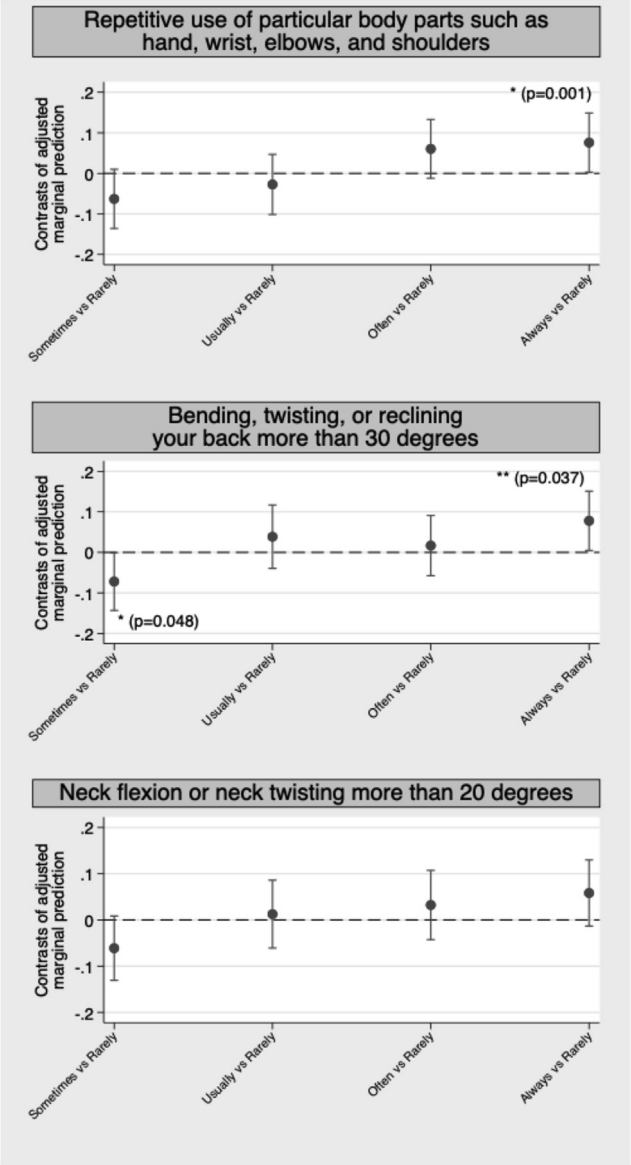

Fig. 2. Adjusted marginal prediction for each group versus the reference group in biomechanical factors.

First, the prevalence of LBP in Jeju Island was 23.7%, which was relatively lower than other regions of Korea [6,11,25].

Due to the subtropical climate of Jeju Island, orchard farming and field crop farming are at almost equal proportions; most of the fruit farming consists of citrus farming [18,21]. Due to the volcanic topography [22], Jeju farmers cultivate specialty wintering crops rather than rice which grows on land [18,20,21]. Among biomechanical factors associated with farming, the most associated risk factors were the excessive movement of the low back or the neck, which are common in rice farming [1]. In citrus farming, the constant elevation of the hands over the shoulders for thinning out the fruits is the action sustained over time. The prevalence of LBP may be lower due to these factors. Studies conducted so far have yielded conflicting findings on the association between type of farming and LBP [2,11,22,25]. In 2009, Kim et al. compared the rate of musculoskeletal pain between apple, pear, peach, grape, and citrus farming. Among them, the prevalence of LBP in citrus farming was 47.2%, which was the lowest among fruit crops, especially when compared to the average prevalence of LBP of 58% in orchard farming. This may be due to relatively fewer working hours compared to other types of fruit farming [22]. More certain associations can be identified by examining farmers engaged in citrus farming in the future.

In addition, since farming in Jeju Island is performed on small and medium-sized farms, there are not many farmers who require repeated tractor use with exposure to strong vibrations. Tractors are a known risk factor for LBP, and this probably lowered the prevalence of back pain [12,18,20,21].

Compared with previous domestic studies, where the average age of the study participants was mostly between 55 and 57 years old, the average age of the SAIF cohort participants in the current study was 62 [6,25]. In general, LBP increases with age [15,16]. Although Jeju Island's agricultural conditions can minimize the prevalence of back pain, it is worth noting that the average age in Jeju Island is higher than in previous reports. Other factors such as climate and dietary habits may also have an effect on LBP; further research is needed to clarify this.

Second, we identified the individual sociodemographic and occupational conditions associated with LBP. In our multivariate analysis, the type of farming, duration of the career in farming, recent prior occupational injury within a year, and stress levels were significantly associated with LBP prevalence. As the farming career increases in duration, movements affecting muscles or ligaments are repeatedly performed, accumulating over time; this leads to LBP [15]. In addition, a high risk of back pain exists if there was a recent prior occupational injury within one year. Due to the small and medium-scale nature of agriculture, it is difficult for others to replace workers in case of any injuries [21]. Consequently, even if farmers suffer agricultural injuries, they return to work before full recovery. This potentially leads to working with less appropriate posture. This can lead to a cycle that exacerbates damage [26]. Among individual factors, the highest risk factor for LBP was the high stress level. Farmers are known to experience high levels of stress, depression, and anxiety, as well as a high risk of suicide due to rapidly changing crop prices, economic problems, and interrelationships among workers [27–30]. Therefore, to lower the risk of LBP among farmers, psychological support remains paramount.

Third, this study identified the effect of occupational biomechanical factors on LBP, even after adjusting for individual and occupational factors. Biomechanical factors associated with LBP were repetitive use of a body part: bending, twisting, or reclining the back and neck flexion or neck twisting. This is consistent with previous findings, which found that workers who mainly bent forward or sideways reported LBP due to unstable posture and excessive workload [11,31,32]. Another risk factor, neck flexion or twisting, occurs almost simultaneously with the motion or flexion of the lower back because tasks that cause the motion of the lower back or neck are often performed simultaneously in framing work [1]. Repetitive flexural movements of the spine cause excessive tension and damage to the intervertebral disc or ligament, which in turn cause musculoskeletal pain [33]. For preventing LBP, it is important to educate farmers on safe posture or pre-work exercise to prevent occupational injury.

This study has limitations. First, this cross-sectional study used cohort data surveys; we could not identify the sequential or causal relationship between LBP and farmers' biomechanical factors and individual factors. Second, because LBP was defined as self-reported, non-traumatic musculoskeletal pain, it was difficult to identify risk factors by their difference in pathological mechanisms. Third, detailed characteristics that cause stress or despair in farmers were not investigated using factor analysis. Therefore, studies including the pathophysiology of LBP and the detailed characteristics of related factors are required in the future.

LBP affects nearly a quarter of Jeju farmers. Biomechanical, occupational, and clinical risk factors promote LBP. Posture education, injury prevention, and psychological support are to play important roles in preventing LBP.

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Ethical considerations and disclosures

This study was approved by the Jeju National University Hospital Institutional Review Board (IRB No. 2020-05-002). Written informed consent was obtained from each farmer when entering the SAIF cohort.

Conflicts of interest

None declared.

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Appendix

Table A.
Contrasts of adjusted marginal predictions for LBP of three agricultural work-related biomechanical factors

	Sometimes (25–49%) vs. rarely (0–24%)	Usually (50%) vs. rarely (0–24%)	Often (51–74%) vs. rarely (0–24%)	Always (75–100%) vs. rarely (0–24%)
4 Repetitive use of particular body parts, such as hand, wrist, elbows, and shoulders	−0.063 −0.136 to 0.010 ($p = 0.091$)	−0.027 −0.101 to 0.047 ($p = 0.470$)	0.060 −0.012 to 0.133 ($p = 0.103$)	0.076 0.003 to 0.149 ($p = 0.001$)
7 Bending, twisting, or reclining your back by more than 30 degrees	−0.072 −0.143 to −0.001 ($p = 0.048$)	0.039 −0.040 to 0.117 ($p = 0.334$)	0.017 −0.058 to 0.091 ($p = 0.659$)	0.078 0.005 to 0.151 ($p = 0.037$)
8 Neck flexion or neck twisting more than 20 degrees	−0.061 −0.131 to 0.009 ($p = 0.086$)	0.013 −0.061 to 0.086 ($p = 0.739$)	0.032 −0.043 to 0.107 ($p = 0.399$)	0.058 −0.013 to 0.130 ($p = 0.111$)

The cell of table expressed as contrasts of adjusted marginal predictions with 95% confidence interval and p-value.
Contrasts of adjusted marinal predictions were calculated after adjusting for a set of covariates (total years of farming, sex, stress level, type of farming, and agricultural injury within a year).
LBP, low back pain.

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