Original Article

Relationship Between Sleep Duration and Suicidal Ideation Among Farmers: Safety for Agricultural Injuries of Farmers Cohort Study of Jeju, Korea

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ABSTRACT

Background: This study was conducted to identify the association between sleep duration and suicidal ideation among farmers in Korea.
Methods: We used Safety for Agricultural Injuries of Farmers cohort data collected from September 2015 to June 2018, which was an agricultural survey on the health and behaviors of adult farmers in Jeju island, Korea.
Results: A total of 964 participants were included in the analysis, and 3.7% of them were identified with having suicidal ideation. The frequencies of average daily sleep duration of <6 h (short sleep), 6—8 h (normal sleep), and >8 h (long sleep) were 24.4%, 70%, and 5.6%, respectively. Multivariate analyses revealed that short sleep duration was significantly associated with suicidal ideation compared with normal sleep duration (odds ratio = 2.49, 95% confidence interval = 1.07—5.77).
Conclusion: Our findings suggest that short sleep duration in farmers result in higher suicidal ideation. Because individuals who have suicidal ideation often commit suicide, careful monitoring is required to prevent suicide in farmers with short sleep duration.

1. Introduction

Globally, agriculture uses a large number of workers, accounting for more than 27% (approximately 210 million) of the world's workforce [1]. In Korea, agriculture is the oldest industry, but its structure and population distribution has changed a lot since the arrival of other industries. However, primary industries such as agriculture still remain as the main industries in many areas, with about 2.2 million farmers are engaged in agriculture [2].

Suicide is one of the most violent causes of death in modern society, and preventing it has become an important issue for public health. Worldwide, 800,000 people die each year from suicide, and the World Health Organization has a plan to reduce suicide by 10%

by 2020 [3]. The suicide rate was 24.6 per 100,000 people in Korea as of 2017, the highest among Organization for Economic Cooperation and Development countries. Therefore, there is a great social interest in suicide [4].

Several studies worldwide have reported that suicide occurs more frequently in farmers than in the general working population [5—9]. Korean studies have also shown that the suicide rate is higher for people engaged in agriculture than those in other occupations, and those in rural areas are higher than those in urban areas [10,11].

Suicide often occurs with several suicide attempts, with individuals having suicidal ideations attempting suicide attempts more often than those who have not [12]. Therefore, identifying

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and correcting the factors associated with suicidal ideation can contribute to the prevention of suicide.

Farmers can easily be exposed to physical and mental health problems because they work hard under challenging conditions [13]. Mental health disorders have been identified as one of the main causes of suicide attempts in farmers [14]. It has been shown that adequate sleep duration promotes the recovery of damaged bodies during the day, and it is important for regulating the physical and mental functions, as well as maintaining personal health [15]. Therefore, ensuring adequate sleep duration for farmers is of great importance.

In the past, there were studies that identified the relationship between suicidal ideation and sleep duration in general adults population or adolescents [15–22], but no studies have confirmed this in farmers. We cross-sectionally conducted this study to investigate the relationship between sleep duration and suicidal ideation based on the collected data of a prospective farmers' cohort of Jeju Island, Korea.

2. Materials and methods

2.1. Participants

This study used participants registered in the Safety for Agricultural Injuries of Farmers (SAIFs) cohort of Jeju National University Hospital's Agricultural Safety and Health Center, which was performed from 2015–2018. The number of farming households in Jeju is 38,444 (2014), with 109,510 individuals in the farming population (18.1% of total population of Jeju island) [23]. This SAIF cohort study was designed to identify the time course of a risk factor of agricultural injuries, not a precise estimate of incidence. The sample size of SAIF cohort was 1,200 (90% power) or 900 (80% power) to detect a minimal effect (8% difference in an agricultural injury). Therefore, the study population was selected only 0.8% of the farming population, in accordance with farming type and distance from accessible medical facilities. Participating farmers should also not have acquired any acute injury associated with their work within two weeks of the survey.

Those who agreed to participate in the research conducted face-to-face interview using a questionnaire by well-educated researchers. Blood tests (total bilirubin, alkaline phosphatase, aspartate transaminase, alanine transaminase, blood urea nitrogen, creatinine, prothrombin time, activated partial thromboplastin time, total cholesterol, high-density lipoproteins cholesterol, low-density lipoprotein cholesterol, fasting plasma glucose) and physical measurements (weight, height, blood pressure, electrocardiogram, chest X-ray, dual-energy X-ray absorptiometry) were also conducted in them. The aforementioned examinations were performed once every quarter to minimize omission of participation in the survey owing to agricultural activities or personal circumstances. The survey items were determined after detailed discussions and consultation meetings by the researchers and related experts. A standard questionnaire sheet for the survey using the selected items was then developed for the study. The survey questionnaire was completed by 964 farmers living in 17 different residential areas.

Our study was conducted with permission from the Institutional Review Board and Ethics Committee of Jeju National University Hospital (IRB No.2020-05-032). All participants gave written informed consent.

2.2. Survey instrument

The SAIF survey consisted of general demographic characteristics, health behavior, health status, and farming information.

Table 1
Baseline characteristics in accordance with sleep duration.

| | Overall | Average sleep duration per day | | | |
| | | <6 h | 6–8 h | >8 h | |
	N = 964	N = 235	N = 675	N = 54	p
Age, year	60.4 ± 11.9	63.6 ± 11.9	58.9 ± 11.7	65.6 ± 10.6	<0.001
Sex (%)					0.020
Male	617 (64.0)	134 (57.0)	451 (66.8)	32 (59.3)	
Female	347 (36.0)	101 (43.0)	224 (33.2)	22 (40.7)	
Suicidal ideation (%)					<0.001
No	928 (96.3)	216 (91.9)	660 (97.8)	52 (96.3)	
Yes	36 (3.7)	19 (8.1)	15 (2.2)	2 (3.7)	
Education level (%)					<0.001
Elementary school or less	250 (25.9)	97 (41.3)	137 (20.3)	16 (29.6)	
Middle school	146 (15.1)	29 (12.3)	105 (15.6)	12 (22.2)	
High school	341 (35.4)	77 (32.8)	243 (36.0)	21 (38.9)	
College or more	227 (23.5)	32 (13.6)	190 (28.1)	5 (9.3)	
Yearly income level, Korean Won, million (%)					0.010
<15	189 (19.6)	60 (25.5)	114 (16.9)	15 (27.8)	
15–29	169 (17.5)	34 (14.5)	125 (18.5)	10 (18.5)	
30–59	179 (18.6)	28 (11.9)	141 (20.9)	10 (18.5)	
≥60	426 (44.2)	113 (48.1)	294 (43.6)	19 (35.2)	
Nonresponders	1 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)	
Farming types (%)					0.158
Crop cultivation	125 (13.0)	33 (14.0)	86 (12.7)	6 (11.1)	
Fruit production	415 (43.0)	82 (34.9)	308 (45.6)	25 (46.3)	
Vegetable production	329 (34.1)	98 (41.7)	215 (31.9)	16 (29.6)	
Livestock production	78 (8.1)	18 (7.7)	55 (8.1)	5 (9.3)	
Others	17 (1.8)	4 (1.7)	11 (1.6)	2 (3.7)	
Employment types (%)					0.121
Salary worker	41 (4.3)	15 (6.4)	25 (3.7)	1 (1.9)	
Self-employed	880 (91.3)	205 (87.2)	625 (92.6)	50 (92.6)	
Others	28 (2.9)	12 (5.1)	14 (2.1)	2 (3.7)	
Nonresponders	15 (1.6)	3 (1.3)	11 (1.6)	1 (1.9)	
Average working duration per day (%)					0.555
<5 h	269 (27.9)	73 (31.1)	178 (26.4)	13 (33.4)	
5–8 h	501 (52.0)	114 (48.5)	361 (53.5)	26 (48.1)	
>8 h	191 (19.8)	47 (20.0)	134 (19.9)	10 (18.5)	
Nonresponders	3 (0.3)	1 (0.4)	2 (0.2)	0 (0)	
Pesticide use (%)					0.362
No	76 (7.9)	60 (8.9)	14 (6.0)	2 (3.7)	
Yes	886 (91.9)	613 (90.8)	221 (94.0)	52 (96.3)	
Nonresponders	2 (0.2)	2 (0.2)	0 (0)	0 (0)	
Pesticide application (%)					0.375
Self	694 (78.3)	167 (75.6)	486 (79.3)	41 (78.8)	
Assistant	121 (13.7)	35 (15.8)	80 (13.1)	6 (11.5)	
Self and assistant	47 (5.3)	9 (4.1)	35 (5.7)	3 (5.8)	
Nonparticipants	20 (2.3)	8 (3.6)	10 (1.6)	2 (3.8)	
Nonresponders	4 (0.5)	2 (0.9)	2 (0.3)	0 (0)	
Past history of pesticide poisoning (%)					0.860
No	848 (95.7)	211 (95.4)	586 (95.6)	51 (98.1)	
Yes	32 (3.6)	7 (3.2)	24 (3.9)	1 (1.9)	
Nonresponders	6 (0.7)	3 (1.4)	3 (0.5)	0 (0)	

Table 1 (*continued*)

	Overall	Average sleep duration per day			
		<6 h	6−8 h	>8 h	
	N = 964	N = 235	N = 675	N = 54	p
Exercise times per week (%)					0.506
None	702 (72.8)	180 (76.6)	481 (71.3)	41 (75.9)	
1−3 times	126 (13.1)	24 (10.2)	93 (13.8)	9 (16.7)	
4−7 times	132 (13.7)	30 (12.8)	98 (14.5)	4 (7.4)	
Nonresponders	4 (0.4)	1 (0.4)	3 (0.4)	0 (0.0)	
Subjective heath status (%)					0.003
Poor	250 (25.9)	84 (35.7)	153 (22.7)	13 (24.1)	
Average	384 (39.8)	85 (36.2)	277 (41.0)	22 (40.7)	
Good	330 (34.2)	66 (28.1)	245 (36.3)	19 (35.2)	
Marital status (%)					0.916
Single	15 (1.6)	3 (1.3)	11 (1.6)	1 (1.9)	
Married	949 (98.4)	232 (98.7)	664 (98.4)	53 (98.1)	
Depression (SF-GDS ≥8) (%)					<0.001
No	832 (86.3)	187 (79.6)	600 (88.9)	45 (83.3)	
Yes	120 (12.4)	48 (20.4)	64 (9.5)	8 (14.8)	
Nonresponders	12 (1.2)	0 (0)	11 (1.6)	1 (1.9)	
Cardiovascular disease (%)					0.391
No	902 (93.6)	216 (91.9)	634 (93.9)	52 (96.3)	
Yes	62 (6.4)	19 (8.1)	41 (6.1)	2 (3.7)	
Smoking (%)					0.039
Never	486 (50.4)	135 (57.4)	323 (47.9)	28 (51.9)	
Former or current	478 (49.6)	100 (42.6)	352 (52.1)	26 (48.1)	
Alcohol intake per month (%)					<0.001
No alcohol intake	119 (12.3)	31 (13.2)	80 (11.9)	8 (14.8)	
1 time or less	158 (16.4)	33 (14.0)	118 (17.5)	7 (13.0)	
2−4 times	146 (15.1)	24 (10.2)	113 (16.7)	9 (16.7)	
5 times or more	305 (31.6)	62 (26.4)	232 (34.4)	11 (20.4)	
Non-responders	236 (24.5)	85 (36.2)	132 (19.6)	19 (35.2)	
Thyroid diseases (%)					0.847
No	914 (94.8)	224 (95.3)	638 (94.5)	52 (96.3)	
Yes	48 (5.0)	10 (4.3)	36 (5.3)	2 (3.7)	
Nonresponders	2 (0.2)	1 (0.4)	1 (0.1)	0 (0.0)	
Musculoskeletal diseases (%)					0.044
No	626 (64.9)	133 (56.6)	456 (67.6)	37 (68.5)	
Yes	334 (34.6)	101 (43.0)	216 (32.0)	17 (31.5)	
Nonresponders	4 (0.4)	1 (0.4)	3 (0.4)	0 (0.0)	
Cardiovascular risk factors (%)					0.043
No	557 (57.8)	126 (53.6)	408 (60.4)	23 (42.6)	
Yes	405 (42.0)	109 (46.4)	265 (39.3)	31 (57.4)	
Nonresponders	2 (0.2)	0 (0.0)	2 (0.3)	0 (0.0)	
Cancer (%)					0.259
No	698 (72.4)	158 (67.2)	501 (74.2)	39 (72.2)	
Yes	59 (6.1)	19 (8.1)	38 (5.6)	2 (3.7)	
Nonresponders	207 (21.5)	58 (24.7)	136 (20.1)	13 (24.1)	

Data are N (%) or mean ± standard deviation values.
SF-GDS, short form of geriatric depression scale.

General demographic characteristics included factors such as age, sex, educational level, marital status, and yearly income level. For the health behavior category, average daily sleep duration was assessed quantitatively by asking, "How many hours do you sleep a day on average for the past 1 year?". Suicidal ideation was evaluated with the question: "Did you have serious thoughts of killing yourself during the past 1 year?". Exercise times per week and smoking status were also assessed. As an alcohol screening instrument, the Korean version of the Alcohol Use Disorders Identification Test was used [24]. It consists of a total of 10 items, of which the alcohol intake frequencies (per month) were evaluated to determine the drinking status. The health status items checked through the questionnaire for cardiovascular risk factors (such as hypertension, diabetes, and dyslipidemia) with drug use for the factors, thyroid disease, cardiovascular diseases (such as stroke, angina, and myocardial infarction), cancer, musculoskeletal diseases, and subjective health status. Depression was also assessed by the Korean version of the short form of geriatric depression scale (SF-GDS). Although SF-GDS is an instrument designed to assess depression in older adults, several studies have reported that it is also valuable for diagnosing depression in younger and middle-aged adults [25−27]. In accordance with the results of the validation study on the Korean version of SF-GDS, depression was defined as a score of 8 or higher for the instrument [28].

Farming types, employment types, average working duration per day, and factors related to pesticide exposure (such as pesticide use, application methods, poisoning history) were also evaluated as items related to agriculture information.

2.3. Statistical analysis

The frequency, percentage, and mean (±standard deviation) were used in accordance with the variable characteristics of the survey data. Average daily sleep duration was classified into three groups: (1) short (<6 h), (2) reference/normal (6−8 h), and (3) long (>8 h). Continuous variables were analyzed for one-way analysis of variance among these groups, and categorical variables were subjected to the chi-square test or Fisher's exact test. Univariate and multivariate analyses were performed through logistic regression analysis to confirm the relationship between suicidal ideation and various variables including average daily sleep duration. For multivariate analysis, three models were constructed using variables with P < 0.2 in the univariate analysis. The analysis used the SPSS 18.0 (IBM Corp., Armonk, NY, USA) program, and it was determined that there was a significant statistical difference when p < 0.05.

3. Results

3.1. General characteristics of participants in accordance with average daily sleep duration

The baseline characteristics of 964 participants selected for the study are presented in Table 1. The average daily sleep time was 6.5 ± 1.5 h (1−14 h), their mean age was 60.4 ± 1.9 years (27−84 years), and there were significant differences between the three groups when they were classified in accordance with the average daily sleep duration. There were more male participants than female participants, and the difference in sex ratio showed statistically significant results between the three groups. A total of 36 participants (3.7%) answered that they had suicidal ideation, with significant differences between the three groups (p < 0.001). Education level, yearly income level, subjective health status, smoking, frequency of alcohol intake per month, depression, musculoskeletal disease, and cardiovascular risk factors showed significant differences between the three groups. However, other variables were not statistically different between the three groups.

Table 2
Multivariable analyses for association between suicidal ideation and sleep duration

	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Average sleep duration per day			
<6 h	2.93 (1.40 −6.12)†	5.41 (1.05 −5.41)*	2.49 (1.07 −5.77)*
6−8 h	Reference	Reference	Reference
>8 h	1.42 (0.30 −6.72)	6.83 (0.26 −6.83)	0.80 (0.14 −4.71)
Sex	1.70 (0.79 −3.68)	1.33 (0.57 −3.08)	3.28 (0.85 −12.68)
Age	1.00 (0.96 −1.05)	0.99 (0.95 −1.04)	1.00 (0.95 −1.05)
Education level			
Elementary school or less	Reference	Reference	Reference
Middle school	0.37 (0.10 −1.37)	0.35 (0.08 −1.46)	0.37 (0.08 −1.67)
High school	0.46 (0.16 −1.34)	0.67 (0.20 −2.23)	0.75 (0.20 −2.79)
College or more	0.47 (0.11 −1.97)	0.90 (0.17 −4.70)	0.91 (0.16 −5.17)
Yearly income level, Korean Won			
<15	Reference	Reference	Reference
15−29	0.64 (0.19 −2.16)	0.70 (0.19 −2.54)	0.81 (0.21 −3.06)
30−59	0.55 (0.14 −2.10)	0.67 (0.16 −2.79)	0.63 (0.14 −2.79)
≥60	0.95 (0.42 −2.14)	1.05 (0.43 −2.56)	0.98 (0.39 −2.49)
Marital status	0.11 (0.03 −0.49)†	0.08 (0.02 −0.39)†	0.07 (0.02 −0.31)†
Depression (SF-GDS≥8)		17.72 (7.68 −40.87)‡	15.64 (6.24 −39.24)‡
Farming types			
Crop cultivation			Reference
Fruit production			1.43 (0.41 −5.04)
Vegetable production			0.57 (0.16 −2.06)
Livestock production			1.81 (0.27 −12.02)
Others			3.98 (0.65 −24.44)
Subjective heath status			
Poor			Reference
Average			0.89 (0.35 −2.24)
Good			0.77 (0.24 −2.49)
Smoking			2.73 (0.69 −10.78)
Musculoskeletal diseases			1.43 (0.62 −3.29)
Cardiovascular risk factors			1.34 (0.59 −3.04)

OR, odds ratio; CI, confidence interval; SF-GDS, short form of geriatric depression scale.
* p < 0.05.
† p < 0.01.
‡ p < 0.001.

3.2. Association between suicidal ideation and sleep duration

The univariate analysis showed that short sleep duration (<6 h) had a statistically significant association with suicidal ideation compared with normal sleep duration (6−8 h) [odds ratio (OR) = 3.87, 95% confidence interval (CI) = 1.93−7.74] (Supplementary Table 1). However, no relationship was shown between suicidal ideation and the long sleep duration (>8 h)

(OR = 1.69, 95% CI = 0.38−7.60). In addition, age, sex, education level, yearly income level, agriculture types, subjective health conditions, marital status, depression, smoking, musculoskeletal diseases, and cardiovascular risk factors were also associated with suicidal ideation (Supplementary Table 1).

In multivariate analysis adjusted for general characteristics (sex, age, education level, marital status, and yearly income level) (Model 1), short sleep duration had a statistical association with suicidal ideation (OR = 2.93, 95% CI = 1.40−6.12) compared with normal sleep duration but not with long sleep duration (OR = 1.42, 95% CI = 0.30−6.72). Model 2, using variables that add depression to the variables in Model 1 and Model 3, adjusted for all potential confounding variables with P < 0.2 in the univariate analysis also showed that short sleep duration has increased the risk of suicidal ideation more significantly than normal sleep duration (Model 2: OR = 5.41, 95% CI = 1.05−5.41; Model 3: OR = 2.49, 95% CI = 1.07− 5.77) (Table 2).

4. Discussion

This cross-sectional study is nested in a prospective cohort of farmers. It has identified the relationship between short sleep duration and suicidal ideation, which can be considered that enough sleep duration helps maintain mental and occupational health. When the sleep duration was less than 6 hours a day, it was found that suicidal ideation was 2.49 times more frequent among farmers. In accordance with the 2016 Center for Disease Control and Injury Prevention report, suicide rates people engaged in agriculture, forestry, and fishing (84% of those study participants consisted of farmers) were 44.9 per 100,000 in 2012 and 32.2 per 100,000 people in 2015, more than twice that of the general occupation group [8,9]. A recent analysis of Koreans' suicide rates over the past 20 years from 1999 to 2018 based on Korean National Statistical Office data indicates that suicide rates in rural areas were consistently higher than those in urban areas [10,11]. In accordance with previous studies, more than half of those who had suicidal ideation are reported to be planning or attempting suicide within a year [29−31]. Therefore, assessing suicidal ideation to prevent suicide can be more important for farmers, and enough sleep duration for those with short sleep can help prevent suicide.

The prevalence of suicidal ideation in the previous Korean studies of the general population widely ranged from 2.1 to 19.6% [15,17,32], which is no significant difference from the rate of 3.7% (2.4% for men and 6.1% for women) among farmers in this study. Previous studies which were conducted for farmers also provided wide ranges of the prevalence. A study of Rural Iowa participants showed the rates of suicidal ideation in men and women were 7.6% and 6.7%, respectively [33], and based on National Surveys on Drug Use and Health from 2008 to 2013, the prevalence of that among people engaged in agriculture, forestry and fishing was 1.3% [8,9]. Two Korean studies of farmers showed that suicidal ideation rates were 4.7−17% for men and 16.5% for women [34,35].

As mentioned earlier, studies have shown that sleep duration and suicidal ideation are related among general adult population [15−22], and most studies have shown that especially short sleep duration increased the suicidal ideation, which was similar to the authors' results. National data for adults in the United States showed that short sleep duration (≤5 h/day) was significantly associated with suicidal ideation (OR = 2.5) [20]. In a 2013 study of 15,236 adults registered in the National Health and Nutrition Examination Survey IV (2007−2009) in Korea, the participants with short sleep duration (≤5 h/day) were also 1.196 times more likely to have suicidal ideation than those with normal daily sleep duration (7 h/day) [15].

Although the pathophysiological mechanisms for short sleep duration and suicidal ideation have yet to be established, from the perspective of neurobiology, the dysfunction of serotonin systems can be a mechanism explaining the relationship.

Serotonin levels are known to be the highest when awakening and reduced during sleep [36,37]. Even though animal studies have shown that sleep deprivation promotes the release of serotonin [38,39], it also desensitizes the serotonin receptors [40,41]. There were human studies that showed lower serotonin synthesis in the prefrontal lobes of people who attempted suicide compared with normal controls [42], and that low serotonin neuron density with reduced serotonin concentration in prefrontal lobes that regulate executive function were associated with aggressive trait and suicidal behaviors [43].

Organophosphate is one of the commonly used pesticides and is also known to affect the serotonin systems [44]. The professional nature of farmers can easily expose them to pesticides and in conjunction with short sleep duration leads to higher risk of suicide.

Previous studies have shown that exposure to pesticides affects suicide or suicidal ideation [35,45]. However, in our study, the univariate analysis showed no association between pesticide-related factors (such as, pesticide use, application methods, and poisoning history) and suicidal ideation (Supplement Table 2). Although the overall participants with acute pesticide exposure had no significant suicidal ideation, in the study of Kim et al., the severe forms of acute pesticide poisoning was statistically more significantly related to suicidal ideation than to the forms of moderate or mild poisoning [34]. A study of rural populations in Zhejiang province of China showed that the risk of suicidal ideation increased when pesticides were stored in the home [46]. Regretfully, the severity of pesticide poisoning symptoms and the location of pesticide storage have not been evaluated in the present study.

A typical mental disorder associated with the dysfunction of serotonin system is depression [47], which is strongly linked to suicidal ideation, and there is also a study that shows that the prevalence of depression in farmers is higher than in other occupational groups [48].

In our study, depression (SF-GDS≥8) was also strongly linked to suicidal ideation (OR = 15.64, 95% CI = 6.24−39.24). When the general characteristics and depression (Model 2), and all potential confounding variables (Model 3) were adjusted, the fact that the suicidal ideation was significantly associated with short sleep duration means that the short sleep duration is a significant factor that affects the suicidal ideation of the farmers. To evaluate depression in the SAIF cohort, SF-GDS was used, which was validated in the Korean version. The tool standardizes what was developed by Sheikh and Yesavage [49] for Koreans to identify depression with 8 cutoff points for major depression [28]. In accordance with the original SF-GDS, which was validated on US participants, 5−9 points were defined as mild depression and 10−15 points were defined as moderate to severe depression. Unfortunately, we could not find the cutoff value of mild depression through studies that proved validity as the Korean version. After including the participants with mild depression of Sheikh and Yesavage criteria (SF-GDS ≥5), the depression was also strongly linked to suicidal ideation in univariate analysis (OR = 53.95, 95% CI = 12.85−226.37). In addition, the association between short sleep duration and suicidal ideation (OR = 2.74, 95% CI = 1.16−6.45) was statistically significant, as shown in Supplement Table 2.

There are some limitations in this study. First, the farming population of Jeju island is more than 100,000, and even if the sample size had been statistically reasonable, our study analyzed only approximately 0.8% of the total farming population of Jeju island. However, it is almost impossible to assess those in all of these populations. In addition, because the participants were not randomly selected corresponding to the population distribution, the results cannot represent the entire farming population of Jeju island. Second, owing to the demographic characteristics of the study participants, this study included a number of elderly participants. The prevalence of sleep disorders, such as insomnia, obstructive sleep apnea, and restless leg syndrome, increases with age and can lead to changes in sleep time [50]. Unfortunately, this study did not evaluate the aforementioned conditions. Third, the study was only analyzed for the quantity of sleep. There are studies in which poor sleep quality are related to suicidal behavior [51−54], but this study did not explore a such factor. Fourth, as mentioned earlier, farmers are vulnerable to mental health issues (depression, anger, anxiety, or financial stress), and these disorders can also increase the risk of suicidal ideation [55]. Although depression was assessed in this study using standardized tools, other mental health disorders were not assessed. Finally, it was not possible to objectively analyze the sleep duration through actigraphy or polysomnography. However, applying those to a large number of participants has a practical difficulty in terms of time and cost.

Clinicians should be aware that short sleep duration can be a modifiable risk factor for suicide in farmers. In addition, the central and local governments currently operate suicide prevention centers to reduce the socially problematic suicide rate in Korea [10,11]. Therefore, farmers with short sleep duration need to be monitored more closely by these institutions. To better realize the relationship between sleep duration and suicidal ideation among those, multivariate analysis is required to analyze sleep disorders, depression, other mental disorders, and qualitative indicators of sleep. In addition to depression, suicidal ideation and exposure to pesticides are also associated with dysfunction of the serotonin system. Further research is also needed to specifically determine the relationship between suicidal ideation and sleep duration by quantitatively measuring serotonin levels and pesticide concentration in farmers.

Disclaimers

None.

Conflict of interest

The authors have no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2020.10.004.

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