• **Original Article**

Risk factors associated with depression and suicidal ideation in a rural population

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Objectives This study aimed to evaluate the risk factors associated with depression and suicidal ideation in a rural population.

Methods A survey was conducted with 543 farmers from Chungcheongnam-do Province using the Center for Epidemiologic Studies Depression Scale (CES-D) for depression, Lubben Social Network Scale (LSNS) for social support, Swedish Q16 for neurotoxicity symptoms and a survey tool for farmer's syndrome.

Results After adjusting for socioeconomic factors using logistic regression analysis, poor self-rated health, low social support and neurotoxicity were positively associated with the risk of depression (odds ratio [OR], 15.96; 95% confidence interval [CI], 3.11 to 81.97; OR, 3.14; 95% CI, 1.26 to 7.82; and OR, 3.68; 95% CI, 1.08 to 12.57, respectively). The risk of suicidal ideation significantly increased with low social support, neurotoxicity and farmer's syndrome (OR, 2.28; 95% CI, 1.18 to 4.40; OR, 6.17; 95% CI, 2.85 to 13.34; and OR, 3.70; 95% CI, 1.51 to 9.07, respectively).

Conclusions Given the overall results of this study, there is a need to establish programs which can improve the health and social relationships of farmers. Also, when farmers have neurological symptoms from pesticide exposure and characteristic symptoms of farmer's syndrome, a monitoring system for depression and suicide must be made available.

Keywords Depression, Suicidal ideation, Neurotoxicity symptom, Farmer's syndrome

Introduction

Depression is one of the most common psychiatric problems in the world. Reportedly, 10% to 20% of the population suffer from the disease [1] and the rate is steadily increasing. Depression causes serious social, occupational, and physical disabilities. Around 10% to 15% of its victims commit suicide [2]. Depression is more prevalent in older age groups. In fact, it is one of the most frequently occurring health problems in the elderly, affecting 20% to 50% of the population [3]. Notably, depression in old age carries even a higher risk of suicide [4]. According to Statistics Korea, in 2014, the suicide rate of those 65 or older in Korea was 55.5 people (per 100000), nearly double that of all age groups, 27.3 people [5].

Korea's population is one of the fastest aging among Organization for Economic Cooperation and Development member states: The country is forecast to become an aged society by 2017 and a super-aged society by 2026. Notably, aging most seriously impacts Korea in rural areas. The aging rate of the farming population is 35.6%, more than three times higher than that of the overall aging rate of the rest of the Korean population [6]. Comparison of elderly depression rates in urban and rural areas shows that the elderly in rural areas have higher depression scores than their urban counterparts. This is due to the fact that there are gaps in physical/psychological factors, socioeconomic status, and access to medical resources between the two places, which also signifies that the elderly in the rural areas are more vulnerable to physical, psychological, and social health prob-

lems [7].

Depression is a serious health issue that should not be overlooked, for it is known to be a crucial predictor of suicide and known to decrease participation in daily activities, which may lead to a lower quality of life [8]. Therefore, to prevent and manage perceived depression, factors that influence depression as well as mediating variables need to be identified.

In particular, considering the unique characteristics of rural areas, it is worth examining the factors that influence farmers exclusively and the effects they have on depression and suicidal ideation. Recent studies have reported that there is an association between the exposure to pesticide and elderly depression [9,10]. Another study found that higher biological exposure index values of agrochemicals may increase the risk of depression [11]. Therefore, it is necessary to investigate the relationship between pesticide-caused neurotoxicity and depression or suicidal thoughts. As farmer's syndrome is a variable closely linked to farmers' stress, it is also meaningful to examine the association between the two factors.

This study aims to identify gaps in depression symptoms and suicidal thoughts by the different sociodemographic characteristics of farmers. Moreover, this study will evaluate the influence that factors related to occupation and health condition have on depression symptoms and suicidal ideation.

Materials and Methods

Study Site and Subjects

From September to December 2014, a survey was conducted on 287 farmers who use protected cultivation and grow field crops in Gongju City, Chungcheongnam-do Province. In addition, from July 21 to July 24 in 2015, 332 farmers who grow fruit trees in Yesan County, Chungcheongnam-do Province were surveyed. To recruit subjects for the survey, the intention and follow-up steps of the survey were explained in village offices and community health centers in the areas of the survey and consent was obtained. The survey was also promoted to community leaders and farmers at leadership meetings and Korea National Agricultural Cooperative Federation's education sessions, and volunteers registered to participate in the survey. Later, one-on-one phone interviews with the volunteers were conducted to explain about the survey and to encourage their participation. A total of 619 farmers participated in the initial study; however, 76 participants had missing data and were excluded, leaving a total of 543 subjects.

The study was approved by the institutional review board of Dankook University Hospital (no. 2014-08-003). The details of participation in the study were explained to the subjects and their written consent was obtained.

Questionnaire Survey Design and Content

General demographic characteristics of the subjects were obtained through the questionnaire, such as sex, age, education level, marital status, and income. Farming-related factors from the questionnaire were also researched, including cropland area, hours of work, and annual amount of pesticide exposure. For measuring self-rated health condition, a Likert 5-point scale was used, in which subjects evaluated their own health status using a single question: 5 = "very healthy"; 4 = "healthy"; 3 = "fair"; 2 = "unhealthy"; and 1 = "very unhealthy."

For evaluating depression, the Center for Epidemiologic Studies Depression Scale (CES-D) [12] was used and the presence of depression is identified when the score is 16 or higher. In order to measure suicidal ideation, the subjects were asked whether they have had suicidal thoughts during the past year. For measuring social support, the Lubben Social Network Scale (LSNS) [13] composed of ten questions was used and it is determined that a person has high social support if the score exceeds 20. The Swedish Q16 [14] was used for measuring neurotoxicity caused by organic solvent (pesticide) poisoning and scores of six or higher indicate probable neurotoxicity.

An instrument developed by Park et al. [15], composed of eight questions on shoulder stiffness, low back pain, numb limbs, nocturia, dyspnea, insomnia, dizziness, and abdominal discomfort, was utilized to measure farmer's syndrome. The results were classified as follows: 0-2 = "negative"; 3-6 = "probable"; and 7 or higher = "positive."

Data Analysis

The collected data was analyzed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA) to find the general characteristics of the subjects and the frequency and percentage of their depression symptoms and suicidal ideation. To identify risk factors of the subjects' depression symptoms and suicidal thoughts, a logistic regression analysis was performed using all surveyed factors as independent variables and presence of depression symptoms and suicidal ideation as dependent variables.

Model 1 was adjusted for sex, age, education level, marital status, and self-rated health condition. Model 2, in addition to the adjusted variables in model 1, was adjusted for each occupational factor including hours of work, cropland area, exposure time to pesticide, neurotoxicity, and farmer's syndrome.

Study Results

Males accounted for 58.7% and females accounted for 41.3% of the subjects. Those who were 60 or older represented 66.5%

of all subjects. Those who competed elementary school education accounted for 51.6%, and 90.4% were married. Subjects who earned 30 million Korean won or higher per year represented 55.4%. Those whose self-rated health condition was "very healthy" or "healthy" accounted for 36.8%, while who answered "unhealthy" or "very unhealthy" represented 32.6%. Those whose social support was high accounted for 80.8%, whereas those with low social support represented 19.2%. Concerning the annual exposure time to pesticide, 10.7% were exposed for 50 or more hours; 22.7% were exposed between 10 hours and 49 hours; and 66.7% were exposed for less than 10 hours. Regarding neurotoxicity symptoms, 54.3% were found to have probable neurotoxicity. In addition, 45.9% were found to have probable farmer's syndrome, while 32.6% tested positive (Table 1).

Based on the CES-D score (16 or higher), 2.8% of males and 7.6% of females were classified as having depression, and 10.7% of males and 16.5% of females answered that they had had suicidal thoughts in the past year. When classifying by age, 8.0% of those in their 70s appeared to have depression and 14.5% have had suicidal ideations. Among those who rated their health condition as "unhealthy" or "very unhealthy", 11.3% were found to have depression and 24.3% have had suicidal ideations. Among those subjects who had low social support, 11.5% had depression and 23.1% have had suicidal thoughts. Moreover, among those whose neurotoxicity results were found to be "probable," 7.5% had depression and 21.0% have had suicidal ideations. Among the subjects who tested positive for farmer's syndrome, 10.7% were found to have depression and 26.0% have had suicidal ideations (Table 2).

To identify factors influencing depression symptoms and suicidal ideation, a logistic regression analysis was performed. The results showed that the risk of depression increased when self-rated health condition was "unhealthy" or "very unhealthy" (odds ratio [OR], 15.96; 95% confidence interval [CI], 3.11 to 81.97) and social support was low (OR, 3.14; 95% CI, 1.26 to 7.82). Regarding occupational factors, neurotoxicity increased the risk of depression (OR, 3.68; 95% CI, 1.08 to 12.57) (Table 3).

Lack of social support (OR, 2.14; 95% CI, 1.18 to 3.87) was found to increase the risk of suicidal ideation. Regarding occupational factors, working between five to eight hours a day (OR, 2.45; 95% CI, 1.15 to 5.23), having cropland area of between 4000 and 7999 pyeong (1.0 pyeong is approximately 3.3 m^2; OR, 2.39; 95% CI, 1.23 to 4.65), presence of neurotoxicity (OR, 6.17; 95% CI, 2.85 to 13.34), and farmer's syndrome (OR, 3.70; 95% CI, 1.51 to 9.07) significantly elevated the risk of suicidal ideation (Table 4).

Discussion

In this study, there was no significant difference in depression symptoms by income or education level. Such a result is not consistent with prior studies, which demonstrated that environmental, economic, social, and demographic factors affect depression symptoms [16-18]. Nonetheless, when a farmer's self-rated health condition was "unhealthy" or "very unhealthy", his or her risk of depression was extremely high. Moreover, low social support significantly increased the risk of depression and suicidal ideation, consistent with other studies [19].

Furthermore, the finding that the risk of depression increases with less social support reconfirms the fact that trust alleviates psychiatric diseases [20,21], while mistrust aggravates mental distress [22].

Table 1. General characteristics of study population

Characteristics	Categories	n	%
Sex	Male	319	58.7
	Female	224	41.3
Age (yr)	<60	182	33.5
	60-69	223	41.1
	≥70	138	25.4
Education	≤Elementary school	280	51.6
	Middle school	110	20.3
	High school	121	22.3
	≥College	32	5.9
Marital status	Married	491	90.4
	Widowed/divorced	52	9.6
Annual income (million KRW)	<10	99	18.2
	10-29	143	26.3
	30-49	125	23.0
	≥50	176	32.4
Self-rated health	Good	200	36.8
	Fair	166	30.6
	Bad	177	32.6
LSNS	High social support (>20)	439	80.8
	Low social support (≤20)	104	19.2
Work hours	<5	126	23.2
	5-8	275	50.6
	>8	142	26.2
Agriculture land area (1000 pyeong[a])	<4.0	265	48.8
	4.0-7.9	179	33.0
	≥8.0	99	18.2
Annual exposure time to pesticide (hr)	<10	362	66.7
	10-49	123	22.7
	≥50	58	10.7
Neurotoxicity symptoms (Q16)	Negative (<6)	248	45.7
	Probable (≥6)	295	54.3
Farmer's syndrome[b]	Negative (0-2)	117	21.5
	Probable (3-6)	249	45.9
	Positive (≥7)	177	32.6

KRW, Korean won; LSNS, Lubben Social Network Scale.
[a]Pyeong: approximately 3.3 m^2.
[b]Farmer's syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.

Table 2. Prevalence of depression and suicidal ideation by sociodemographic characteristics

		CES-D score		Depression[a]			Suicidal ideation		
		Mean	SE	n	%	p-value	n	%	p-value
Sex	Male	3.49	0.31	9	2.8	0.01	34	10.7	0.05
	Female	4.89	0.48	17	7.6		37	16.5	
Age (yr)	<60	4.05	0.76	9	4.9	0.07	26	14.3	0.06
	60-69	3.45	0.39	6	2.7		25	11.2	
	≥70	5.11	0.58	11	8.0		20	14.5	
Education	≤Elementary school	4.87	0.43	18	6.4	0.25	47	16.8	0.06
	Middle school	3.37	0.54	2	1.8		10	9.1	
	High school	3.31	0.46	5	4.1		12	9.9	
	≥College	2.38	0.64	1	3.1		2	6.3	
Marital status	Married	3.82	0.28	19	3.9	0.008[b]	62	12.6	0.34
	Widowed/divorced	6.38	1.02	7	13.5		9	17.3	
Annual income (million KRW)	<10	7.13	0.76	11	11.1	0.01	20	20.2	0.13
	10-29	3.90	0.36	5	3.5		17	11.9	
	30-49	2.85	0.54	3	2.4		13	10.4	
	≥50	3.36	0.76	7	4.0		21	11.9	
Self-rated health	Good	2.26	0.22	2	1.1	<0.001	16	8.0	<0.001[b]
	Fair	3.37	0.35	4	2.4		12	7.2	
	Bad	6.77	0.68	20	11.3		43	24.3	
LSNS	High social support (>20)	3.62	0.28	14	3.2	0.001[b]	47	10.7	0.001
	Low social support (≤20)	5.99	0.75	12	11.5		24	23.1	
Work hours	<5	5.91	0.75	11	8.7	0.05	13	10.3	0.40
	5-8	3.66	0.34	11	4.0		41	14.9	
	>8	3.23	0.40	4	2.8		17	12.0	
Agriculture land area (1000 pyeong[c])	<4.0	4.25	0.37	14	5.3	0.42	30	11.3	0.46
	4.0-7.9	3.89	0.53	7	3.9		29	16.2	
	≥8.0	3.90	0.53	5	5.1		12	12.1	
Annual exposure time to pesticide (hr)	<10	3.63	0.30	15	4.1	0.54	43	11.9	0.60
	10-49	4.30	0.61	7	5.7		18	14.6	
	≥50	6.31	1.08	4	6.9		10	17.2	
Neurotoxicity symptoms (Q16)	Negative (<6)	2.46	0.24	4	1.6	0.001	9	3.6	<0.001
	Probable (≥6)	5.42	0.44	22	7.5		62	21.0	
Farmer's syndrome[d]	Negative (0-2)	2.58	0.33	1	0.9	<0.001	8	6.8	<0.001
	Probable (3-6)	2.76	0.26	6	2.4		16	6.4	
	Positive (≥7)	6.90	0.67	19	10.7		47	26.0	

CES-D, Center for Epidemiologic Studies Depression Scale; SE, standard error; KRW, Korean won; LSNS, Lubben Social Network Scale.
[a]Depression: CES-D score ≥16.
[b]Fisher's exact test.
[c]Pyeong: approximately 3.3 m^2.
[d]Farmer's syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.

A large percentage of the subjects of this study was 60 or older and thus was more vulnerable to depression than their younger counterparts [3]. A study on the effects of neighbors and social capital on elderly depression reported that the older adults' risk of depression decreases with more active participation in their residential community [23]. Similarly, social capital such as trust, social networks, and participation in society lessens the risk of depression. Therefore, the expansion of social capital plays a pivotal role in preventing depression.

When it comes to occupational factors affecting depression and suicidal ideation, neurotoxicity significantly increases both depression and suicidal thoughts. Farmer's syndrome significantly increases the chances of suicidal ideation. In this study, we focused particularly on identifying effects that neurotoxicity caused by pesticide poisoning and their effects on depression and suicidal ideation, through the Swedish Q16, which measures neurotoxicity that occurs with organic solvent intoxication. There are fairly consistent reports across different countries that poisoning history increases the risk of depression [24,25].

One's having a history of pesticide poisoning implies a more direct health influence than the pesticide exposure index. Therefore, it can be argued that the experience of pesticide poisoning has stronger association with other health effects including depression than the cumulative exposure index of pesticide. In other words, while occupational, cumulative exposure to pesticide merely reflects a situation that one is exposed to the source, and a history of pesticide poisoning signifies a more di-

Table 3. Logistic regression analysis of depression

	Crude	Model 1[a]	Model 2[b]
Sex			
Male	1.00 (reference)	1.00 (reference)	
Female	2.83 (1.24, 6.47)	1.72 (0.66, 4.50)	
Age (yr)			
<60	1.00 (reference)	1.00 (reference)	
60-69	0.53 (0.19, 1.52)	0.41 (0.12, 1.38)	
≥70	1.67 (0.67, 4.14)	0.53 (0.14, 2.00)	
Education			
≤Elementary school	1.00 (reference)	1.00 (reference)	
Middle school	0.27 (0.06, 1.18)	0.44 (0.09, 2.25)	
High school	0.63 (0.23, 1.73)	1.13 (0.22, 5.74)	
≥College	0.47 (0.06, 3.64)	0.79 (0.05, 12.14)	
Marital status			
Married	1.00 (reference)	1.00 (reference)	
Widowed/divorced	3.86 (1.54, 9.69)	1.91 (0.60, 6.06)	
Annual income (million KRW)			
<10	1.00 (reference)	1.00 (reference)	
10-29	0.29 (0.10, 0.86)	0.48 (0.13, 1.81)	
30-49	0.20 (0.05, 0.73)	0.37 (0.08, 1.78)	
≥50	0.33 (0.12, 0.88)	0.82 (0.19, 3.44)	
Self-rated health			
Good	1.00 (reference)	1.00 (reference)	
Fair	2.44 (0.44, 13.52)	2.12 (0.36, 12.35)	
Bad	12.61 (2.90, 54.77)	15.96 (3.11, 81.97)	
LSNS			
High social support (>20)	1.00 (reference)	1.00 (reference)	
Low social support (≤20)	3.96 (1.77, 8.84)	3.14 (1.26, 7.82)	
Work hours			
<5	1.00 (reference)		1.00 (reference)
5-8	0.44 (0.18, 1.03)		0.64 (0.23, 1.78)
>8	0.30 (0.09, 0.98)		0.61 (0.15, 2.47)
Agriculture land area (1000 pyeong[c])			
<4.0	1.00 (reference)		1.00 (reference)
4.0-7.9	0.73 (0.29, 1.85)		1.66 (0.52, 5.35)
≥8.0	0.95 (0.33, 2.72)		2.26 (0.57, 9.00)
Annual exposure time to pesticide (hr)			
<10	1.00 (reference)		1.00 (reference)
10-49	1.40 (0.56, 3.51)		2.19 (0.72, 6.62)
≥50	1.71 (0.55, 5.36)		2.42 (0.58, 10.08)
Neurotoxicity symptoms (Q16)			
Negative (<6)	1.00 (reference)		1.00 (reference)
Probable (≥6)	4.92 (1.67, 14.46)		3.68 (1.08, 12.57)
Farmer's syndrome[d]			
Negative (0-2)	1.00 (reference)		1.00 (reference)
Probable (3-6)	2.86 (0.34, 24.07)		2.04 (0.22, 18.81)
Positive (≥7)	13.95 (1.84, 105.69)		6.36 (0.73, 55.05)

Values are presented as odds ratio (95% confidence interval).
KRW, Korean won; LSNS, Lubben Social Network Scale.
[a]Model 1: adjusted for sex, age, education, marital status, income, self-rated health.
[b]Model 2: adjusted for sex, age, education, marital status, income, self-rated health, and each occupational factor.
[c]Pyeong: approximately 3.3 m^2.
[d]Farmer's syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.

rect health effect and thus can be used as an indicator more closely related with depression.

Most of the studies on the prevalence rate and relevant factors of depression symptoms in rural populations in Korea report consistent results with nationwide occurrence rates (9.0 to 33.0%). However, there are few studies with specific focus on

Table 4. Logistic regression analysis of suicidal ideation

	Crude	Model 1[a]	Model 2[b]
Sex			
Male	1.00 (reference)	1.00 (reference)	
Female	1.66 (1.01, 2.74)	1.22 (0.69, 2.15)	
Age (yr)			
<60	1.00 (reference)	1.00 (reference)	
60-69	0.76 (0.42, 1.36)	0.58 (0.31, 1.12)	
≥70	1.02 (0.54, 1.91)	0.46 (0.20, 1.04)	
Education			
≤Elementary school	1.00 (reference)	1.00 (reference)	
Middle school	0.50 (0.24, 1.02)	0.56 (0.25, 1.25)	
High school	0.55 (0.28, 1.07)	0.88 (0.38, 2.05)	
≥College	0.33 (0.08, 1.43)	0.57 (0.11, 2.91)	
Marital status			
Married	1.00 (reference)	1.00 (reference)	
Widowed/divorced	1.45 (0.67, 3.12)	0.98 (0.40, 2.44)	
Annual income (million KRW)			
<10	1.00 (reference)	1.00 (reference)	
10-29	0.53 (0.26, 1.08)	0.63 (0.28, 1.41)	
30-49	0.46 (0.22, 0.98)	0.60 (0.25, 1.46)	
≥50	0.54 (0.27, 1.05)	0.78 (0.32, 1.85)	
Self-rated health			
Good	1.00 (reference)	1.00 (reference)	
Fair	0.90 (0.41, 1.95)	0.74 (0.33, 1.67)	
Bad	3.69 (1.99, 6.83)	3.32 (1.70, 6.48)	
LSNS			
High social support (>20)	1.00 (reference)	1.00 (reference)	
Low social support (≤20)	2.50 (1.45, 4.33)	2.14 (1.18, 3.87)	
Work hours			
<5	1.00 (reference)		1.00 (reference)
5-8	1.52 (0.78, 2.96)		2.45 (1.15, 5.23)
>8	1.18 (0.55, 2.54)		2.06 (0.85, 4.99)
Agriculture land area (1000 pyeong[c])			
<4.0	1.00 (reference)		1.00 (reference)
4.0-7.9	1.51 (0.87, 2.62)		2.39 (1.23, 4.65)
≥8.0	1.08 (0.53, 2.20)		1.51 (0.66, 3.49)
Annual exposure time to pesticide (hr)			
<10	1.00 (reference)		1.00 (reference)
10-49	1.27 (0.70, 2.30)		1.32 (0.69, 2.54)
≥50	1.55 (0.73, 3.28)		1.98 (0.82, 4.75)
Neurotoxicity symptoms (Q16)			
Negative (<6)	1.00 (reference)		1.00 (reference)
Probable (≥6)	7.07 (3.43, 14.55)		6.17 (2.85, 13.34)
Farmer's syndrome[d]			
Negative (0-2)	1.00 (reference)		1.00 (reference)
Probable (3-6)	0.94 (0.39, 2.25)		0.87 (0.35, 2.19)
Positive (≥7)	4.93 (2.23, 10.87)		3.70 (1.51, 9.07)

Values are presented as odds ratio (95% confidence interval).
KRW, Korean won; LSNS, Lubben Social Network Scale.
[a]Model 1: adjusted for sex, age, education, marital status, income, self-rated health.
[b]Model 2: adjusted for sex, age, education, marital status, income, self-rated health, and each occupational factor.
[c]Pyeong: approximately 3.3 m^2.
[d]Farmer's syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.

farmers [26]. A survey on Korean male farmers found that in 2010, 10.4% of farmers had depression symptoms. Those who had experienced occupational pesticide poisoning had a higher risk of experiencing symptoms. The risk was even higher with more severe poisoning, in cases where the victim had visited medical institutions, or had multiple poisonings [27]. There-

fore, providing early detection and treatment for pesticide poisoning victims is crucial for preventing depression.

Generally, pesticide ingestion is thought of as a way of killing oneself. However, unintentional exposure to pesticide can be a cause of intentional pesticide ingestion. In other words, long-term exposure to pesticide can increase depression or impulsivity via neurobiological effects, which can directly lead to intentional pesticide ingestion if one has an easy access to the chemicals [28].

Depression and suicide have been known to be related to a low serotonin level [29]. Low serotonin is associated with the cholinesterase level. This link leads to a hypothesis that organophosphate pesticides can influence depression via the non-cholinesterase mechanism [30]. Several studies have reported already that organophosphates are linked to depression and suicide [31,32]. One study's finding that higher biological exposure index values of pesticides increase the risk of depression supports such reports [11].

The hypothesis that agrochemicals can be a cause of suicide, not a means, is worth consideration in viewing suicide from the environmental health point of view, instead of seeing it as an individual's problem. Similarly, high rates of suicide and injury n rural areas should be addressed by taking pesticide ingestion into consideration, beyond the conventional view that such incidents are merely caused by individual's negligence or personal reasons.

Farmer's syndrome, a health problem of rural areas that commonly affects professional farmers, has been used as a useful health management indicator of rural residents. The current study demonstrated that the presence of farmer's syndrome significantly elevates the risk of suicidal ideation. This is a meaningful finding considering prior study results in Korea that have shown a group with a high incidence of the condition experienced a significantly lower quality of life [33].

Overall, the results of this study show that Korea needs to strengthen programs for helping farmers enhance satisfaction levels with their health and for improving their social relationships through more participation in society. Moreover, we need a depression and suicide monitoring system for farmers who complain of neurological symptoms caused by pesticide exposure or exhibit commonly found key symptoms.

The limitations of this study include the following: Selection bias may have existed due to the volunteer status of the participants. It is likely that more of those who did not have depression may have been included in the study than those who had depression. Moreover, since many subjects were 60 or older, the accuracy of their answers to the survey could be questionable.

In the elderly, symptoms such as a decrease in cognitive func-

tion, depression, auditory disorders, or attention deficiency are easily found. Therefore, it is possible that they may not correctly understand the interview content, drop out during the interview, or even refuse to be interviewed. In addition, as a cross-sectional study, causal relationships of the variables cannot be identified.

Despite such limitations, this study has significant implications. First, the results confirmed the effects of social support and one's self-rated satisfaction with their health on depression and suicidal ideation in famers, which warrants the need for programs that can help farmers enhance satisfaction with their health and increase social participation. Furthermore, the study demonstrated the effects of neurotoxicity caused by pesticide exposure and farmer's syndrome on depression and suicidal thoughts. Based on the results, we propose the need for monitoring programs to prevent famers from pesticide exposure and farmer's syndrome.

Conflict of Interest

The authors have no conflicts of interest associated with material presented in this paper.

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