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-
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 those 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).

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 (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 | 439 | 80.8|
|                       | Low social support  | 104 | 19.2|
| Work hours            | <5                  | 126 | 23.2|
|                       | 5-8                 | 275 | 50.6|
|                       | >8                  | 142 | 26.2|
| Agriculture land area | <4.0                | 265 | 48.8|
| (1000 pyeong)         | 4.0-7.9             | 179 | 33.0|
|                       | ≥8.0                | 99  | 18.2|
| Annual exposure time  | <10                 | 362 | 66.7|
| to pesticide (hr)     | 10-49               | 123 | 22.7|
|                       | ≥50                 | 58  | 10.7|
| Neurotoxicity symptoms| Negative (<6)       | 248 | 45.7|
|                       | Probable (≥6)       | 295 | 54.3|
| Farmer's syndrome     | Negative (0-2)      | 117 | 21.5|
|                       | Probable (3-6)      | 249 | 45.9|
|                       | Positive (≥7)       | 177 | 32.6|

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 m²; 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 2. Prevalence of depression and suicidal ideation by sociodemographic characteristics

|                          | CES-D score | Depression<sup>a</sup> | 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                | 0.006<sup>b</sup> | 62 ± 12.6 | 0.34    |
| Widowed/divorced         | 6.38 ± 1.02 | 7 ± 13.5                |                   | 9 ± 17.3  |         |
| **Annual income** (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<sup>b</sup> |
| 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      | 3.62 ± 0.28 | 14 ± 3.2                | 0.001<sup>b</sup> | 47 ± 10.7 | 0.001  |
| Low social support       | 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**|             |                         |                   |           |         |
| <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**|             |                         |                   |           |         |
| Farmer's syndrome<sup>c</sup> | 2.46 ± 0.24 | 4 ± 1.6                | 0.001<sup>b</sup> | 9 ± 3.6  | <0.001  |
| Negative (<6)            | 5.42 ± 0.44 | 22 ± 7.5               |                   | 62 ± 21.0 |         |
| Probable (<6)            | 2.76 ± 0.26 | 6 ± 2.4               |                   | 16 ± 6.4  |         |
| Positive (≥7)            | 6.90 ± 0.67 | 19 ± 10.7              |                   | 47 ± 26.0 |         |

<sup>a</sup>CES-D, Center for Epidemiologic Studies Depression Scale; SE, standard error; KRW, Korean won; LSNS, Lubben Social Network Scale.

<sup>b</sup>Fisher’s exact test.

<sup>c</sup>Pyeong: approximately 3.3 m².

<sup>d</sup>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-
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 3. Logistic regression analysis of depression

|                          | Crude                        | Model 1<sup>a</sup>                        | Model 2<sup>b</sup>                        |
|--------------------------|------------------------------|--------------------------------------------|--------------------------------------------|
| **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<sup>c</sup>)** |                              |                                            |                                            |
| <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)           | 3.88 (1.08, 12.57)                        |                                            |
| **Farmer’s syndrome<sup>d</sup>** |                              |                                            |                                            |
| 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.
<sup>a</sup>Model 1: adjusted for sex, age, education, marital status, income, self-rated health.
<sup>b</sup>Model 2: adjusted for sex, age, education, marital status, income, self-rated health, and each occupational factor.
<sup>c</sup>Pyeong: approximately 3.3 m<sup>2</sup>.
<sup>d</sup>Farmer’s syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.
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].

Table 4. Logistic regression analysis of suicidal ideation

|                          | Crude               | Model 1<sup>a</sup> | Model 2<sup>b</sup> |
|--------------------------|---------------------|---------------------|---------------------|
| 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)    | 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<sup>c</sup>) |                   |                     |                     |
| <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<sup>d</sup> |                   |                     |                     |
| 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.
<sup>a</sup>Model 1: adjusted for sex, age, education, marital status, income, self-rated health.
<sup>b</sup>Model 2: adjusted for sex, age, education, marital status income, self-rated health, and each occupational factor.
<sup>c</sup>Pyeong: approximately 3.3 m<sup>2</sup>.
<sup>d</sup>Farmer’s syndrome: shoulder pain, back pain, numbness, nocturia, dyspnea, insomnia, dizziness, abdominal discomfort.
Before, 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 mechanism. 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 in 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 function, 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 farmers, 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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References

1. Riolo SA, Nguyen TA, Greden JF, King CA. Prevalence of depression by race/ethnicity: findings from the National Health and Nutrition Examination Survey III. Am J Public Health 2005;95(6):998-1000.
2. World Health Organization. The world health report 2001 - mental health: new understanding, new hope [cited 2010 Nov 9 ]. Available from: http://www.who.int/whr/2001/en/.
3. Park, EA, Lee IS. Factors affecting the depression of the elderly women in poverty. J Agric Med Community Health 2009;34(2):256-266 (Korean).
4. Koenig HG, Cohen HJ, Blazer DG, Pieper C, Meador KG, Shelp F, et al. Religious coping and depression among elderly, hospitalized medically ill men. Am J Psychiatry 1992;149(12):1693-1700.
5. Korean Statistical Information Service. Deaths and death rates by cause (236 item), sex and age [cited 2016 Aug 25]. Available from: http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DY_1B34E07&conn_path=12 (Korean).
6. Statistics Korea. Population projections for provinces: 2010-2040; 2012 Jun 27 [cited 2016 Aug 25]. Available from: http://kostat.go.kr/portal/english/news/1/1/11/index.board? (Korean).
7. Kang HW, Park KM. Comparison of correlates of depression in
late-life between urban and rural areas. J Korean Gerontol Soc 2012;32(1):129-143 (Korean).
8. Yang SM, Rim CS, Oh YJ. A relative effects of related-variables on depression of the rural elderly. J Welf Aged 2007;36:139-158 (Korean).
9. Avigliano L, Fassiano AV, Medesani DA, Ríos de Molina MC, Rodriguez EM. Effects of glyphosate on growth rate, metabolic rate and energy reserves of early juvenile crayfish, Cherax quadricarinatus M. Bull Environ Contam Toxicol 2014;92(6):631-635.
10. Freire C, Koifman S. Pesticides, depression and suicide: a systematic review of the epidemiological evidence. Int J Hyg Environ Health 2013;216(4):445-460.
11. Kim B, Jung A, Yun D, Lee M, Lee MR, Choi YH, et al. Association of urinary 3-phenoxbenzoic acid levels with self-reported depression symptoms in a rural elderly population in Asan, South Korea. Environ Health Toxicol 2015;30:e2015002.
12. Lewinsohn PM, Seeley JR, Roberts RE, Allen NB. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. Psychol Aging 1997;12(2):277-287.
13. Lee KW, Kim SY, Chung W, Hwang GS, Hwang YW, Hwang IH. The validity and reliability of Korean version of Lubben social network scale. Korean J Fam Med 2009;30(5):352-358 (Korean).
14. Hogstedt C, Hane M, Axelson O. Diagnostic and health care aspects of workers exposed to solvents. In: Zenz C, editor. Developments in occupational medicine. Chicago: Year Book Medical Publishers; 1980, p. 249-258.
15. Park TJ, Kim BS, Chon HJ. Factors associated with farmers’ syndrome. Korean J Rural Med 1994;19(1):5-13 (Korean).
16. Carpiniello B, Carta MG, Rudas N. Depression among elderly people. A psychosocial study of urban and rural populations. Acta Psychiatr Scand 1989;80(5):445-450.
17. Henderson AS, Scott R, Kay DW. The elderly who live alone: their mental health and social relationships. Aust N Z J Psychiatry 1986;20(2):202-209.
18. Nilsson LV, Persson G. Prevalence of mental disorders in an urban sample examined at 70, 75 and 79 years of age. Acta Psychiatr Scand 1984;69(6):519-527.
19. Son JA, Suh SR, Kim M. Factors related to depression of rural elders. J Korean Gerontol Nurs 2015;17(1):56-64 (Korean).
20. De Silva MJ, Huttly SR, Harpham T, Kershaw MG. Social capital and mental health: a comparative analysis of four low income countries. Soc Sci Med 2007;64(1):5-20.
21. Wang H, Schlesinger M, Wang H, Hsiao WC. The flip-side of social capital: the distinctive influences of trust and mistrust on health in rural China. Soc Sci Med 2009;68(1):133-142.
22. Hyyppä MT, Mäki J. Individual-level relationships between social capital and self-rated health in a bilingual community. Prev Med 2001;32(2):148-155.
23. Choi MY. An empirical study of the effects of neighborhoods and social capital on elderly people depression. Korean J Soc Welf Res 2008;18:25-46 (Korean).
24. Stallones L, Beseler C. Pesticide poisoning and depressive symptoms among farm residents. Ann Epidemiol 2002;12(6):389-394.
25. Beseler CL, Stallones L. A cohort study of pesticide poisoning and depression in Colorado farm residents. Ann Epidemiol 2008;18(10):768-774.
26. Cho MJ, Lee JY, Kim BS, Lee HW, Sohn JH. Prevalence of the major mental disorders among the Korean elderly. J Korean Med Sci 2011;26(1):1-10.
27. Kim J, Ko Y, Lee WJ. Depressive symptoms and severity of acute occupational pesticide poisoning among male farmers. Occup Environ Med 2013;70(5):303-309.
28. London L, Flisher AJ, Wesseling C, Mergler D, Kromhout H. Suicide and exposure to organophosphate insecticides: cause or effect? Am J Ind Med 2005;47(4):308-321.
29. Oquendo MA, Mann JJ. The biology of impulsivity and suicidality. Psychiatr Clin North Am 2000;23(1):11-25.
30. Aldridge JE, Seidler FJ, Meyer A, Thillai I, Slotkin TA. Serotonergic systems targeted by developmental exposure to chlorpyrifos: effects during different critical periods. Environ Health Perspect 2003;111(4):1736-1743.
31. Davies R, Ahmed G, Freer T. Chronic exposure to organophosphates: background and clinical picture. Adv Psychiatr Treat 2000;6:187-192.
32. Parrón T, Hernández AF, Villanueva E. Increased risk of suicide with exposure to pesticides in an intensive agricultural area. A 12-year retrospective study. Forensic Sci Int 1996;79(1):53-63.
33. Park I, Joo A, Kim Y. The relation between farmers’ syndrome and quality of life of residents in suburban area. J Korean Acad Community Health Nurs 2008;19(3):495-505 (Korean).