Does Pesticide Exposure Affect Male Farmer's Lower Urinary Tract Symptoms?

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Research

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Abstract

Purpose: Research on the relationship between lower urinary tract symptoms and pesticides is limited. Thus, we investigated the relationship between full-time male farmers' exposure to organophosphorus and pyrethroid pesticides and the degree of lower urinary tract symptoms.

Methods: Four metabolites of each of organophosphate and pyrethroid in urine from 348 full-time male farmers were analysed. Subjects' pesticide-related characteristics including international prostate symptoms score (IPSS) and pesticide poisoning symptoms within 48 hours of exposure to pesticides and general characteristics were assessed through one-to-one interviews using a structured questionnaire.

Findings: Lower urinary tract symptoms of full-time male farmers with 1-2 pesticide poisoning symptoms (odds ratio [OR] 2.63, 95% confidence interval [CI] 1.21-5.73) and ≥ 3 symptoms (OR 10.36, 95% CI 2.18-49.15) were significantly higher than those without symptoms. The odds ratios of two- and three-fractile groups of pyrethroid urinary metabolites were 2.50 (95% CI 1.23-5.06) and 2.72 (95% CI 1.37-5.43), respectively, compared to the one fractile group.

Conclusion: Relationships among pesticide poisoning symptoms within 48 hours of exposure to pesticides, total amount of pyrethroid pesticide metabolites in urine, and the lower urinary tract symptoms of male farmers were observed in the present study, and this needs further investigation.

1. Introduction

There are more than 1,000 different kinds of pesticides including insecticides, herbicides, and fungicides (fungus remover), and they are toxic substances used to control pests and diseases.¹ The use of pesticides has contributed to abundant food supply today by improving agricultural productivity and quality by protecting crops from diseases and pests.² In particular, the agricultural population in South Korea is declining every year as the number of people aged 65 years and older continue to rise sharply from 16.2% in 1995 to 44.7% in now.³ The use of pesticides plays an important role of filling in the labour shortage and reducing agricultural production costs and also contributes greatly to improving the lives of farmers.²

Despite their benefits, pesticides can remain in the soil or flow into streams causing environmental pollution, and the possibility of pesticide residues on harvested crops harming humans cannot be excluded⁴. In addition, the health hazard to farmers due to inhalation and exposure to pesticides is assumed to be high as a result of excessive usage.⁵⁻⁶ Rusiecki⁷ reported that 87% of people who were exposed to a high level of pesticides experienced long-term side effects without visiting the hospital. Exposure to pesticides is related to various malignant tumours, respiratory diseases (such as asthma, chronic bronchitis, and wheezing), depression, neurological diseases (such as Parkinson's disease, and peripheral neuritis), ophthalmic diseases (such as retinal degeneration), diabetes, changes in the time of menopause and infertility, and immunotoxicity.⁸⁻⁹ In addition to these symptoms, exposure to pesticides

also affects the urinary system, and some organic chlorinated pesticides increase the risk of benign prostatic hyperplasia (BPH) due to their effect which is similar to steroid hormones.¹⁰ Parsons et al. also found higher level of organo-hydrochloric insecticide such as pp-DDE in patients with BPH compared to healthy individuals¹¹. Exposure to organic solvents has also been reported to cause urinary incontinence.^{8,12} In addition, pesticide factory workers complained of abdominal pain, dysuria, urinary urgency, hemuresis, and haemolytic cystitis during bladder biopsy, and similar results were found in animal experiments.¹³

Lower urinary tract symptoms such as frequent urination and urinary urgency are common problems of the urinary system that affect most men and are progressive diseases that can cause serious complications.¹⁴⁻¹⁵ In particular, lower urinary tract symptoms significantly affect the quality of life by causing physical, mental, and social problems rather than being life threatening, which necessitates an investigation among male farmers using hazardous substances such as pesticides many of whom are in their middle age. Other countries have conducted various studies on pesticides including cohort studies on exposure during pregnancy¹⁶⁻¹⁷ or to examine the relationship with specific diseases such as diabetes and prostate cancer^{7,18}. In the case of South Korea, however, studies have mostly focused on the assessment of pesticide exposure and there is no study conducted on the effect of pesticides on health.^{4,19-20} Some previous studies comprehensively identified the harmful effects of pesticides, but they did not present definite data from Korean settings.⁹ Accordingly, the present study was conducted to investigate (1) the proportion of full-time male farmers with lower urinary tract symptoms (2) the relationship among the general characteristics, chronic disease, existence of BPH, depression, and lower urinary tract symptoms of farmers, and (3) the relationship between pesticide poisoning-related symptoms, level of exposure to each of organophosphorus and pyrethroid pesticides (urinary metabolites), and lower urinary tract symptoms.

2. Materials And Methods

2.1 Research design

The present study was a descriptive survey to investigate the general characteristics, exposure to pesticides, depression, and the level of lower urinary tract symptoms among male farmers.

2.2 Subjects And Procedure

A survey and medical examination were conducted among 864 farmers (475 men and 389 women) who participated in a physical examination at the Farmer's Health and Safety Center of Dankook University from 2014 to 2015. A survey was also conducted on 532 facility cultivation farmers (264 men and 268 women) in Gongju-si in 2014 and 332 (211 men and 121 women) apple growers in Yesan-gun in 2015. The subjects agreed to participate in the study through a prior notice. A total of 348 men who responded that they were full-time farmers, took urine test related to pesticide exposure, and sincerely responded to a

questionnaire related to pesticide exposure, depression, and lower urinary tract symptoms were included. The general characteristics, level of pesticide exposure, prostate symptoms of the subjects were assessed through one-to-one interviews using a structured questionnaire. Survey agents who received standardization training helped farmers who were mostly of old age to answer the questionnaire.

2.3 Research Variables

2.3.1 General characteristics

Subjects' general characteristics included age, body mass index (BMI), smoking, alcohol consumption, exercise level, chronic disease, and diagnosis of BPH. Ages were grouped into under 50, 50–59, 60–69, 70–79, and 80 years or older. Based on WHO criteria, BMI was classified into underweight ($BMI < 18.5$), normal ($18.5 \leq BMI \leq 22.9$), overweight ($23 \leq BMI \leq 24.9$), obesity ($25 \leq BMI \leq 29.9$), and severe obesity ($BMI \geq 30$)²¹. Farmers who were diagnosed with one or more of the four major diseases of hypertension, hyperlipidaemia, stroke, and angina were defined as “chronic disease.” The farmers were determined to be diagnosed with BPH based on “yes” or “no” answer to a question asking whether they had been diagnosed with BPH in the self-administered questionnaire and the proportion of BPH was 7.2% in this study.

1. Pesticide Symptoms

The authors defined ‘pesticide symptoms’ as a symptom which the participant experienced among 21 clinical symptoms provided in the questionnaire within 48 hours after exposure to pesticides over the last 1 year²² and the authors classified into 3 categories depending on the number of symptoms (0, 1–2, ≥ 3). The 21 clinical symptoms included ‘skin irritation, dizziness, nausea, fatigue, headache, eye irritation, vomiting, sore throat, chest pain, runny nose, excessive sweating, paresthesia, hyperactivity (anxiety), muscle weakness, lacrimation, diarrhea, dyspnea, blurred vision, slurred speech, paralysis, and syncope’.^{22–25} Pesticide symptoms was based on WHO.²⁶

2.3.3 Depression

The Center for Epidemiological studies-Depression Scale (CES-D) is a self-rating depression scale and easy to use in epidemiological studies because items are very simple and severity is measured based on the duration of the symptom²⁷. The CES-D was also standardized in South Korea in 1993²⁸. To measure subjects' level of depression, the Korean version of CES-D, a self-report scale, was used. The scale consists of a total of 20 items on a 3-point Likert scale from “very rare” for zero point to “mostly did” for three points. Positive items were inversely scored, and depression was diagnosed if the score was 16 points or higher out of a total of 60 points.²⁸

2.3.4 Pesticide Exposure

Four organophosphorus pesticides including DiMethylPhosphate (DMP), DiMeThylthioPhosphate (DMTP), DiEthylPhosphate (DEP), and DiEthylThiophosphate (DETP), and four pyrethroid pesticide metabolites including (Cis-2,2-(dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid(Cis-DCCA), Trans-2,2-(Dichlorovinyl)-2,2-dimethylCyclopropane Carboxylic Acid (Trans-DCCA), 3-PhenoxyBenzoic Acid(3-PBA), and Cis-2,2-(dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid (DBCA) were analysed. Frozen urine samples were taken out and thawed for 30 minutes, centrifugated, and the supernatant was used for analysis. Quantitative analysis was performed to determine metabolite concentration in the sample using a gas chromatograph-mass spectrometer (GC/MS). Hewlett-Packard (HP) 5890 GC connected via a direct interface with HP 7673A autosampler for sample injection were used for samples collected in 2014. For samples collected in 2015, AG 7693 autosampler connected via a direct interface to Agilent Technologies (AG) 7000C GC/MS Triple Quad was used. To draw the calibration curve and to determine the recovery rate and detection limit, newborn urine was used as blank and confirmed that it did not have any of the metabolites of interest before the analysis. Schatten analysis method was used without modification for organophosphorus metabolites.²⁹

Four pyrethroid metabolites (Cis and trans-3-(2-2dichlorovinyl)-2, 2-dimethylcyclopropane carboxylic acid (Cis-DCCA, Trans-DCCA), 3-phenoxybenzoic acid (3-PBA), and Cis-3-(2-2dibrmovinyl)-2, 2-dimethylcyclopropane carboxylic acid (DBCA) were selected and for analysis Uey ama method was used without modification ³⁰. The LOD of the samples in 2014 was Cis-DCCA 1.0 µg/L, trans-DCCA 1.0 µg/L, 3-PBA 0.5 µg/L, and DBCA 1.0 µg/L, and the LOD of the samples in 2015 was Cis-DCCA 0.5 µg/L, trans-DCCA 0.5 µg/L, 3-PBA 0.3 µg/L, and DBCA 0.5 µg/L.

All eight metabolites were corrected with urine creatinine, and if the values were lower than the values of LOD, the values were replaced with the values obtained by dividing LOD with the square root of two.³⁰ For the replacement of organophosphorus and pyrethroid metabolites, the four metabolites of each group were summed to obtain the total exposure values of organophosphorus and pyrethroid pesticides, and the two values were divided by the urine creatinine value of each subject, and the three fractiles of the values were used in the analysis.

The median of the organophosphate metabolite was DMP 0.0004 µg/ g crea, DMTP 0.0026 µg/ g crea, DEP 0.0004 µg/ g crea, and DETP 0.0033 µg/ g crea. The median of the pyrethroid metabolite was Cis-DCCA 0.0080 µg/ g crea, trans-DCCA 0.0108 µg/ g crea, 3-PBA 0.0243 µg/ g crea, and DBCA 0.0058 µg/g crea. One, two, and three fractiles of organophosphorus metabolites in urine were ≤ 0.02 µg/g crea, $0.03-0.22$ µg/g crea, and ≥ 0.23 µg/g crea, respectively, and three fractiles of pyrethroid metabolites in urine were ≤ 0.03 µg/g crea, $0.04-0.10$ µg/g crea, and ≥ 0.11 µg/g crea, respectively.

2.3.5 Lower Urinary Tract Symptoms

For lower urinary tract symptoms, the Korean version of the International Prostate Symptoms Score (IPSS) was used.³¹ The scale measures seven symptoms including the sensation of residual urine, frequent urination, intermittent urination, urinary urgency, weak stream, urinary hesitancy, and night urination, and the score for each symptom was from zero point for “Not at all” to five points for “Always”.³¹ The total score was 35 points and symptoms were classified into minor, moderate and severe symptoms for scores 0–7, 8–19 and 20–35, respectively.³² In the present study, low urinary tract symptom group was defined as IPSS score eight points or higher as in a previous study and subjects were classified into “non- symptom group” and “symptom group” .³²

2.4 Data Analysis

The collected data were analysed using SPSS 22.0 program. The general characteristics, pesticide exposure, and lower urinary tract symptoms of the subjects were analysed using chi-squared test and p for trend test. To determine if lower urinary tract symptoms vary depending on pesticide concentration, Mann-Whitney test was performed. A nonparametric test was used because the data distributions of age, depression scale, the metabolites of organophosphorus and pyrethroid pesticides were not normal. To identify the factors that affect lower urinary tract symptoms, multivariable logistic regression analysis was performed, and the significance level for all analyses was set at $p < 0.05$.

3. Results

3.1 Lower urinary tract symptoms according to the general characteristics of the subjects

Statistically significant differences were found between the two groups in age, existence of BPH, pesticide symptoms, and 3-fractiles of pyrethroid pesticide concentration ($p < 0.05$). Among 348 subjects, 186 (53.4%) responded that they have lower urinary tract symptoms. The proportion of symptom group increased with age, and the increase was higher for subjects with BPH (84.0%) than the subjects without BPH (51.1%). The proportion of symptom group increased with increasing pesticide symptoms and the fractile of pyrethroid pesticides ($p < 0.05$) (Table 1).

Table 1
The General and Pesticide-related Characteristics according to the Presence of
Lower Urinary Tract Symptoms in Male Full-time Farmers (N = 348)

	None (%)	Symptom (%)	p-value
	(n = 162)	(n = 186)	
Age (years)			
< 50	14(87.5)	2(12.5)	0.00*
50–59	28(68.3)	13(31.7)	
60–69	75(50.7)	73(49.3)	
70–79	34(31.5)	74 (68.5)	
≥ 80	11(31.4)	24(68.6)	
BMI			
Low weight	3(25.0)	9(75.0)	0.11
Normal	40(38.8)	63(61.2)	
Overweight	48(50.0)	48(50.0)	
Obese	61(50.4)	60(49.6)	
Extremely Obese	10(62.5)	6(37.5)	
Chronic disease†			
No	110(47.2)	123(52.8)	0.73
Yes	52(45.2)	63(54.8)	
Benign Prostate Hyperplasia			
No	158 (48.9)	165(51.1)	0.00*
Yes	4(16.0)	21(84.0)	
Smoking			
Non	113(44.8)	139(55.2)	0.18
Smoker (Quit and present)	49(51.0)	47(49.0)	
Drinking			
No	145(47.5)	160(52.5)	0.41
Drinker	17 (39.5)	26(60.5)	
* p-value < 0.05, ** p-for trend test < 0.05			

	None (%)	Symptom (%)	p-value
Exercise			
No	133 (46.2)	155(53.8)	0.73
Yes	29(48.3)	31(51.7)	
Depression			
No	159(47.2)	178(52.8)	0.16
Yes	3(27.3)	8(72.7)	
Pesticide symptoms			
0	142(49.3)	146(50.7)	0.02 **
1–2	17(39.5)	26(60.5)	
≥ 3	3(17.6)	14(82.4)	
Organophosphate pesticide (µg/g crea)			
1st (≤ 1.59)	72(44.7)	89(55.3)	0.63
2nd (1.60-22.19)	20(43.5)	26(56.5)	
3rd (≥ 22.20)	70(49.6)	71(50.4)	
Pyrethroid pesticide (µg/g crea)			
1st (≤ 3.09)	38(61.3)	24(38.7)	0.03 **
2nd (3.10–9.66)	57 (45.6)	68(54.40)	
3rd (≥ 9.67)	67(41.6)	94(58.4)	
†Chronic disease include hypertension, hyperlipidaemia, stroke and angina			
*p-value < 0.05, **p-for trend test < 0.05			

3.2 Differences in pesticide concentration according to lower urinary tract symptoms

The mean age (70.22 ± 8.26 years) of the symptom group was significantly higher than the non-symptom group (64.70 ± 10.41 years), the mean depression score of the symptom group was also significantly higher compared to the non-symptom group ($p < 0.05$) and the mean pyrethroid of the symptom group was also significantly higher compared to the non-symptom group ($p < 0.05$). However, the mean value of

the organophosphorus of the non-symptom group was not significantly higher than the symptom group (Table 2).

Table 2

The Mean Age (year and Standard Deviation(SD)) and Pesticides in Male Full-Time Farmers according to the Presence of Lower Urinary Tract Symptoms

	Normal	Symptom	p-value [†]
Age (Year ± SD)	64.70 ± 10.41	70.22 ± 8.26	0.00
Depression Scale	2.59 ± 3.74	4.23 ± 6.50	0.01
Organophosphate Pesticide/Creatinine(μg/g crea)	122.90 ± 273.40	109.23 ± 258.36	0.22
Pyrethroid Pesticide/Creatinine(μg/g crea)	41.18 ± 233.91	32.06 ± 73.51	0.02*
[†] Mann-Whitney test			

3.3 Influence of general characteristics, depression, and pesticide exposure on lower urinary tract symptoms

The results of multivariable logistic regression analysis performed to determine the effect of general characteristics, depression, pesticide symptoms, and pesticide exposure of the subjects on lower urinary tract symptoms are presented in Table 3. Age, existence of BPH, depression, pesticide symptoms, and 3-fractiles of pyrethroid pesticide were found to be correlated with lower urinary tract symptoms ($p < 0.05$). In the case of age, lower urinary tract significantly increased with increasing age in those aged 60 years or older compared to those aged under 60 years, which is seen in the odds ratios for 60–69 years (OR 11.96, 95% CI 2.10-68.03), 70–79 years (OR 26.33, 95% CI 4.41–157.10), and 80 years or older (OR 23.30, 95% CI 3.37-161.29). The lower urinary tract symptoms increased for subject who had 1–2 pesticide poisoning symptoms (OR 2.63, 95% CI: 1.21–5.73) and those who had ≥ 3 symptoms compared to those without symptoms (OR 10.36, 95% CI: 2.18–49.15). Two and three fractiles of pyrethroid pesticides metabolites were 2.50 (95% CI 1.23–5.06) and 2.72 (95% CI: 1.37–5.43), respectively, which shows statistically significant increase in the lower urinary tract symptoms than 1-fractile or less pyrethroid pesticides metabolites (Table 3).

Table 3
The Adjusted Odds of the Lower Urinary Tract Symptoms in Full-Time Male Farmers

	OR [‡]	95% CI
Age (years)		
< 50	1	
50–59	4.45	0.72–27.41
60–69	11.96	2.10–68.03
70–79	26.33	4.41–157.10
≥ 80	23.30	3.37–161.29
BMI		
Low weight	1	
Normal	0.57	0.13–2.56
Overweight	0.42	0.09–1.96
Obese	0.38	0.08–1.74
Extremely Obese	0.18	0.03–1.22
Chronic disease [†]		
No	1	
Yes	0.91	0.54–1.55
Benign Prostate Hyperplasia		
No	1	
Yes	4.66	1.35–16.08*
Smoking		
Non	1	
Smoker (Quit and present)	1.06	0.59–1.90
Drinking		
No	1	
Drinker	1.07	0.52–2.22
Exercise		
No	1	

	OR [†]	95% CI
Yes	0.78	0.41–1.47
Depression		
No	1	
Yes	3.63	0.95–20.24
Pesticide symptoms		
0	1	
1–2	2.63	1.21–5.73*
≥ 3	10.36	2.18–49.15*
Organophosphate pesticide (µg/g crea)		
1st (≤ 1,59)	1	
2nd (1.60-22.19)	0.99	0.46–2.11
3rd (≥ 22.20)	1.01	0.60–1.72
Pyrethroid pesticide (µg/g crea)		
1st (≤ 3.09)	1	
2nd (3.10–9.66)	2.50	1.23–5.06*
3rd (≥ 9.67)	2.72	1.37–5.43*
[†] OR = odds ratio, [‡] CI = confidence interval, Chronic disease includes hypertension, hyperlipidaemia, stroke and angina; *p < 0.05		

4. Discussion

The results of the present study showed that 53.4% of the subjects who were full-time male farmers complained about lower urinary tract symptoms and the proportion increased with increasing age, but it does not appear to be related to BMI, exercise, drinking, smoking, chronic diseases, and existence of depression. Lower urinary tract symptoms were found to be related to BPH, number of pesticide poisoning symptoms experienced by full-time male farmers within 48 hours of exposure to pesticides, and 2- and 3-fractiles of pyrethroid pesticide concentration. The frequency of lower urinary tract symptoms increases with increasing age³³, and 30.5% and 40.4% of men in their 60 s and 70 s, respectively, have been reported to have contracted the symptoms. In addition, one-third of men aged 65 years and older who do not have symptoms or the symptom is mild will be diagnosed with prostate symptoms within two years, and a quarter of men who already have moderate or greater prostate

symptoms will experience worsening of symptoms.¹¹ The present study also found that the odds ratios of people with lower urinary tract symptoms increased with increasing age.

BPH is the major cause of lower urinary tract symptoms in men, and 90% of men aged 85 years or older have it ³⁴. The odds ratio of lower urinary tract symptoms in male farmers diagnosed with BPH was significantly high at 4.66 (95% CI 1.35–16.08). Statistically significant differences were found in lower urinary tract symptoms depending on age, education level, and health condition ³² and it is known that the symptoms can be caused even by alcohol, smoking, low physical activity, excessive fluid intake, metabolic syndrome, and bladder outlet obstruction.^{35–37} Lower urinary tract symptoms have been reported to be related to chronic diseases such as hypertension or diabetes ¹⁸ and because they occur simultaneously in considerable number of elderly, they are assumed to be related to each other.³⁸ The present study, however, did not find comorbidity with chronic diseases, drinking, smoking, and exercise.

Depression was not related to lower urinary tract symptoms in the present study. Some previous studies found significant relationships³⁹, and Song³⁷ found significantly higher scores of lower urinary tract symptoms in patients with depression and suggested that the prevention of depression in the elderly and psychological management is important to prevent lower urinary tract symptoms. Although depression was not a significant factor in the present study, the relationship between depression and lower urinary tract can be understood more clearly if the number of subjects is increased, or follow-up studies are conducted to monitor these patients.

The present study found that symptoms within 48 hours of pesticide application were related to lower urinary tract symptoms, and the higher the number of symptoms, the stronger the relationship. Research on organophosphorus and pyrethroid pesticides that were analysed in the present study among various types of pesticides has mostly focused on (1) birth outcome, (2) neurological behaviour and neurophysiological studies, (3) sperm quality and gene damage, (4) hormonal abnormalities, (5) DNA damage, and (6) other health problems.⁴⁰ Among these, synthetic pyrethroid pesticide, which has similar structure to that of pyrethrins, has been used in agriculture and indoors worldwide due to its strong toxicity to harmful insects and low effect on humans.⁴⁰ A study on workers of pyrethroid pesticide factory found that long-term exposure to pyrethroid caused hormonal disorders, oxidative damage, and lipid peroxidation.⁴¹ Meeker et al. found an inverse relationship between male hormone testosterone and the total concentration of pyrethroid.⁴² Han et al. found that 3-PBA is related to increase in luteinizing hormone LH hormone and decrease in estradiol.⁴³ Koureas stated that pesticides appear to be related to endocrine disruption to a certain degree in that six out of seven previous studies found that urine biomarkers of organophosphorus and pyrethroid pesticides are related to the concentration of thyroid and sex hormones.⁴⁰ The finding of the present study is similar to that of previous studies that showed the relationship with male and female hormones in that the odds ratios for lower urinary tract symptoms in the present study were significantly higher for 2- and 3-fractile groups of pyrethroid than 1-fractile group.

This study has some limitations. First, it is highly possible that there may be recall bias in pesticide poisoning symptoms experienced within 48 hours of exposure because it was based on the recollection of past events. The possibility of obtaining similarly high or low scores for both pesticide exposure symptom questionnaire and IPSS cannot be ruled out in farmers who are sensitive or insensitive to their own health even though there is no clearly overlapping item between the two questionnaires because both the questionnaires are focused on symptoms. Second, the present study was conducted over two years, but it cannot be considered as a longitudinal study due to changes in participants. Determining the occurrence and exacerbation of lower urinary tract symptoms and BPH in male farmers and their relationships with pesticide exposure by increasing the number of subjects and ensuring additional follow up in future studies may help to improve the health of these male farmers. Third, biomarkers to objectively assess lower urinary tract symptoms may be necessary because the symptoms were identified with a questionnaire only. Finally, more research is necessary to apply the findings of the present study to all male farmers because only full-time male farmers in specific areas were used as subjects in the present study. This study has some strengths. First, the response rate and reliability of the survey is higher than that of self-reported questionnaires without interviews because the survey was conducted through one-to-one interviews between researchers and the participants. Second, examining the relationship between urine metabolites and lower urinary tract symptoms by measuring urine samples is a major advantage of the present study. Third, determining if the subjects had been diagnosed with BPH and using the information for correction is considered as the third advantage.

5. Conclusion

Although age was highly associated with lower urinary tract symptoms, the possible relationship between pesticide exposure and lower urinary tract symptoms was observed in the present study.

Further research on the relationships between pesticide poisoning symptoms within 48 hours of exposure to pesticides, pyrethroid pesticide, and lower urinary tract symptoms of full-time male farmers are necessary to confirm our findings and inform appropriate interventions.

Declarations

Ethics approval and consent to participate: The present study was approved by the IRB of Dankook University (No.2014-08-003) and written consents were received from the subjects after received an explanation about the research

Consent for publication

Not applicable

Availability of data and materials

The dataset generated during study are not publicly available because the detailed individual data is restricted for both legal and ethical concerns.

Competing interests

The authors declare that they have no conflicts of interest

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Authors' contributions

RS conceptualized the idea, KMG and RS performed the data analyses. SJY and KMG wrote the first manuscript. RS, KMG and SJY revised final manuscript. All authors contributed to the draft of revision and approved the final manuscript.

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