Original Article

Assessment of Cardiovascular Disease Risk in Greenhouse Agriculture Workers Exposed to Pesticide

Derya Adibelli, PhD, RN
Assoc. Prof. Akdeniz University Kumluca Health Science Faculty Department of Public Health Nursing, Antalya, Turkey

Ilknur Ozkan, PhD, RN
Assist. Prof. Akdeniz University Kumluca Health Science Faculty Department of Internal Medicine Nursing, Antalya, Turkey

Emine Ilaslan, PhD, RN
Lecturer. Akdeniz University Kumluca Health Science Faculty Department of Internal Medicine Nursing, Antalya, Turkey

Correspondence: Derya Adibelli, PhD, RN, Assist. Prof. Akdeniz University Kumluca Health Science Faculty Department of Public Health Nursing, Antalya. E-mail: deryaadibelli@akdeniz.edu.tr

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Abstract

Objective: This study was conducted to assess the risk of cardiovascular disease in greenhouse agriculture workers exposed to pesticides.
Methodology: This cross-sectional study was conducted with 244 people working in greenhouse agriculture in a district center. The data collection tool was used; while the software of SPSS 22.0 in their assessment. In analysis, besides descriptive statistics, logistic regression and linear regression analysis were applied.
Results: Most of the participants (69.5%) stated that they had direct contact with the pesticide and 53.0% of them stated that they did not use personal protective equipment. The mean of the risk of cardiovascular disease of the participants is 2.43±2.43 (min-max = 1-14). Peer pesticide application (OR=0.13, p=0.020), respiratory distress (OR=0.24, p=0.019) and cough complaints (OR=4.14, p=0.001) were found to be associated with increased cardiovascular disease risk. In linear regression analysis; waist circumference (p = 0.000) was found to increase the risk of cardiovascular disease.
Conclusions: The CVD risk of the participants was moderate. It was found that some of them experienced symptoms related to the respiratory and nervous system; the existence of respiratory distress and cough complaint, waist circumference were associated with increased CVD risk. Health checks should be carried out periodically in greenhouse workers and training and supervision should be provided on the use of personal protective equipment.

Key Words: Agricultural worker, cardiovascular diseases, greenhouse, pesticides

Introduction

Pesticides are a group of chemicals that are used very often in many areas around the world to combat pests, especially in agriculture. Although the use of pesticides increases the productivity in agricultural fields, they cause water, soil, air pollution and disrupt the balance of the ecological system due to their resistance to natural degradation. Especially organochlorine pesticides soluble in fatty tissue accumulate in the bioecosystem and reach harmful levels for all living things. It is stated that organophosphate and carbamate types of pesticides have a direct negative effect on the central nervous system and liver, cause the destruction in erythrocytes and leukocytes, renal and hepatic

toxicity due to their toxic effects, depressive symptoms, decline in cognitive functions, impairment in neurological functions in practitioners (Izushi & Ogata 1990; Brower et al. 1991; Freire & Koifman 2013). In the studies, it was determined that the pesticide exposure was associated with the risk of fatal and non-fatal myocardial infarction (Schreinemachers 2006; Mills et al. 2009; Dayton et al. 2010), organochlorine group pesticide exposure was found to increase the risk of peripheral artery disease (Min et al. 2011). In one study, abnormal cardiac findings such as pericarditis, auricular thrombus, right ventricular hypertrophy, myocardial interstitial edema were identified in acute organophosphate poisoning (Anand et al. 2009). In addition, there are data regarding the fact that the pesticides used extensively in greenhouse agriculture accumulate in adipose tissue, triggering a large number of health problems (Wang et al. 2011; Achour et al. 2017).

Background

Cardiovascular diseases (CVD) are among the main causes of disease and death in our country as in the whole world. It is estimated that CVD-related deaths will rise to 23.3 million by 2030 (www.who.int/entity/cardiovascular_diseases/en/; CDC 2011). Although there are risk factors of cardiovascular diseases that can and cannot be changed, it the studies, serum lipid profile (Kabakçi et al. 2007), hypertension (Domanski et al. 2002; Glynn et al. 2002), diabetes and smoking (Teo et al. 2006; Anand et al. 2008) were found to be directly associated with the cardiovascular diseases and risk factors. It is considered that besides the factors such as hypertension, diabetes, cholesterol and smoking, the pesticides triggering the inflammation and oxidative stress may also be a risk factor for cardiovascular diseases (Rao et al. 2007; Awang et al. 2011; Mostafalou & Abdollahi 2013).

Determining the cardiovascular disease development risk in greenhouse agriculture workers with high pesticide exposure is very important in terms of the approaches protecting and improving the health. There are numerous risk calculation methods in calculating cardiovascular risk. Framingham Risk Scoring System, SCORE (Systematic Coronary Risk Evaluation), PROCAM, WHO (World Health Organization) Risk Model, JBS-2, QRISK and QRISK 2 are some of them (Kultursay 2011). In the Dyslipidemia Guide, jointly published by the European Society of Cardiology and the European Atherosclerosis Society in July 2011, the use of the SCORE system was suggested (Reiner et al. 2011). This system is based on data from a large European population as well as aims to make risk estimation in cases that are apparently healthy, i.e., clinically showing no symptoms (Kabakci,et al. 2007).

Agricultural workers are a group that is exposed to pesticides and ignored in terms of health problems. During the literature review, small number of studies examining the relationship between pesticide exposure and cardiological abnormality, dysfunction was found (Wahab et al. 2016), but no study examining the risk of cardiovascular disease by the exposure was found. The study was conducted to assess the risk of cardiovascular disease in greenhouse agriculture workers exposed to pesticides.

Research Questions

- What are the health status of those working in greenhouse agriculture?
- What are the blood pressure, total cholesterol, serum glucose, waist circumference, BMI values of those working in greenhouse agriculture?
- What are the cardiovascular risk levels of those working in greenhouse agriculture?
- Is there a relationship between the use of pesticides and the risk of cardiovascular disease?

Methodology

Design: This cross-sectional study was conducted between April 2018 and October 2019 with the greenhouse agriculture workers working in district center of XXX district of XXX province.

Sample: 3786 people, who were working in greenhouse agriculture in the district center where the research was conducted and registered in the greenhouse registration system, constitute the population of the study and 244 people, who agreed to participate in the study, constitute the sample of the study. Those who were not diagnosed with Diabetes Mellitus and heart disease, whose first degree relatives did not have a history of heart disease, worked in the greenhouse agriculture for at least a year, were under 65 years of age, did not have

communication problems and did not receive any psychiatric disease diagnosis were included in the study, those who did not have such criteria were not included in the study. G-Power statistical analysis program was used in the power analysis of the sample of the study (G*Power 3.1.9.2). In the power analysis conducted after the study, the sample was found to provide "94% power in the 95% confidence range with a 2.5% effect size." Cohen's d formula is widely used in calculating the effect size in the studies. The value obtained from the calculations is 0.20= small, 0.50= medium, 0.80= large effect size (Cohen 1988). This value is also used to estimate sample size. Small effect sizes indicate the need for large sampling (Cohen 1988). In addition to these calculations made via the formula, some software programs were developed for power analysis and sample volume determination. When the data about the statistical analyses used in the study were entered into the power analysis software, it defined the 2.5% effect size as "small". In this context, small effect size was taken as the basis for keeping the sample number high.

Measures: The study data were collected by using face-to-face interview method and taking direct measurements from the workers during the break times in the days that the participants was working in the greenhouse. The data collection form used for data collection was prepared by the researchers in accordance with the literature (Garcia-Garcia et al. 2016; Kim et al. 2017).

Data collection form: Consists of three parts. There are 20 questions that evaluate the sociodemographic information of the workers in the first section, their professional information about pesticide application in the second section, and health status information in the third section. The time to fill out the form is approximately 15-20 minutes. In this study, among the risk calculation systems, the Heartscore software, which is the electronic equivalent of SCORE, was used.

Heartscore: In this program, the data on systolic blood pressure, cholesterol value and smoking status were used to calculate a person's 10-year CVD risk. (http://www.heartscore.org/tr_TR). According to the SCORE calculation; <1%= means low risk, ≥ 1% - <5%= medium risk, ≥ 5% - <10%= high risk, ≥10%= very high risk (Ural 2012). Treatment recommendations are planned by considering SCORE risk values and LDL level (Ural 2012).

Blood pressure measurement: It was obtained in a sitting position, from right arm and after at least 5-minute resting, by measuring twice with 20-minute interval and taking the mean of the measurements. Calibrated aneroid sphygmomanometer was used in measuring blood pressure.

Measurement of metabolic variables: Cholesterol and glucose values were studied in capillary blood sample by using Accutrend Plus GCT Glucose & Cholesterol Measurement Device. For glucose measurements, the participants were measured at least 8 hours fasted. In the studies, it was found that the measurement made by using Accutrend Plus by taking blood from capillaries was highly correlated with normal laboratory results and could be used to study lipid profile (RehmanArshad 2013; Conti et al. 2015). It was reported that the measurement made by using this device may be used to determine cardiovascular risk rather than to diagnose hyperlipidemia (Scafoglieri et al. 2012; RehmanArshad 2013; Coqueiro et al. 2014). Characteristics of the Device;

• It is a device that measures blood glucose, total cholesterol, and triglycerides, which are three key tests in the preliminary diagnosis and follow-up of cardiovascular diseases.

• Easy to use and portable system for healthcare professionals and patients.

• During the measurement, the test strips that are ready to use with 1 drop of fingertip blood and can be stored at room temperature are used. Blood is dripped from the fingertip onto the strip, the cholesterol result appears on the screen in about 3 minutes (http://www.rochediagnostics.com.tr/home/diagnostik2/accutrend--plus-sistemi.html).

Anthropometric measurements: Rechargeable and portable height-weight measuring device was used for height-weight measurements, waist circumference measurements were taken with an inelastic plastic tape measure and the body mass index (BMI) values of the participants were calculated (with the formula of kg/m2).

Analytic Strategy: The data were evaluated in SPSS 22.0 software. In addition to descriptive statistics, logistic regression analysis and linear regression analysis were used in multivariate analyses. The means were provided with standard deviation (mean ± SD), and $p<0.05$ was considered

statistically significant.

Ethical Principles: In order to carry out the study, ethics permission was obtained from XXX University Clinical Researches Ethics Committee (XXX) and legal permission (XXX) was obtained from XXX District Health Directorate. The study was conducted in accordance with the Helsinki Declaration Principles (revised in 2013 in Brazil). Prior to the application, the explanations about the purpose of the study, the duration of filling out the questionnaire, the fact that the participation in the study was on a voluntary basis was made and their informed consent was obtained from the participants who wanted to participate in the study after, if any, their questions were answered.

Results

When the sociodemographic characteristics of the participants were examined; it was found that the average age was 50.85±14.40 and the majority were female (79.9%), graduated from primary school (67.1%), did not smoke (79.8%) and did not use alcohol (93.8%). Most of the participants apply pesticides (54.8%), and they mainly apply in the fall-winter-spring season (72.5%). 69.5% of them stated that they had direct contact with the pesticide and 45.1% of them stated that they applied the pesticide by themselves. 53.0% of the participants did not use personal protective equipment, 53.7% of them threw empty pesticide cans into the litter bins on the streets, and 33.9% of them washed their greenhouse clothes at home together with other laundry (Table 1).

When the health status of the participants were examined, more than half (51.2%) described their health status as moderate. 23.0% of the participants reported respiratory distress, 33.2% of them coughs, 29.9% of them stertorous respiration, 27.0% of them tremors-numbness in hands and feet, 22.1% of them walking and balance impairment, 16.4% of them inability to urinate, and 33.2% of them edema in hands and feet. When the averages of the participants' metabolic variables (together with min-max. values); it was observed that systolic blood pressure average was 125.53±21.83 (80-220 mmHg), diastolic blood pressure average was 80.94±11.70 (60-120 mmHg), total cholesterol average was 186.48±35.37 (140-400 mg/dl), serum glucose average was 126.86±53.43 (67-399 mg/dl), waist circumference average was 97.74±15.08 (58-136 cm), BMI average was 29.99±5.69 (15.24-45.20), and risk of CVD was 2.43±2.43 (1-14) (Table 2).

In multivariate analysis made by using logistic regression, while it was determined that the pesticide application (OR=1.68, p=0.392), direct contact with the pesticide (OR=1.54, p=0.431) and not to use personal protective equipment (OR=1.55, p=0.226) did not increase the risk of the CVD, peer pesticide application (OR=0.13, p=0.020) was associated with the risk of the CVD. It was determined that the gender (OR=0.10, p=0.000) was associated with the CVD risk and the risk increased in women, and smoking (OR=16.18, p=0.000) increased the CVD risk (Table 3).

In the multivariate analysis in which the relationship between some health problems of the participants and CVD risk was examined, it was determined that the respiratory stress (OR=0.24, p=0.019) and cough complaints (OR=4.14, p=0.001) in the participants associated with the increased CVD risk (Table 4).

In the linear regression analysis in which the relationship between participants' waist circumference and CVD risk was examined; it was determined that waist circumference (p=0.000) increased the CVD risk (Figure).

Table 1. Distribution of Socio-Demographic Characteristics of the Participants (n=244)

Characteristics	n	%
Sex		
Female	195	79.9
Male	49	20.1

Educational Status		
Illiterate	22	9.1
Literate	6	2.5
Primary school	163	67.1
Secondary school	17	7.0
High school	17	7.0
University and higher	18	7.3
Smoking		
Yes	49	20.2
No	195	79.8
Using alcohol		
Yes	17	6.2
No	227	93.8
Pesticide application		
Yes	136	54.8
No	108	45.2
The season when the pesticide is applied the most		
Autumn-Spring	113	72.5
Summer	23	14.7
Throughout the year	20	12.8
Direct contact with the pesticide		
Yes	121	69.5
No	53	30.5
The person applying the pesticide		
Me	88	45.1
My spouse	42	21.5
Children	9	4.6
Other workers	56	28.8
Personal protective equipment usage		
I do not use	98	53.0
I use	87	47.0
Empty pesticide cans		
I am leaving them at the greenhouse where I worked	1	0.5
I dispose of them into the litter bins on the streets	99	53.7

I bury them under the ground	11	5.9
I send them for recycling	42	22.8
I burn them in the fire	15	8.3
Other	17	9.8
Washing the greenhouse clothes together with other laundries		
Yes	63	33.9
No	123	66.1
Age Average		30.14±5.58

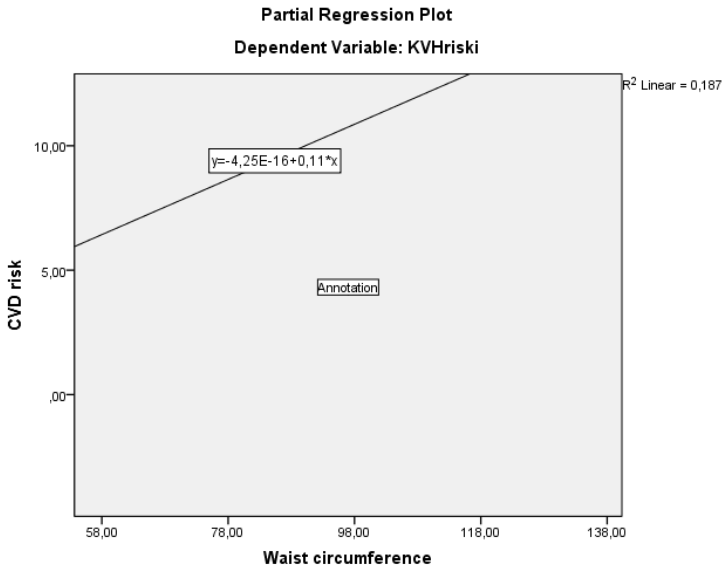

Figure. Multiple Linear Regression Analysis of the Relationship between Waist Circumference and Cardiovascular Diseases Risk of Participants

Table 2. Distribution of Health Status and Stories of the Participants (n=244)

Characteristics	**n**	**%**
Description of the Health Status		
Bad	22	9.0
Moderate	125	51.2
Good	93	38.1

Very good	4	1.6
Respiratory distress		
Yes	56	23.0
No	188	77.0
Cough		
Yes	81	33.2
No	163	66.8
Wheezing respiration		
Yes	73	29.9
No	171	70.1
Tremor-numbness in hands and feet		
Yes	66	27.0
No	178	73.0
Walking and balance impairment		
Yes	54	22.1
No	190	77.9
Inability to urinate		
Yes	40	16.4
No	204	83.6
Edema in hands and feet		
Yes	81	33.2
No	163	66.8
Systolic blood pressure mean	125.53±21.83	
Diastolic blood pressure mean	80.94±11.70	
Total cholesterol mean	186.48±35.37	
Serum glucose mean	126.86±53.43	
Waist circumference mean	97.74±15.08	
BMI* mean	29.99±5.69	
CVD risk** mean	2.43±2.43	

*Body Mass Index, **Cardiovascular disease risk

Table 3. Logistic Regression Analysis for the Relationship of Pesticide Use and Some Characteristics of the Participants with the Cardiovascular Diseases Risk

Variables	Odds Ratio (95% GA)	p*
	CVD Risk	
Pesticide application[a,b]	1.68 (0.51-5.55)	0.392
Direct contact with the pesticide[a,b]	1.54 (0.52-4.59)	0.431
The person applying the pesticide[c]	0.13 (0.02-0.72)	0.020
Personal protective equipment usage[a,b]	1.55 (0.76-3.18)	0.226
Gender[1,2]	0.10 (0.04-0.25)	0.000
Smoking[a,b]	16.18 (6.60-39.66)	0.000

*p<0.05, [1]Female, [2]Male, [a]No, [b]Yes, [c]Peer application

Table 4. Logistic Regression Analysis for the Relationship of Some Health Problems of the Participants with the Cardiovascular Diseases Risk

Variables	Odds Ratio (95% GA)	p*
	CVD Risk	
Respiratory distress[a,b]	0.24 (0.07-0.79)	0.019
Cough[a,b]	4.14 (1.79-9.56)	0.001
Wheezing respiration[a,b]	2.37 (0.82-6.89)	0.111
Tremor-numbness in hands and feet[a,b]	0.53 (0.20-1.40)	0.204
Walking and balance impairment[a,b]	1.07 (0.38-3.01)	0.888
Inability to urinate[a,b]	1.85 (0.81-4.81)	0.204
Edema in hands and feet[a,b]	0.41 (0.15-1.08)	0.72

*p<0.05, [a]Yes, [b]No

Discussion

Since no study examining the CVD risk in greenhouse farming was found in the literature, the findings of this study were discussed with the existing literature. The majority of the participants stated that they applied the pesticides mostly in autumn-winter-spring season and generally applied them by themselves. In a retrospective study conducted in the Mediterranean region supporting our study, it was determined that the pesticides were mostly applied in the fall-winter-spring months in greenhouse agriculture (Adibelli et al. 2019). From these results, it was understood that there was pesticide use in ¾ of the year and that participants were exposed to pesticides either indirectly or directly.

In the study, most of the participants stated that they had direct contact with the pesticide. It was

determined more than half of the participants did not use personal protective equipment, threw empty pesticide cans into the litter bins on the streets, and washed their greenhouse clothes at home together with other laundry. During the data collection process, some participants stated that they disposed of empty pesticide cans into water channels and streams. Waste management and recycling of plastic wastes are extremely important today, however, it is observed that these plastic wastes containing chemical residues are left unconsciously to nature and there is a serious lack of awareness among agricultural workers. It is also possible that the pesticides used may adversely affect health by reducing the antioxidant system and catalase activity which provides the balance between the formation and removal of free radicals in the body, and by causing peroxidation in the cells. Considering that they will continue for many years in their professional lives and will be exposed to the toxic effect of pesticides for many years, this exposure may cause the increase in the risk of diseases, in which the reactive oxygen derivatives had a role, such as cancer, various heart diseases, premature aging, arthritis, cataracts. It can open (Comelekoglu & Mazmanci 2000). However, in order to prevent the exposure of workers to the harmful effects of pesticides, it was reported, even in the sales of pesticides, that 98% of the exposure of the skin to pesticides can be prevented by the use of appropriate personal protective equipment (Cakar et al. 2013). When the literature is examined, getting the results that occupational diseases and health problems are high in agricultural workers in the world indicates that the personal protection is inadequate or flawed, and that pesticide practitioners have insufficient knowledge about storing, applying and disposing of these products (Sankoh et al. 2016; Elibariki & Maguta 2017; Sharifzadeh et al. 2017). In other studies conducted in our country, it was determined that the rate of personal protective use during pesticide applications ranged between 13-41% and that the workers had insufficient knowledge about pesticide application (Ergonen et al. 2005; Sahin et al. 2010; Yavuz et al. 2014).

In the study, some of the participants stated that they had respiratory distress, coughing, stertorous respiration, tremor-numbness in hands and feet, walking and balance impairment, inability to urinate and edema in hands and feet. Chronic exposure to pesticides may cause adverse effects on the nervous system, endocrine system, cardiovascular system, thyroid function (Toft et al. 2006; Piccoli et al. 2016). In a study of the presence of neurological symptoms in the children of agricultural workers exposed to pesticide, the symptoms such as headache, dizziness, excessive sweating, tremor, muscle weakness, insomnia, headache, and numbness in the lower extremities were identified in children exposed to pesticide (Rastogi et al. 2010). In the studies, it was indicated that exposure to pesticides reduces cholinesterase levels (Suemizu et al. 2014; Garcia-Garcia et al. 2016) and low cholinesterase levels increase the findings of asthma-related lung inflammation (Dalvie et al. 2010). Since the pesticides also contain respirable components (Amaral 2014), the respiratory tract is one of the most common ways of affecting. In the studies in which respiratory functions of the greenhouse workers were examined, it was expressed that chronic cough, dyspnea, rhinitis, bronchial hyperactivity, asthma-related symptoms were observed at a high rate (Hoppin et al. 2008; Hernandez et al. 2011; Amaral 2014; Henneberger et al. 2014; Quansah et al. 2016) and that even non-occupational exposure caused respiratory problems (Ye et al. 2017). These data in the literature are in line with our findings.

When the mean of the metabolic variables of the participants was examined; the mean values of the variables affecting the CVD risk were normal, however, from the perspective of min-max values, it was observed that the systolic blood pressure of the sample group was max. 220 mmHg, total cholesterol value was max. 400 mg/dl, serum glucose value was max. 399 mg/dl. Although the mean waist circumference (97.74 ± 15.08) and the mean BMI (29.99 ± 5.69) of the data set were high, the risk of CVD was moderate (2.43 ± 2.43). Although there is data in the literature that the increase in the BMI increases the level of pesticides in adipose tissue (Stellman et al. 2000; Muscat et al. 2003; Munoz-de-Toro et al. 2006; Arrebola et al. 2010; Brauner et al. 2012), the opposite data were also available (Fernandez et al. 2008; Moon et al. 2012). The high waist circumference used in the detection of abdominal adiposity (95.77±15.18 in females, 105.55 ± 11.91 in males) supports the relationship between pesticide exposure and adipose tissue. Although waist circumference measurement is not

used to calculate CVD risk in SCORE software, it is known that abdominal fat increase is directly related with cardiac dysfunction, sudden heart attack and CVD risk (Onat et al. 2003; Adibelli & Kilic 2017). The CVD risk is a finding that occurs in a long period. In this study, although the CVD risk was found to be moderate (according to the SCORE risk calculation), high waist circumference measurements revealed a risk in terms of the cardiac functions.

In the study, it was determined that pesticide application, direct contact with pesticide and use of personal protective equipment did not affect the CVD risk. Unlike the results of the study, Goncharov et al. (2008) reported that polychlorinated biphenyls (the PCBs) increase the synthesis of cholesterol and triglycerides and are important risk factors for direct cardiovascular disease. At the conclusions of eight studies examined in a systematic review, it was determined that the various electrocardiogram (ECG) changes occurred in acute pesticide intoxication and the most common abnormality were long-term QT interval. In the same study, it was indicated that pesticide exposure was associated with increased cardiovascular disease risk and cardiovascular mortality risk (Wahab et al. 2016). In another study, it was suggested that cardiovascular effects may be caused by the introduction of pesticides into the bloodstream via the respiratory tract or by increased cholinergic activity leading to prolonged depolarization at the nerve endings (Kim et al. 2014). In a study different from our study findings, it was determined that the negative effects of pesticides on health varied depending on the type of pesticide, precautions taken during the application, and age and health status of the sample (Damalas & Eleftherohorinos 2012).

In the study, it was determined that peer pesticide application was related to the CVD risk. In a study, it was determined that other family members applying pesticides were exposed to pesticide residues that came from shoes used in the greenhouse, clothes of farmworkers and were dragged outdoors as aerosols when they were sprayed (Damalas & Eleftherohorinos 2012). In this respect, the risk of CVD may be increased with increased exposure in peer pesticide applicants.

In the study, it was found that gender was associated with CVD risk, the risk in women was higher, and smoking increased the CVD risk. Although smoking is one of the main components used in the calculation of the CVD risk, there is a great deal of evidence about the negative effects of smoking on cardiological functions (Teo et al. 2006; Anand et al. 2008). The fact that the CVD risk in women increased was emphasized in many studies in recent years (Ford & Capewell 2007; Engbending & Wenger 2008; Kuznar 2010). Moreover, the fact that the majority of the sample group was female in this study may have affected the finding between gender and the CVD risk.

In the study, it is found that respiratory distress and cough were associated with increased CVD risk. Consistent with our study findings, Peiris-John et al. (2005) reported that the absorption of organophosphate group pesticides is rapid by inhalation and most of them enter the systemic circulation directly through the liver where they are metabolized and cause cardiac disorders. Considering that the cardiovascular system is closely related to the respiratory system in terms of oxygen delivery to tissues, it is expected that the cardiovascular system is affected by the changes in the respiratory system.

It was found that the systolic blood pressure, waist circumference and total cholesterol levels of the participants increased the CVD risk. Systolic blood pressure and total cholesterol levels are two important metabolic variables used in the calculation of the CVD risk and are expected to be associated with the CVD risk. Although many risk factors were identified for cardiovascular diseases, dyslipidemia, smoking, high blood pressure, and obesity account for 80% of the risk (Jellinger et al. 2017). It is thought that dyslipidemia may be a prerequisite rather than a major factor for CVD risk (Jellinger et al. 2017). Obesity and abdominal adiposity are independent risk factors for CVD and strongly correlate with insulin resistance (Jellinger et al. 2017). The waist circumference of ≥94 cm in Turkish men and ≥80 cm in Turkish women indicates abdominal adiposity. The fact that, in this study, the waist circumference measurements is high in men and women and that it is found to be associated with the CVD risk is in parallel with the literature findings.

Limitations of the Study: The area where the study

is conducted is a settlement where the greenhouse farming is applied intensively. However, due to the nature of the study, for the necessity of making capillary measurements and receiving anthropometric measurements, so some of the greenhouses in the district center could not be visited during working hours. Due to the fasting of at least 8 hours for serum glucose measurement, the measurements could not be taken in some data collection areas. Furthermore, since this study is limited to the reportings and metabolic measurements of the people living in a district center and working in greenhouse farming it cannot be generalized to the whole society.

Conclusion: In the study, it was found that most of the participants applied the pesticide themselves, had direct contact with the pesticide, and more than half of them did not use personal protective equipment. In the study, while the CVD risk of the participants was determined as moderate, some of them experienced the symptoms related to the respiratory and nervous systems. Being female, peer pesticide application, respiratory distress and cough complaints, systolic blood pressure, waist circumference, and total cholesterol levels were found to be associated with increased CVD risk.

In line with these results:

- The training and supervision on the use of personal protective equipment during pesticide applications are absolutely necessary.
- Considering that the CVD risk occurs over the years with the combination of some components, it is necessary to minimize the use of pesticides in order to avoid chronic effects of pesticide exposure and to increase the use of biological agents in obtaining efficient and quality products.
- In terms of the responsibilities of the health professionals; health checks should be carried out in greenhouse workers at certain periods during the year, the trainings should be conducted on subjects such as smoking, nutrition and physical activity for health-protective behaviors and when deviations from health are detected, the workers should be referred to the health institutions for early diagnosis.
- Within the scope of preventive health services, the public health and family health nurses serving in the region where the greenhouse farming is intensively applied; the annual CVD risks of the workers should be monitored and referred to the lifestyle changes or medical treatment according to their risk levels.

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