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Health effects of agricultural pesticides.

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Abstract

As widely used agricultural chemicals, pesticides are main source of air, water and soil pollution. They are also significant risk factors on human life not only effects on health as a result of misuse or accident, but also via leave a lasting harmful chemicals into the environment. The aim of this study is to investigate relationship between pesticides and human health. OECD environment statistics and WHO health statistics are used for the analysis. Pesticides variables are defined as insecticide, fungicide, herbicide and other pesticides sales, tonnes of active ingredients. Quality of life variables are defined as lung cancer (DALYs/1000 capita) per year, asthma (DALYs/1000 capita) per year, Chronic Obstructive Pulmonary Disease-COPD (DALYs/1000 capita) per year, respiratory infection (DALYs/1000 capita) per year, cardiovascular disease (DALYs/1000 capita) per year, under age 5 mortality rate per 1000 live births. Canonical correlation analysis is used to explain the correlation between two data sets. As a result, it has been found positive associations between agricultural pesticide use and health risk. Insecticide has the most negative effect on the health. The present study finds no significant relationship between fungicide/herbicide sales and health factor. There is a strong significant positive link between pesticide sales and under age 5 mortality rate. Pesticide has also an impact on respiratory infection and cardiovascular disease. Production, use, storage, packaging and disposal of packaging after use processes of pesticides should be controlled. The use of pesticides should be minimized by the policies such as biological management of the pest and good agricultural practices.

Keywords: Environment; Good agricultural practices; Health; Occupational health and safety in agriculture, Pesticide.

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Introduction

Pesticides represent widely used chemical substances in agriculture to increase production and quality through controlling pests and pest-related diseases. The widespread use of pesticides is a significant source of air, water and soil pollution. Pesticides are also very important risk factors on human life not only effects on health as a result of misuse or accident, but also via leave a lasting harmful chemicals into the environment.

The majority of pesticides are not specifically targeting the pest, during the application non-target plants and animals are also affected. It has been estimated that only about 0.1% pesticides reach the target organisms and the remaining applied pesticides contaminates the surrounding environment [1]. All creatures, humans and the environment are at risk of adverse effects of pesticides but especially agricultural workers and family members of pesticide applicators have the highest risk of exposure [2]. The leading causes of work-related pesticide exposures are accidental spillage of pesticides, leakages from its packaging, not using or incorrect uses of equipment, and failure to comply with safety guidelines [3]. People may be exposed to pesticides by producing, transporting, preparing for application, applying or entering pesticide-applied area [3,4]. Using pesticides-effected material or product is also a main source of exposition.

The effects of agricultural pesticides on non-target organisms continue to become a major problem in the society. Many studies have examined the effects of pesticides exposure on a lot of health problems especially the risk of cancer. The purpose of this study is to analyze the impact of pesticides used in agriculture applications on human health using data from OECD environment statistics and WHO health statistics.

Materials and Methods

Data

Data of this study was collected from 20 countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom and Turkey). For this study, the countries were selected due to data quality and data availability both of

OECD environment statistics and WHO health statistics. WHO statistics were used as the main source of health risk (Estimates based on Comparative Risk Assessment, evidence synthesis and expert evaluation for regional exposure and WHO country health statistics-2004 by WHO) [5] data set (Y variables set) and are defined as;

y1: Lung cancer (disability-adjusted life years (DALYs) /1,000 capita) per year.

y2: Asthma (DALYs/1,000 capita) per year.

y3: Chronic Obstructive Pulmonary Disease-COPD (DALYs/1,000 capita) per year.

y4: Respiratory infection (DALYs/1,000 capita) per year.

y5: Cardiovascular disease (DALYs/1,000 capita) per year.

y6: Under age 5 mortality rate per 1,000 live births.

OECD environment statistics were used as the main source of pesticide (sales tonnes of active ingredients, average 2004-2011) [6] data set (X variables set) and are defined as follows;

x1: Insecticide sales, tonnes of active ingredients.

x2: Fungicide sales, tonnes of active ingredients.

x3: Herbicide sales, tonnes of active ingredients.

x4: Other pesticides sales, tonnes of active ingredients.

Statistical method

In this study, canonical correlation analysis (CCA) is used to explain the linear correlation combination between X and Y variable sets by using XLSTAT and NCSS package programs. CCA is a way of measuring the linear relationship between two multidimensional variables as one of the most general multivariate techniques. For more information about CCA, see references [7].

Results

Descriptive statistics (the mean values and standard deviation) of each variable considered in both sets are presented in Table 1.

Table 1. Descriptive statistics.

Type	Variable	Mean	Standard Deviation
Y	Lung cancer	1.195	0.445
Y	Asthma	0.75	0.274
Y	COPD	0.58	0.307
Y	Respiratory infection	0.48	0.419
Y	Cardiovascular disease	3.88	1.317
Y	5> mortality	5.9	4.898
X	Insecticide	952.85	1876.414
X	Fungicide	4599.65	8039.013
X	Herbicide	4783	5867.554
X	Other pesticides	1899.95	2672.179

The Pearson's correlations between health risk and pesticide variables are presented in Table 2. According to the result of the current study, the association between under age 5 mortality rate per 1,000 live births and insecticide sales is very strong. Insecticide is also positively correlated with respiratory infection and cardiovascular disease. There is also a positive relationship between other pesticides sales and under age 5 mortality rate.

Table 2. *Correlation matrix.*

Variables	Lung cancer	Asthma	COPD	Respiratory	Cardiovascular	5> mortality	Insecticide	Fungicide	Herbicide	Other
Lung cancer	1	-0.50	0.50	-0.24	0.56	-0.12	0.00	0.08	0.21	0.07
Asthma	-0.50	1	-0.06	0.10	-0.50	0.16	-0.04	-0.01	0.02	0.15
COPD	0.50	-0.06	1	0.04	0.29	0.18	0.12	-0.28	-0.10	-0.08
Respiratory	-0.24	0.10	0.04	1	0.34	0.80	0.67	-0.14	-0.14	0.21
Cardiovascular	0.56	-0.50	0.29	0.34	1	0.30	0.36	-0.22	-0.09	-0.05
5> mortality	-0.12	0.16	0.18	0.80	0.30	1	0.91	-0.01	0.09	0.46
Insecticide	0.00	-0.04	0.12	0.67	0.36	0.91	1	0.20	0.22	0.58
Fungicide	0.08	-0.01	-0.28	-0.14	-0.22	-0.01	0.20	1	0.85	0.84
Herbicide	0.21	0.02	-0.10	-0.14	-0.09	0.09	0.22	0.84	1	0.84
Other	0.07	0.15	-0.08	0.21	-0.05	0.46	0.58	0.84	0.84	1

The test statistics for the canonical correlation analysis are presented in Table 3. The canonical correlation between the

first pair (0.966) was found to be significant ($p<0.01$) from the likelihood ratio test. The remaining canonical correlation is not statistically significant ($p>0.05$).

By construing the first canonical variate it is possible to find relationship between health risk and pesticide as rate of 93 %. For the variate there is very strong significant correlation between health risk and pesticide.

Table 3. *Canonical correlations section.*

Variate Number	Canonical Correlation	R-Squared	F-Value	Num DF	Den DF	Prob Level	Wilks' Lambda
1	0.966212	0.933566	2.97	24	36	0.001563	0.022379
2	0.648965	0.421156	0.99	15	31	0.487475	0.336858

F-value tests whether this canonical correlation and those following are zero.

The first canonical variate suggests that about 26.8% of the variation in Y variables is explained by the X variables and about 27% of the variation in X variables is explained by the Y variables. To evaluate the important accounts of the significant canonical function, canonical loadings were used in this study. Canonical loadings greater than ± 0.30 were considered to be important. The variable-variate correlations (canonical loadings and canonical cross loadings) of the first canonical variate are presented in Table 4. Under age 5 mortality rate per 1,000 live births, insecticide sales, respiratory infection, other pesticides sales and cardiovascular disease are the most influential variables in forming Y1 and X1. This means, insecticide has the most negative effect on the health. The present study finds no significant relationship between fungicide/herbicide sales and health factor. There is a strong significant positive link between pesticide sales and under age 5 mortality rate. Pesticide has also an impact on respiratory infection and cardiovascular disease.

Table 4. *Variable-Variate Correlations (canonical loadings and canonical cross loadings).*

	Y1	X1
Lung cancer	-0.01	-0.01
Asthma	-0.06	-0.06
COPD	-0.24	-0.23
Respiratory	-0.73	-0.73
Cardiovascular	-0.40	-0.38
5> mortality	-0.99	-0.95
Insecticide	-0.92	-0.95
Fungicide	0.01	0.01
Herbicide	-0.12	-0.13
Other	-0.47	-0.48

Discussion

Because of their inherent toxicity and widespread use, pesticides are recognized as an important health risk and a serious threat to public health. Several studies frequently show associations between pesticides exposure and their health effects. Children are the most vulnerable group because of age-related potential pesticide exposure risk and more exposure effect on their small body mass.

A positive association between the direct exposure of children to pesticides and cancer has been put forward [8]. Several epidemiological studies also show that relative risks of cancer occurrence in children are associated with parental exposure to pesticides [9,10]. Matching pesticide data and medical records a study reported that pregnant women living nine miles of farms where pesticides are sprayed have an increased risk of losing an unborn baby to birth defects [11]. Parallel to these results we found positive relationship between pesticide (especially insecticide and other pesticide) and under age 5 mortality rate. It is reported that there is a strong relationship between herbicides/insecticides and asthma diagnosis before 5 years of age [12].

Results from several studies, support our finding, reported that pesticide exposure negatively affects the cardiovascular and respiratory system [13,14]. Correlation between pesticide exposure and chronic respiratory symptoms and respiratory disease was also suggested by former studies [15,16].

The epidemiological researches about pesticide exposure in humans and cancer risk have been studied for many years. Some studies reported that there is no clear link between pesticide exposure and lung function. The most similar to ours, researchers reported no statistically significant consistent associations between agricultural pesticide use and lung cancer [17,18]. But different from these results, it was reported that there is an important risk of lung cancer among women exposed to pesticides at work [19]. A positive link has also been found between pesticides and breast or prostate cancers [20]. An additional risk of lung cancer was stated among vineyard workers exposed to arsenic-based pesticides [21].

Although no statistically significant association, support our finding, was reported [22] most epidemiological studies have suggested positive links between agricultural pesticide use and asthma [15,23,24]. Pesticides exposure may be a risk factor for asthma among agricultural workers. It has been found that pesticides may be an overlooked contributor to asthma risk among farmers [23]. A study also suggested that pesticide exposure could play a role in allergic asthma [24].

Conclusion

A primary objective of policies around the world is to protect human health. In this paper the relationship between some health risk and pesticide sales is analysed. The results show that pesticides have an effect on human health. Besides

contributing to the literature, the findings also highlight the need to take this association into account for community development policies and programs. Production, use, storage, packaging and disposal of packaging after use processes of pesticides, which is a very important risk factor on human health and the environment, should be controlled. Farmers should be informed about misuse, intentionally harmful use of non-purpose thread or application errors such as protective clothing use during application, comply with the rules of personal hygiene, overdose and unnecessary duplication, exposure and contacting to chemicals via educational programs. Safe use of pesticides should be provided. Chemicals are causing persistent organic pollutants should be banned. Prohibited (such as DDT) and restricted hazardous chemicals should be controlled more effectively. The use of pesticides should be minimized by the policies such as biological management of the pest and good agricultural practices. This paper suggests valuable results for further studies by identifying the effect of pesticides on human health.

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