UNIVERSITI PUTRA MALAYSIA

OCCURRENCE OF AZOXYSTROBIN, PYMETROZINE AND TEBUCONAZOLE IN PERSONAL AIR SAMPLES AND THEIR REPORTED HEALTH SYMPTOMS AMONG PADDY FARMERS AND NON-EXPOSED GROUP IN TANJUNG KARANG, SELANGOR

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BY

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ABSTRACT

OCCURRENCE OF AZOXYSTROBIN, PYMETROZINE AND TEBUCONAZOLE IN PERSONAL AIR SAMPLES AND THEIR REPORTED HEALTH SYMPTOMS AMONG PADDY FARMERS AND NON-EXPOSED GROUP IN TANJUNG KARANG, SELANGOR

NORHAZWANI BINTI ZAMRI

Introduction: Malaysia is one of the countries that put huge efforts in strengthening their paddy and rice industry due to its vital significance as country's staple food. Hence, in an effort to improve production yield, the use of pesticides consequently prevalent and act as a crucial tool. However, pesticides contamination has become unavoidable problems especially among paddy farmers who are constantly handling pesticides as it gives variety of adverse health symptoms. **Objective:** To determine the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in the personal air samples and their reported health symptoms among paddy farmers and non-exposed group. **Methodology:** A comparative cross-sectional study was conducted among 85 paddy farmers and 85 non-exposed group in Kampung Sawah Sempadan, Tanjung Karang, Selangor by convenient sampling. All respondents were required to answer a set of questionnaires. A solid sorbent tube (XAD-2 resin) with a clip was attached to the respondents' breathing zone and an air pump fastened to the belt to collect the personal air samples. Pesticides collected in the XAD-2 resin were extracted with acetone, centrifuged, concentrated via nitrogen blowdown and reconstituted with 1mL of 3:1 ultrapure water: methanol solution. The extract was analysed by using Ultra-high-performance chromatography tandem mass spectrometry (UHPLC-MS/MS). **Results and Discussion:** The maximum concentrations of azoxystrobin, pymetrozine and tebuconazole found in personal air samples were 53.80ng m^{-3}, 365.80ng m^{-3} and 337.10ng m^{-3}) respectively. The concentrations of target compounds were significantly different among paddy farmers and non-exposed group There was significant difference on reported health symptoms such as breathing difficulties, chest pain, nausea, vomiting and runny nose among paddy farmers and non-exposed group. Other than that, there was significant association between sociodemographic background (age and level of education) and reported health symptoms among paddy farmers as compared to non-exposed group. There was significant association between lifestyle (smoking status, consumption of vegetables and fruits once a week and exercise practice) and reported health symptoms among paddy farmers as compared to non-exposed group. There was significant association between concentration of pymetrozine and tebuconazole with reported health symptoms among paddy farmers as compared to non-exposed group **Conclusion:** The findings in this study can be beneficial in terms of risk management within agricultural community.

Keywords: Pesticides, inhalation, reported health symptoms, personal air samples, paddy farmers

ABSTRAK

KEJADIAN AZOXYSTROBIN, PYMETROZINE DAN TEBUCONAZOLE DI DALAM SAMPEL UDARA PERIBADI DAN GELAJA KESIHATAN YANG DILAPORKAN DALAM KALANGAN PESAWAH PADI DAN KUMPULAN TIDAK TERDEDAH DI TANJUNG KARANG, SELANGOR

NORHAZWANI BINTI ZAMRI

Pengenalan: Malaysia adalah salah satu negara yang menitikberatkan industri padi dan beras kerana ia penting sebagai makanan ruji. Oleh itu, dalam usaha untuk meningkatkan hasil pengeluaran, penggunaan racun perosak semakin berleluasa. Walau bagaimanapun, pencemaran racun perosak telah menjadi masalah yang tidak dapat dielakkan terutamanya dalam kalangan pesawah padi kerana ia memberi pelbagai gejala kesihatan yang negatif. **Objektif:** Untuk menentukan kepekatan racun perosak (azoxystrobin, pymetrozine dan tebuconazole) di dalam sampel udara peribadi dan gejala kesihatan yang dilaporkan dalam kalangan pesawah padi dan kumpulan tidak terdedah. **Metodologi:** Kajian rentas keratan perbandingan ini dilakukan dalam kalangan 85 pesawah padi dan 85 kumpulan tidak terdedah di Kampung Sawah Sempadan, Tanjung Karang, Selangor dengan menggunakan persampelan secara mudah. Semua responden dikehendaki menjawab satu set borang soal selidik. Tiub sorben pepejal (resin XAD-2) beserta klip diletakkan di bahagian zon pernafasan responden dan pam udara disangkut pada tali pinggang untuk mengumpul sampel udara peribadi. Racun makhluk perosak yang terkumpul di dalam resin XAD-2 telah diekstrak dengan menggunakan aseton, disentrifugasi, ditumpukan melalui tamparan nitrogen dan dibentuk semula dengan 1mL 3: 1 air ultrapure: penyelesaian metanol. Ekstrak itu dianalisis dengan menggunakan spektrometri massa ultra kromatografi berprestasi tinggi (UHPLC-MS / MS). **Keputusan dan Perbincangan:** Kepekatan maksimum azoxystrobin, pymetrozine dan tebuconazole yang terdapat dalam sampel udara peribadi ialah 53.80ng m^{-3}, 365.80ng m^{-3} dan 337.10ng m^{-3}. Kepekatan kompound sasaran adalah berbeza dalam kalangan pesawah padi dan kumpulan tidak terdedah. Terdapat perbezaan yang signifikan terhadap gejala kesihatan yang dilaporkan seperti kesukaran bernafas, sakit dada, mual, muntah dan hidung hidung dalam kalangan pesawah padi dan kumpulan tidak terdedah. Selain itu, terdapat hubungan yang signifikan antara latar belakang sosiodemografi (umur dan tahap pendidikan) dengan gejala kesihatan yang dilaporkan dalam kalangan pesawah padi berbanding kumpulan yang tidak terdedah. Terdapat juga hubungan yang signifikan antara gaya hidup (status merokok, penggunaan sayur-sayuran dan buah-buahan seminggu sekali dan amalan senaman) dengan gejala kesihatan dalam kalangan pesawah padi berbanding kumpulan yang tidak terdedah. Terdapat hubungan yang signifikan antara kepekatan pymetrozine dan tebuconazole dengan gejala kesihatan yang dilaporkan dalam kalangan pesawah padi berbanding dengan kumpulan tidak terdedah. **Kesimpulan:** Penemuan dalam kajian ini boleh memberi manfaat dari segi pengurusan risiko dalam komuniti pertanian.

Kata kunci: Racun serangga, pernafasan, gejala kesihatan yang dilaporkan, sampel udara peribadi, pesawah padi

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LIST OF ABBREVIATIONS

IADA	Projek Pembangunan Pertanian Bersepadu
FAO	Food and Agriculture Organization
NIEHS	National Institute of Environmental Health Sciences
MSDS	Material safety data sheet
PPE	Personal protective equipment
NAFP	National Agro-food Policy
USEPA	United State Environmental Protection Agency
HQ	Hazard Quotient
FDA	Food and Drug Administration
FAO	Food and Agriculture Organization
SDH	Social Determinants of Health
UHPLC MS/MS	Ultra-High-Performance Liquid Chromatography Tandem Mass Spectrometry
AHS	Agriculture Health Study
ESI	Electrospray ionization
HCL	Hydrochloric acid
IDL	Instrumental detection limit
IQL	Instrumental quantification limit

MDL	**Method detection limit**
MQL	**Method quantification limit**
R^2	**Regression coefficient**
S/N	**Signal to-noise-ratio**
RSD	**Relative standard deviation**
WHO	**World Health Organisation**
SPSS	**Statistical Package for the Social Science**
RRF	**Relative response factor**
RSC	**Royal Society of Chemistry**

CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture in Malaysia involves crops planting, livestock rearing and fishery. With no expectation, Malaysia is one of the countries that put huge efforts in strengthening its food security. It is proven by the Malaysia trend of rice production and consumption (Ye, Beach, Martin, & Senthilselvan, 2017). Shaffril et al., (2010) also pointed out that it become more concerned among society due to assure the consistency of supplying food and being a vital medium in solving poverty. Norimah et al. (2008) stated that Malaysian adult population consumed an average of two and half plate of rice daily. Therefore, within the rapidly growing population, the enhancement in the productivity of local rice is compulsory.

Rice are vastly grown around 300,500 ha of land in Peninsular Malaysia whereas 190,000 ha in East Malaysia (Ahmad and Tahar, 2014). Adam and El Pebrian (2017) mentioned that, almost 300,000 farmers involved in the paddy cultivation activity in Malaysia. Indeed, the temperature regime and the precipitation dissemination in the country also are reasonable for all year cultivation of rice. There are several major cultivation sites that has been identified; Kemubu Agricultural

Development Authority (Kelantan) (KADA), Kedah, Kelantan, and Northwest Selangor project, Seberang Perai "Projek Pembanguan Pertanian Bersepadu" (IADA), Penang, Perak and Katara (Adnan, Nordin, & Ali, 2018). As cited from the Ministry of Agriculture and Agro-based Industry (MARDI,2010), 72% of the total demand for rice in Malaysia contributed by IADA, the main paddy producing area.

According to World Health Organization (WHO) (2018), around the world more than 1000 pesticides applied and every of them associated with different properties and toxicological effects. The pesticides can kill living organisms (e.g., weeds (herbicides), insects (insecticides), fungus (fungicides) and rodents (rodenticides) (Kim, Kabir, & Jahan, 2017). Likewise, they are prevalent in an effort to improve production yield and act as an alternative to sustain in land productivity, reduce crop damage problems as well as to ensure that the quantity and quality of agricultural products (Hamsan et al., 2017). Regardless of the intensive use of pesticides, it may not only result in high residues in the crops but also the environment via the process of leaching, run off, erosion, aerial drift or volatilization of the pesticides (Zaidon et al., 2018).

Previously, notification related to health effects of pesticides also have been shortlisted. Exposure through consumption, dermal contact and inhalation caused the persistent nature and high toxicity of these pesticides. Moreover, Kim et al. (2016) revealed that bioaccumulation in the food chains consequently effect the human health. In conjunction to this, there is a necessity to monitor the pesticides usage in agricultural field and limit its exposure to human and environment. Therefore, the aim of this study

was to determine the occurrence of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples and their reported health symptoms among paddy farmers and non-exposed group.

1.2 Problem Statement

The study area selected for this research is Tanjung Karang, Selangor because it is known as "the rice bowl of Selangor" and being the third largest area of paddy field in Peninsular Malaysia. There are almost 2194 families of farmers with 14848 acres of rice field and producing an average of 3.8 ton of rice per hectare per year (Fuad et al., 2012). Due to this situation, pesticides are widely used in paddy cultivation to kill pests or improve yield (WHO, 2018). The high risks groups exposed to pesticides include production workers, formulators, sprayers, mixers, loaders and agricultural farm workers.

An interview was conducted six months ago to identify the frequently used pesticides in the paddy cultivation activities. Three of the popular pesticides (azoxystrobin, pymetrozine and tebuconazole) were selected for this study. Based on the Material Safety Data Sheet (MSDS), these compounds (azoxystrobin, pymetrozine and tebuconazole) were found to have potential health effects to human.

As indicated by the Food and Agriculture Organization (FAO) inventory, numerous countries are in excess of 500,000 tons of unused and old pesticides that

compromising the environment and public health. Based on a review by Mamane et al. (2015), there were 12 out of 15 cross-sectional studies investigating the relationship between occupational pesticides exposure with respiratory diseases or other symptoms such as chronic wheeze, cough, dyspnoea, chest tightness as well as breathlessness. The study results provide evidences that farming exposure to pesticides is associated with higher prevalence of respiratory symptoms.

Based on the field observation in the area, majority of the paddy farmers did not wear proper personal protective equipment (PPE) while handling pesticides **(Figure 1.1).** Further increasing in the risk of exposure due to the absences of PPE and poor personal hygiene (Baharuddin, et al., 2011). Dermal and inhalation are the most common routes for pesticide exposure. According to the previous study (Hamsan et al., 2017) in the same area, only 8.4% of the paddy farmers wear proper PPE while 91.6% did not wear proper PPE.

In short, this research aimed to measure the occurrence of pesticides (azoxystrobin, pymetrozine and tebuconazole) and assess their reported health symptoms among paddy farmers and non-exposed group. It studied on some contributing factors such as lifestyle, socio-demographic background of respondents and concentrations of pesticides to the reported health symptoms of the target population.

Figure 1.1: Farmers do not wear proper PPE while spraying pesticide

1.3 Study Justification

A billion of Ringgit has been granted to enhance rice production in the past of fifty years. Rendering to this, it portrays the urgency in improving the primary source of food in Malaysia. Certainly, more pesticides are being utilized to expand this already massive production of rice. Agricultural tasks performed in paddy fields include spraying and mixing pesticides, scattering seed, and harvesting crops. The risks and consequences of being directly exposed to pesticides may differ according to the task and doses used, resulting in different symptoms (Sapbamrer, Ratana & Sakorn Nata, 2013). Thus, study on reported health symptoms among paddy farmers and non-exposed group are essential for the evaluation of the persistence of pesticide and their breakdown products.

To a certain extent, there were several studies focusing on pesticide exposure in ambient air (Batterman et al., 2008; Coscollà et al., 2014a, 2014b, 2013, 2011, 2010, 2009; Lin et al., 2015; López et al., 2017, 2016; Yang et al., 2008; Yusà et al., 2014, 2009; Zhao et al., 2015). However, there were not many studies measured on the concentration of pesticides in personal air samples. Among the few were reported on the concentrations of imidacloprid (Choi et al., 2013), chlorpyrifos, dicrotophos, profenofos (Jaipieam et al., 2009), 2,4-D, paraquat (Baharuddin et al., 2011), atrazine (Lozier et al., 2013), penconazole (Tsakirakis et al., 2014) and amitraz (Aghasil et al., 2010).

Currently, there are no studies have compared the health symptoms among paddy farmers and non-exposed group due to occupational exposure of pesticides in personal air samples. Thus, the aims of this study are to determine the occurrence of azoxystrobin, pymetrozine and tebuconazole in personal air samples and their reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor through occupational exposure.

Study by Kim et al. (2016) have indicated that, long term exposure of handling pesticides may lead to chronic health effects such as cancer, neurobehavioral changes, liver abnormalities, kidney dysfunction and Parkinson diseases. Additionally, low level of awareness among farmers regarding safety protocol is other factor causing health effect. Thus, the occurrence data of pesticides in Malaysian paddy field in this study gave benefits to community in term of awakening the public understanding and

concerns on the hazardous health effect of pesticides as well as practicing good lifestyles.

1.4 Conceptual Framework

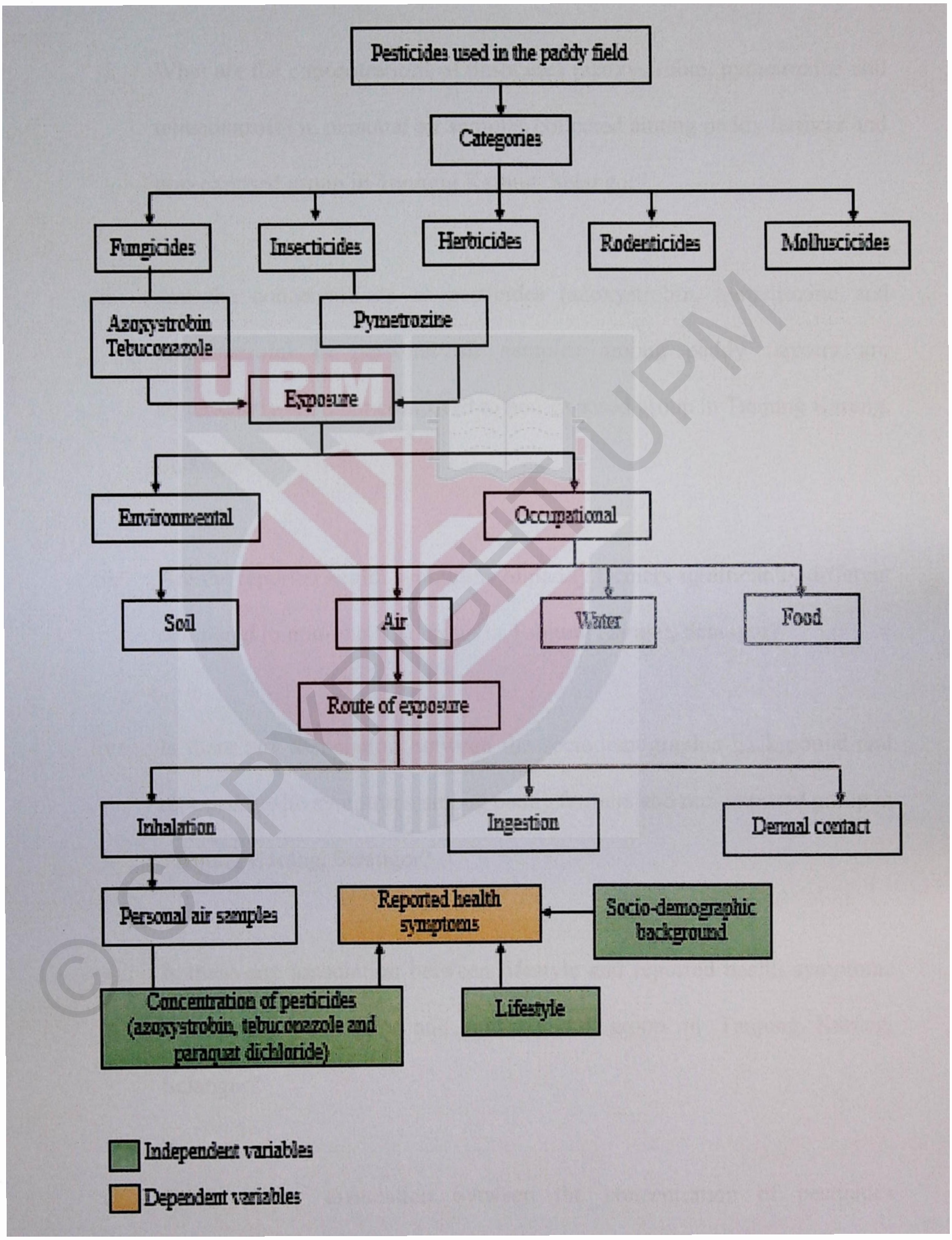


Figure 1.2 : Conceptual framework

1.5 Research Questions

i. What are the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples collected among paddy farmers and non-exposed group in Tanjung Karang, Selangor?

ii. Are the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples among paddy farmers are significantly different compared to non-exposed group in Tanjung Karang, Selangor?

iii. Are the reported health symptoms of paddy farmers significantly different compared to non-exposed group in Tanjung Karang, Selangor?

iv. Is there any association between the sociodemographic background and reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor?

v. Is there any association between lifestyle and reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor?

vi. Is there any association between the concentration of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples and

reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor?

1.6 Hypothesis

i. The concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in the personal air samples collected among paddy farmers are significantly different compared to non-exposed group in Tanjung Karang, Selangor.

ii. The reported health symptoms among paddy farmers are significantly different compared to non-exposed group in Tanjung Karang, Selangor.

iii. The sociodemographic background is significantly associated with the reported health symptoms among the paddy farmers and non-exposed group in Tanjung Karang, Selangor.

iv. The lifestyle is significantly associated with the reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

v. The concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples is significantly associated with the reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

1.7 Research Objectives

1.7.1 General Objective:

To determine the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples and their reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

1.7.2 Specific Objectives:

i. To determine the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

ii. To compare the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) in personal air samples among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

iii. To compare the reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

iv. To determine the association between the socio-demographic background and the reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

v. To determine the association between lifestyle and the reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

vi. To determine the association between the concentrations of pesticides (azoxystrobin, pymetrozine and tebuconazole) and reported health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

CHAPTER 2

LITERATURE REVIEW

2.1 Pesticides and Agricultural Development

Throughout in Malaysia it is estimated the paddy planted area is 672,000 hectares while the average national paddy production is 3.660 metric tonnes per hectare (Department of Agriculture). National Agro-food Policy (NAFP, 2011-2020) outlined the strategies for paddy and rice industries to strengthen the industry through six strategies (to increase productivity and rice quality, to increase efficiency mechanization and automation, intensifying the use of by-products from rice, strengthening rice stockpile management, restricting the incentive and subsidy for rice and strengthening the institutional management of paddy and rice).

Generally, crop quality improvement can be obtained when using pesticides as it controls numerous insect pests, illnesses, and weeds during cultivation and storage. Moreover, it also reduces the work load and time among the paddy farmers. In conjunction, direct contact with pesticides by workers that handle and apply these agents can prompt to harmful effects depending on the level of exposure and toxicity of these toxic compounds (Choi et al., 2006).

Although epidemiological studies have attempted to investigate the association between long-term pesticide exposures and a number of adverse health outcomes (e.g., neurologic, reproductive, endocrine and respiratory disorders, and cancer at different sites), clear linkages have yet to be established. Therefore, safety evaluation of workers is positively required to analyse occupational exposure. Several factors that affect the level of exposure have been identified in the other study. For instance, properties of compound, the personal hygiene, time of contact with the chemical and equipment used for application of the pesticides (Kim et al., 2012).

2.2 Properties of Target Compounds

2.2.1 Azoxystrobin

Azoxystrobin is a wide-spectrum systemic fungicide belonging to the pesticidal compounds called b-methoxyacrylates, which are derived from the naturally-occurring strobilurins. It acts by inhibiting electron transport in pathogenic fungi as well as provide protection against fungal diseases caused by *Ascomycota, Deuteromycota, Basidiomycota and Oomycota* groups. It is widely used for cereal and others crops (Von Stackelberg, 2012).

Azoxystrobin has low acute toxicity via the oral, dermal and inhalation routes of exposure. It is neither an eye or skin irritant nor a skin sensitizer. Previous study stated that dietary administration of azoxystrobin to rats resulted in decreased body weights, decreased food intake and utilization, increased diarhea and other clinical

toxicity observations (increased urinary incontinence, hunched postures and distended abdomens). In addition, liver effects characterized by increased liver weights, increases in alkaline phosphatase and gama glutamyl transferase, decreases in albumin, gross and histological lesions in the liver and bile ducts, were seen in rats. Detail information of azoxystrobin is summarized in **Table 2.1**.

2.2.2 Pymetrozine

Pymetrozine (6-methyl-4-[(E)-pyridin-3-ylmethylideneamino]-2,5-dihydro -1,2,4-triazin-3-one) is new active ingredients and a type of insecticides. It has been classified under Toxicity Category IV for acute inhalation. Strictly, pymetrozine is intended to kill members of the class Insecta (RSC, 2017). In paddy cultivation seasons, pymetrozine is used for preventing, destroying, repelling or controlling insects. As stated in Table 2.1, humans are likely to get cancer when exposed to this insecticide because an investigation on rats showed that tumours occurred when exposed to it (USEPA, 2018).

A few symptoms such as eye, skin and respiratory passage irritation can be diagnosed when human inhaled the insecticides. In addition, according to United States Environmental Protection Agency (USEPA) (2018), previous tests suggest that this insecticides under triazine group. Other than that, pymetrozine focusing three major areas in our body which are the liver, hematopoietic system as well as lymphatic system. A survey on pesticide use among paddy farmers in Tanjung Karang showed

that they used pymetrozine and had reported a few health symptoms such as by chest pain, cough and breathing difficulties (Hamsan et al., 2018). Detail information of pymetrozine is summarized in **Table 2.1**.

2.2.3 Tebuconazole

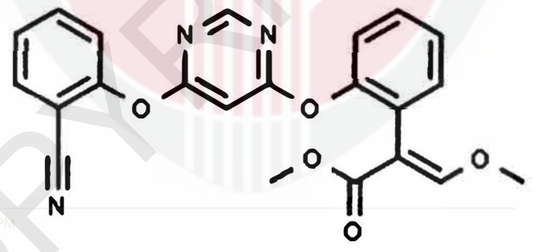
One of most effective triazole fungicide for a variety of landscaping and farming activities is Tebuconazole. It uses a systematic action by inhibiting ergosterol biosynthesis. This substance has been used effectively to protect various crops against fungal diseases and for the treatment of fungal infections (RSC, 2015).

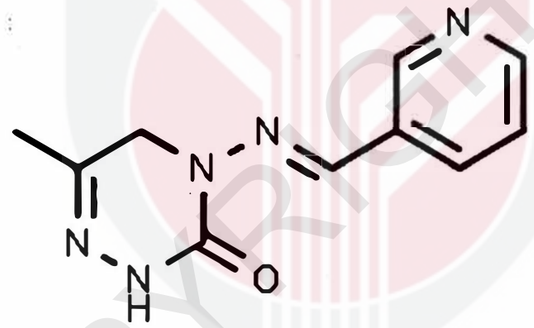
Despite its broad usage, tebuconazole is considered to be a potentially dangerous substance. The World Health Organization (WHO) has deemed tebuconazole to be a "slightly hazardous" substance and an "acute hazard". Their residues have been frequently detected in agricultural products, soils, effluents of wastewater treatment plants, surface waters, human urine and hair samples (Zhang et al., 2015; Dong et al., 2013; Kahle et al., 2008; Mercadante et al., 2014; Schummer et al., 2012).

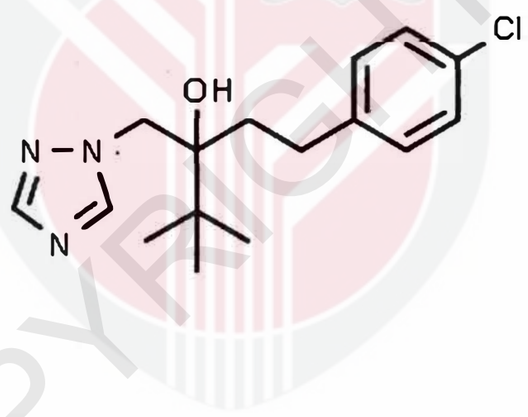
Pesticides Properties Database stated that tebuconazole targets' body systems are the liver and bloodstream as well as can harm to the eyes, digestive and reproductive systems. Much evidences also showed liver carcinogenicity, hepatic

toxicities, reproductive and developmental toxicities induced by triazole fungicides (Hester et al., 2006, 2012; Zhuang et al., 2015; Goetz and Dix, 2009; Mu et al., 2016). Detail information of tebuconazole is summarized in **Table 2.1**.

Table 2.1: Information of the target compounds

Name[a] Type[a] Class[a] IUPAC Name[a] CAS-No.[a]	Molecular formula[a]	Molecular structure[b]	Molecular weight, g mol^{-1}[a]	Log Kow[a]	Cancer classification[c]
Azoxystrobin Fungicide Strobin methyl (E) - 2-[2-[6-(2 cyanophenoxy) pyrimidin-4-yl]oxyphenyl]-3-methoxyprop-2-enoate 131860-33-8	$C_{22}H_{17}N_3O_5$		403.394	2.50 at 20°C	Not Likely Carcinogenic to Humans

Name[a] Type[a] Class[a] IUPAC Name[a] CAS-No.[a]	Molecular formula[a]	Molecular structure[b]	Molecular weight, (g/mole)[a]	Log Kow[a]	Cancer Classification[c]
Pymetrozine Insecticide Triazine 6-methyl-4-[(E)-pyridin-3-ylmethylideneamino]-2,5-dihydro-1,2,4-triazin-3-one 123312-89-0	$C_{10}H_{11}N_5O$		217.232	0.18	Likely Carcinogenic to Humans.

Name[a] Type[a] Class[a] IUPAC Name[a] CAS-No.[a]	Molecular formula[a]	Molecular structure[b]	Molecular weight, g mol^{-1}[a]	Log Kow[a]	Cancer classification[c]
Tebuconazole Fungicide Azole 1-(4-chlorophenyl)-4,4-dimethyl-3-(1,2,4-triazol-1-ylmethyl) pentan-3-ol 107534-96-3	$C_{16}H_2ClN_3O$		307.822	3.7	Group C - Possible human carcinogen

[a]PubChem 2016. National Center for Biotechnology Information (NCBI). https://pubchem.ncbi.nlm.nih.gov (accessed April 2019)
[b]Chemspider 2015. Royal Society of Chemistry. http://www.chemspider.com/ (accessed April 2019)
[c]USEPA (2018). Chemicals Evaluated for Carcinogenic Potential (Annual Cancer Report 2018). http://npic.orst.edu/chemicals_evaluated.pdf (accessed April 2019

2.3 Effects of Pesticides on Human Health

In agriculture, pesticides have become a veteran key player as they demolish and control pests from disturbing the productions of crops (Zaidon et al., 2017). The risk of exposure depends on the type of pesticides, the duration and route of exposure and also the health status of individual. Despite the use of personal protective equipment (PPE), the health conditions of paddy farmers in agricultural practices can be affected through various type of exposure, including consumption of contaminated food, residing close to agricultural fields as well as agricultural occupation.

The acute effects of exposure to pesticides are skin and eye irritation, headache, nausea and dizziness while chronic effects are asthma, diabetes, and cancer (Kim et al., 2016). In addition, there are several studies have been identified from 2007 to 2017, suggested the adverse health effects associated with exposure to pesticides. Samsuddin et al. (2016) reported that, workers who are chronically exposed to low dose mix pesticides are possibly at higher risk of cardiovascular diseases. A genotoxicity study of organophosphate on Orang Asli children living in an agricultural island in Kuala Langat, Selangor proved that there is association between the organophosphate in urine and the residential period in the agricultural village. Those who had lived there for ten years and above had significantly longer comet tail length. In consequence, the extent of the DNA damage occurred. Other studies also reported that significant association between pesticides exposure and semen quality (Hossain et al., 2010).

2.4 Sociodemographic, Lifestyle and Human Health

Sociodemographic is a background information of a population in an area such as age, sex, race, educational status, income and geographic location. Technically, our whole range of biological, psychological and socioeconomic factors affect our health and interact each other (Hardy, Acciai, & Reyes, 2014). Finding from a group of population in Norway regarding ageing factor with self-reported health reflected that it can affected self-reported health directly and also indirectly through increased levels of pathology (Lorem et al., 2017). Pappa et al. (2009) state that education is a stable and measurable variable that acquired in early adulthood. Nowadays, it is a main aspect of social position. Study on association between socioeconomic status (education and income) and health-related quality of life among urban general population in Greek showed that low education and low income were factors that impaired health quality (Pappa et al., 2009). When individuals possess higher education levels perhaps, he or she can control the risk of incidents within the family, social and community that might affect health as compared to those with only primary education.

Concept from WHO Commission on the Social Determinants of Health (SDH) clearly showed that both lifestyle risk factors and their wider determinants ('the cause of the causes') produce by the society itself. Literatures from (Graham & White, 2016) portrayed that physical inactivity, unhealthy diets, smoking and harmful alcohol consumption has been noticed as underlying the chronic health effect among community especially in developed countries. In Europe country, it is reported that

one from four persons consume the recommended minimum of five portion of fruit and vegetables a day. These changes in activity and dietary intake can turn to major health effect.

2.5 Work Tasks of the Paddy Farmers

Most of the paddy farmers receive the greatest risks of exposure to pesticides through their work tasks (Baharuddin et al., 2011). Generally, they involve in the following basic sequential stages: (1) mixing and loading (2) application and (3) clean-up (Macfarlane, Carey, Keegel, El-Zaemay &Fritschi, 2013). Among these, mixing and loading are the tasks associated with the greatest intensity of exposure (E. MacFarlane et al., 2013). During these phases, it involves measuring the pesticides and pouring it into the sprayer that will be added with water. The application of pesticides such as spraying, exposed the farmers to pesticides even longer. E. Macfarlane et al. (2013) demonstrated that the type of equipment used during application, will affect the amount deposited. In recent study, it justifies that narrowly focused spray nozzles associate least exposure rather than wide area spray nozzles. Besides, cleaning pesticides application equipment is a crucial farm pesticide task. Thus, it exposes farmers longer as the time is equal to the mix, load and apply.

Most pesticides enter the body dermally, followed by respiratory and oral route. It has been approved by Anderson and Meade (2014) that dermal exposure is one of the most common and effective routes among pesticide applicators and

particularly associated with handling concentrates. It has been proven in research on dermal exposure, that splashes and spills contribute as a source of surface contamination because they lead to high personal exposure and can overwhelm usual protective measure (Lebailly et al., 2009). Statistic from Agricultural Health Study (USA) shows that 14% of farmers reported ever having such as exposure event which occurs during mixing/loading, application as well as clean-up phases.

According to Jaipam et al. (2009), the paddy farmers also may be exposed to pesticides residue via direct and indirect inhalation during preparation (mixing and loading) and application (spraying). The presence of volatile components of pesticides increase the accessibility exposure through inhalation (Amaral, 2014). Applying pesticides in confined spaces (e.g., an unventilated storage area or greenhouse) has been recognized as significant respiratory exposure to pesticides (Kim et al., 2016). Furthermore, those groups who handle pesticides or equipment for their application are susceptible to consume pesticides if they do not practice personal hygiene prior to eating or smoking (U.S. Environmental Protection Agency, USEPA, 2007). Therefore, the labelling and handling of pesticides should be instructed carefully such as not to clear a spray nozzle by blowing through their mouth and relabelled the bottle or food container after being transferred from original labelled container.

2.6 Legislation and Regulation

In Malaysia, legislations and regulations for the management of pesticides already being practiced to ensure the safety usage of pesticides before being introduced into the market. Particularly, there are several legislations and regulations have been applied which related to the usage of pesticides. One of them is Pesticides Act 1974. Primarily, this act regulates the company or person who want to import or manufacture the pesticides to apply to the Board for the registration of the pesticides. Under Section 10, it stated that every person must notify to the Board if there are any adverse effects from the pesticides on human beings, animals, plants, fruits or property within sixty days from such discovery.

Apart from that, Environmental Quality Act 1974 is another law that control the discharge of chemicals including pesticides into the environment. Under section 14, an owner or occupier of a premises shall adopt the best management practice for discharge of any industrial effluent or mixed effluent for any parameter as specified in Ninth Schedule.

In addition, Occupational Safety and Health (Use and Standard of Exposure Chemical Hazardous to Health) Regulation 2000 is made to provide legal framework in order to control exposure of chemical hazardous such as pesticides to health at workplace. This regulation also aimed to set a standard of exposure of chemical hazardous among workers at the workplace. Hence, among the three type of pesticides

(azoxystrobin, pymetrozine and tebuconazole) in my study, all of their PEL are not being stated. Also, under Section IV, it stated that an employer should made an assessment of the risks created by the chemicals exposed to the health of the employees if he/she wanted to carry out any work. For that reasons, any pesticides that have health risks for the paddy farmers must be assessed before doing the work tasks.

2.7 Personal Protective Equipment (PPE)

Department of Standards Malaysia and SIRIM Berhad has developed Malaysian standard code of recommended practice (MS 479:2012) as a guideline to determine the adequacy of dermal and inhalation protection. MS 479:2012 recommended that when handling pesticides, the following articles of clothing should be worn during the preparation (mixing/loading) and application (spraying) of pesticides: (i) regular work clothes (long pants and sleeves; heavyweight and tightly woven fabrics of cotton or polyester/cotton blends); (ii) gloves (PVC, rubber, nitrile or neoprene gloves should be used in handling concentrates but are unsuitable for continuous wear); (iii) boots (rubber or PVC boots); (iv) face shield (face shields are intended for face protection); (v) wide-brimmed hat or hood (may be a hat with a broad brim or a full hood that drapes to cover the shoulders); (vi) face masks (masks of gauze or similar material are capable of filtering the particles from a wettable powder spray and may be worn to reduce respiratory exposure if such protection is considered desirable for compounds of moderate toxicity); and (vii) respirators (designed to protect from toxic vapors, gases or droplets of very toxic materials; the paddy farmers must be specifically chosen for each compound being used to ensure the safe handling of agricultural pesticides (DOS,2012).

For example, a study of Malaysian paddy farmers found that cytogenetic damage can be decreased with appropriate use of PPE (Hamid et al., 2016). E. Macfarlane et al. (2013) also demonstrated that absorption to the body can be reduce by suitable gloves and clothes. In short, paddy farmers should require to wear proper

PPE when handling pesticides as it is key control measure for preventing the pesticides exposure.

CHAPTER 3

METHODOLOGY

3.1 Chemicals and standards

Reference standards of azoxystrobin (98.5%), pymetrozine (99.0%) were purchased from Dr. Ehrenstorfer (Germany). Tebuconazole (99.3%) was purchased from Sigma-Aldrich (Germany). The internal standards (IS) diuron-d6 (99.9%) and imidacloprid-d4 (99.9%) were purchased from Sigma-Aldrich (Germany). Stock standard solutions (1000mg L-1) were prepared monthly by dissolving the standards in methanol. Working standard solutions (10mg L-1) were prepared from the stock standard solutions weekly. HPLC-grade methanol and HPLC-grade acetone were purchased from Fisher Scientific (UK).

3.2 Study Design

A comparative cross-sectional study was used for this research from December 2018 until April 2019 with the comparison between 85 paddy farmers (exposed group) and 85 office workers (non-exposed group). Moreover, the concentration of pesticides (azoxystrobin, tebuconazole and paraquat dichloride) were measured in the laboratory

and related with the health symptoms among paddy farmers and non-exposed group in Tanjung Karang, Selangor.

3.3 Study Location

The study was carried out in Tanjung Karang, Selangor which specifically conducted in paddy field area of Kampung Sawah Sempadan. The zone was selected because on account of the fact that it was the third largest paddy field in Peninsular Malaysia which was otherwise called "the rice bowl of Selangor" (Fuad et al., 2012). The study location and sampling site were delineated in **Figure 3.1.** As expressed in sampling site map, Kampung Sawah Sempadan had 24 blocks in particular as Block A until Block X.

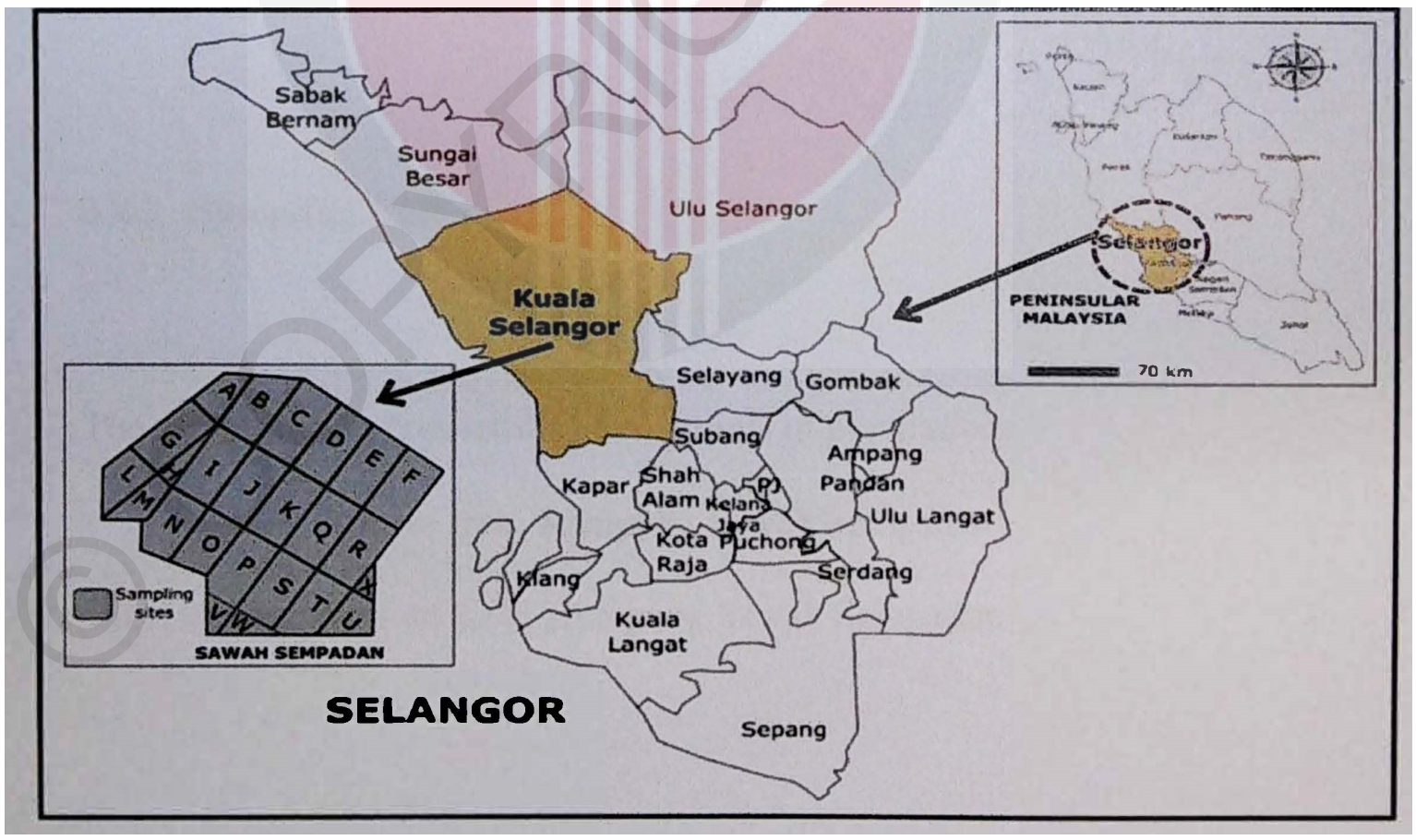


Figure 3.1: Location of the sampling sites at Kampung Sawah Sempadan, Kuala Selangor

3.4 Sampling

3.4.1 Sampling Population

The target population consisted of paddy farmers and office workers from Kampung Sawah Sempadan, Tanjung Karang, Kuala Selangor.

3.4.2 Sampling Frame

The sampling frame in this study were the paddy farmers and office workers that fulfilled the inclusion and exclusion criteria. The name list of the paddy farmers was obtained from Farmers Organization Authority in Tanjung Karang.

3.4.3 Sampling Unit

The sampling unit consisted of two groups of populations:

i. Paddy farmers from Kampung Sawah Sempadan

ii. Office workers from Kampung Sawah Sempadan

3.5 Subject Criteria

The inclusion criteria for the paddy farmers were:

i. Male farmers who worked in the paddy field and directly involved in preparation and application of pesticides

ii. Age between 18 to 59 years old

iii. Farmers had been worked for at least 6 months

The exclusion criteria for the paddy farmers were:

i. Foreign farmers who worked in the paddy field and directly involved in preparation and application of pesticides

The inclusion criteria for office workers were:

i. Male office workers who lived at the same area with exposed group

ii. Age between 18 to 59 years old

iii. Individuals with no history of occupational or household and garden exposure to pesticides

3.5.1 Cofounders

3.5.1.1 Lifestyle:

i. Person who active smokers

ii. Person who rarely exercise

iii. Person who rarely consume vegetables and fruits

3.5.1.2 Sociodemographic backgrounds:

i. Education level

ii. People who aged between 18 to 59 years old

3.6 Sample Size

3.6.1 Sampling Method and Subject Recruitment

A total of 85 paddy farmers and 85 office workers who fulfilled the inclusion and exclusion criteria were selected by convenient sampling. The sample size was calculated according to formula adapted from Social Research Methods (Lemeshow et al., 1990). Below is the formula adapted from Lemeshow et al. (1990):

$$n = \frac{\{Z_{\frac{\alpha}{2}}\sqrt{2\bar{P}(1-\bar{P})} + Z_{1-\beta}\sqrt{P_1(1-P_1) + P_2(1-P_2)}\}}{(P_1 - P_2)^2} \qquad \textbf{Eq. 3.1}$$

Where,

$\bar{P} = (P_1 + P_2)/2$

P_1 = *estimated proportion (larger)*

P_2 = *estimated proportion (smaller)*

Effect size

$ESp = \phi_1 - \phi_2$

Where,

ESp = *effect size for proportion*

ϕ_1, ϕ_2 = *arcsine transformation for proportions (groups 1,2)*

Both value for P_1 and P_2 were obtained based on the study by Abdul Hamid et al. (2016) which were 0.564 and 0.333 respectively. Below is the calculation for sample size in this study:

$$N = \frac{\{1.96\sqrt{2(0.4485)(1-0.4485)} + 0.842\sqrt{0.564(1-0.564)+0.333(1-0.333)}\}}{(0.564-0.333)^2}$$

= 71

= 71 (+20%)

= 85 respondents in each group

The sample size was increased by 20% to consider non-response missing data. Thus, the total sample size in this study was **170 respondents (85 exposed group; 85 non-exposed group).**

3.7 Study Instrumentations

3.7.1 Questionnaire

The farmers and non-exposed group in this study were required to answer a set of questionnaires. The questionnaire was adapted according to two standard questionnaires: (i) Agriculture Health Study (AHS) by Alavanja, (1996); Hou et al. (2013); Andreotti et al. (2015), and (ii) Vietnam: Pesticide Use Survey (Berg, 2001). It comprised of four sections; Section A: personal information of the respondents, Section B: working background, Section C: lifestyle, Section D: reported health symptoms. A sample of questionnaire is attached as **Appendix 1.**

3.7.2 Ultra-High-Performance Liquid Chromatography Tandem Mass Spectrometry (UHPLC-MS/MS)

UHPLC-MS/MS (Agilent, USA) was used to analyse the concentrations of pesticides and the methods conditions are as follow: Chromatographic separation was conducted on an Eclipse Plus C18 column (2.1mm x 50mm I.D., 1.8µm particle size) (Agilent, USA). The mobile phase compositions and mixture are shown in the **Table 3.1**. The flow rate and the column temperature were set for 0.5 mL / min and 40 °C, respectively. Apart from that, total run time and the injection volume were 20 minutes and 2.0 µL respectively. All of the pesticides were detected by using electrospray ionization (ESI) in positive mode. The optimised ESI and MS/MS conditions were summarized in **Table 3.2**. The optimised

operating conditions were as follows: capillary voltage, 3500 V; gas temperature, 220 °C; gas flow, 11 L/min and nebulizer is 30 psi.

Table 3.1: Mobile phase compositions and mixture

	Time (min)	A (%)	B (%)	flow rate (mL/min)
1	0	94.00	6.00	0.5
2	15.00	2.00	98.00	0.5
3	18.00	2.00	98.00	0.5
4	18.01	94.00	6.00	0.5
5	20.00	94.00	6.00	0.5

Mobile phase A (aqueous): 0.1% formic acid and 5 Mm ammonium formate in ultrapure water

Mobile phase B (solvent): 0.1% formic acid and 5Mm ammonium formate in methanol

Table 3.2: Precursor ions, product ions, collision energy and fragmentation voltage for the 3 target compounds and 2 internal standards

Target compounds	Precursor ion m/z	Product, m/z (Collision energy, V)	Fragmentation, V
Azoxystrobin	404.10	372.10 (8)	380
		329.10 (32)	
Pymetrozine	218.11	78.88 (52)	380
		51.00 (60)	
Tebuconazole	308.10	124.90 (47)	380
		70.00 (40)	
Internal standards	**Precursor ion, m/z**	**Product, m/z (Collision energy, V)**	**Fragmentation, V**
Diuron-d_6	239.00	78.00 (25)	380
Imidacloprid-d_4	260.10	212.90 (21)	380

3.8 Sampling Technique

3.8.1 Selection of targeted compound

The main 15 commonly used pesticides in Tanjung Karang, Selangor were recognized upon interviewing the paddy farmers. It was conducted six months before the collection of personal air samples. Among of these, only 3 of the compounds were selected for this research which were azoxystrobin, pymetrozine and tebuconazole. **Table 3.3** indicated pesticides active ingredients with their frequency and percentage of usage among paddy farmers

Table 3.3: Active ingredients used in pesticides for paddy farming, frequency and percentage of usage among farmers

Active Ingredients	Frequency	Percentage	
Chlorantraniliprole	44	53.0	
Difenoconazole	44	53.0	
Paraquat Dichloride	2	2.4	
Isoprothiolane	41	49.4	
Propiconazole	38	45.8	
Azoxystrobin	27	32.5	target compounds
Tebuconazole	29	34.9	
Pymetrozine	43	51.8	
Trifloxystrobin	29	34.9	
Fipronil	22	26.5	

Tricyclazole	21	25.3
Imidacloprid	17	20.5
Buprofezin	13	15.7
Pretilachor	10	12.0
2,4-D butyl ester	31	37.3

*n = 170

3.8.2 Personal air sampling

The sampling method was based on Hamsan et al., (2017). Upon personal air sampling for the occupational exposure of pesticides among paddy farmers and office workers, a personal air monitor equipped with an air pump (Gillian GilAir 3, Sensidyne, Flourida, USA), a solid sorbent tube (SKC Sorbent Tube, XAD-2, 8x110mm in size, 2-section, 200/400 mg sorbent, SKC, USA) were used. The dual-layered solid sorbent tube consisted of one larger bed of absorbent (400mg) followed by a smaller back-up bed (200mg) was used to trap any sample breakthrough.

The personal air samples were collected with average of 2 hours/day for each group. For paddy farmers, we collected the samples during the spraying activity in the morning around 6.00 am to 9.00 am. Meanwhile, for the office workers, they were approached at any time during working hours. A solid sorbent tube was attached to the both groups' breathing zone with a clip as well the air pump was fastened to the belt.

The flow rate was set at 2 L min^{-1} and calibrated by external calibrator (Model 4146 Calibrator TSI, USA).

The solid sorbent tube was removed from the personal air sampler after the paddy farmers finished all activities related to pesticides application (mixing, loading and spraying) while for office workers, it was removed when duration of sampling was compatible with exposed group. Then, XAD-2 resins were removed from solid sorbent tube by breaking the glass of the tube. All resins were transferred to 15mL centrifuge tube and spiked with internal standard (imidacloprid-d_4 and diuron-d_6) for further extraction.

3.8.3 Extraction Method

The samples were extracted based on Hamsan et al. (2017). 10 mL of acetone was used to extract the pesticides collected in the XAD-2 resin. They were centrifuged at 40 x 100 rpm for 5 min followed by the supernatant was decanted into a centrifuge tube. Next, the extract was concentrated via a gentle stream of nitrogen until near dryness and reconstituted with 1 mL of injection solution (3:1 ultrapure water/HPLC-grade methanol). UHPLC-MS/MS was used to analyse an aliquot (2 µL) of the extract.

3.9 Quality Control

3.9.1 Questionnaires

The questionnaires were pre-tested among paddy farmers and office workers at Kampung Sungai Burung, Tanjung Karang to ensure the reliability and validity. The socio demographics background of the respondents in pre-test were similar to the respondents in this study. 10% from the total sample size of this study were selected as respondents. Cronbach's Alpha analysis was analysed to measure the consistency, reliability as well as validity of the questionnaire used in this study. The result showed the acceptable value of 0.728.

3.9.2 Cleaning of Glassware

According to USEPA method 1699, all glassware was washed by acid wash to guarantee that they were free of contaminants. Next, they were soaked with 5-10% hydrochloric acid (HCL) overnight followed by washed with Decon 90. By then, the glassware was rinsed instantly, first with methanol, then with hot tap water. After that, the glassware was rinsed with methanol again, followed by acetone, and then dichloromethane. Subsequently after washing, all glassware was dried at 60°C and capped with solvent rinsed aluminium foil to prevent any accumulation of dust or other contaminants.

3.9.3 Calibration of UHPLC MS/MS

UHPLC-MS/MS was calibrated for each compound analysed to ensure the validity and reliability. The instrument was calibrated with each analyte at a five-point calibration curve at range 0.1 to 500 ng/mL. At concentration of 50 ng/mL at each calibration point was added with labelled of internal standards (ISs), imidacloprid-d_4 and diuron-d_6 to generate relative response factors (RRF).

3.9.4 Method blank

All the samples were spiked with IS mixtures prior to extraction. Mixture of IS was spiked into one blank XAD-2 resin and ran through the entire sample preparation and extraction procedure for every batch of sample analysis to check for any possible background contamination in the sample. Internal standard (imidacloprid-d_4 and diuron-d_6) were used to quantify the concentration of the target compound in this study.

The concentration of pesticides in personal air samples were calculated using this formula (HSE, 2015):

$$C_{air} = \frac{C \times V}{V_{air}}$$

Eq. 3.2

In which C_{air} is the concentration of pesticides in the air (ng m^{-3}), C is the pesticide's concentration in the extract (ng mL^{-1}), V is the final volume of the extract (1 mL) and V_{air} is the volume of air sampled (m^3).

Volume of air sampled was calculated using this formula (HSE, 2015):

$$V_{air} = F \times T \times CF \qquad \text{Eq. 3.3}$$

In which V_{air} is the volume of the air sampled (m^3)., F is the flowrate (L min^{-1}), T is the sampling duration (min) and CF is conversion factor from liter to m^3 (0.001).

3.9.5 Extraction Recovery

The extraction recovery was evaluated by spiking the samples with varied amounts of standard solutions of azoxystrobin, pymetrozine and tebuconazole (Zhuang et al., 2009). The percent of recovery was calculated based on Ho et al. (2012).

$$\text{Recovery (\%)} = \frac{C_F - C_{UC}}{C_S - C_{UC}} \times 100 \qquad \text{Eq. 3.4}$$

In which, comparing the concentrations for each compound spiked before extraction (C_p) to its concentration spiked after concentration (C_a) in the sample and C_{qc} is the concentration of analyte in blank sample.

3.9.6 Instrumental Performance and Method Validation

The mixtures of pesticide standard together with IS were spiked into the blank XAD-2 resin in decreasing amount to determine the MDL and MQL. XAD-2 resin was extracted and analysed using UHPLC-MS/MS as described in 3.8.3. MDL and MQL were determined with a signal-to-noise ratio of >3 and >10, respectively (Choi et al., 2013).

3.10 Statistical analysis

All the data collection was analysed by using Statistical Package for the Social Sciences (SPSS) Version 22. Descriptive data for continuous variables were presented in means and standard deviation (SD) while percentages (%) and frequency were used to explain categorical variables for the objective to determine the concentrations of pesticides in personal air samples collected among paddy farmers and non-exposed group. Apart from that, Mann-Whitney U test was used to compare the concentrations of target compounds among paddy farmers and non-exposed group. Other than that, Chi-Square was used to determine the comparison between the concentration of pesticides; reported health symptoms among paddy farmers and non-exposed group.

Additionally, it also was used to determine the association of lifestyle; sociodemographic background with the reported health symptoms among paddy farmers and non-exposed group.

3.11 Ethical consideration

The study was approved by University Research Ethics Committee of University Putra Malaysia (JKEUPM) with the reference number JKEUPM-2018-371. All the respondents were briefed on this study and written consent was obtained from them prior to the study. All the information that assembled in this study was kept private and confidential as well as was used for study purpose only.

CHAPTER 4

RESULT

4.1 Quality control

Calibration curves were obtained for all analytes to determine the concentration of pesticides in the personal air samples. Linear range, regression coefficients (R^2), MDL, MQL and recovery for azoxystrobin, pymetrozine and tebuconazole are summarized in **Table 4.1**. Five-point calibration curves for all target compounds were derived in the range of 0.01 µg/ L and 500 µg/ L. The selectivity was excellent, as no other interfering peaks were observed at the retention time of all target compounds. All calibration curves of the target compounds showed good linearity with regression coefficient (R^2) ranges from 0.9994 to 0.9999. The MDL and MQL were reported in the unit ng sample^{-1} instead ng m^{-1} as the blank XAD-2 resin were spiked with pesticides standard and IS directly without any volume of air passing through (Hamsan et al., 2017). The extraction recovery was examined for concentrations 100 ng sample^{-1} and ranged from 96% to 98%. All RSD values were less than < 10% which indicates reasonable extraction efficiencies.

Table 4.1: Linear ranges, regression coefficients (R^2), percentage of recovery, MDL and MQL of all target compounds

Target compound	Linear range (ng mL^{-1})	R^2	Recovery % (RSD %), n = 3 100 ng sample-1	MDL (ng $sample^{-1}$)	MQL (ng $sample^{-1}$)
Azoxystrobin[b]	0.1-500	0.9999	96 (7.3)	0.1	1.0
Pymetrozine[b]	0.1-500	0.999	98 (4.4)	0.3	0.6
Tebuconazole[a]	0.1-500	0.9994	96 (6.4)	0.3	0.5

R^2: Coefficient of determination

Recovery %: Percentage of the concentrations of each analyte spiked before sample extraction compared to its concentration spiked after sample extraction in the XAD-2 resin

RSD: Relative standard deviation

MDL: Method detection limit

MQL: Method quantitation limit

Internal standards; [a]Diuron-d_6 and [b]Imidacloprid-d_4

4.2 Sociodemographic background of paddy farmers and non-exposed group

Eighty-five paddy farmers and 85 non-exposed group were participated in this study. It showed the summary with 100% of the respondents were male Malay paddy farmers and male Malay office workers. Both groups were aged between 18 to 59 years old with mean age of 42 years old. The mean of the weight of the exposed group was 72.03 kg while the non-exposed group was 78.21 kg respectively. Meanwhile, the mean height for exposed group and non-exposed group were 166.41cm and 167.00 cm respectively. In addition, the body mass index (BMI) for exposed group was 26.67 kg/m2 while for non-exposed group 28.00 kg/m2. The education level of exposed group was lower than non-exposed group as majority of the exposed group got education until secondary level (81.2%). Almost 56.5% of the non-exposed group got tertiary education level. Based on the questionnaire, 55.3% of the exposed group and 38.8% non-exposed group were reported as smokers. The sociodemographic information of respondents is summarized in **Table 4.2.**

4.3 Concentrations of pesticides in personal air samples

Table 4.4 illustrates the concentration of pesticides found in personal air samples among paddy farmers and non-exposed group respectively. The target pesticides were detected in 170 personal air samples. The most frequently of pesticides detected among paddy farmers in order of frequency were tebuconazole, pymetrozine and azoxystrobin. Tebuconazole had the highest mean concentration (36.19 ng m^{-3}) while azoxystrobin had the lowest mean concentration (2.52 ng m^{-3}) among all target

compounds for paddy farmers. The highest concentration detected among all personal air samples collected for paddy farmers was pymetrozine (365.80 ng m^{-3}).

Next, the most frequently of pesticides detected among non-exposed group in order of frequency were pymetrozine, tebuconazole and azoxystrobin. Pymetrozine had the highest mean concentration (0.48 ng m^{-3}) while azoxystrobin had the lowest mean concentration (0.20 ng m^{-3}) among all target compounds for non-exposed group. The highest concentration detected among the personal air samples collected for non-exposed group was azoxystrobin (9.60 ng m^{-3}).

Table 4.2: Sociodemographic background of paddy farmers (n=85) and non-exposed group (n=85) in Kampung Sawah Sempadan

	Exposed Group			Non-exposed Group		
Variables	**Mean ± SD**	**Minimun**	**Maximum**	**Mean + SD**	**Minimum**	**Maximum**
Age (years)	41.65 ± 11.06	18	59	41.86 ± 10.10	18	59
Weight (kg)	72.03 ± 14.93	50	112	78.21 ± 16.52	50	137
Height (cm)	166.41 ± 5.94	153	180	167.00 ± 6.69	150	180
BMI (kg/m^2)	26.67 ± 8.52	18	89	28.00 ± 5.73	19	52
	Category	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	
Gender	Male	85	100	85	100	
Race	Malay	85	100	85	100	
Education	No formal education	1	1.2	0	0	
	Primary	12	14.1	2	2.4	
	Secondary	69	81.2	35	41.2	
	Tertiary	3	3.5	48	56.5	
Smoking (batang/day)		47	55.3	33	38.8	

Table 4.3: Normality test result of study variables among respondents

Variables	Statistic	p-value	Normality
Azoxystrobin	0.518	<0.001	Not normal
Pymetrozine	0.458	<0.001	Not normal
Tebuconazole	0.338	<0.001	Not normal

Table 4.4: Concentrations of pesticides in personal air samples among paddy farmers (n=85) and non-exposed group (n=85)

Target compounds	Exposed Group					Non-exposed Group				
	Mean	Standard deviation	Minimum	Maximum	Frequency of detection in personal air samples	Mean	Standard deviation	Minimum	Maximum	Frequency of detection in personal air samples
Azoxystrobin[b]	2.52	9.02	<MQL	53.80	9	0.20	1.31	<MQL	9.60	2
Pymetrozine[b]	21.34	66.68	<MQL	365.80	22	0.48	1.46	<MQL	6.70	9
Tebuconazole[a]	36.19	56.65	<MQL	337.10	61	0.32	1.22	<MQL	6.20	6

MQL, method quantification limit
[a]Diuron-d_6
[b]Imidacloprid-d_4

4.4 Comparison of concentrations of pesticides in personal air samples among paddy farmers and non-exposed group

The comparison between concentrations of pesticides among exposed group and non-exposed group is summarized in **Table 4.5**. The result shows a significant difference *($p < 0.05$)* between exposed group and non-exposed group for azoxystrobin ($p = 0.026$), pymetrozine ($p = 0.005$) and tebuconazole ($p = 0.000$) respectively.

Table 4.5: Comparison of concentrations of pesticides in personal air samples among paddy farmers (n=85) and non-exposed group (n=85)

Target compounds	Median (IQR)		z	*p*[a]
	Exposed group	Non-exposed group		
Azoxystrobin	0.000 (0.00)	0.000 (0.00)	-2.226	0.026*
Pymetrozine	0.000 (3.05)	0.000 (0.00)	-2.828	0.005*
Tebuconazole	13.100 (42.80)	0.000 (0.00)	-8.333	0.000*

[a] Obtained from Mann-Whitney U test

* p value is significant at 0.05 levels

4.5 Comparison of reported health symptoms among paddy farmers and non-exposed group

The comparison between reported health symptoms among exposed and non-exposed group is summarized in **Table 4.6.** They were asked whether they had experienced these signs and symptoms in the past 12 months. As illustrated below, Chi-square analysis showed a significant difference ($p < 0.05$) between exposed and non-exposed group for certain variables, such as breathing difficulties ($X^2 = 22.667$, $p = 0.001$), chest pain ($X^2 = 7.441$, $p = 0.006$), nausea ($X^2 = 22.694$, $p = 0.001$), vomiting ($X^2 = 3.977$, $p = 0.046$) and runny nose ($X^2 = 9.947$, $p = 0.003$). Next, most of the reported health symptoms among exposed group who directly involved with pesticides showed higher percentage than non-exposed group. However, no significant difference ($p > 0.05$) was reported for cough, phlegm, wheezing, sore throat and dizziness for both grou

Table 4.6: Comparison of reported health symptoms between paddy farmers and non-exposed group

Reported health symptoms	Exposed group (n=85)		Non-exposed group (n=85)			
	n (%)		n (%)			
	Yes	No	Yes	No	X^2 Value	*p* value
Breathing difficulties	20 (23.5)	65 (76.5)	0 (0.0)	85 (100.0)	22.667[a]	**0.001***
Chest pain	20 (23.5)	65 (76.5)	7 (8.2)	78 (91.8)	7.441[a]	**0.006***
Cough	34 (40.0)	51 (60.0)	28 (32.9)	57 (67.1)	0.914[a]	0.339
Phlegm	4 (4.7)	81 (95.3)	5 (5.9)	80 (94.1)	0.001[b]	1.000
Wheezing	3 (3.5)	82 (96.5)	0 (0.0)	85 (100.0)	1.357[b]	0.244
Sore throat	20 (23.5)	65 (76.5)	21 (24.7)	64(75.3)	0.032[a]	0.858
Nausea	35 (41.2)	50 (58.8)	8 (9.4)	77 (90.6)	22.694[a]	**0.001***
Vomiting	13 (15.3)	72 (84.7)	5 (5.9)	80 (97.1)	3.977[a]	**0.046***
Dizziness	36 (42.4)	49 (57.6)	27 (31.8)	58 (68.2)	2.043[a]	0.153
Runny nose	15 (17.6)	70 (82.4)	3 (3.5)	82 (96.5)	9.947[a]	**0.003***

[a]Pearson Chi-Square
[b]Continuity Correction
* p value is significant at 0.05 levels; **p value is significant at 0.01 levels

4.6 Association between sociodemographic and reported health symptoms among paddy farmers and non-exposed group

The association between age and their reported health symptoms among exposed and non-exposed group was presented in **Table 4.7.** This study showed that there was significant association ($P < 0.05$) between age of 30 to 39 years old, 40 to 49 years old and 50 to 59 years old with their reported health symptoms among exposed group as compared to non-exposed group. There was a significant association at the age of 30 to 39 years old for the breathing difficulties ($X^2 = 7.566$, $p = 0.006$), chest pain ($X^2 = 7.566$, $p = 0.006$) and nausea ($X^2 = 8.400$, $p = 0.004$), 40 to 49 years old for nausea ($X^2 = 6.857$, $p = 0.009$), 50 to 59 years old for nausea ($X^2 = 6.857$, $p = 0.009$) among the exposed group. However, there was no significant association $p > 0.05$) for any reported health symptoms for the age of 18 to 19 years old and 20 to 29 years old among the two groups.

Table 4.8 shows the association between level of education and their reported health symptoms among exposed group and non-exposed group. This study showed that there was significant association between secondary education level with breathing difficulties ($X^2 = 11.041$, $p = 0.01$), chest pain ($X^2 = 3.859$, $p = 0.049$) and nausea ($X^2 = 5.182$, $p = 0.023$) among exposed group. Among all the reported health symptoms, breathing difficulties (100%) was the highest percentage prevalence among exposed group. Other than that, it was proved that there was also a significant relationship between tertiary education level with nausea ($X^2 = 19.489$, $p = 0.001$) among exposed group. However, there was no significant association between no

formal education level and primary education level with their reported health symptoms among the two groups.

Table 4.7: Association between age and reported health symptoms among paddy farmers (n=85) and non-exposed group (n=85)

Health symptoms	Age																			
	18-19				20-29				30-39				40-49				50-59			
	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*
Breathing difficulties	-	-	-	-	4 (100)	0 (0)	2.625[b]	0.105	8 (100)	0 (0)	7.566[b]	0.006**	3 (100)	0 (0)	1.436[b]	0.231	5 (100)	0 (0)	3.514[b]	0.061
Chest pain	-	-	-	-	4 (80)	1 (20)	0.974[b]	0.324	8 (100)	0 (0)	7.566[b]	0.006**	3 (75)	1 (25)	0.276[b]	0.599	5 (50)	5 (50)	0.000[a]	1.000
Cough	1 (100)	0 (0)	0.000[b]	1.000	4 (33.3)	8 (66.7)	2.333[a]	0.127	7 (58.3)	5 (41.7)	0.467[a]	0.495	11 (64.7)	6 (35.3)	2.471[a]	0.116	11 (55)	9 (45)	0.311[a]	0.577
Phlegm	-	-	-	-	-	-	-	-	1 (50)	1 (50)	0.000[b]	1.000	1 (50)	1 (50)	0.000[b]	1.000	2 (40)	3 (60)	0.000	1.000
Wheezing	1 (100)	0 (0)	0.000[b]	1.000	1 (100)	0 (0)	0.000[b]	1.000	1 (100)	0 (0)	0.000[b]	1.000	-	-	-	-	-	-	-	-
Sore throat	0 (0)	1 (100)	0.000[b]	1.000	3 (37.5)	5 (62.5)	0.175[b]	0.676	3 (42.9)	4 (57.1)	0.000[b]	1.000	6 (66.7)	3 (33.3)	0.566[b]	0.452	8 (50)	8 (50)	0.000[a]	1.000
Nausea	1 (100)	0 (0)	0.000[b]	1.000	4 (66.7)	2 (33.3)	0.212[b]	0.645	9 (90)	1 (10)	8.400[a]	0.004**	11 (78.6)	3 (21.4)	6.857[a]	0.009**	10 (83.3)	2 (16.7)	6.788[a]	0.009**
Vomiting	-	-	-	-	3 (100)	0 (0)	1.493[b]	0.222	4 (57.1)	3 (42.9)	0.000[b]	1.000	3 (100)	0 (0)	1.436	0.231	3 (60)	2 (40)	0.000[b]	1.000
Dizziness	1 (100)	0 (0)	0.000[b]	1.000	6 (46.2)	7 (53.8)	0.144[a]	0.705	9 (52.9)	8 (47.1)	0.099[a]	0.753	10 (66.7)	5 (33.3)	2.593[a]	0.107	10 (58.8)	7 (41.2)	0.760[a]	0.383
Runny nose	-	-	-	-	3 (75)	1 (25)	0.292[b]	0.589	5 (83.3)	1 (16.)	1.750[b]	0.186	5 (83.3)	1 (16.7)	1.750	0.186	2 (100)	0 (0)	0.519[b]	0.471

[a]Pearson Chi-Square
[b]Continuity Correction
* p value is significant at 0.05 levels; **p value is significant at 0.01 level

Table 4.8: Association between level of education and reported health symptoms among paddy farmers (n=85) and non-exposed group

Health Symptoms	Level of Education															
	No formal				Primary				Secondary				Tertiary			
	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*
Breathing Difficulties	0 (0.0)	0 (0.0)	-	-	1 (100.0)	0 (0.0)	0.000[b]	1.000	18 (100.0)	0 (0.0)	11.041[a]	**0.01****	1 (100.0)	0 (0.0)	3.586[b]	0.058
Chest pain	0 (0.0)	0 (0.0)	-	-	3 (100.0)	0 (0.0)	0.000[b]	1.000	17 (85.0)	3 (15.0)	3.859[a]	**0.049***	0 (0.0)	4 (100.0)	0.000[b]	1.000
Cough	1 (100.0)	0 (0.0)	-	-	4 (66.7)	2 (33.3)	0.984[b]	0.321	27 (73.0)	10 (27.0)	1.130[a]	0.288	2 (11.1)	16 (88.9)	0.302[b]	0.583
Phlegm	0 (0.0)	0 (0.0)	-	-	1 (100.0)	0 (0.0)	0.000[b]	1.000	3 (75.0)	1 (25.0)	0.000[b]	1.000	0 (0.0)	4 (100.0)	0.000[b]	1.000
Wheezing	0 (0.0)	0 (0.0)	-	-	0 (0.0)	0 (0.0)	0.000[b]	1.000	3 (100.0)	0 (0.0)	0.399[b]	0.527	0 (0.0)	0 (0.0)	-	-
Sore throat	1 (100.0)	0 (0.0)	-	-	2 (100.0)	0 (0.0)	0.000[b]	1.000	16 (66.7)	8 (33.3)	0.001[a]	0.970	1 (7.1)	13 (92.9)	0.000[b]	1.000
Nausea	1 (100.0)	0 (0.0)	-	-	4 (100.0)	0 (0.0)	0.015[b]	0.904	27 (81.8)	6 (18.2)	5.182[a]	**0.023***	3 (60.0)	2 (40.0)	19.489[b]	**0.001****
Vomit	0 (0.0)	0 (0.0)	-	-	2 (100.0)	0 (0.0)	0.000[b]	1.000	10 (90.9)	1 (9.1)	2.208[b]	0.137	1 (20.0)	4 (40.0)	0.170[b]	0.680
Dizzy	0 (0.0)	0 (0.0)	-	-	7 (77.8)	2 (22.2)	0.117[b]	0.733	26 (72.2)	10 (27.8)	0.851[a]	0.356	3 (16.7)	15 (83.3)	3.221[b]	0.073
Runny nose	0 (0.0)	0 (0.0)	-	-	1 (100.0)	0 (0.0)	0.000[b]	1.000	14 (87.5)	2 (12.5)	3.790[a]	0.052	0 (0.0)	1 (100.0)	0.000[b]	1.000

(n=85)

[a]Pearson Chi-Square
[b]Continuity Correction
* p value is significant at 0.05 levels; **p value is significant at 0.01 level

4.7 Association between lifestyle and reported health symptoms among paddy farmers and non-exposed group

Table 4.9 showed that the association between lifestyle such as smoking status, consumption of vegetables and fruits at least once time per week, exercising at least once a week and supplements intake with their reported health symptoms among exposed and non-exposed group. There was significant association for smoker with reported health symptoms of breathing difficulties ($X^2 = 8.011, p = 0.005$), chest pain ($X^2 = 4.285, p = 0.038$), nausea ($X^2 = 15.276$, $p = 0.001$), dizziness ($X^2 = 4.981$, $p = 0.026$) and runny nose ($X^2 = 4.493$, $p = 0.034$) among exposed group. Similarly, this study showed that there was a significant association between consuming vegetables at least once per week with several reported health symptoms such as breathing difficulties ($X^2 = 22.995, p = 0.001$), chest pain ($X^2 = 7.654, p = 0.006$), nausea ($X^2 = 21.922, p = 0.001$), vomiting ($X^2 = 4.003, p = 0.043$) and runny nose ($X^2 = 9.129, p = 0.003$) among exposed group. Also, there was a significant association between consuming fruits at least once per week with breathing difficulties ($X^2 = 22.148$, $p = 0.001$), chest pain ($X^2 = 7.268, p = 0.007$), nausea ($X^2 = 22.313, p = 0.001$), vomiting ($X^2 = 3.784, p = 0.049$) and runny nose ($X^2 = 8.796, p = 0.003$) among exposed group. As indicated in **Table 4.9**, exercise at least once a week showed a significant association for breathing difficulties ($X^2 = 10.409, p = 0.001$), chest pain ($X^2 = 3.958, p = 0.047$), nausea ($X^2 = 14.137, p = 0.001$) and runny nose ($X^2 = 3.056, p = 0.047$) among the exposed group. However, there was no significant

association between supplement intake and their reported health symptoms among both groups.

Table 4.9: Association between lifestyle and reported health symptoms among paddy farmers (n=85) and non-exposed group (n=85)

Health Symptoms	Smoker				Vegetable [1]				Fruit [1]				Exercise [1]				Supplement			
	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*	Exposed (%)	Non-exposed (%)	X^2	*p*
Breathing difficulties	12 (100.0)	0 (0.0)	8.011[b]	0.005*	20 (100.0)	0 (0.0)	22.995[a]	0.001*	20 (100.0)	0 (0.0)	22.418[a]	0.001*	7 (100.0)	0 (0.0)	10.409[b]	0.001*	3 (100.0)	0 (0.0)	2.999[b]	0.083
Chest pain	11 (84.6)	2 (15.4)	4.285[a]	0.038*	20 (74.1)	7 (25.9)	7.654[a]	0.006*	20 (74.1)	7 (25.9)	7.268[a]	0.007*	7 (70.0)	3 (30.0)	3.958[b]	0.047*	1 (33.3)	2 (66.7)	0.001[b]	1.000
Cough	20 (71.4)	8 (28.6)	2.857[a]	0.091	32 (53.3)	28 (46.7)	0.494[a]	0.482	34 (54.8)	28 (45.2)	0.808[a]	0.369	13 (39.4)	20 (60.6)	0.205[a]	0.650	4 (33.3)	8 (66.7)	0.001[b]	1.000
Phlegm	2 (100.0)	0 (0.0)	0.224[b]	0.636	4 (44.4)	5 (55.6)	0.001[b]	1.000	4 (44.4)	5 (55.6)	0.001[b]	0.985	1 (16.7)	5 (83.3)	0.351[b]	0.554	2 (40.0)	3 (60.0)	0.001[b]	1.000
Wheezing	2 (100.0)	0 (0.0)	0.224[b]	0.636	3 (100.0)	0 (0.0)	1.382[b]	0.240	3 (100.0)	0 (0.0)	1.333[b]	0.248	1 (100.0)	0 (0.0)	0.082[b]	0.774	-	-	-	-
Sore throat	10 (76.9)	3 (23.1)	2.115[a]	0.146	20 (48.8)	21 (51.2)	0.018[a]	0.892	20 (48.8)	21 (51.2)	0.050[a]	0.824	11 (37.9)	18 (62.1)	0.048[a]	0.826	3 (33.3)	6 (66.7)	0.001[b]	1.000
Nausea	24 (88.9)	3 (11.1)	15.276[a]	0.001*	34 (81.0)	8 (19.0)	21.922[a]	0.001*	35 (81.4)	8 (18.6)	22.313[a]	0.001*	15 (71.4)	6 (28.6)	14.137[a]	0.001*	2 (100.0)	0 (0.0)	1.302[b]	0.254
Vomit	7 (77.8)	2 (22.2)	0.759[b]	0.383	13 (72.2)	5 (27.8)	4.093[a]	0.043*	13 (72.2)	5 (27.8)	3.874[a]	0.049*	5 (55.6)	4 (44.4)	0.804[b]	0.370	0 (0.0)	1 (100.0)	0.001[b]	1.000
Dizziness	23 (74.2)	8 (25.8)	4.981[a]	0.026*	35 (56.5)	27 (43.5)	1.798[a]	0.180	36 (57.1)	27 (42.9)	1.884[a]	0.170	15 (42.9)	20 (57.1)	0.999[a]	0.318	4 (40.0)	6 (60.0)	0.001[b]	1.000
Runny nose	8 (100.0)	0 (0.0)	4.493	0.034*	15 (83.3)	3 (16.7)	9.129[a]	0.003*	15 (83.3)	3 (16.7)	8.796[a]	0.003*	7 (70.0)	3 (30.0)	3.958[b]	0.047*	2 (100.0)	0 (0.0)	1.302[b]	0.254

[a]Pearson Chi-Square

[b]Continuity Correction

* p value is significant at 0.05 levels; **p value is significant at 0.01 levels

[1]at least once per week

4.8 Association between concentrations of pesticides and their reported health symptoms among paddy farmers (n=85) and non-exposed group (n=85)

Table 4.10 shows the association between concentration of pesticides (azoxystrobin, pymetrozine and tebuconazole) and their reported health symptoms among exposed and non-exposed group. Based on the result, it showed that there was significant association ($p < 0.05$) between concentration of pymetrozine with vomiting ($X^2 = 6.374$, $p = 0.012$) and runny nose ($X^2 = 6.374$, $p = 0.012$) among exposed group as compared to non-exposed group. Next, there was also significant association ($p < 0.05$) between concentration of tebuconazole with breathing difficulties ($X^2 = 22.950$, $p = 0.000$), chest pain ($X^2 = 14.925$, $p = 0.000$), cough ($X^2 = 4.919$, $p = 0.027$) and nausea ($X^2 = 27.318$, $p = 0.000$) among exposed group as compared to non-exposed group.

Table 4.10: Association between concentrations of pesticides and reported health symptoms among paddy farmers (n=85) and non-exposed group (n=85)

Reported health symptoms	Target compounds											
	Azoxystrobin				Pymetrozine				Tebuconazole			
	Exposed (%)	Non-exposed (%)	X^2	*P*	Exposed (%)	Non-exposed (%)	X^2	*P*	Exposed (%)	Non-exposed (%)	X^2	*P*
Breathing difficulties	3 (60.0)	2 (40.0)	2.725[b]	0.099	5 (35.7)	9 (64.3)	0.452[b]	0.501	18 (100.0)	-	22.950[a]	**0.000***
Chest pain	2 (100.0)	-	0.000[b]	1.000	7 (100.0)	-	0.871[a]	0.351	19 (95.0)	1 (5.0)	14.925[a]	**0.000***
Cough	2 (66.7)	1 (33.3)	0.110[b]	0.740	10 (90.9)	1 (9.1)	0.174[a]	0.677	30 (93.7)	2 (6.3)	4.919[a]	**0.027***
Phlegm	-	-	0.013[b]	0.909	-	-	1.166[b]	0.280	1 (100.0)	-	2.255[b]	0.133
Wheezing	-	9 (100.0)	0.000[b]	1.000	-	9 (100.0)	0.150[b]	0.903	3 (100.0)	-	2.314[b]	0.128
Sore throat	2 (66.7)	1 (33.3)	0.000[b]	1.000	6 (85.7)	1 (14.3)	0.189[b]	0.664	14 (93.3)	1 (6.7)	0.359[a]	0.549
Nausea	4 (80.0)	1 (20.0)	1.518[b]	0.218	8 (80.0)	2 (20.0)	0.544[a]	0.461	31 (96.9)	1 (3.1)	27.318[a]	**0.000***
Vomiting	1 (100.0)	-	0.000[b]	1.000	6 (75.0)	2 (25.0)	6.374[b]	**0.012***	10 (100.0)	-	1.870[a]	0.171
Dizziness	3 (75.0)	1 (25.0)	0.000[b]	1.000	12 (85.7)	2 (14.3)	0.505[a]	0.477	29 (93.5)	2 (6.5)	3.083[a]	0.079
Runny nose	2 (66.7)	1 (33.3)	1.831[b]	0.176	8 (100.0)	-	6.734[b]	**0.012***	9 (100.0)	-	0.740[b]	0.390

X^a Pearson Chi-Square

X^b Continuity correction

*p value is significant at 0.05 levels, **p is significant at 0.01 levels

CHAPTER 5

DISCUSSION

5.1 Sociodemographic background of paddy farmers and non-exposed group

A total of 170 respondents in this study were interviewed for their sociodemographic background. All of them were Malay paddy farmers and Malay office workers as majority the residents in Kampung Sawah Sempadan were Malay. In term of gender, all the paddy farmers were male which conclude that paddy cultivation activities in this area involved male only. As we conducted comparative cross-sectional study, thus for the non-exposed group also comprised of male office workers. In addition, the average of age of both groups were 42 years old respectively. The body mass index (BMI) for exposed group was 26.67 kg/m^2 while for non-exposed group 28.00 kg/m^2. It indicates that both groups were overweight as the range was more than 25.00 kg/m^2. The education level of exposed group was lower than non-exposed group as majority of the exposed group got education until secondary level (81.2%). Almost 56.5% of the non-exposed group got tertiary education level. Based on the questionnaire, 55.3% of the exposed group and 38.8% non-exposed group were reported as smokers.

5.2 Concentrations of pesticides among paddy farmers and non-exposed group

The highest mean concentration of pesticides (azoxystrobin, pymetrozine and tebuconazole) were tebuconazole (36.19 ng m^{-3}) and followed by pymetrozine (20.04 ng m^{-3}). The result reported in this study is lower than the result reported by Hamsan et al. (2017) where the mean concentrations of azoxystrobin, pymetrozine and tebuconazole were 20.04 ng m^{-3}, 79.51 ng m^{-3} and 53.03 ng m^{-3} respectively. The maximum concentration of azoxystrobin, pymetrozine and tebuconazole collected among paddy farmers were 53.80 ng m^{-3}, 365.80 ng m^{-3} and 337.10 ng m^{-3} respectively. The fungicides usage among farmers in the sampling area preferred to use tebuconazole instead of azoxystrobin because they claimed that azoxystrobin was more expensive but less effective when compared to tebuconazole.

The highest mean concentration collected of these three target compounds among non-exposed group was pymetrozine (0.48 ng m^{-3}) and followed by tebuconazole (0.32 ng m^{-3}). The maximum concentrations of azoxystrobin, pymetrozine and tebuconazole collected among paddy farmers were 9.60 ng m^{-3}, 6.70 ng m^{-3} and 6.20 ng m^{-3} respectively. Although they are not directly exposed to pesticides, the concentration of three target compounds were detected but in low concentrations as compared to exposed group as their workplace are near to the paddy fields area. General population or non-exposed group can expose to the pesticides in or around work place that are nearby to the paddy field areas (Damalas & Eleftherohorinos, 2011).

5.3 Comparison of concentrations of pesticides in personal air samples among exposed group and non-exposed group

The comparison between concentrations of pesticides in personal air samples shows a significant difference between exposed group and non-exposed group for azoxystrobin, pymetrozine and tebuconazole respectively. Exposed group have higher concentrations of pesticides than non-exposed group because they are at greater risk to exposed to pesticides residue via direct and indirect inhalation during preparation (mixing and loading) and application (spraying) (Jaipieam et al., 2009). Additionally, this finding also similar to Dzulkifli, Latiff, Majid and Awang (2011) who claimed that at least 72% of farmers in Tanjung Karang had experienced acute poisoning symptoms when handling pesticides.

5.4 Comparison of reported health symptoms among paddy farmers and non-exposed group

The result in this study showed that certain health symptoms such as breathing difficulties, chest pain, nausea, vomiting and runny nose were significantly different among exposed group as compared to non-exposed group. The paddy farmers have higher percentage on prevalence of all these reported health symptoms as compared to non-exposed group. Previous study in Ethopia on occupational pesticides exposure and respiratory health reported that higher prevalence of respiratory symptoms in exposed than unexposed group (Negatu et al., 2017). This finding also supported by a matched case control study in Eastern India showed that compared to controls, agricultural workers who sprayed pesticides have almost all respiratory symptoms including runny nose, sore throat, dry cough, wheezing, breathlessness

and chest tightness (Chakraborty et al., 2009). Moreover, another study of 140 exposed group and 80 non-exposed group reported there was a significant difference between both groups for certain health effect such as nausea (Baharuddin et al., 2011). The finding in this study also corresponded to the study in Thailand. The study showed that difficulty of breathing and chest pain were significantly higher among rice farmers compared to non-exposed group.

5.5 Association between sociodemographic and reported health symptoms among paddy farmers and non-exposed group

The association between age and reported health symptoms was significant among exposed group as compared to non-exposed group. It showed that in the age of 30 to 39 years old, there was significant association in breathing difficulties, chest pain and nausea among paddy farmers as compared to non-exposed group. Based on a study by Li et al. (2018), respondents at the age 30 to 40 years old have higher percentage of excellent self-rated health (35.58%). Besides, in the age of 40 to 49 years old and 50 to 59 years old, there were significant association of nausea among paddy farmers as compared to non-exposed group. However, in the age of 18 to 29 years old, there was no significant association of reported health symptoms among paddy farmers and non-exposed-group.

To summarize the result of Chi square analysis, the secondary education level was significantly associated on breathing difficulties, chest pain and nausea among paddy farmers as compared to non-exposed group. Additionally, there was also significant association on nausea at the tertiary education among paddy farmers as compared to non-exposed group. However, there was no significant association on reported health symptoms at the no formal

education and primary education among paddy farmers and non-exposed group. Montazeri, Goshtasebi & Vahdaninia (2008) stated that respondents who with higher education rated their health significantly better than those with lower education levels. In this study, most of the respondents recruited were in secondary education level compared to tertiary and primary education level.

5.6 Association between lifestyle and reported health symptoms among paddy farmers and non-exposed group

This study investigated showed the association between lifestyle such as smoking status, consumption of vegetables and fruits at least once time per week, exercising once a week and supplements intake with their reported health symptoms among exposed and non-exposed group. Based on the survey, the exposed group in Kampung Sawah Sempadan started smoking since in early adulthood. WHO (2015) stated, longer exposure to tobacco smoke had increased risk of contracting various health symptoms that lead to wide range of diseases.

Percentages of exposed group that consuming vegetables and fruits at least once a week are higher compared to non-exposed group. However, there was significant association with reported health symptoms among exposed group for breathing difficulties, chest pain, nausea, vomiting and runny nose respectively. Slavin & Lloyd (2012) stated that fruits and vegetables supply vitamins and minerals to our diet and are sources of phytochemicals that function as antioxidants, phytoestrogens, and anti-inflammatory agents and through other protective mechanisms. In contrary, in this case, the exposed group who directly exposed to pesticides

was more prominent to the reported health symptoms even though they consume vegetables and fruits at least once a week.

From the result, exercise once a week also has a significant association to the reported health symptoms. The results showed the paddy farmers experienced higher percentage of reported health symptoms compare to non-exposed group. During the interview with exposed group some of them claimed they do not have sufficient time to do physical activities since most of them worked in the morning and evening. According to Anderson et al. (2015), it stated that exercise associated with high self-reported health status and high prevalence of healthy lifestyles behaviours. A study by Rimes et al. (2015) also mentioned that exercise gives several health benefits such as cardiovascular improvements. However, in this case, the exposed group who directly exposed to pesticide was more prominent to reported health symptoms even though they exercise at least once per week.

5.7 Association between concentrations of pesticides and their reported health symptoms among paddy farmers and non-exposed group

Chi-square test was used to determine the association between concentration of pesticides (azoxystrobin, pymetrozine and tebuconazole) and their reported health symptoms among exposed and non-exposed group. The result in this study showed that there was significant association between concentration of pymetrozine with vomiting and runny nose among exposed group as compared to non-exposed group. Next, there was also significant association between concentration of tebuconazole with breathing difficulties, chest pain, cough and nausea among exposed group. The percentage of the respondents who experienced

the health symptoms were higher in exposed group as compared to non-exposed group. Similar finding was reported in Baharuddin et al. (2011) where the study reported an increase of health symptoms occurred among farmers who applied pesticides.

However, the result in this study was in contrast with Hamsan et al. (2018) which the study showed that there was no significant association between concentrations of pymetrozine and tebuconazole with all self-reported respiratory symptoms. This could be due to the concentrations of pymetrozine and tebuconazole detected in Hamsan et al. (2018) was lower as compared to this study.

CHAPTER 6

CONCLUSION, LIMITATION AND RECOMMENDATIONS

6.1 Conclusion

The mean concentrations of azoxystrobin, pymetrozine and tebuconazole (2.52 ng m^{-3}, 21.34 ng m^{-3} and 36.19 ng m^{-3}) collected among paddy farmers in personal air samples were higher as compared to non-exposed group. Besides, the concentrations of azoxystrobin (53.80 ng m^{-3}), pymetrozine (365.80 ng m^{-3}) and tebuconazole (337.10 ng m^{-3}) were significantly different among paddy farmers as compared to non-exposed group. There were significant different between paddy farmers and non-exposed group for certain reported health symptoms such as breathing difficulties (23.5%), chest pain (23.5%), nausea (41.2%), vomiting (15.3%) and runny nose (17.6%). Among the both groups, the reported health symptoms showed higher percentage among paddy farmers than non-exposed group. There was significant association between the socio-demographic background (age and level of education) and reported health symptoms among paddy farmers as compared to non-exposed group. For the age of 30 to 39 years old, there was significant association between breathing difficulties, chest pain and nausea among the paddy farmers as compared to non-exposed group. Apart from that, in the age of 40 to 49 years old and 50 to 59 years old, there were significant association of nausea among the paddy farmers as compared to non-exposed group. For the level of education, there was significant association between breathing difficulties, chest pain and nausea at the

secondary level of education. Meanwhile, in the tertiary education level, there was significant association between nausea among the paddy farmers as compared to non-exposed group. There was association between lifestyle (smoking status, consumption of fruit and vegetables and exercise practice) with reported health symptoms among paddy farmers as compared to non-exposed group. For the smoking status, there was significant association between breathing difficulties, chest pain, nausea, dizziness and runny nose among the paddy farmers as compared to non-exposed group. For the consumption of vegetables, there was significant association with breathing difficulties, chest pain, nausea, vomiting and runny nose among the paddy farmers as compared to non-exposed group. Other than that, for the consumption of fruit, there was significant association on breathing difficulties, chest pain, nausea, vomiting and runny nose among the paddy farmers as compared to non-exposed group. Last but not least, there was significant association between breathing difficulties, chest pain, nausea and runny nose with exercise practice at least once per week among the paddy farmers as compared to non-exposed group. However, in this case, the exposed group who directly exposed to pesticide was more prominent to reported health symptoms even though they exercise at least once per week and consume vegetables and fruits at least once per week. The concentration of pymetrozine was significantly associated with vomiting and runny nose among the paddy farmers as compared to non-exposed group. On top of that, the concentration of tebuconazole was significantly associated with breathing difficulties, chest pain, cough and nausea among the paddy farmers as compared to non-exposed group.

6.2 Limitations

Some limitations during this study were the respondents cannot give accurate information especially for the lifestyle. Most of them do not remember precisely how often they do exercise or consume vegetables and fruit in a week as well as the period of taking supplements. On the other hand, we also had difficulties in reaching the respondents as most of the paddy farmers in Kampung Sawah Sempadan were foreign workers who are being recruited by the local paddy farmers.

6.3 Recommendations

6.3.1 Future research

In short, this study showed an association between contributing factors such as sociodemographic and lifestyle among exposed group as compared to non-exposed group. Thereby, further studies that focusing on non-exposed group are required to evaluate other contributing factors with their reported health symptoms For instance, consideration of the distance of their house within the paddy field by sampling the ambient air or effects of outdoor activities during spraying of pesticides among non-exposed group, especially the susceptible group such as children, elderly, pregnant women and immunocompromised.

6.3.2 Paddy farmers and non-exposed group

Paddy farmers and non-exposed group who handled pesticides should wear proper PPE during the preparation and application of pesticides to reduce the health effect through various route of exposure. Governments also can regulate the pesticides used among farmers to emphasise the usage. Last but not least, farmers as well as non-exposed group must be encouraged slowly to practice organic farming as alternative to synthetic pesticides. The principles of organic food production aim to minimize the pollution and prevalence of health problems caused by pesticides. Ministry of Agriculture and Agro-based Industry should give supports in term of training, financial as well as knowledge in enhancing the practice. Moreover, in the current need is to address the awareness among community to have healthy lifestyle to avoid health symptoms when exposed to pesticides.

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APPENDIX A:

Questionnaire

ID Responden: ☐☐☐

Tarikh:

JABATAN KESIHATAN PERSEKITARAN & PEKERJAAN

FAKULTI PERUBATAN DAN SAINS KESIHATAN

UNIVERSITI PUTRA MALAYSIA

KEJADIAN RACUN PEROSAK DI DALAM SAMPEL UDARA PERIBADI DAN GEJALA KESIHATAN DALAM KALANGAN PESAWAH PADI DAN KUMPULAN YANG TIDAK TERDEDAH DI TANJUNG KARANG, SELANGOR

ARAHAN SOALAN:

1. Borang soal selidik ini mengandungi **Empat (4)** bahagian iaitu: Soalan Saringan

   Bahagian A : Maklumat Diri

   Bahagian B : Latar Belakang Pekerjaan

   Bahagian C : Gaya Hidup

   Bahagian D : Maklumat Gejala/Tanda Kesihatan

2. Anda diminta menjawab semua soalan di dalam buku soalan ini
3. Buku soalan ini hendaklah dikembalikan kepada pengkaji setelah selesai menjawab.

KEJADIAN RACUN PEROSAK DI DALAM SAMPEL UDARA PERIBADI DAN GEJALA KESIHATAN DALAM KALANGAN PESAWAH PADI DAN KUMPULAN YANG TIDAK TERDEDAH DI TANJUNG KARANG, SELANGOR

KEGUNAAN PENYELIDIK

BAHAGIAN A: MAKLUMAT DIRI

1. Jantina:

☐ Lelaki ☐ Perempuan

2. Umur : ..... tahun

3. Bangsa:

☐ Melayu
☐ Cina
☐ India
☐ Lain-lain (sila nyatakan): .....

4.Tahap pendidikan:

☐ Tiada pendidikan formal
☐ Pendidikan Primer (Sekolah rendah)
☐ Pendidikan Sekunder (Sekolah menegah)
☐ Pendidikan Tertinggi (Peringkat Universiti/Kolej)

BAHAGIAN B: LATAR BELAKANG PEKERJAAN

5. Pekerjaan sekarang : .....

6. Tempoh bekerja di tempat sekarang: ..... bulan/ tahun

7. Jumlah hari bekerja dalam seminggu: ..... hari/seminggu

8. Jumlah masa bekerja dalam sehari: ..... jam/sehari

9. Pekerjaan terdahulu: .....

10. Tempoh bekerja di tempat dahulu: ..... bulan/ tahun

SULIT

KEJADIAN RACUN PEROSAK DI DALAM SAMPEL UDARA PERIBADI DAN GEJALA KESIHATAN DALAM KALANGAN PESAWAH PADI DAN KUMPULAN YANG TIDAK TERDEDAH DI TANJUNG KARANG, SELANGOR

KEGUNAAN PENYELIDIK

BAHAGIAN C: GAYA HIDUP

11. Adakah anda merokok sekarang?

☐ Ya ☐ Tidak

12. Adakah anda makan sayur-sayuran?

☐ Ya ☐ Tidak

13. Adakah anda makan buah-buahan?

☐ Ya ☐ Tidak

14. Adakah anda melakukan aktiviti senaman?

☐ Ya ☐ Tidak

15. Adakah anda mengambil sebarang makanan tambahan?

☐ Ya ☐ Tidak

SULIT

KEJADIAN RACUN PEROSAK DI DALAM SAMPEL UDARA PERIBADI DAN GEJALA KESIHATAN DALAM KALANGAN PESAWAH PADI DAN KUMPULAN YANG TIDAK TERDEDAH DI TANJUNG KARANG, SELANGOR

KEGUNAAN PENYELIDIK

BAHAGIAN D: GEJALA/TANDA KESIHATAN

16. Apakah jenis-jenis gejala/tanda yang anda alami dalam tempoh masa 12 bulan yang lepas? (Sila tandakan (/) pada mana yang berkaitan)

No	Gejala/Tanda Kesihatan	Pernah mengalami gejala/tanda		Berjumpa doktor apabila mengalaminya	
		Ya	Tidak	Ya	Tidak
1	Loya				
2	Muntah				
3	Pening				
4	Berkahak				
5	Sukar bernafas				
6	Batuk				
7	Sakit tekak				
8	Hidung Berair				
9	Sakit Dada				
10	Berdehit				

Parameter Komposisi Badan	**Keptusan**
Tinggi	m
Berat	kg
Indeks Jisim Badan	kg/m^2
Catatan:	

SULIT

~ Borang soal selidik tamat ~

Terima kasih atas kerjasama yang telah anda berikan.

Adakah anda ingin mengetahui keputusan kajian ini. Jika ya, sila isikan maklumat berikut untuk makluman tentang keputusan kajian.

☐ **Ya** ☐ **Tidak**

Nama: .....

Alamat surat menyurat: .....

.....

.....

No. Telefon: .....

APPENDIX B:

Consent Form

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN
Kejadian racun perosak di dalam sampel udara peribadi dan gejala kesihatan dalam kalangan pesawah padi dan kumpulan yang tidak terdedah di Tanjung Karang,Selangor.

2. PENGENALAN
Pengenalan pelbagai jenis racun perosak dalam aktiviti pertanian seperti penanaman padi semakin meluas terutamanya di Malaysia yang merupakan sebuah negara yang banyak bergantung kepada hasil pertanian. Kawasan kajian yang menjadi pilihan di dalam kajian ini ialah kawasan sawah padi Kampung Sawah Sempadan, Tanjung Karang, Kuala Selangor. Kajian ini akan dijalankan pada bulan Disember 2018 sehingga Jun 2019 yang melibatkan seramai 85 orang pesawah padi yang memakai dan tidak memakai peralatan perlindungan diri_dan 85 orang daripada kumpulan yang tidak terdedah. Penanaman padi di kawasan kajian ini telah menjadi identiti penduduk setempat kerana penduduk kawasan ini kebanyakannya merupakan petani yang mengusahakan tanaman padi di sekitar Kampung Sawah Sempadan. Kawasan ini telah dipilih untuk menjadi kawasan kajian kerana pemerhatian mendapati bahawa hampir semua petani yang mengusahakan tanaman padi di kawasan ini tidak menggunakan kelengkapan pelindung diri semasa menjalankan aktiviti di sawah padi seperti ketika menyembur racun perosak kepada tanaman. Racun perosak boleh tersebar melalui konteks kulit,mata dan rantaian makanan. Berdasarkan kajian terdahulu, racun perosak adalah berbahaya kepada kesihatan kerana boleh mengakibatkan pelbagai jenis gejala kesihatan.Misalnya seperti, batuk,loya,kegatalan kulit, muntah dan kebas. Penemuan kehadiran racun perosak dalam udara telah banyak dilaporkan. Namun, tiada kajian mengenai kehadiran pelbagai racun perosak dalam sampel udara peribadi. Sehingga kini, tiada kajian yang telah dijalankan mengenai gejala kesihatan dalam kalangan pesawah padi dan kumpulan tidak terdedah berdasarkan pendedahan pekerjaan kepada racun perosak dalam sampel udara peribadi di Malaysia Oleh itu, kajian ini dilakukan untuk mengkaji kejadian racun perosak di dalam sampel udara peribadi dan gejala kesihatan dalam kalangan pesawah padi dan kumpulan tidak terdedah di Tanjung Karang,Selangor.

3. APAKAH YANG PERLU ANDA LAKUKAN?
Responden dikehendaki untuk menjawab semua soalan yang terdapat di dalam borang kaji selidik yang dibekalkan oleh penyelidik. Selain itu, responden perlu memakai sampel udara peribadi untuk menentukan kepekatan racun perosak yang digunakan.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?
Kanak-kanak yang berusia 18 tahun ke bawah dan orang dewasa yang berusia 59 tahun ke atas tidak dibenarkan menyertai kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Responden yang menyertai kajian ini dapat mengetahui maklumat gejala kesihatan peribadi akibat daripada pendedahan kepada racun perosak. Selain itu, respoden juga akan diberikan insentif sebanyak RM50.00. Penyertaan daripada responden adalah sukarela dan boleh menarik diri.

b) KEPADA PENYELIDIK?

Penyelidik akan dapat mengumpul maklumat mengenai kejadian kepekatan racun perosak dalam sampel udara peribadi dan gejala kesihatan di kawasan sawah padi Kampung Sawah Sempadan dan seterusnya mengkaji gejala kesihatan dalam kalangan pesawah padi dan kumpulan tidak terdedah.

6. ADAKAH IA BERISIKO?

Tidak, responden hanya perlu mengisi borang kaji selidik yang dibekalkan oleh penyelidik dan juga memberikan kerjasama untuk membenarkan penyelidik memasang sampel udara peribadi.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Ya,segala maklumat dan identiti responden adalah sulit dan akan kekal rahsia dan hanya akan digunakan untuk tujuan kajian sahaja.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Responden boleh menghubungi penyelidik kajian ini:

0132587798
NORHAZWANI BINTI ZAMRI
JABATAN SAINS KESIHATAN PERSEKITARAN DAN PEKERJAAN,
FAKULTI PERUBATAN DAN SAINS KESIHATAN,
UNIVERSITI PUTRA MALAYSIA,
43400 UPM SERDANG,
SELANGOR,MALAYSIA.

0126140221/0389472396
HO YU BIN,Ph.D
JABATAN KESIHATAN PERSEKITARAN DAN PEKERJAAN,
FAKULTI PERUBATAN DAN SAINS KESIHATAN,
UNIVERSITI PUTRA MALAYSIA,
43400 UPM SERDANG,
SELANGOR,MALAYSIA

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh .....

Tandatangan .....
(*Penyelidik*)

APPENDIX C:

Ethical Approval

APPENDIX D:

Original Data

Table 1: Concentrations of target compounds detected in the personal air samples among the paddy farmers, ng m^{-3} (n=85)

Personal Air Samples	azoxystrobin	pymetrozine	tebuconazole
1	ND	ND	ND
2	ND	ND	99.6
3	ND	ND	139.8
4	ND	ND	33.8
5	ND	ND	ND
6	ND	ND	ND
7	ND	3.9	ND
8	ND	ND	ND
9	ND	ND	ND
10	ND	6.7	ND
11	ND	ND	31
12	ND	ND	ND
13	ND	151.1	ND
14	ND	194.1	ND
15	ND	ND	ND
16	ND	ND	23.1
17	ND	11.7	ND
18	ND	ND	ND
19	ND	16.7	66.6
20	ND	ND	ND
21	11.8	ND	ND
22	ND	ND	15.5
23	ND	ND	16.3
24	ND	ND	ND

25	ND	3.2	3.3
26	ND	ND	12.9
27	ND	ND	22.4
28	ND	ND	ND
29	31.6	18.6	83.7
30	ND	3.5	22.7
31	7.4	10.2	ND
32	ND	ND	13.1
33	ND	ND	21.2
34	ND	ND	ND
35	47.8	ND	41.3
36	ND	ND	ND
37	16.1	ND	10.2
38	ND	ND	11.9
39	18.3	ND	ND
40	17.7	17.9	64.3
41	ND	ND	120.5
42	ND	ND	5.1
43	ND	ND	6
44	ND	ND	32.1
45	ND	2.9	13
46	ND	6.4	4.1
47	ND	ND	4.2
48	ND	ND	40.4
49	ND	ND	42.1

50	ND	ND	31.3
51	ND	ND	23
52	ND	105.1	36.9
53	ND	ND	168.7
54	ND	ND	43.5
55	ND	ND	119.3
56	ND	ND	ND
57	ND	ND	49.5
58	ND	ND	134.3
59	ND	ND	337.1
60	ND	3.5	ND
61	ND	ND	63.6
62	ND	271.6	18.1
63	ND	ND	15.2
64	ND	ND	ND
65	ND	ND	11.1
66	ND	ND	ND
67	ND	ND	198
68	ND	ND	50.7
69	ND	266.2	124.4
70	ND	ND	61.7
71	ND	ND	26.8
72	ND	ND	4.3
73	ND	ND	87.5
74	ND	ND	32.3

75	ND	ND	32.2
76	ND	ND	6.8
77	ND	ND	ND
78	ND	200.3	178.6
79	ND	365.8	30.7
80	ND	ND	3.7
81	ND	5.1	ND
82	ND	5.3	6.2
83	ND	ND	124.4
84	ND	144	61.7
85	53.8	ND	26.8

ND: Not Detected

Table 2: Concentrations of target compounds detected in the personal air samples among the non-exposed group, ng m^{-3} (n=85).

Personal Air Samples	azoxystrobin	pymetrozine	tebuconazole
1	ND	ND	ND
2	ND	6.7	ND
3	ND	ND	ND
4	ND	ND	ND
5	ND	ND	ND
6	ND	ND	ND
7	ND	ND	ND
8	ND	ND	ND
9	ND	ND	ND
10	ND	ND	ND
11	ND	ND	ND
12	ND	ND	ND
13	ND	ND	ND
14	ND	ND	ND
15	ND	3.5	ND
16	ND	ND	ND
17	ND	ND	ND
18	ND	ND	ND
19	ND	ND	ND
20	ND	ND	ND
21	ND	ND	ND
22	ND	ND	ND
23	ND	ND	ND
24	ND	ND	ND

25	ND	3.2	3.3
26	ND	ND	12.9
27	ND	ND	22.4
28	ND	ND	ND
29	ND	ND	ND
30	ND	ND	ND
31	7.4	ND	ND
32	ND	ND	ND
33	ND	ND	ND
34	ND	ND	ND
35	ND	ND	ND
36	ND	ND	ND
37	ND	ND	ND
38	ND	ND	ND
39	ND	ND	ND
40	ND	ND	ND
41	ND	ND	ND
42	ND	ND	ND
43	ND	ND	6
44	ND	ND	ND
45	ND	2.9	ND
46	ND	6.4	4.1
47	ND	ND	4.2
48	ND	ND	ND
49	ND	ND	ND

50	ND	ND	ND
51	ND	ND	ND
52	ND	ND	ND
53	ND	ND	ND
54	ND	ND	ND
55	ND	ND	ND
56	ND	ND	ND
57	ND	ND	ND
58	ND	ND	ND
59	ND	ND	ND
60	ND	3.5	ND
61	ND	ND	ND
62	ND	ND	ND
63	ND	ND	ND
64	ND	ND	ND
65	ND	ND	ND
66	ND	ND	ND
67	ND	ND	ND
68	ND	ND	ND
69	ND	ND	3.7
70	ND	5.1	ND
71	ND	5.3	6.2
72	ND	ND	ND
73	ND	ND	ND
74	ND	ND	ND

75	ND	ND	ND
76	ND	ND	ND
77	ND	ND	ND
78	ND	ND	ND
79	ND	ND	ND
80	ND	ND	ND
81	ND	ND	ND
82	ND	ND	ND
83	ND	ND	ND
84	ND	ND	ND
85	ND	ND	ND

ND: Not Detected