EDITORIAL

Exposures of Pesticides and Health Impact on the Agricultural (Paddy) Community in Malaysia

Yu Bin Ho

Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
Email: yubin@upm.edu.my

Malaysian Journal of Medicine and Health Sciences (2023) 19(3):1-4. doi:10.47836/mjmhs19.3.1

INTRODUCTION

Agriculture is one of Malaysia's most important contributions, estimated to improve GDP by 4.3% by 2030 (1). In Malaysia, rice is one of the most frequently farmed crops, in addition to oil palm and rubber, with annual consumption per person averaging 73.9 kilograms (2). Commercial pesticides have thus been widely utilized in agriculture to meet this need since they are readily available, easy to use, and effective. Pesticides are also utilized to manage diseases and pests that constitute a major threat to agricultural output.

Tanjung Karang is the third-largest contributor to Malaysia's paddy output and is located in the Integrated Agricultural Development Area (IADA) Barat Laut Selangor. Research investigating the health effects of pesticide exposure on residents, farmers, and other adjacent groups has been conducted in Tanjung Karang, Selangor.

EXPOSURE OF PESTICIDES IN TANJUNG KARANG PADDY FIELD

Humans may be exposed to pesticides from environmental and occupational exposure. Pesticides can contaminate various environmental components, including water, air, soil, and food, which can pose a significant risk to human health through ingestion, inhalation, and dermal contact. Farmers and pesticide sprayers are the common groups exposed to pesticides due to occupational exposure. Farmers may be inhaled the pesticides while carrying out the spraying activity and working in the field without proper personal protection equipment (PPE). On the other hand, the local community may be exposed to a background concentration of pesticides due to ongoing spraying activity in the agricultural field. Also, local communities may be ingested polluted drinking water due to surface run-off and leaching from the paddy field. Figure 1 summarised the exposure of pesticides to the agricultural community in Tanjung

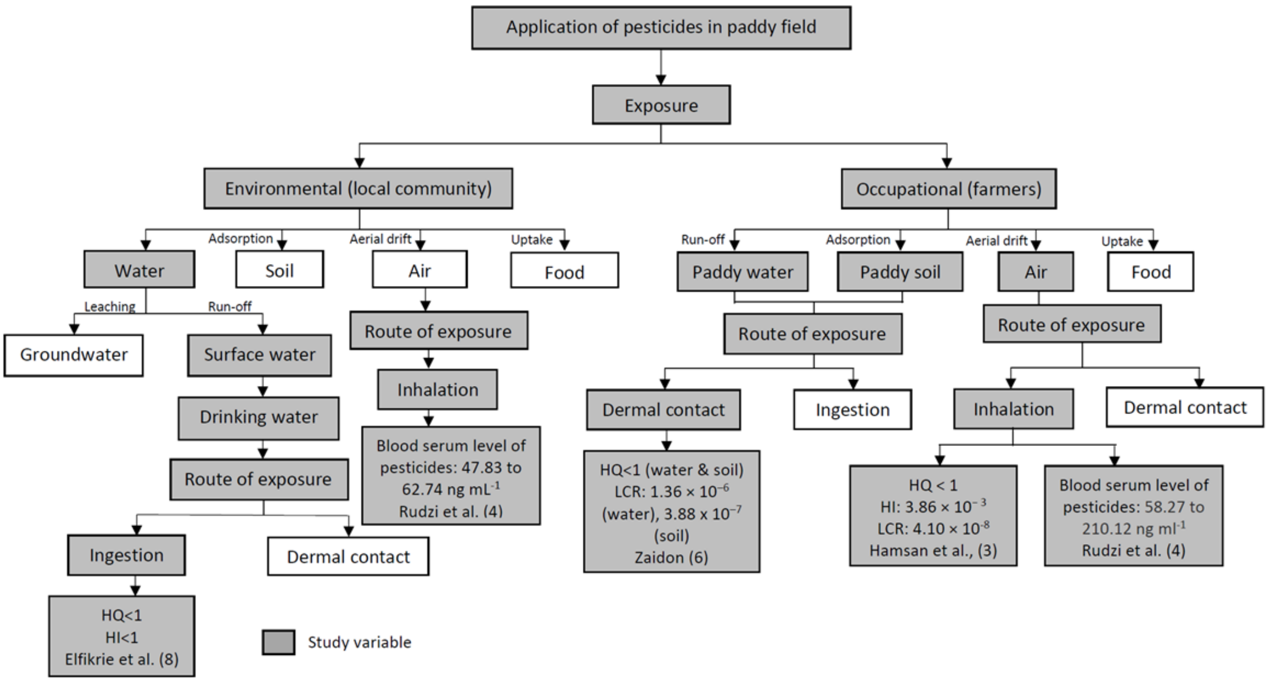

Figure 1: Summary of the exposures to pesticides in Tanjung Karang paddy field and their respective health risk.

Karang and their respective health risks.

EXPOSURES OF PESTICIDES AMONG FARMERS

By handling, mixing, and spraying pesticides onto crops, farmers are significantly exposed to pesticides through inhalation, ingestion, and skin contact. According to Hamsan et al., (3), 83 farmers' personal air samples were contaminated with 13 currently-used pesticides (CUPs). Pretilachlor had the greatest mean pesticide content across all personal air samples (107.19 ng m^{-3}), whereas imidacloprid had the lowest mean value (18.96 ng m^{-3}). Out of 83 personal air samples obtained in the study area, 82 showed evidence of the specified pesticides. Tricyclazole, tebuconazole, chlorantraniliprole, isoprothiolane, trifloxystrobin, difenoconazole, fipronil, pretilachlor, pymetrozine, imidacloprid, propiconazole, buprofezin, and azoxystrobin were identified as the most frequently detected pesticides in the samples based on detection frequency. The values of the hazard index (HI) (3.86×10^{-3}) and the hazard quotient (HQ) of less than 1 respectively indicate that the risk of pesticide-related illnesses was insignificant for the targeted farmers. Pymetrozine's lifetime cancer risk (LCR) was 4.10×10^{-8} at an acceptable level (LCR < 10^{-6}).

Rudzi et al. (4) carried out a further follow-up investigation in Tanjung Karang, Selangor. Thirteen pesticide concentrations were found in the blood serum and personal air of 85 paddy farmers and 85 non-farmers. Farmers' median pesticide exposure levels in personal air samples varied from 10.69 to 188.49 ng m^3, whereas non-farmers median exposure levels ranged from 5.79 to 73.66 ng m^3. For farmers, the median level of pesticides in blood serum ranged from 58.27 to 210.12 ng mL^{-1}, whereas for non-farmers, it ranged from 47.83 to 62.74 ng mL^{-1}. Farmers had significantly greater concentrations of twelve pesticides in blood serum and eleven pesticides in personal air than non-farmers ($p<0.05$). All pesticides found in personal air had a strong correlation with farmers' blood serum concentrations ($p<0.05$).

The two main and most frequent ways people are exposed to pesticides at work are inhalation and dermal absorption (5). Farmers may be exposed to pesticides directly while handling them or indirectly through the exposure of pesticide residues in the soil and water surrounding their paddy fields. According to Zaidon (6), soil and water samples from Kampung Sawah Sempadan, Tanjung Karang, contained traces of thirteen currently used pesticides. The three insecticides (chlorantraniliprole, isoprothiolane, and trifloxystrobin) were the most often found in paddy soil. On the other hand, azoxystrobin, chlorantraniliprole, and trifloxystrobin were the pesticides most commonly found in paddy water. The mean concentration of chlorantraniliprole was the highest for paddy water (6.56 ng mL^{-1}) and paddy soil (15.82 ng mL^{-1}). The concentration of the target analytes in the paddy soil samples and the concentration of the target analytes in the paddy water samples had a significant positive correlation ($r= 0.70$) ($p\leq 0.01$). After the application of pesticides to crops, pesticides will either seep into the soil or will run-off into the water. Based on the findings, none of the target analytes presented a significant non-carcinogenic health risk to paddy farmers in soil and water via dermal exposure, either individually or in combination. In addition, pymetrozine presented a minimal cancer risk (3.88×10^{-7}) to farmers in paddy soil and a probable cancer risk (1.36×10^{-6}) in paddy water through dermal exposure. Meaning that, when exposed to pymetrozine in paddy water, roughly 2 out of every 1 million farmers are at risk of getting cancer.

EXPOSURE TO PESTICIDES IN THE LOCAL COMMUNITY

Farmers may apply pesticides, which may then diffuse into surface water through several mechanisms, including surface and subsurface run-off, agricultural field soil erosion, aerial drift, and deposition through volatilization (7). As a result, pesticide contamination of surface and groundwater in the vicinity of agricultural areas commonly happens. In those areas where pesticides are present, these waters could serve as drinking water sources. Elfikrie et al. (8) identified the presence of pesticides in the Tengi River and the effectiveness of pesticide removal in Tanjung Karang's conventional drinking water treatment plant (DWTP). A total of thirty river water samples and eighteen DWTP water samples were obtained. The findings revealed that in river water samples, propiconazole had the highest mean concentration (4493.1 ng L^{-1}), whereas pymetrozine had the lowest mean concentration (1.3 ng L^{-1}). Tengi River had traces of eleven out of thirteen pesticides. With removal efficiency of 77% for imidacloprid, 86% for propiconazole and buprofezin, and 88% for tebuconazole in the DWTP's finished water, four target pesticides were insufficiently eliminated. The DWTP's effectiveness in removing pesticides is recommended to be improved to lower the consumption risk for the populations in Tanjung Karang and Sekinchan. According to the hazard quotient, it was unlikely that the use of finished water from the DWTP would have a harmful non-cancer effect on the community. Also, the non-cancer risk of exposure to the combination of pesticides was not significant because the HI was less than one.

RECOMMENDATIONS

According to Hamsan et al. (9), farmers in Tanjung Karang, Selangor, have reported thirteen different types of pesticides used by them. Based on the report, pesticides were used at different seasons depending on their need. Also, farmers tend to mix multiple pesticides and apply them to the crops. Farmers are significantly exposed to pesticides if improperly use personal protective equipment (PPE). Non-compliance with PPE was found to be directly related to the farmers' educational background and knowledge of PPE (10-11). Farmers, employers, and regulators often overlook the health risks of using pesticides.

It is advised that farmers use the appropriate PPE when handling and applying pesticides. The Guidelines for the Use of Personal Protective Equipment published by the Department of Occupational Safety and Health Malaysia, states that PPE must be made to be compatible with the following six types of exposure: the respiratory system, the body, the hand, the legs and feet, the head, the eyes and face protection, the respiratory system, the body, and the hand (12). The Factories and Machinery Act of 1967, the Occupational Safety and Health Act of 1994, the Occupational Safety and Health (Use and Standards of Exposure of Chemical Hazardous to Health) Regulations of 2000, and the Malaysian standard code of recommended practice (MS 479:2012) all emphasize the use of personal protective equipment. The details of the recommended PPE according to the exposed area are stated in Table I.

Table I: PPE that suitable for the exposed area

Exposed Area	Suitable Equipment	Descriptions
Head protection	Helmet, face shield	Protection against chemical splashes, burns, and dermal absorption.
Face/Eyes protection	Face shield, google, safety spectacles	Protection against chemical splashes, eye irritation, and skin absorption.
Respiratory system	Facemask, respirator,	Protection against inhalation of chemical vapor, gaseous
Body	Long sleeves shirt, apron, full coverall, chemical suit	Protection against chemical splashes, burns, and dermal absorption.
Hands	Gloves; neoprene, nitrile, or PVC	Protection against chemical splashes, burns, and dermal absorption.
Legs/Feet	Long Pants, chemical suit, coverall, closed shoes, boots	Protection against chemical splashes, burns, and dermal absorption.

Pesticide volatility, sprayer types, application methods and skills, and climatological conditions during application, such as wind direction and speed, temperature, relative humidity, and atmospheric stability, can have an impact on the amounts of pesticides in air samples (13). Tanjung Karang's spraying operations were often conducted in the early morning to prevent increased wind and temperature levels that might enhance the drift of the pesticides sprayed. Pesticides that have been applied can travel away from their intended target location through particle drift and vapor drift (14). When there is field spraying activity nearby, spray drift might escalate to background levels of pesticides in the area.

In addition, it is advisable to periodically review the list of pesticides subsidized by the government to guarantee their safety and practicality. Although the application of pesticides may ultimately aim to increase agricultural productivity, it may also have negative effects on the environment and human health.

Consistent water quality monitoring was advised for the drinking water treatment facility and its processes due to Tengi River's pesticide pollution. To improve the effectiveness of pesticide removal in drinking water treatment plants, it is advised that some advanced water treatment techniques be added. It is advised to utilize some of the home water filtration systems with advanced treatment in the community that receives finished water from the DWTP.

ACKNOWLEDGEMENT

The Malaysian Ministry of Higher Education (MOHE) Fundamental Research Grant Scheme (FRGS) project FRGS/1/2015/SKK06/UPM/02/9 and FRGS/1/2018/SKK06/UPM/02/23 supported all the works in this study.

REFERENCES

1. Malaysian Ministry of Agriculture and Food Industry. National Agrofood Policy 2021-2030; 2021. [cited 2023 April 10]. Available from: https://www.fama.gov.my/dasar-agromakanan-negara-2.0-dan2.0-
2. Department of Statistics Malaysia. Department of Statistics Malaysia Official Portal; 2020. [cited 2023 April 11]. Available from: https://www.dosm.gov.my/v1/ index.php?r=column/cthemeByCat& cat=164&bul_id=cHgwanhNdU4vWXRvc3pnZU9xSjZTUT09&menu_id=Z0VTZGU1UHBUT1VJMFlpaXRRR0xpdz09
3. Hamsan H, Ho YB, Zaidon SZ, Hashim Z, Saari N, Karami, A. Occurrence of commonly used pesticides in personal air samples and their associated health risk among paddy farmers. Science of the Total Environment. 2017;603–604:381–389. doi:10.1016/j.scitotenv.2017.06.096
4. Rudzi SK, Ho YB, Tan ESS, Jalaludin J, Ismail P. Exposure to Airborne Pesticides and Its Residue in Blood Serum of Paddy Farmers in Malaysia. Int. J. Environ. Res. Public Health 2022;19:6806. doi:10.3390/ijerph19116806
5. MacFarlane E, Carey R, Keegel T, El-Zaemay S, Fritschi L. Dermal exposure associated with the occupational end use of pesticides and the role of protective measures. Safety and Health at Work, 2013;4(3):36–141. doi:10.1016/j.shaw.2013.07.004
6. Zaidon SZ. Simultaneous quantification of pesticides in paddy soil and water using UHPLC-MS/MS and their associated dermal health risk assessment [unpublished Doctorate's thesis]. Serdang (MY): Universiti Putra Malaysia; 2019.
7. Reichenberger S, Bach M, Skitschak A, Frede HG.

Mitigation strategies to reduce pesticide inputs into ground and surface water and their effectiveness; A review. Sci. Total Environ. 2007;384:1–35. doi:10.1016/j.scitotenv.2007.04.046

8. Elfikrie N, Ho YB, Zaidon SZ, Juahir H, Tan ESS. Occurrence of pesticides in surface water, pesticides removal efficiency in drinking water treatment plant, and potential health risk to consumers in Tengi River Basin, Malaysia. Science of the Total Environment. 2020;712. doi:10.1016/j.scitotenv.2020.136540
9. Hamsan H, Ho YB, How V, Hashim Z, Saari N. A survey on pesticide use and self-reported respiratory health symptoms among paddy farmers in Tanjung Karang, Malaysia. Malaysian Journal of Medicine and Health Sciences. 2018;14(8):56–63.
10. Sharifzadeh MS, Damalas CA, Abdollahzadeh G. Perceived usefulness of personal protective equipment in pesticide use predicts farmers' willingness to use it. The Science of the Total Environment. 2017;609:517–523. doi:10.1016/J.SCITOTENV.2017.07.125
11. Yuantari MGC, van Gestel CAM, van Straalen NM, Widianarko B, Sunoko HR, Shobib MN. Knowledge, attitude, and practice of Indonesian farmers regarding the use of personal protective equipment against pesticide exposure. Environmental Monitoring and Assessment. 2015;187(3):1–7. doi:10.1007/S10661-015-4371-3/TABLES/4
12. Department of Safety and Health Malaysia. Chapter 1: Guidelines on the Use of PPE Against Chemical Hazards. Department of Occupational Safety & Health, Ministry of Human Resources, Malaysia; 2005.
13. Majewski MS, Coupe RH, Foreman WT, Capel PD. Pesticides in Mississippi air and rain: A comparison between 1995 and 2007. Environmental Toxicology and Chemistry. 2014;33(6):1283–1293. https://doi.org/10.1002/etc.2550
14. Kruger GR, Klein RN, Ogg CL, Vieira BC. Spray Drift of Pesticides. Nebraska Extension Publications; 2019. https://extensionpublications.unl.edu/assets/html/g1773/build/g1773.htm