A Pilot Survey of Pesticide-Specific Urinary Metabolites among Farmers in Chiang Mai Highland Agricultural Area

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ABSTRACT

This study surveyed the exposure to pesticides among farmers in Chiang Mai's highland agricultural area. Ethnic Hmong farmers, living in Baan Buak Jan, Mae Rim District, Chiang Mai Province were selected as the study population. Pesticide-specific urinary metabolites were used as biomarkers of exposure to a variety of pesticides, including organophosphorus pesticides, synthetic pyrethroids and selected herbicides. Our method employed a simple solid-phase extraction, followed by a gold standard analytical method, using isotope dilution high performance liquid chromatography- tandem mass spectrometry (LC/MS/MS). A total of 40 urine samples from Hmong farmers were analyzed for 19 specific pesticide metabolites. We found that para-nitrophenol (PNP, a specific metabolite of methyl parathion and parathion) was the dominant analyte, having the highest amounts in all urine samples tested. We also found the metabolites of chlorpyrifos, common pyrethroids and permethrin/cypermethrin, namely 3,5,6-trichloro-2-pyridinol (TPCY), 3-phenoxybenzoic acid (3-PBA) and cis- & trans-3-(2,2-dichlorovinyl)-2, 2-dimethylcyclopropane-1-carboxylic acids (c- & t-DCCA) respectively. The Hmong farmers were classified into groups according to their type of plantation or crop, resulting in the following breakdown: flower plantations (n=20), vegetable plantations (n=11) and flower and vegetable plantations (n=9). Thai farmers who had pesticide-free vegetable plantations (n=8) were used as a comparison group. The results showed that there was no significant difference among all analytes detected in farmers with different crop types (Mann-Whitney-U test $p>0.05$). However, a significant difference in PNP concentrations was found between farmers on plantations using pesticides and those on pesticide-free plantations (Mann-Whitney-U test $p<0.05$). No correlation was observed among individual analytes except for 3-PBA and t-DCCA (Pearson $p=0.00$), suggesting a common source for these two analytes, likely permethrin or cypermethrin insecticides. This study demonstrated pesticide exposure among farmers who use pesticides on their plantations in Thailand.

Further studies are required to determine if any pesticide-related health outcomes are associated with these exposures.

Key words: Urinary metabolites, Pesticides exposure, LC/MS/MS, Farmers in Thailand

INTRODUCTION

In Thailand, pesticides, particularly those in the organophosphate and carbamate groups, are widely used for agriculture and household purposes. Production of fruits and other high-value crops for export and local consumption often involves extensive use of agrochemicals, including pesticides (Kunstadter et al., 2001). As farmers have gradually switched from low-value to high-value crop production, the overall consumption of pesticides has naturally increased. In order to raise yield, farmers have intensified pesticide use in the production of all crops, as reflected by increasing shares of pesticide costs in total production costs (Paopongsakorn et al., 1998).

Thailand is a major market for pesticides which are mostly imported for industrial and agricultural use. Since pesticides were first imported into Thailand under the "Green Revolution Policy", part of the 1st National Economic and Social Development Plan in 1966, the total amount of imported pesticides has dramatically increased year by year. In 2000, the entire amount of imported pesticides was 52,739 tons which cost about 7,294 million baht. Most were herbicides, followed by insecticides, disease control agents, plant growth regulators and so on. Using the WHO hazard categories, 55.93% of imported insecticides fell into the Ia category (extremely hazardous) and the Ib category (highly hazardous) (Alternative Agricultural Network, 2003).

Because pesticides are often overused, Thai farmers' current use of pesticides is highly inefficient and has led to chemical poisoning. For instance, in order to save labor costs associated with spraying, farmers often mix pesticides themselves, creating a "cocktail" of several chemicals without considering their synergistic effects. In addition, farmers frequently increase the concentration of pesticides in the belief that increased intensities will lead to better protection (Poapongsakorn et al., 1998). During 2000-2001, the project carried out by Thailand's Food and Drug Administration had found that organophosphorus showed major problem among group of exposed people (Food and Drug Administration., 2001).

Chiang Mai Province, known as the capital city of Northern Thailand, has seen rapid development in education, industry and tourism. However, agriculture is still the major occupation in rural areas, and consequently, many resources have been used and new technologies adopted to improve the agricultural systems which is comprised of the production systems and supporting ancillary components. Most of the farmers have basically aimed at increasing their production in order to increase their income, and in some cases, just to survive. Plenty of pesticides, therefore, have been applied at almost every step in agricultural practice. Pesticides are commonly used among agriculturists and the rate of application in the agricultural sector is increasing every year (Nakma, 2002).

Recently, the research done among Hmong farmers in Chiang Mai Province, Thailand suggested that half of the studied group had risky or unsafe levels of cholinesterase