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Associations between pesticide use and respiratory symptoms: A cross-sectional study in Southern Ghana

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ABSTRACT

Background: Indiscriminate use of pesticides is a common practice amongst farmers in Low and Middle Income Countries (LMIC) across the globe. However, there is little evidence defining whether pesticide use is associated with respiratory symptoms.

Objectives: This cross-sectional study was conducted with 300 vegetable farmers in southern Ghana (Akumadan). Data on pesticide use was collected with an interviewed-administered questionnaire. The concentration of seven organochlorine pesticides and 3 pyrethroid pesticides was assayed in urine collected from a sub-population of 100 vegetable farmers by a gas chromatograph equipped with an electron capture detector (GC-ECD).

Results: A statistically significant exposure-response relationship of years per day spent mixing/applying fumigant with wheezing [30–60 days/year: prevalence ratio (PR)=1.80 (95% CI 1.30, 2.50); >60days/year: 3.25 (1.70–6.33), p for trend=0.003] and hours per day spent mixing/applying fumigant with wheezing [1–2 h/day: 1.20 (1.02–1.41), 3–5 h/day: 1.45 (1.05–1.99), >5 h/day: 1.74 (1.07–2.81), p for trend=0.0225]; days per year spent mixing/applying fungicide with wheezing [30–60 days/year: 2.04 (1.31–3.17); >60days/year: 4.16 (1.72–10.08), p for trend=0.0017] and h per day spent mixing/applying fungicide with phlegm production [1–2 h/day: 1.25 (1.05–1.47), 3–5 h/day: 1.55 (1.11–2.17), >5 h/day: 1.93 (1.17–3.19), p for trend=0.0028] and with wheezing [1–2 h/day: 1.10 (1.00–1.50), 3–5 h/day: 1.20 (1.11–1.72), >5 h/day: 1.32 (1.09–2.53), p for trend=0.0088]; h per day spent mixing/applying insecticide with phlegm production [1–2 h/day: 1.23 (1.09–1.62), 3–5 h/day: 1.51 (1.20–2.58), >5 h/day: 1.85 (1.31–4.15), p for trend=0.0387] and wheezing [1–2 h/day: 1.22 (1.02–1.46), 3–5 h/day: 1.49 (1.04–2.12), >5 h/day: 1.81 (1.07–3.08), p for trend=0.0185] were observed. Statistically significant exposure-response association was also observed for a combination of activities that exposes farmers to pesticide with all 3 respiratory symptoms. Furthermore, significant exposure-response associations for 3 organochlorine insecticides: beta-HCH, heptachlor and endosulfan sulfate were noted.

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Conclusions: In conclusion, vegetable farmers in Ghana may be at increased risk for respiratory symptoms as a result of exposure to pesticides.

1. Introduction

The use of synthetic pesticides in agriculture has grown dramatically in Low and Middle Income Countries (LMIC) across the globe bringing in its wake both beneficial and potential deleterious effects on the environment and human health (McCauley et al., 2001; Alavanja and Bonner, 2012).

In Ghana, agriculture plays a crucial role in the socio-economic development, employing about 60% of the labor force, contributing to approximately 33% of the gross domestic product and accounting for more than 40% of export earnings. Cultivation of vegetables plays a critical role in the agricultural sector (Ntow and Botwe, 2011). In Ghana, different kinds of pesticides are registered and imported and these are widely used on crops of tomato, eggplant, pepper and onion to mention a few. Some regions are known to specialize in the production of only one or two vegetables (Ntow et al., 2009). Vegetable farming on this scale attracts many pests and the plants are afflicted with disease.

Consequently, chemical pesticides are intensively applied to manage both pests and plant pathogens. Pesticide use in Ghana continues to increase as agriculture production intensifies (Ntow et al., 2001). Commonly used pesticides include herbicides (44%), insecticides (33%) and fungicides (23%) (Ntow et al., 2006). The continuing use of banned pesticides including aldrin, dieldrin, endosulfan, lindane, DDT, and methyl bromide has also been recently reported. Farmers who apply these pesticides are often illiterate, lack the necessary training, equipment and safety information (Abdul-Rahaman, 2015).

Practices that predispose farmers and others to the harmful effects of pesticides are widespread in Ghana and include application just before harvest (thus contaminating the crop shortly before consumption), applying pesticides at larger amounts than recommended for optimal effect, applying pesticides intended for growing crops onto stored crops, using pesticides banned elsewhere in addition to obsolete or expired pesticides. Especially hazardous behaviors include tasting pesticide mixtures to determine their strength, re-using pesticide-containing drums and other contaminated containers for water storage, using hands to mix pesticides and, using unapproved spraying tools. (Danquah et al., 2009; Ntow, 2001, 2006). Misuse of highly toxic pesticides, coupled with a weak enforcement of existing legislative framework for the registration and regulation of pesticides and their use have resulted in a plethora of environmental, domestic animal and human contamination reports (Adu-Kumi et al., 2010; Akoto et al., 2013; Essumang et al., 2013; Hogarh et al., 2014; Ntow et al., 2008; Osei-Fosu et al., 2014). Notwithstanding this, in Ghana as in many other developing countries, the data required to elucidate the full, or even partial, extent of adverse human health effects from exposure to pesticide chemicals is extremely difficult to obtain. This is due to the lack of effective monitoring systems for the total amounts and types of pesticides purchased, stored, used or disposed by concentrated release into the environment, especially at the regional and local level and the absence of epidemiologic evidence. Farmers, including vegetable farmers, know very little about the health hazards associated even with careful use, and especially misuse of pesticides. Residents in communities living adjacent or close to the farming fields are also likely to be unaware of the health hazards. There are anecdotal reports of skin irritations, headaches, general body weakness, difficulty in breathing, dizziness, lung dysfunction, asthma, chronic obstructive pulmonary diseases, respiratory tract infections, and interstitial lung disease in farmers visiting medical facilities but these have not been evaluated by epidemiological studies. This lack of evidence for adverse human effects of pesticide use provided the fundamental motivation for this study. This paper examines the association between the use of pesticides, including fumigants, fungicides, herbicides and insecticides and adverse respiratory symptoms in Ghana. Estimates of exposure were obtained by analysis of organochlorine and pyrethroid insecticides and/or their human urinary residues. This paper adds to our understanding of the possible contribution of the often discriminate use of pesticides to the risk for respiratory illness in Ghana.

2. Methods

2.1. Study design/setting

This cross-sectional study was conducted at Akumadan, a prominent vegetable farming community in the Offinso North District of the Ashanti Region, located about 95 km north–west of Kumasi, the administrative capital of the Ashanti region. Akumadan is a hetero-ethnic area made up of 30 farming communities (Fig. 1). It has a population of approximately two thousand seven hundred (2700) of whom about 85% are engaged in vegetable cultivation.

The major vegetables cultivated are pepper, eggplant (*Solanum melongena*), okro and tomatoes with tomato constituting about 80% of total vegetables produced (Ntow et al., 2001). Other cultivated crops include maize, cassava, plantain and cocoa. The natural vegetation of Akumadan is semi-deciduous forest, most of which has been cleared by extensive on-going logging activities which has facilitated an extensive farming economy. This geographic area was selected because it is an agricultural area with the one of the highest reported uses of, and exposures to, pesticides in Ghana (Ntow et al., 2001).

2.2. Source/study population

The population studied included all 700 vegetable farmers who are members of the Akumadan Vegetable Growers Association (AVGA). From this population, 300 participants were randomly selected. Inclusion criteria were: having been a farmer in this area for at least twelve months; serving as an active member of the AVGA; being more than eighteen years of age; and agreeing to comply with the study protocol.

2.3. Data collection

All 300 participants were interviewed with a modified version of a questionnaire used in a previous study (LaVerda et al., 2015). The questionnaire included questions related to personal information such as age, gender, marital status, level of education, smoking status, any other occupation(s), hours (h) spent on the farm on average, and predominant type of crop grown. There were questions on use of pesticides (yes or no), how long a farmer has