

Understanding South African herbicide workers’ residual take-home exposure risks from personal protective equipment cleaning and storing practices

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Abstract

Exposure to pesticides has been associated with several adverse health effects. When workers who spray pesticides take contaminated Personal Protective Equipment (PPE) and work clothes home, those items pose a risk of cross-contamination. Agriculture employers are recommended to make facilities available for workers to clean and store contaminated items at the workplace to reduce the risk of cross-contamination. However, little research has been conducted on forestry workers, for whom at-work cleaning and storage facilities may be less feasible.

Working for Water (WfW) is a South African programme that focuses on removing invasive alien vegetation and alleviating poverty through providing job opportunities to unemployed individuals in low-income settings. WfW forestry workers use herbicides to remove the invasive vegetation. Unlike agricultural workers, WfW forestry workers undertake projects that are transient and tend to be on mountainous or steep terrain. The work environment poses challenges for at-work access to amenities or facilities to clean and store contaminated PPE. Workers have few alternatives but to take contaminated items home. WfW safety protocols do not currently address the risks associated with take-home residues or indicate how workers should clean and store contaminated items. This study is part of a larger project focusing on developing protocols to reduce the risks of cross-contamination and exposure to residues.

This dissertation provides baseline data for improved WfW safety protocols through the exploration of workers' at-home risks of cross-contamination, and the role that worker

perceptions and access to amenities have on cleaning and storing behaviors for contaminated items. The Protocol (Part A) describes the methods used to collect and analyze the data. The Literature Review (Part B) presents the risks of take-home residues associated with cross-contamination and the importance of exploring workers' perceptions and access to amenities to promote safety compliance.

The Article (Part C) explores WfW workers' cleaning and storing behaviors, what contaminated items are taken home, the workers' access to amenities in the home, and the workers' perceived risk of exposure. Questionnaires were administered to 29 WfW workers across three excavation sites (Tokai, Citrusdal and Hermanus) that were selected based on convenience sampling. Findings showed that most of the participants took contaminated items home daily. Many participants (55.2%) did not have access to running water. Access to running water and type of housing influenced whether the contaminated items were washed indoors or outdoors, and how they were washed. WfW participants who lived in a shack were more likely to leave contaminated items on the couch or bed or with other clothing items than those living in permanent dwellings. Those workers were more likely to keep them in a non-permeable transport bag, outside, or separate drawers away from clean items. The majority of subjects (65.5%) perceived exposure to herbicides as dangerous to their health. The participants' perceived risk was associated with whether they took contaminated PPE items home, but not how they were cleaned or stored. WfW Safety protocols should emphasize the importance of keeping contaminated items contained and reducing contact with household surfaces or clean clothes. Workers' cleaning and storing practices and their associated risk of cross-

contamination are largely determined by the amenities they have access to. For new safety protocols to be effective, they need to be realistic and take into account the constraints workers face.

Part A. Proposal

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1. Introduction

Personal protective equipment (PPE) and work clothes that are occupationally exposed to pesticides can lead to cross-contamination in the worker's home and result in residue exposure to the worker and members of the household. Exposure to pesticides can have several adverse health effects. Although acute symptoms may seem mild; such as skin, eye and respiratory irritation (1,2), prolonged exposure to small doses has been associated with reproductive abnormalities (3), and contribute to the onset of cancers, diabetes, neurological diseases and depression (1–5). Appropriate cleaning and storing practices of contaminated PPE and work clothes could reduce the risk of cross-contamination, and thereby reduce residue exposure in the home (6–9). Unfortunately, there is currently little guidance on cleaning and storing practices that are suitable for workers in low and middle-income countries (LMICs). Populations in LMICs face several social, political and economic factors that can increase their risk of exposure, which include; poor regulation of pesticides, poor access to amenities, low levels of education, poor knowledge regarding the risk of pesticides among workers and management, poor access to health services, and high levels of turnover among workers (7,10–14). Such factors can have an impact on the safety behaviors workers engage in and their risk of exposure.

Working for Water (WfW) is a government program in South Africa where workers mix and apply herbicides to kill alien invasive vegetation, but their pesticide handling guidelines (15) do not include cleaning and storing practices for contaminated PPE.

Equipping workers with appropriate guidelines to clean and store contaminated PPE and work clothes could significantly reduce their risk of exposure to residues and prevent the

development of chronic health conditions. The development of appropriate guidelines requires more research to understand workers' risk of cross-contamination and exposure and opportunities for change. This study is a sub-study of a parent study that will explore the risks of exposure associated with the cleaning and storing of contaminated PPE at work and in the home and opportunities for change. This sub-study will focus on where and how the workers clean contaminated PPE and clothing, what amenities they have access to in the home, what PPE they use and bring into the home and their perceived risk of exposure. This information will assist in the development of guidelines that are feasible to implement for the WfW worker population and prevent cross-contamination and residue exposure in the home.

2. Summary of literature

Pesticides are used in a variety of sectors including to support agriculture or control invasive vegetation, but have been associated with harmful health effects if ingested, inhaled or if they make dermal contact (1,2,4,16). Acute symptoms of exposure include skin irritation, airway obstruction, asthma, diarrhea, and eye irritation (1,2,4,10,16). Prolonged exposure, even in small doses, has been associated with the breakage of chromosomes, oxidative stress and endocrine disruption. This can cause reproductive abnormalities, neurological disorders, and further non-communicable diseases (NCDs) such as hypertension, cancer, diabetes, atherosclerosis, and even tissue damage to the brain (1–4,16,17). As many of these symptoms develop slowly over a long period of time, and sometimes long after exposure has ceased, the association between exposure and disease is not always recognized. This is particularly true for herbicides and exposures in LMICs, where factors such as poor reporting, misclassification and lack of

health care facilities in rural areas make it difficult to estimate levels of pesticide poisoning and exposure (18). Broad estimates suggest that exposure to pesticides are responsible for over three million cases of acute poisoning, and 220 000 fatalities per year worldwide (11). Even though LMICs use only 20% of agrochemicals, they experience 99% of the deaths associated with them (16,19,20). This discrepancy has been attributed to several social, political and economic factors, including the poor regulation of pesticides in LMICs, poor access to necessary health services, low levels of education, lack of access to information, and poor understanding regarding the risks of pesticides (10,11,18,21). Workers in LMICs experience compounding factors, such as: poor diets, compromised immune systems, low levels of education, that can further exacerbate the impact of NCDs caused by exposure (11,22–24). As a result of these compounding factors, it is apparent that workers in LMICs are at an increased risk of exposure to pesticides.

Workers are at risk of exposure not only at work, but also in the home when contaminated PPE is worn home or not cleaned properly (2,8,9). This can result in cross-contamination as pesticide residues come into contact with household surfaces or settle in house-dust. Curwin and colleagues (2005) compared levels of pesticides in house dust among farmers in Iowa, USA, and found that levels were significantly higher in the homes of farm workers who worked with pesticides than farm workers who did not use pesticides or non-farm workers (9). As pesticides were not being sprayed close to the homes, it was assumed that they were brought into the home on the workers' boots and contaminated clothing. In addition to whether or not workers interacted with pesticides

before returning home, Lozier and colleagues (2012) found that the levels of the pesticide atrazine in house dust among another set of farmers in Iowa, USA, were significantly associated with whether the worker took his/her boots off outside or inside the home (8). The levels were also significantly higher when workers reported taking their clothes off in the master bedroom compared to outside. These studies highlight that if contaminated PPE enters the home, it will cause cross-contamination. Preventing cross-contamination significantly reduces levels of pesticide residues in the home. Residues will pose a risk of exposure not only to the worker, but to all members of the household as they touch surfaces or inhale house dust (25). Preventing take-home residue exposure requires workers to engage in behaviors that prevent cross-contamination from contaminated PPE and clothing items.

Studies on PPE safety compliance suggest that safety behavior is complex, and underlying social, cultural and economic factors can put workers in LMICs at an increased risk of take-home residue exposure (26–28). Workers' knowledge, beliefs and attitudes will play an important role in shaping their perceptions around risk, barriers, self-efficacy, outcomes and susceptibility. These perceptions will influence a worker's intention to engage in safety behaviors (29–32). PPE offers up to 85% protection against exposure, but is contingent on consistent safety compliance (2). Naidoo et al. (2010), however, found that only a little over 50% of 803 female farm workers in Kwazulu Natal (KZN), SA, reported using any PPE at all when mixing or applying pesticides (26). Gloves were used less than 20% of the time and masks were worn less than 15% of the time. The women who had received training were more likely to use PPE than those who

had not, but very few had had access to any training. In this setting, training around handling and understanding pesticides was not the norm. Naidoo and colleagues, (2010) further found that only a few women correctly interpreted the safety label to keep out of reach from children (26). Hazard labels and pesticide instructions were not well understood by this population. Studies suggest that low levels of education decrease the worker's ability to interpret safety labels, and decreases the likelihood of safety behavior compliance (10,28,33). Again, those who had received training were more likely to correctly interpret the warning label, and those who correctly interpreted it were more likely to keep it out of the reach of children (26). Nevertheless, levels of education further impact the worker's ability to understand or learn complex processes, which can decrease the efficacy of training provided in a classroom settings (28). In this manner, not only do many workers in LMICs have poor access to cleaning facilities, appropriate PPE, and sufficient safety and risk information, but their risk of exposure is further exasperated by low levels of education and a poor understanding of risk and safety behaviors. Poor understanding of pesticide risks can perpetuate social behavioral norms that can lead to exposure (7). Factors in the occupational environment such as the terrain, the weather, poor access to amenities, and high worker turnover can motivate poor safety behaviors such as not washing hands, not removing contaminated items before eating or drinking (14,34). Social modeling and interpersonal support are great predictors of PPE and safety behaviors (30), and hence if the workers are immersed in a culture of risky social norms, coupled with a poor understanding of residue exposure risk, those social norms are likely to perpetuate worker perceptions and promote behaviors that put workers at risk of residue exposure.

WfW is a government public works program in South Africa. It was first launched in 1995 by the Department of Water Affairs and Forestry (15), and is now administered by the Department of Environmental Affairs (35). The program is concerned with water conservation and seeks to create employment by removing alien invasive vegetation (14). WfW has over 300 programs across all nine provinces and provides jobs and training to approximately 45,000 people per year (35). Invasion by foreign species can disrupt the natural ecosystem, because their roots tap deeper and use more water than indigenous plants. This causes water shortages and poses several threats to the environment (Cronk & Fuller, 2014). It has been estimated that 9 000 foreign plants have been introduced to South Africa, 198 of them classified as invasive, and these plants cover over 10% of the country (35). Thus far, the program has managed to clear over one million hectares, although those areas still require annual maintenance to prevent resurgence of the alien vegetation (35). This program clears alien invasive vegetation through a combination of felling, burning, species-specific insects and diseases, and spraying herbicides. The WfW workers who spray and mix herbicides may be subject to some of the underlying social economic and political factors associated with LMICs that could increase their risk of exposure to residues in the home.

In a study on WfW worker's safety behaviors, Andrade-Rivas & Rother (2015) discovered that many WfW workers believed the primary purpose of their PPE was to protect them against snakes, rather than occupational exposure to pesticides when mixing or spraying (34). Believing that the primary purpose of PPE was to protect against snakes

and not exposure to pesticides meant that they perceived the snakes and not the pesticide as a risk. With little perceived risk of exposure; they had little incentive to be cautious to avoid it, and hence were observed taking a lunch break on their contaminated PPE. Not only does this put them in direct contact with the pesticide residues, but the food they consume becomes exposed too. A poor understanding of the risks of pesticide exposure, or that they could get exposed to the pesticides from residues on the PPE, raises question regarding measures they would take to clean that contaminated PPE and prevent cross-contamination.

The workers' knowledge, beliefs, attitudes and perceptions are subject to individual, interpersonal and organizational factors. These factors will shape the workers' beliefs and behaviors around safety (30,31). Mayer et al. (2010) found that agricultural workers in Florida who were frequently subjected to warning signs, and who believed that hand-washing was important to their supervisors, were more likely to wash their hands in the workplace than workers who did not have this belief or receive signs (36). Wirth & Sigurdsson (2008) explain that signage, immediate feedback, and supervision help reinforce a safety culture by acting as cues to reinforce the beliefs around risk and prevent the emergence of social norms that underpin poor safety behaviors (32).

Workers' safety behaviors in the home will be contingent on their beliefs, and hence it is important to understand what the cues are in the workplace that will shape the workers' behaviors, attitudes and beliefs around risk and safety behaviors.

WfW workers mix and spray in an occupational environment where safety behaviors can be cumbersome; for example, the terrain is difficult, the weather conditions are inclement and they experience pressure to reach productivity goals. Workers express that the PPE gets in the way and is uncomfortable in those conditions (34,37). Wirth & Sigurdsson (2008) suggest that workers' perceptions are constantly influenced by social and occupational cues around them. In that case, the inconvenience of complying with PPE safety protocols use shape workers' reluctance to do so (32). The reluctant behaviors could furthermore inadvertently communicate that there is little risk associated with exposure to pesticides and pesticide residues. If workers do not believe that there is a sufficient risk to warrant the use of PPE in the workplace, they may not believe there is sufficient risk associated with cross-contamination and residue exposure to take caution in the home.

Unlike many agricultural projects, WfW excavation projects are inherently temporary, the projects move to new areas that need to be excavated and hence sites are not well established (14). Work is done on mountains and in fields, making it difficult to accommodate amenities such as running water. This can make cleaning contaminated items cumbersome, and without established facilities at the workplace, PPE and contaminated items are taken home for cleaning. This results in a risk of cross-contamination and residue exposure in the home. The WfW program has specified standard operating procedures (SOPs) regarding which PPE should be used when applying or mixing herbicides to prevent occupational exposure among workers (15), and contractors are expected to provide this PPE to workers. WfW does not, however,

provide a document with practical guidance for workers regarding how to clean or store contaminated clothes. WfW workers are not equipped with knowledge regarding appropriate cleaning and storing practices, or the risks associated with exposure to pesticide residues.

WfW faces several obstacles to providing effective safety training and communicating appropriate cleaning and storing guidelines. Training can have a positive impact on risk perceptions and safety behaviors (38). WfW however faces a high worker turnover rate, which Shackleton et al. (2016) warn can put strain on management and safety training. It requires not only more time invested in providing training, but also more financial investment in PPE, increased oversight (39), and as Andrade-Rivas & Rother (2015) found to be true, many workers will miss their training. The WfW projects are based in low-income settings where workers have low levels of education and get paid poorly, which does not motivate them to stay on the projects for long (37). These factors can result in a poorer understanding of the risks of pesticide exposure, and can make safety training more difficult for WfW management (10,39,40).

Management themselves may not be familiar with the risks associated with residues. In comparison to other pesticides, herbicides do not have severe acute effects, and are therefore not recognized to be as hazardous with regard to regulations based on the Hazardous Chemical Substances Regulations 1995 (41). Compounded by the short-term nature of the projects, the high worker turnover, and poor access to health services, it is likely that management is not aware of any health conditions associated with exposure

among past workers, or whether there are risks of take-residue exposure among current workers. Mitigating exposure to residues through cross-contamination in the home has been a neglected area regarding the health and safety of WfW workers and their family members. Cleaning and storing protocols intended for workers in high income countries, such as those for the US (42), require access to amenities that many workers in LMICs simply do not have, and the implementation among WfW workers becomes unfeasible. The environmental terrain, low resource setting and constantly moving nature of the projects makes it difficult for the program to provide access to sufficient amenities for cleaning of contaminated items to occur at the work place, so workers do take contaminated items home. Appropriate guidelines for WfW workers to prevent exposure to take-home residues requires further research to gain an understanding of the risk of cross-contamination in the home. Documenting where and how workers clean contaminated items, as well as their access to amenities in the home and their perceived risks of exposure, will facilitate the development of cleaning and storing guidelines for contaminated items that can feasibly be implemented among WfW workers.

3. Purpose

The purpose of this study is to support the prevention of cross-contamination and take-home residue exposure among WfW workers by assisting in the development of cleaning and storing guidelines of contaminated PPE that are appropriate for WfW workers. Additionally, findings from this study will supplement the parent study with a description of the risks of take-home residue exposure among WfW workers.

4. Aim

The aim of this study is to document the risk of cross-contamination and residue exposure in the home of WfW workers and provide recommendations to support the development of cleaning and storing guidelines for contaminated PPE that are appropriate for WfW workers.

5. Objectives

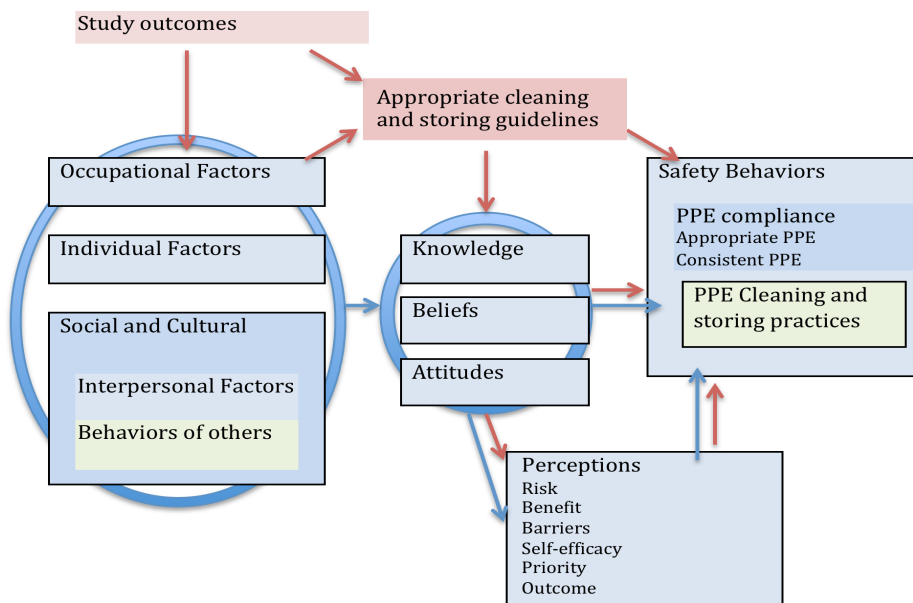
The aim to provide recommendations to WfW for appropriate cleaning and storing guidelines and document the risk of cross-contamination and take-home residue exposure will be achieved through the following objectives;

- To document where, how and how often WfW workers clean contaminated SOP prescribed PPE items.
- To document which contaminated items are brought into the home and where it is stored.
- To describe what amenities for cleaning contaminated PPE workers have access to in the home.
- To document WfW perceived risk of herbicide exposure.
- To make recommendations to WfW on appropriate cleaning and storing guidelines of contaminated PPE for WfW workers.

As seen in Figure 1, the occupational, individual and social cultural factors influence each other. There are currently no guidelines for WfW workers on appropriate cleaning and storing practices. Knowledge, current beliefs, and attitudes towards safety behaviors

are influenced by external and internal factors and influence each other. Poor knowledge, false beliefs, and a negative attitude towards safety can increase impact workers' likelihood of engaging in safety behaviors, including how they clean and store contaminated items. Through this study, appropriate guidelines for cleaning and storing contaminated items are to be provided to workers by WfW to influence workers' knowledge and hence beliefs and attitudes. This will shape their perceptions and provide them with the tools to engage in safe behaviors. Workers engaging in safe behaviors will have a social influence on other workers, and thereby, in the long run, a safety culture will develop with safe cleaning and storing behaviors that will reduce the risk of cross-contamination and residue exposure, and further promote a better understanding of the risks associated with exposure.

Figure 1: Schematic for the intended outcomes of the study



6. Methodology

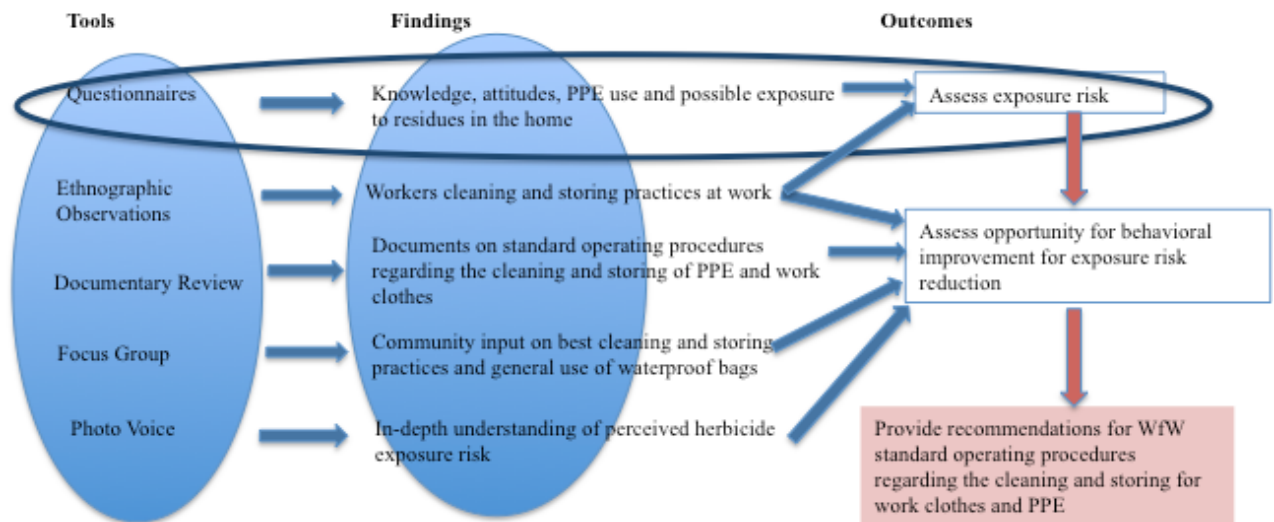
Study design

The proposed research objectives will be addressed through the analysis of secondary data collected as part of a qualitative study exploring workers' cleaning and storing practices, PPE use, their access to amenities, and their attitudes and beliefs regarding pesticide exposure. This parent study is titled; "*Assessing Working for Water workers washing and storing of herbicide contaminated personal protective equipment and work clothes: Identifying the risk prevention measures of cross-contamination for family members and home environment*" (HREC REF 213.2016, Appendix C).

The parent study seeks to find opportunities to prevent the risks of cross-contamination and herbicide residue exposure among WfW workers with an intention to provide WfW with recommendations for guidelines on PPE cleaning and storing practices that would reduce residue exposure at work and in the home. As seen in Figure 2, the parent study will assess the risk of residue exposure in the home and at the work place, and investigate opportunities to that risk of exposure through appropriate cleaning and storing guidelines. The parent study will include questionnaires, ethnographic observations, a documentary review, focus groups, and photo voice. The scope of this sub-study will cover an analysis of the questionnaires, with an intention to focus on the risk of exposure to residues through cross-contamination in the home. These questionnaires were administered between February 2016 and August 2016 at the Hermanus, Tokai and Cirtusdal WfW locations. This sub-study will explore workers' access to amenities in the home, workers'

perceived risk of herbicide exposure, which contaminated PPE they bring home, as well as how and how frequently they clean it. As part of the parent study, the ethnographic observations will be used to assess the risks of exposure in the work place, and how behaviors around PPE use, storing and cleaning could potentially be changed in that setting. The documentary review will provide insight into recommendations provided elsewhere in different settings, as well as give insight into the information that is missing for workers and management regarding mitigating residue exposure. The focus groups will give the community and workers an opportunity to provide input and insight into cultural norms and beliefs, and assist the investigators in developing appropriate and feasible guidelines for the WfW population. The photo voice will be an opportunity for workers and management to express their beliefs, knowledge and attitude, and describe their behaviors in an in-depth manner, allowing the investigators to obtain a deeper understanding regarding residue exposure risk among individuals of this population. This sub-study will provide recommendations to WfW on suitable guidelines for the workers' cleaning and storing of contaminated PPE taken home, but should act as a supplement to the parent study. The parent study findings will collectively provide a suitable overview on the risks of residue exposure among workers, as well as opportunities for safer cleaning and storing practices. The study will deliver recommendations for appropriate cleaning and storing guidelines in the home and at the work place for WfW.

Figure 2: Schematic for scope of study in relation to the parent study



Study population

Three WfW contract teams will be invited for participation; one team from each of the following locations; Tokai, Citrusdal and Hermanus. These locations were selected based on convenience sampling from sites WfW deems appropriate. WfW contract teams include approximately 10 employees. All team members who participate in the study will be categorized by WfW as a contractor, general worker, peer educator, herbicide applicator, first aider, health and safety representative or driver; according to the activities they are certified and trained to perform. Participants will be representational of the DWAF (2007) team inclusion criteria, which stipulates that team members must be unemployed at the time of hiring, over half of the team are required to be women, and at least 20% of the team need to be under 25.

Data collection

Arrangements for data collection at the Hermanus, Citrusdal and Tokai locations will be made between the WfW contractor and the researchers at a time that is convenient for the

contractor's entire team to be available for up to three hours on one afternoon.

Fieldworkers will travel to the site for data collection. The fieldworkers will consist of MPH working on the parent study, and individuals who will be briefed by the team of researchers prior to the event. All participants will complete a questionnaire after consenting and then participate in a brief safety seminar. A team of four fieldworkers will administer the questionnaires face-to-face, where one fieldworker will be paired with one participant at a time. Afterwards, the fieldworkers will run the safety seminar for the entire team together. For participants who do not speak English, the questionnaire will be administered in the participant's preferred language by a fieldworker fluent in Xhosa or Afrikaans, which are the most common primary languages of the workers depending on site. The questionnaires (Annex A) will take approximately 30-45 minutes per participant to complete. Participation will be voluntary and all participants will sign a consent form (Annex B) prior to starting the questionnaire. Each participant will be assigned a subject number and his or her identity will remain confidential.

Data analysis

Data collected from the questionnaires will be coded into categorical variables and entered into SPSS 24. This study will focus incorporate demographic information, listed access to amenities, perceived risk of exposure, greatest fear at work, responses on where and how contaminated items are cleaned, where and what contaminated PPE is stored, and how frequently contaminated items are cleaned. Open-ended responses will be categorized and coded thematically prior to analysis. The codes will be collapsed into no more than 6 unique responses for any given variable. The data will be cross-tabulated. Significant group differences will be assessed using Fishers Exact unless data meets

criteria for the Chi squared test. A conventional p-value of < 0.05 will be used to indicate significant differences. Inferences around risk, practices, beliefs, access to amenities and demographic characteristics will be made through exploring workers' answers and evident correlations.

7. Limitations

This study represents a small sample of WfW workers in different Western Cape environments, and findings may not be generalizable to all WfW workers who spray herbicides or other populations in similar settings. Furthermore, the questionnaires will be completed in a face-to-face setting to ensure that participants understand the questions, are able to communicate their answers, and are less likely to skip any questions. The face-to-face format of the questionnaires could however lead to social desirability bias, where participants answer how they feel the interviewer wants them to answer. The outcomes of this should be considered in conjunction with the rest of the larger study in order to make informed decisions about appropriate interventions, as this data depends only on what the workers claim to be their behaviors, and does not capture what they actually do.

8. Description of risks and benefits

Participants will not be subjected to any additional exposure to hazardous materials for this study. Their identity will remain confidential. Once the questionnaires have been completed, the participants will be asked to stay for the brief herbicide safety seminar. The seminar will be an interactive opportunity for workers to discuss the risks associated with herbicide exposure and what measures they take to prevent exposure. It will be an opportunity to educate them on risks associated with pesticide and residue exposure. This

could help them improve their safety practices, and share knowledge and experiences with other workers. All participants will be provided with snacks and drinks, and will be compensated for their time to complete the questionnaire and attend the safety seminar at the same rate they would get paid for their job.

Information provided by the participants will provide necessary information to improve operating standards and training targeted at workers at WfW locations. In the future, new cleaning and storing guidelines will help reduce take-home residue exposure to workers and family members at these and similar locations. This could reduce the risks of herbicide exposures of workers and their family members.

9. Data safety

All of the questionnaire papers will be kept in a labeled envelope locked away in a specified cabinet at the UCT Environmental Health Division. The head of the division will have access to the key and permission will need to be granted for anyone else to receive access to data. All coded information will stay on a password locked computer, and backups will be made onto one flash-drive, which only the researchers and PI will access. Information regarding data analysis will only be circulated amongst those individuals directly working on this study. Data will be kept for five years, at which point all data will be destroyed.

10. Ethics

The parent study obtained ethics approval from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee, which can be seen in (Appendix B), with HREC REF 213/2016. Ethics for this subset study will be obtained from University

of Cape Town’s Faculty of Health Sciences Human Research Ethics Committee.

Participants will provide written consent in their language of choice (English, Xhosa, Afrikaans).

11. Time Frame

	Mar – May 2016	Jun - Sept 2016	Oct - Jan 2016	Feb – April 2017	May – July 2017	Aug – Sept 2017	Sept – Jan 2017/2018	May 2018
Document Review								
Data collection								
Code and Input data								
Background Literature								
Write Protocol								
Literature Review								
Data Analysis								
Journal write up								
Final Submission								

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Part B: Literature Review

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1. Introduction

Pesticide exposure in low- and middle-income countries

Pesticide exposure is a modern environmental health hazard. The World Health Organization (WHO) estimates that, globally, there are three million cases of severe pesticide-poisoning per year, of which 99% occur in low- and middle-income countries (LMICs) (1). The disproportionate impact of pesticide exposures in LMICs has been attributed to several factors, including low levels of education, poor regulation of pesticides, poor understanding of risks, and inadequate access to resources such as protective equipment or cleaning facilities (1–5). Furthermore, pressures to minimize immediate expenses as well as high worker turnover rates can further influence decisions managers make to prioritize productivity over safety (2,4,6,7). African countries account for only 2-4% of the global pesticide market (1), but environmental health hazards, which have primarily been attributed to pesticide exposures, account for one third of the disease burden in Africa (5). Improved safety measures, including the reduction of pesticide residues carried into the home by workers applying pesticides, are necessary to reduce the burden of disease attributed to exposures in South Africa and similar LMICs.

Working for Water forestry workers in South Africa

Working for Water (WfW) is a South African government public works project that provides employment to marginalized populations and engages in social development through eradicating alien invasive vegetation (8). Forestry workers employed by WfW mix and spray herbicides as one of the mechanisms to remove the invasive vegetation (8–10). Alien invasive vegetation poses a threat to the natural eco-system and causes water shortages, fire hazards, and the endangerment of indigenous plant and animal species

(9,11). The program has cleared over a million hectares thus far and provides jobs and training to over 45,000 people per year (8,11). The program's success in job creation and clearing alien vegetation has enabled rapid growth of the program, but worker exposure to herbicides continues (9,10,12). The program is managed by The Department of Environmental Affairs (DEA). Workers are employed from impoverished areas in close proximity to sites that need to be cleared, and work on a site in teams of 8-12 people. Those workers receive PPE, such as boots, goggles, gloves, tshirts and overalls, and are meant to receive training prior to working. There is a high turnover rate amongst workers and not all of them do receive that training (28). Although most workers would become familiarized with the safety SOPs on how to use their PPE at the workplace, there are no published SOPs on the appropriate cleaning or storing behaviors regarding contaminated items. Some of the risks of occupational exposure may be carried home in the form of residues on contaminated items, and could further put other household members at risk of exposure (13–18).

Take-home residue exposure risk

Contaminated work clothes and personal protective equipment (PPE) items can carry residues into the home, which poses a risk of cross-contamination (18,19,16,13,17). Pesticide residues from the contaminated items can settle in house-dust (19,16,13,17,15). This puts household members at risk of exposure through breathing in dust with residues, or touching surfaces that have been contaminated by settled house-dust (15). The risk of cross-contamination and residue exposure to workers and their family members could be reduced by improving safety behaviors of workers who handle pesticides at work and

infrastructure changes to promote these behaviors (18,16,20). Exploring WfW workers' current risks of cross-contamination, access to amenities, and risk perceptions, could facilitate the reduction of take-home residue exposure among forestry workers who use pesticides at work in LMICs.

2. Aim

This review aimed to evaluate existing research to inform this study on risks of residue exposure and factors that impact safety behavior compliance that are relevant to forestry workers in LMICs.

3. Objectives

The objectives of this literature review were to:

- Identify health risks associated with cross-contamination and pesticide residue exposure among forestry and agricultural workers.
- Describe how factors such as workers' perceptions and the social, economic and physical working environment where chemicals are used may impact on safety behaviors and the risks of pesticide residue exposure.
- Identify the gaps in the literature regarding the risk of take-home residue exposure among forestry workers in LMICs.

4. Literature search strategy

4.1 Databases and search terms

The search engines PubMed, JSTOR, Google Scholar, Science Direct and ProQuest were

used to identify articles published in indexed journals between 2000 and 2017. The areas of focus were:

- Health risks associated with the exposure to agricultural pesticides and herbicides. (Search terms included: pesticide, herbicide, occupational, health risk, exposure, agriculture, forestry, chronic disease, non-communicable disease and symptoms.)
- Risk factors for cross-contamination and take-home residue exposure. (Search terms included: pesticide, cross-contamination, take-home, residue, herbicide, agricultural, farmworker.)
- Safety behaviors and factors that impact safety compliance such as PPE use, appropriate washing of PPE and hand-washing. (Search terms included: Personal Protective Equipment, safety behaviors, compliance, agriculture, forestry and safety culture.)
- WfW and similar programs comparable to WfW (Search terms included: Working for Water, alien vegetation eradication, workers, South Africa and herbicide.)

4.2 Inclusion and exclusion criteria

- Only literature published in English was included.
- Agricultural workers who spray or mix pesticides at work belong to a similar work force and share a similar risk of pesticide exposure as forestry workers. There is more literature on agricultural workers than forestry workers, and hence studies on risks of exposure were included for forestry and agricultural workers.
- Herbicides are one type of pesticides and some risks of exposure are similar to other types of pesticides. This review, therefore, included literature on the risks of

exposure to any pesticide sprayed or mixed at the workplace in agricultural or forestry settings.

- Studies that focused on risks of dietary exposure to pesticides and benefits of organic foods were excluded, because the mechanism of exposure was not comparable to exposures through cross-contamination or take-home residues.
- Studies on occupational safety behaviors were included if they assessed factors affecting motivation and compliance that could be generalized to forestry workers who mix and spray herbicides in LMICs.
- Literature that was published prior to the year 2000 was excluded as it was deemed outdated.
- Studies that focused on risks of residential use of pesticides were excluded, because the mechanism of exposure is not comparable to the occupational risks carried home on contaminated items.
- Literature that focused on risks associated with changes in pesticide toxicity with temperature, the soil used or the amounts of groundwater was excluded because the risks of exposure were not comparable to risks of residue exposure.
- As proposed by the framework for assessing quality and rigor by Caldwell and colleagues (2005), if the population and sampling method were not clearly stated, the literature was excluded (21).

5. Literature Summary

5.1 Health Risks associated with exposure

Pesticide exposure can occur through ingestion, inhalation, or dermal or ocular contact. Acute symptoms of exposure can include dizziness, headaches, blurred vision, dyspnea, muscle cramps, asthma, fatigue, diarrhea, nausea, vomiting, itchy skin, dermatitis, respiratory infections, gastro-intestinal infections, red eyes, lack of concentration, and muscle weakness (1,22,23). Prolonged exposure to pesticides can also interfere with the endocrine system (24–29) and cause epigenetic damage by altering DNA (17,21,23,24). This will affect several biological pathways and thus could become a precursor to a broad spectrum of non-communicable diseases, including cancers (24,26,28,30,31), neurobehavioral problems, mood disorders (32,33), reproductive abnormalities, neurological disorders and diabetes (23,30). Consistent low-dose exposures, such as to residues, can cause oxidative stress and endocrine disruption, which through the accumulative toxicity can cause damage to vital cell functions (34). For instance, there has been a correlation between lifetime exposure to pesticides and the development of progressive neurological diseases such as Parkinson's disease (30,14), Alzheimer's disease and amyotrophic lateral sclerosis (ALS) (27,29). Kim and colleagues (2013) also suggest that the accumulative toxicity of pesticide exposure is correlated with symptoms of depression (33). This correlation is supported by Meyer and colleagues (2010), who found that the populations in the regions in Brazil with the highest per capita pesticide use had significantly more suicide attempts and rates of depression than in other regions (32). There is also evidence that children with pre-or post-natal exposure have impaired vision, motor skills, communication skills and behavioral problems such as Attention Deficit Disorder (ADD) and Attention Deficit Hyperactive Disorder (ADHD) (30,35–37).

Pesticides have anti-androgenic, endocrine disrupting, and epigenetic effects that are possibly associated with poor sperm quality, reduced sperm concentration, interference with sperm morphology and motility, testes structure, and sex hormone blood levels (24,28–30). Preventing exposure to residues, therefore, not only prevents the future development of diseases among workers who handle pesticides, but the possible development of diseases in future generations.

Several believed associations between pesticides and non-communicable diseases are hard to demonstrate. Epidemiological studies aiming to portray such association are costly and face inherent obstacles in study design (38). For instance, most chronic diseases have several risk factors, there is a lag time between the cell damage caused by exposure and the expression of disease symptoms, and cell damage can be expressed across a broad spectrum of diseases (38). These factors make it challenging to capture the association between pesticide exposures and a given disease. For example, the estrogenic properties of pesticides are believed to increase the risk of uveal melanoma, but since both cases of uveal melanoma and exposure to pesticides are rare, a case-control study only found a correlation with wide confidence intervals, and the relationship was not significant (31). Similarly, pesticide exposure is believed to increase the risk of leukemia, lung cancer, multiple myeloma, non-Hodgkin lymphoma, Hodgkin lymphoma, and prostate cancer, but observational studies have only found non-significant correlations (29,30,39). Low power in such correlations have been attributed to the difficulties in measuring exposure and disease (38).

In the same way, individuals who become sick may not know that it results from exposure, as there is little indication over time that they have been exposed to toxic levels. For instance, Corriols et al. (2009) found in a Nicaraguan survey that although 62% of those exposed to pesticides reported symptoms associated with poisoning, only 4% believed that meant they had been poisoned. Mancini et al. (2005) similarly recorded acute poisoning symptoms of cotton growers in India immediately after they sprayed pesticides. Only 16% of the 323 reported spraying events were asymptomatic after spraying, but only 8% of the poisoning cases sought care. Both studies indicate the workers appear to have a limited understanding of the association between symptoms and exposure. This could suggest that workers and their employers in LMICs such as Nicaragua and India will also not be aware of the risks of residue exposure. Exposure to residues accumulate in toxicity (34), which means that cell damage can occur without symptoms and cause disease many years later. Without the understanding of exposure risks, there is little incentive to take cautionary measures to prevent low dose exposures such as take-home residue exposure.

5.2 Cross-contamination and take-home residue exposure risk

There is little literature on the risk of take-home residue exposure among forestry workers, but studies show that agricultural workers who handle pesticides at work are at risk of exposure to residues transferred from contaminated clothes, boots or PPE into their home (16,13). A study comparing the homes of farmers and non-farmers in Iowa, USA (16), and a review of literature focusing on exposure risks among women in agricultural areas in North America (13), both showed that the homes of pesticide

applicators have significantly higher levels of pesticide residues measured in house dust than other houses in the same communities. In such instances, the risks of exposure are transferred from the pesticide applicators' workplace into their home, which extends the risk to all household inhabitants. Lu and colleagues (2000), for instance, compared urine samples and hand-wipes among 109 children up to the age of six in Washington State, USA (15). Children of parents who worked with pesticides had a median level of pesticide metabolites in their urine five times higher than those, from the same community, whose parents did not work with pesticides. Ten of the sixty-four children whose parents handled pesticides, compared to none of the other children, had organophosphate residues on their hands. Those children never directly handled pesticides. This demonstrates that the accumulative residues that build up through cross-contamination put household members at risk of exposure. When contaminated items are not kept contained and enter the home, then cross-contamination will result in residue exposure. Given the challenges workers in LMICs face regarding the safe storage of contaminated items and access to appropriate cleaning amenities could therefore put them at an even greater risk of take-home residue exposure.

5.3 Work practices and the risk of cross-contamination

There are at-work behaviors among pesticide applicators that increase the risks of cross-contamination in their home (18,41,42). Lozier and colleagues (2012) found that the amount of time workers spent handling pesticides, as well as the amount of land they sprayed, was correlated with the amount of residues transferred into the home (18).

Levels of residues found in house dust of agricultural workers were also significantly

higher during the spraying season than the levels measured prior to the spraying season. The accumulative contamination of boots, PPE and work clothes increases the risk of cross-contamination in the home. Unlike agricultural workers, WfW workers apply herbicides year round, and do not have a spraying season (43). How the risks of transferring residues into the home among forestry workers compare to agricultural workers has not been explored in the literature.

The South African Regulations on Hazardous Chemicals (44) suggest that the risks of exposure are reduced when measures are taken to prevent contaminated items from entering the home. Guidelines for the appropriate and safe handling of contaminated PPE include:

“Subject to the provisions of the Facilities Regulations, an employer shall, where reasonably practicable, provide employees using personal protective equipment as contemplated in sub-regulation (1), with:

(a) adequate washing facilities which are readily accessible and located in an area where the facilities will not become contaminated, in order to enable the employees to meet a standard of personal hygiene consistent with the adequate control of exposure, and to avoid the spread of an HCS;

(b) two separate lockers separately labeled 'protective clothing' and 'personal clothing', and ensure that the clothing is kept separately in the locker concerned;

(c) separate 'clean' and 'dirty' change rooms if the employer uses or processes an HCS to the extent that the HCS could endanger the health of persons outside of the workplace.”

The stipulated sub-regulations to prevent cross-contamination would necessitate that facilities for washing, changing and storing be made available, but this simply may not be feasible for forestry workers such as the WfW workers (2,10,43,45).

Given the nature of vegetation excavation work, and the terrain WfW and similar forestry workers work on (2,45), the recommended facilities for workers handling hazardous chemicals may not reasonably be provided in a stationary form. WfW forestry workers work at a location only long enough to treat that site, and then move to the next site to remove alien vegetation. It would be costly to build structures in temporary locations (10,45,46). Furthermore, they work on terrain where it is difficult to orchestrate access to amenities (2,43) as the sites are mountainous and steep, with many trees and bushes (2,43,45). Cross-contamination risk reduction is complex to address at the workplace, and therefore, it is important that workers engage in risk reducing behaviors at home, and that the pesticides used are not unduly hazardous.

5.4 At-home practices and the risk of cross-contamination

The at-home behaviors of workers who handle pesticides can impact the risks of cross-contamination and exposure to residues (18,20). For instance, a study on 24 agricultural families in the northwestern United States indicated that the amount of time workers spent in contaminated work clothes in the home before getting changed affected the amount of organophosphate residues found in house dust (20). The study established that

homes where workers changed out of work clothes within two hours of getting home was associated with significantly less residues compared to the houses of workers who got changed two hours after getting home. It was not clear, however, what factors impact the amount of time workers spend in contaminated clothes before getting changed.

The risk of cross-contamination is also related to the location, in the home, where workers remove contaminated items (18). Lozier and colleagues (2012) assessed chronic exposures to low doses of organophosphates in the households of 24 families of commercial pesticide applicators in Iowa, USA (18). They found that residue levels in house dust were generally higher in the rooms where workers got changed. There is limited literature on at-home behaviors and risks of exposure among workers who handle pesticides in LMICs. Workers' living arrangements, such as those who live in non-permanent dwellings or do not have the luxury of multiple rooms (45), could result in workers getting changed in the same room as where they sleep, eat and/or socialize with all family members. This would increase the risks of cross-contamination and residue exposure.

WfW forestry workers in South Africa have been observed wearing contaminated items home (43), and appear to have limited options not to (45). Deziel and colleagues (2015) suggests that contaminated boots carry residues into the home, and thereby create a path for exposure to family members, but this risk can be reduced by keeping contaminated boots outside the home (13). Workers such as WfW forestry workers potentially transfer risks of exposure on contaminated items they wear home, but the extent of that risk and

what measures they take to prevent cross-contamination have not been investigated. Arcury (2006) suggests that the interaction between the socio-cultural factors such as poor understanding, poor access to resources, low levels of education and lack of affordable options to ensure safety is a matter of social injustice towards workers in LMICs (6). The risks of cross-contamination and factors associated with workers' at-home safety measures, such as where they place contaminated items, would provide insight into the risks of cross-contamination and residue exposure among workers in LMICs.

5.5 Safety compliance

Knowledge and behaviors

If workers engaging in risk reducing safety behaviors can reduce the risks of take-home residue exposure, then workers' compliance requires a good understanding of what safety practices are expected of them (7,47,48). Effective communication is necessary to enable workers to engage in safety practices (47), and it furthermore motivates them to do so (48). Comprehension of safety information supports both workers' perceived risk and perceived control, which are associated with safety behavior compliance (49,50), whereas workers using pesticides who are unaware of risks associated with exposure are less likely to engage in risk-reducing safety behaviors (41,51–53). For example, Naidoo and colleagues (2010) conducted a study on female agricultural workers in Kwazulu Natal, South Africa, and found that only 45.6% of the 803 women participants reported that they washed their PPE after foliar spraying (50). Furthermore, 43.3% of the women did not wear PPE when mixing and 45.1% when applying pesticides, and a small number of

women even reported storing their contaminated PPE with other clothes, food and water. These high exposure risk behaviors were significantly associated with low scores in knowledge and perceived risk of exposure, as measured by a questionnaire administered to the participants. Similarly, Raksanam and colleagues (2012) found that poor safety practices, such as PPE use or pesticide application behaviors, among Thai agricultural workers could be attributed to erroneous beliefs around pesticide toxicity or perceived susceptibility (51). Quandt and colleagues (2006) suggest that is not uncommon for workers who spray and mix pesticides to have erroneous beliefs regarding residue exposure risk, because many believe that pesticides need to be wet to the touch, seen, and smelt for exposure to occur (41). They do not realize that they are susceptible, because the residues are invisible to them. Hispanic agricultural workers in North Carolina, USA, also reported that they did not believe they would be exposed from touching sprayed plants, or through the residues brought into the home, because they did not realize that residues that were not apparent posed a risk of cross-contamination or exposure (52). A poor understanding of exposure risk and susceptibility, such as in the studies stated above, could result in both a low incentive to prevent exposure and little knowledge of how to do so. Erroneous beliefs do, thereby, increase easily preventable risks of exposure.

Effective safety training

Ensuring that workers understand risks of residue exposure and engage in appropriate risk reducing safety practices is complex. Training is associated with increased worker knowledge regarding pesticide risk and toxicity, and improves compliance in safety

behavior such as PPE use (7,54). However, factors including level of education, worker income level, productivity pressures, and low levels of literacy can become obstacles to the implementation of training (45,46,48–50,54–56). Levesque and colleagues (2012), for instance, attributed the poor understanding of risks of pesticide exposure among Hispanic agricultural workers in North Carolina, USA, who had received training, to low levels of education (55). Arcury and colleagues (2010) explain that low levels of education result in limited literacy, undeveloped skills for learning, and an inability to learn complex systems (49). Workers with low levels of education, therefore, may not be able to translate risk information into related safety behaviors. Coetzer and Louw (2012) suggest, in an evaluation of the WfW contractor development model, that many WfW workers are not accustomed to learning in a classroom setting, and therefore, the classroom-teaching style of WfW induction training may be ineffective for promoting safety practices (12). When workers are accustomed to learning through experiencing rather than through classroom instruction, being given the information in a classroom will not necessarily translate into practice. Houbraken and colleagues (2016) found that Vietnamese agricultural workers who had high levels of education still had low levels of exposure risk knowledge, and propose that knowledge regarding pesticide risk and exposure is accrued through experiences with pests, pesticides and disease (53). Communicating risk and safety practices are best translated into improved safety behaviors if they are given in a context where and how those practices would be performed.

Barriers to implementing an effective safety culture

Further barriers to the implementation of effective training include high worker-turnover rates (2), and this can by extension impact the safety culture as a whole (57). Shackelton and colleagues (2016) explain that low-paying jobs and low-income settings are associated with a high worker turnover rate (2), and this impacts managers' ability to feasibly provide training to all workers (2,12,45). WfW workers are an example of where, although in theory induction training is required, many WfW workers do not receive it (43). This is because the high turnover of WfW workers means that new workers might have missed a group induction training session and yet will still apply herbicides. To provide individualized training to unskilled workers would cost time and human resources, which in the short-term would result in a loss in hours of productivity (2,12). There is significant pressure on WfW contractors to meet vegetation-clearing goals, because they only get paid once the designated land has been cleared, regardless of how long it actually takes to be cleared (8). As a result, contractors and workers are inadvertently incentivized to prioritize efficiency, and by extension, individualized induction training becomes unfeasible, and new workers are put to work almost immediately with little or no training (12). In this case, the economic environment places an emphasis on productivity in a context where all workers have not necessarily obtained sufficient safety training. These factors will influence beliefs, motivations and attitudes of the workers, and the practices that evolve through those shared beliefs and attitudes develop into the safety culture among the workers (57). The resulting behaviors, perceptions and attitudes continue to influence and amplify each other, and thereby cement the poor safety culture and risks of exposure (57,58).

Safety as a perceived priority

Workers' motivation to comply with safety behaviors is contingent on an understanding that safety should be prioritized (47). Katz-Navon and colleagues (2005) suggest that within an organizational setting, the management style will shape the workers' safety behaviors by the extent to which safety is treated as a priority (47). If the organization and the supervisors do not treat safety as a priority, neither will the workers. Mayer and colleagues (2010) found that agricultural workers in Florida, USA, who perceived that safety was important to their supervisors were significantly more likely to engage in safety behaviors such as hand-washing (59). In contrast, working youth in North Carolina, USA, who believed that supervisors could do more to ensure their safety, and believed supervisors prioritized cheap and fast work over safety, were less likely to engage in safety behaviors such as hand-washing, despite having received training (60). These examples highlight how imperative it is that managers and supervisors treat safety as a priority for workers, and influence the work environment as far as possible, for workers to be incentivized to engage in safety behaviors. Wirth and Sigurdsson (2008) suggest that frequent warning signs, immediate feedback, and positive reinforcement are vital tools in promoting safety practices (48). As managers continue to communicate safety as a priority, and workers are given the tools to engage in safety, they empower workers to make safety a priority, and create a positive attitude towards safety.

Environment and fostering a safety culture

In a similar manner, environments that facilitate safety behaviors enable workers to engage in them and act as cues that shape workers' attitudes and perceptions, which reinforces the safety culture (7,48,57,58). Levesque and colleagues (2012) found that

farm workers in North Carolina who were provided with soap and water for hand-washing were not only more likely to wash their hands, but also more likely to use PPE than those who were not. Additionally, pesticide safety practices, including PPE use, were more frequent among those who had sufficient water for bathing and laundry in the home than those who reported that they did not. It therefore appears that when workers are incentivized and empowered to prioritize safety, they have a positive attitude towards safety practices beyond just the one practice facilitated. Providing workers with amenities achieves that. It empowers workers and communicates that taking multiple safety precautions are important. However, whether this correlation between an environment that endorses safety behaviors and an increase in safety behaviors within the workplace extends to safety behaviors outside the workplace, such as the home, has not been explored. Nevertheless, it raises concerns, because if safety behavior compliance can be attributed to access to amenities, then what is the impact of not having access to amenities on workers such as WfW forestry workers and other pesticide handlers in LMICs? Furthermore, do low levels of education impact the extent to which safety as a priority in the work place translates into safety behaviors at home? And equally important, does a poor safety culture at work translate into poor safety practices in the home?

Social influences on safety behaviors

If workers risk of take-home residue exposure can be reduced by safety practices, it should be noted that workers' intentions to engage in or violate recommended safety behaviors are also strongly influenced by interpersonal factors, such as social norms,

social modeling, peer influence and peer support (7,41,58,61–63). Cox and Jones (2006) suggest that workers fear social exclusion, and thus could be likely to violate safety behaviors despite knowledge regarding risks of exposure if it means complying with the normative behaviors of their community members (61). According to Lu and colleagues (2015), after controlling for personal characteristics, social modeling, social norms, and interpersonal support were the greatest predictors of PPE use among Chinese migrant workers (63). This raises the question of how social, environmental and economic factors interact, and what drives the safety behaviors of workers in LMICs, where access to amenities, training and signage may not be feasible.

Factors shaping WfW workers safety culture

A better understanding of the current safety behaviors and potential risks of exposure among WfW workers would provide insight into the risks of exposure among workers in LMICs and approaches that persons in management positions could take to address those risks. For instance, WfW workers were observed engaging in high risk of exposure behaviors such as taking their lunch breaks and eating in their contaminated overalls, and wearing their contaminated items home (43). Such behaviors could be influenced by the misconception some WfW workers held that the primary purpose of their PPE was to protect them from snakes rather than exposure to herbicides (43). This would be a reflection of a poor understanding of the risks of exposure and potentially problems with the effective implementation of induction training. However, workers may not have much alternative, as they do not necessarily have access to cleaning or changing facilities in the field that would facilitate removing themselves from contaminated items (43). The

terrains they work in are largely mountainous without trails for human traffic. It is thus unlikely that they would see frequent safety signage in the field to reinforce safety behaviors, nor would they necessarily interpret signs well given the poor literacy and low levels of education. Understanding what social, economic and environmental factors shape WfW workers' behaviors would support efforts to change the safety culture that underpins the workers' safety behaviors.

6. Gaps in the literature

Literature on the risk of exposure to take-home pesticide residues has primarily focused on agricultural workers. Forestry workers have been a neglected research population. Although forestry workers and agricultural workers are similar workforces, contextual differences such as the terrain and the transient nature of their work could impact how cross-contamination risk could be prevented. Furthermore, much of the literature on factors that affect the risks of take-home residues has been conducted in the USA, and the findings may not be generalizable to workers in LMICs. According to the literature, work environments that facilitate safety behaviors result in greater safety compliance and the perception that safety is a priority. Further research is necessary to evaluate the risks of exposure in LMICs where recommendations to facilitate safety behaviors, such as providing amenities and signage, and are based on high-income and agricultural settings, may not be feasible.

The literature has looked at factors, such as supervisor's attitude towards safety, signage and access to amenities that positively influence workers' perceptions and safety

behaviors at their workplace. However, there is little literature that has investigated how such factors in the work environment could influence the likelihood that workers will engage in safety behaviors at their home, or what alternative factors drive safety behaviors in the home. Many workers in LMICs will not have access to cleaning or storing facilities for contaminated items in the work-place, and hence there will be a significant risk of cross-contamination associated with the contaminated items that are taken home. Exploring WfW workers' perceived risk, their access to amenities, and how that relates to where and how they clean contaminated items in the home, could help contextualize the risks of cross-contamination among forestry workers in LMICs. A better understanding of the risks of take-home residue exposure among WfW forestry could, furthermore, act as a platform for the development of guidelines that are suitable and feasible to implement for reducing at-home cross-contamination among forestry workers in LMICs.

7. Conclusion

Contaminated items brought home by workers leave residues in the home, which put workers and other household members at risk of exposure. Exposure to residues can lead to several chronic diseases. Risks of cross-contamination are impacted by the amount of time workers spend handling pesticides, whether contaminated items are brought home, whether contaminated items are removed within two hours of going home, and where those items are removed. Although ideally contaminated items would never leave the workplace, this is not necessarily a feasible solution in many LMICs. Safety behaviors around contaminated items brought home could reduce the risks of cross-contamination, but safety compliance is complex and influenced by several interrelated social,

environmental and economic factors. At-home safety behaviors and risks of take-home residue exposure among forestry workers in LMICs have thus far not been explored in the literature. A better understanding of the risks of exposure and the home environment of WfW workers will provide insight into how at-home safety practices are shaped among workers in LMICs. This could provide a platform for further research on ways to reduce the risks of take-home residue exposure among workers in LMICs in the future.

8. References

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Part C: Journal Article

Understanding South African herbicide workers' residual take-home exposure risks from personal protective equipment cleaning and storing practices

Journal Article

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Abstract

Forestry workers who mix and spray herbicides at work may leave work with contaminated clothing or personal protective equipment (PPE). This pilot study assesses the risks of taking home herbicide residues on contaminated items among forestry workers in South Africa. This is a sub-study of a larger study. Questionnaires were administered to 29 workers at three Department of Environmental Affairs Working for Water (WfW) work-sites. The questions explored the workers' cleaning and storing practices, perceived risk of exposure, which contaminated items they brought home, and their access to amenities in the home. Responses were tabulated and significant associations were assessed using the Fisher's exact test. In this study, 89.7% participants took contaminated PPE items home daily. The majority (62.1%) lived in a non-permanent dwelling, and over half (55.2%) did not have access to running water. Dwelling type and access to water were both associated with where the items were washed, and dwelling type also impacted how PPE was stored. Although the majority of participants (65.5%) perceived herbicides as dangerous to their health, perceived risk had no association with workers' cleaning or storing behaviors. Risks of cross-contamination were largely influenced by the amenities the workers had access to. Underlying socio-economic factors (e.g., type of housing, access to amenities, services and resources) appeared to put poor workers at risk of exposure. Work safety protocols to reduce the risks of cross-contamination need to take into account the constraints workers in low- and middle-income countries (LMICs) face. Governments should collaborate with forestry management to regulate the toxicity of the pesticides used, and set guidelines to keep

contaminated PPE contained, and reduce the risks of cross-contamination and residue exposure in the workers' homes.

Key Words

Forestry workers, Pesticides, Exposure, Cross-contamination, Residues

Introduction

Pesticide exposures in low- and middle-income countries

Pesticide exposure is a modern health concern, and globally attributes to over 220 000 fatalities per year (1). Low- and middle-income countries (LMICs) experience 99% of the deaths associated with these exposures, even though market sales indicate that they account for only 20% of worldwide usage (2,3). Several interrelated social, economic and political factors create challenges to the implementation of exposure-reducing safety measures in LMICs. Such factors include, but are not limited to, poor access to amenities and health services, low levels of education, and a poor understanding of the risks of pesticide exposure (1,4–6). Such challenges can impact workers' safety compliance and could lead to an increased risk of exposure to take-home residues among workers who mix and spray pesticides in LMICs.

Risks of pesticide exposure

Individuals are exposed to pesticides when they ingest, inhale, make dermal contact to or get pesticide residues in their eyes (7). Exposure can interfere with vital cell functions through the breakage of chromosomes, oxidative stress, or endocrine disruption (7–12)

and thereby lead to a broad spectrum of diseases. These include cancers (13–18), neurobehavioral disorders (19–21), birth defects (17), reproductive abnormalities (12,17,22), neurological disorders (8,23), diabetes (17), hypertension (24), and atherosclerosis (17). Symptoms of disease can develop gradually, and long after initial exposures (7,11,25,26). Many workers do not realize that residues, which they cannot see, smell or taste, can lead to exposure (27). Workers, therefore, do not necessarily realize that there are exposure risks, or that symptoms they experience result from exposure (26).

Cross-contamination and take-home residue exposure risk

Providing workers with personal protective equipment (PPE) can reduce the risk of exposure to pesticides when they are mixing or spraying them in the workplace (7,28), but does not address the risks of take-home residue exposure. Contaminated PPE items that are not cleaned or stored safely could transfer risks of exposure into the home (7,27,29,30). Based on research among farmers and non-farmers in Iowa, USA (31) and a literature review on non-occupational pesticide exposure in Northern America (32), houses of pesticide applicators have significantly higher levels of pesticide residues found in house dust as compared to the houses of non-farmers in the same communities. This is indicative of the risks of exposure workers who handle pesticides bring into the home through cross-contamination. Lozier and Colleagues (2012) established that the levels of residues in farmworkers' homes in eastern Iowa, USA, were significantly associated with whether or not they took contaminated boots off inside or outside the home (30). This suggests that safety behaviors that keep contaminated items contained

and away from the home to decrease the opportunity for cross-contamination could reduce the risk of residue exposure among the home residents. Although the risks of take-home residue exposure in LMICs has thus far been a neglected area of research in the Literature, those findings indicate that without suitable strategies to prevent contaminated items from entering the home of workers who mix and spray pesticides, there is a risk of cross-contamination and exposure to residues. Safety guidelines that extend to at-home safety behaviors are a necessary step to reduce the risks of exposure associated with the occupational use of pesticides.

Working for Water (WfW) is a government public works program in South Africa concerned with water conservation, and aims to create employment opportunities through efforts to remove invasive alien vegetation. The program is managed by The Department of Environmental Affairs (DEA) and has successfully cleared over a million hectares of land (33–35). Methods to clear unwanted species include tree felling, burning and spraying herbicides, either by a handheld sprayer or a knapsack (33–35). The department hires contractors in impoverished areas close to sites where land needs to be cleared. Those contractors build teams of 8-12 workers, and one such team will clear a specified area. The WfW program provides workers with PPE (such as gloves, boots, goggles, working t-shirts and overalls), and has established standard operating procedures (SOPs) for the appropriate use of that PPE (36). However, protocols regarding the handling of contaminated PPE items have thus far not been included in the WfW safety SOPs. The South African Regulations on Hazardous Materials recommend that when feasible, facilities should be made available for workers who handle hazardous materials to get

changed, as well as clean and store contaminated PPE items (37). However, the steep mountainous terrain and transient nature of WfW projects make it challenging to provide such facilities at the excavation sites (28,33). Many WfW workers take contaminated item home (28). Workers are meant to receive training upon hire, but with high turnover rates, not all workers do (28). Given that workers do not have facilities at the sites to clean or store contaminated items, and do take items home, suggests that they and all household members at risk of exposure to take home residues.

There are several factors that shape workers' safety behaviors in the workplace. These include the extent to which workers perceive safety to be a priority in the workplace (38–40), workers' knowledge and perceptions regarding risk (39,41,42), the behaviors of their peers (43,44), and the resources they have access to and are provided with (45). A study on WfW workers' safety compliance indicated that WfW workers' behaviors regarding PPE (such as not wearing gloves when mixing or spraying herbicides, and sitting on contaminated overalls during their lunch breaks) put them at risk of exposure at the workplace (28). However, the risks of exposure among workers who handle pesticides extend beyond the workplace and are carried into the home. Those workers' safety behaviors in the home have not been investigated. The clothes or personal protective equipment workers wear when handling the pesticides can become contaminated. If those contaminated items are brought home, then herbicide residues are carried into the home and put all household members at risk of exposure. The aim of this study was to document the amenities WfW workers have access to at home, as well as their perceived risk of exposure, the contaminated PPE items they take home, and where and how they

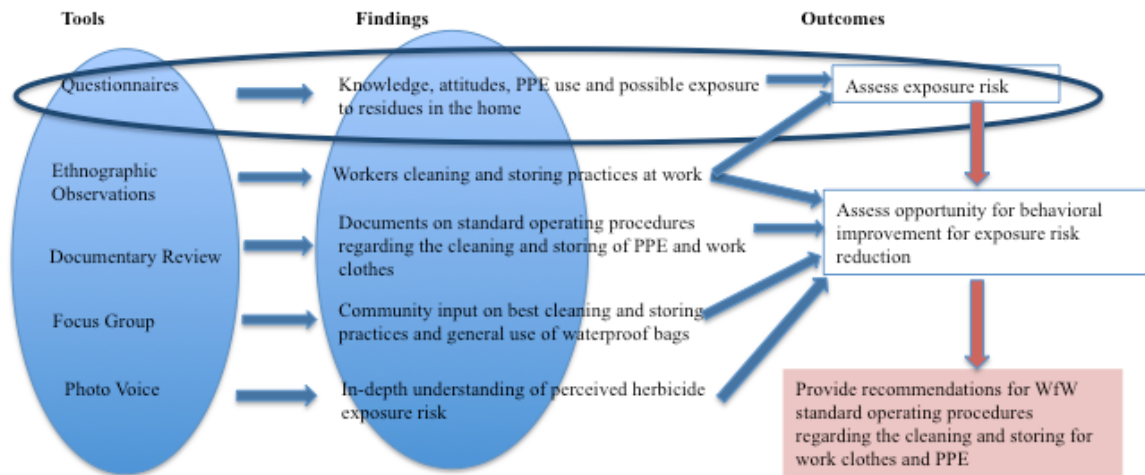
are cleaned and stored to assess the risk of cross-contamination. Findings could be used to direct future research and support strategies that can feasibly be implemented in LMIC settings to reduce the risks of take-home residue exposure.

Methods

Study design

This is a sub-study consisting of the analysis of questionnaires that were collected as part of a larger exploratory pilot study. The aim of the larger study was to assess WfW workers' risk of herbicide residue exposure, both at work and in the workers' homes, and identify opportunities to improve safety behaviors to reduce the risks of pesticide residue exposure among forestry workers in LMICs. Figure 1 illustrates the various data collection methods and how they supported the objectives of the parent study, as well as the role of this sub-study in relation to the parent study. This study focused on the at-home risks of cross-contamination and exposure by evaluating the questionnaires administered to explore the cleaning and storing behaviors of contaminated PPE items, worker's access to amenities in the home, and the worker's perceived risk of exposure. This sub-study will support directing future research, and in conjunction with the parent study, provide comprehensive guidelines, strategies and policies for WfW to reduce the risks of occupational herbicide exposure at work or in the workers' homes.

Figure 1



Participants

This study included 29 participants. All participants were part of a contracted WfW team. WfW contracted teams usually include eight to twelve employees. The Department of Water Affairs and Forestry (DWAF) have WfW published standard operating procedures (SOPs) (2007) with inclusion criteria for WfW contract teams that stipulate that team members must be unemployed at the time of hiring, over half of the team are required to be women, and at least 20% of the team need to be at or under the age of 25 (36). Participants included in the study were members of such a contracted team who were present on the day for which data collection was arranged at a given location. Spraying herbicides was part of the job description of all members present at the time and location where data was collected.

Data Collection

Trained fieldworkers and University of Cape Town (UCT) postgraduate students administered the questionnaires in a face-to-face setting to available members of a contractor's team at three WfW program sites between February 2016 and August 2016. They were administered in English, Afrikaans or Xhosa, depending on the subject's preferred language. The questions consisted of both closed and open-ended questions. The sites (Tokai, Citrusdal and Hermanus) were selected based on convenience sampling.

Ethics

Contractors provided consent to the study research team to interview participants at the WfW work site at an arranged time. All participants signed written consent forms and The University of Cape Town Faculty of Human Research Ethics Committee granted ethics approval for the study (HREC REF 569/2017)(Annex D).

Analysis

Data were entered into and analysis conducted using IBM® SPSS® Statistics 24. The participants' characteristics were summarized using mean and inter-quartile range for continuous variables, and frequency and percentage for categorical variables. All characteristics were described by location. Amenities, perceptions, and PPE cleaning and storing practices were measured as categorical variables. Analyses were conducted to infer relationships between the behaviors (including which PPE is taken home, where it and how it is washed, and where it is stored), with perceptions around risk of exposure and access to amenities, and explore differences by location or age group. Associations were assessed using the Fisher's exact test, as data did not meet requirements for the Chi-

squared test. A conventional p-value of < 0.05 was used to indicate significant associations.

Results

Demographic information

Participants' characteristics can be seen in Table 1. The majority (62%) were female. The mean age of participants was 34, and this ranged from 17 to 58. The participants' primary language differed by location. It was Xhosa in Tokai and Hermanus, and Afrikaans in Citrusdal. The participants' level of education was low, 35% had an education level less than grade nine and only 14% had matriculated.

Table 1 Participants' Demographics by Location

	Total	Tokai	Citrusdal	Hermanus	Difference between Locations
	N =29	n=8	n=9	n=12	P-value
	f (%)	f (%)	f (%)	f (%)	
Gender					
Female	18 (62)	6 (75)	4 (44)	8 (67)	0.394
Male	11 (38)	2 (25)	5 (56)	4 (33)	
Age					
Mean age (age range)	34 (17-58)	28 (21-31)	41 (21-58)	33 (17-47)	0.021
Age group < 26	6	2	1	3	0.194
Age group 26-35	13	6	2	5	
Age group 36-45	7	0	4	3	
Age group >46	3	0	2	1	
Languages					
Home Language Xhosa	20 (69)	8 (100)	0 (0)	12 (100)	
Home language Afrikaans	9 (31)	0 (0)	9 (100)	0 (0)	
Highest level of education					
< Grade 9	10 (35)	1 (13)	5 (56)	4 (33)	0.219
Grade 9	2 (7)	0 (0)	0 (0)	2 (17)	
Grade 10	8 (28)	3 (37)	2 (22)	3 (25)	
Grade 11	5 (17)	2 (25)	0 (0)	3 (25)	
Matric	4 (14)	2 (25)	2 (22)	0 (0)	

*Significant p-values are in bold

Amenities

As seen in Table 2, the majority of participants (93%) have electricity at home. Two thirds of the participants (62%) live in a shack (which is a temporary dwelling constructed out of materials such as metal sheets and plywood) as opposed to a permanent dwelling (such as a concrete home), but this differed significantly by location ($p=0.002$). Tokai is a city, whereas Citrusdal and Hermanus are both rural settings. All participants from Tokai (100%) lived in a shack, compared to 56% in Citrusdal and 42 % Hermanus. The majority of participants (55%) did not have access to running water or an indoor toilet. Only a third of the participants (38%) had access to a washing machine, of which none lived in the city of Tokai. Access to running water, a nearby outdoor tap and a washing machine differed significantly by location.

Table 2 Amenities, perceptions and risk behaviors by location

	Total	Tokai	Citrusdal	Hermanus	Difference between Locations
Number of Participants	N= 29 f (%)	n = 8 f (%)	n = 9 f (%)	n =12 f (%)	P-value
Housing					
Permanent Dwelling	11 (38)	0 (0)	4 (44)	7 (58)	
Shack	18 (62)	8 (100)	5 (56)	5 (42)	0.024
Amenities					
Access to running water in the home	13 (45)	0 (0)	5 (56)	8 (67)	0.008
Electricity in the home	27 (93)	7 (88)	8 (89)	12 (100)	0.498
Indoor toilet	13 (45)	1 (12.5)	5 (56)	7 (58)	0.145
Access to outdoor tap close to the home	19 (66)	2 (25)	9 (100)	8 (67)	0.002
Washing machine	11 (38)	0 (0)	7 (78)	4 (33)	0.003
Perceived Risk					
Pesticide residues are dangerous	19 (66)	5 (63)	6 (67)	8 (67)	
Pesticide residues are not dangerous	10 (34)	3 (37)	3 (33)	4 (33)	1.000
Biggest Danger feared at work					
Tree felling chainsaws	5 (17.2)	3 (38)	1 (11)	1 (8)	
Snakes	6 (20)	2 (25)	1 (11)	3 (25)	
Herbicides	15 (52)	1 (13)	7 (78)	7 (58)	
Other	1 (3)	0 (0)	0 (0)	1 (8)	

Unspecified	2 (7)	2 (25)	0 (0)	0 (0)	0.068
PPE Cleaning behaviors					
Washed by hand	20 (69)	7 (88)	4 (44)	9 (75)	0.136
Not washed by hand	9 (31)	1 (12)	5 (56)	3 (25)	
Location of Washing					
Indoor bathroom	9 (31)	0 (0)	3 (33)	6 (50)	0.001
Indoor washroom	1 (3)	0 (0)	1 (11)	0 (0)	
Indoor unspecified	6 (21)	1 (13)	0 (0)	5 (42)	
Outdoor	12 (41)	7 (88)	5 (56)	0 (0)	
At work	1 (3)	0 (0)	0 (0)	1 (8)	
Washed anywhere indoors	16 (55)	1 (13)	4 (44)	11 (92)	0.001
Washed outdoors or at work	13 (45)	7 (87)	5 (56)	1 (83)	
How are items washed?					
Bath	7 (24)	0 (0)	1 (11)	6 (50)	0.001
Bucket	13 (45)	8 (100)	3 (33)	2 (17)	
Unspecified	1 (3)	0 (0)	0 (0)	1 (8)	
Machine	8 (28)	0 (0)	5 (56)	3 (25)	
PPE storing behaviors					
Take PPE home daily	26 (89.7)	8 (100)	9 (100)	9 (75)	0.099
PPE not taken home daily	3 (10)	3 (25)	0 (0)	0 (0)	
PPE items taken home daily					
Gloves	12 (45)	4 (50)	1 (11)	8 (67)	0.043
Spray-suit	19 (65)	4 (50)	9 (100)	6 (50)	0.024
Goggles/helmet	15 (52)	5 (63)	2 (22)	8 (67)	0.117
Location contaminated PPE items are placed					
Bag	6 (21)	1 (13)	2 (22)	3 (25)	0.798
In home living space/couch/with other clothes	11 (38)	3 (38)	4 (44)	4 (33)	
Bathroom	3 (10)	0 (0)	1 (11)	2 (17)	
Outside or in car	2 (7)	0 (0)	1 (11)	1 (8)	
Unspecified	7 (24)	4 (50)	1 (11)	2 (17)	

*Significant p-values are in bold

Perceived Work Risk

The majority of participants (66%) believed that residue exposure from contaminated PPE items was dangerous to their health (Table 2). Half of the participants (52%) claimed that they considered herbicide exposure to be the biggest danger they fear at work, compared to 21% who considered their biggest fear was snakes, and 17% who considered it chainsaws for tree felling. Participant's perceived risks did not differ by location. However, the most frequently named biggest perceived danger at work among participants from the city of Tokai was chainsaws for felling (34%), and herbicides for

both Hermanus (58%) and Citrusdal (78%), but these differences were not significant ($p=0.068$).

PPE Cleaning Behaviors

The majority of the participants (69%) washed their PPE by hand (Table 2). However, most of the 11 participants who lived in a permanent dwelling had access to a washing machine (64%), and they did not wash PPE by hand (Table 3). Participants were asked to indicate whether they washed PPE items in the bathroom, washroom, and outdoors or at work, and the most frequent response (41%) indicated that they wash PPE outside (Table 2). However, 21% did not specify whether they washed items in the washroom or the bathroom, but indicated that they did wash indoors, and only one (3%) said they washed it at work. When comparing in-home options (which included the washroom, bathroom and unspecified) to out-of-home options (which were outdoors or at work), more participants (55%) washed PPE in the home than outside (45%). Where participants washed PPE differed significantly with respect to access to running water, where 92% of the 13 participants with running water washed items in-doors, compared to 25% of the 16 participants who did not have access to running water ($p<0.001$,) (Table 3). Likewise, all 11 participants who lived in permanent housing washed items indoors compared to only 33% of the 18 participants who lived in a shack ($p<0.001$)(Table 3). Almost half (45%) of the participants indicated that they wash PPE in a bucket (Table 2), which comprised 72% of responses from those who lived in a shack, and none from those who lived in a permanent dwelling (Table 3). Almost a quarter (24%) of the participants indicated that they wash PPE in the bath (Table 2), which was 22% of the responses of those who lived

in a shack and 27% of those who lived in permanent housing (Table 3). Over a quarter (28%) washed PPE in the washing machine (Table 2), which was 72% of those who had access to a washing machine (Table 3). As seen in Figure 2, housing type, access to running water and access to an indoor tap had the significant relationships with most of the cleaning behaviors. Where and how participants clean items is primarily dictated by their housing type and access to running water in the home. The participants' perceived risk of residue exposure or work dangers had no impact on how or where they cleaned PPE (Table 4).

Table 3 Washing behaviors by amenities

N=29	Housing type		P-value	Running water		P-value	Electricity		p-value
	Shack n=18 f (%)	Dwelling n=11 f (%)		Yes n=13 f (%)	No n=16 f (%)		Yes n=27 f (%)	No n=2 f (%)	
PPE Washing behaviors									
Handwash	16 (89)	4 (36)	0.010	7 (54)	13 (81)	0.226	18 (67)	2 (100)	1.000
Not Handwash	2 (11)	7 (64)		6 (46)	3 (19)		9 (33)	0 (0)	
Washing Location									
Indoor bathroom	1 (6)	8 (73)	0.001	8 (62)	1 (6)	0.001	9 (33)	0 (0)	0.557
Indoor washroom	0 (0)	1 (9)		1 (8)	0 (0)		1 (4)	0 (0)	
Indoor unspecified	4 (22)	2 (18)	0.001	3 (23)	3 (19)	0.001	6 (22)	0 (0)	0.192
Outdoor	12 (67)	0 (0)		1 (8)	11 (69)		10 (37)	2 (100)	
Work	1 (6)	0 (0)	0.001	0 (0)	1 (6)	0.001	1 (4)	0 (0)	0.557
Do you wash in the home?									
Indoor	5 (28)	11 (100)	0.001	12 (92)	4 (25)	0.001	16 (59)	0 (0)	0.192
Outdoor	13 (72)	0 (0)		1 (8)	12 (75)		11 (41)	2 (100)	
How are items washed?									
Bath	4 (22)	3 (27)	0.001	4 (31)	3 (19)	0.018	7 (26)	0 (0)	0.520
Bucket	13 (72)	0 (0)		2 (15)	11 (69)		11 (41)	2 (100)	
Unspecified	0 (0)	1 (9)	0.001	1 (8)	0 (0)	0.018	1 (4)	0 (0)	0.520
Machine	1 (6)	7 (64)		6 (46)	2 (12)		8 (30)	0 (0)	

N=29	Indoor Toilet		p-value	Yard tap		p-value	Washing machine		p-value
	Yes n=13 f (%)	No n=15 f (%)		Yes n=19 f (%)	No n=8 f (%)		Yes n=11 f (%)	No n=18 f (%)	
PPE Washing behaviors									
Handwash	6 (46)	13 (87)	0.059	10 (53)	8 (100)	0.026	3 (27)	17 (94)	0.001
Not Handwash	7 (54)	2 (13)		9 (47)	0 (0)		8 (73)	1 (6)	
Where in the house?									

Indoor bathroom	9 (69)	0 (0)		7 (37)	0 (0)		7 (63)	2 (11)	
Indoor washroom	1 (8)	0 (0)		1 (5)	0 (0)		1 (9)	0 (0)	
Indoor unspecified	1 (8)	5 (33)		3 (16)	3 (38)		0 (0)	6 (33)	
Outdoor	2 (15)	9 (60)		7 (37)	5 (62)		3 (27)	9 (50)	
Work	0 (0)	1 (7)	0.001	1 (5)	0 (0)	0.136	0 (0)	1 (6)	0.004
Do you wash in the home?									
Indoor	11 (85)	5 (133)		11 (58)	3 (38)		8 (73)	8 (44)	
Outdoor	2 (15)	10 (67)	0.008	8 (42)	5 (62)	0.361	3 (27)	10 (56)	0.249
How are items washed?									
Bath	3 (23)	4 (27)		4 (21)	2 (25)		2 (18)	5 (28)	
Bucket	2 (15)	10 (68)		7 (37)	6 (75)		1 (9)	12 (67)	
Unspecified	1 (8)	0 (0)		0 (0)	0 (0)		0 (0)	1 (6)	
Machine	7 (54)	1 (7)	0.011	8 (42)	0 (0)	0.011	5 (72)	0 (0)	0.001

*Significant p-values are in bold

Figure 2 Summary of significant relationships between amenities and washing behaviors

Access to Amenities						
Behaviors	Housing Type	Running Water	Electricity	Indoor Toilet	Yard Tap	Washing Machine
Hand-wash	✓	✗	✗	✗	✓	✓
Washing location	✓	✓	✗	✓	✗	✓
Wash in or out the house	✓	✓	✗	✓	✗	✗
How it is washed	✓	✓	✗	✓	✗	✗

* ✓ indicates a significant relationship between access to the named amenity and the indicated washing behavior. ✗ indicates no positive relationship.

Table 4 PPE taken home, storing and cleaning behaviors by risk perceptions and greatest perceived risk

N = 29	Residues are dangerous to health			Greatest perceived danger to self at work					P-value
	Dangerous n=19 f (%)	Not n=10 f (%)	p-value	Tree felling n=5 f (%)	Snakes n=6 f (%)	Herbicides n=15 f (%)	Other n=1 f (%)	Unspecified n=2 f (%)	
Where									
Bathroom	6 (31)	3 (30)		1 (20)	1 (17)	7 (47)	0 (0)	0 (0)	
Washroom	0 (0)	1 (10)		0 (0)	1 (17)	0 (0)	0 (0)	0 (0)	
Unspecified	4 (21)	2 (20)		2 (40)	2 (33)	1 (7)	1 (1)	0 (0)	
Outdoor	8 (42)	4 (40)		2 (40)	2 (33)	6 (40)	0 (0)	2 (100)	
Work	1 (5)	0 (0)	0.862	0 (0)	0 (0)	1 (7)	0 (0)	0 (0)	0.339
Indoor	10 (53)	6 (60)		3 (60)	4 (67)	8 (53)	1 (100)	0 (0)	
Outdoor	9 (47)	4 (40)	1.000	2 (40)	2 (33)	7 (47)	0 (0)	2 (100)	0.631
Bath	5 (26)	2 (20)		1 (20)	1 (17)	4 (27)	1 (100)	0 (0)	
Bucket	8 (42)	5 (50)		3 (60)	3 (50)	5 (33)	0 (0)	2 (100)	
Unspecified	1 (5)	0 (0)		0 (0)	0 (0)	1 (7)	0 (0)	0 (0)	
Machine	5 (26)	3 (30)	1.000	1 (20)	2 (33)	5 (33)	0 (0)	0 (0)	0.916

PPE home daily	16 (84)	10(100)		5 (100)	5 (83)	13 (87)	1 (100)	2 (100)	
No daily	3 (16)	0 (0)	0.532	0 (0)	1 (17)	2 (13)	0 (0)	0 (0)	1.00
Which PPE items are taken home daily?									
Gloves									
Yes	5 (26)	8 (80)		3 (60)	4 (67)	5 (33)	1 (100)	2 (100)	
No	14 (74)	2 (20)	0.016	2 (40)	3 (330)	10 (67)	0 (0)	0 (0)	0.271
Spray-suit									
Yes	11 (58)	8 (80)		3 (60)	3 (50)	12 (80)	1 (100)	2 (100)	
No	8 (42)	2 (20)	0.414	2 (40)	3 (50)	3 (20)	0 (0)	0 (0)	0.170
Goggles and helmet									
Yes	7 (37)	8 (80)		3 (60)	5 (83)	6 (40)	1 (100)	2 (100)	
No	12 (63)	2 (20)	0.050	2 (40)	1 (17)	9 (60)	0 (0)	0 (0)	0.146
Boots									
Yes	7 (44)	7 (78)		2 (50)	4 (67)	7 (50)	1 (100)	0 (0)	
No	9 (56)	2 (22)	0.208	2 (50)	2 (33)	7 (50)	0 (0)	0 (0)	0.919
Where are items stored?									
Bag	4 (21)	2 (20)		1 (20)	1 (17)	3 (20)	1 (100)	0 (0)	
In home/living space	6 (32)	5 (50)		1 (20)	3 (50)	7 (47)	0 (0)	0 (0)	
Bathroom	2 (10)	1 (10)		0 (0)	0 (0)	3 (20)	0 (0)	0 (0)	
Outside/car	1 (5)	1 (10)		1 (20)	1 (17)	0 (0)	0 (0)	0 (0)	
Unspecified	6 (32)	1 (10)	0.750	2 (40)	1 (17)	2 (13)	0 (0)	2 (100)	0.326

*Significant p-values are in bold

PPE items in the home

The majority of workers (90%) take PPE home on a daily basis (Table 2). The PPE item most frequently taken home daily basis was the blue overalls (66%), which workers would refer to as spray-suits. Over half (52%) took their goggles and helmet home daily (which workers use for tree felling rather than spraying), and almost half the participants (48%) said they wear their boots home after foliar spraying (Table 2). The likelihood that workers wore boots home after foliar spraying differed significantly by age group (Table 5). Workers under the age of 25 were most likely, and workers under 35 were still more likely to wear them home than those over the age of 35. Whether workers described taking contaminated PPE home daily had no relationship with age at all. There was a significant association between participants' perceived danger to health and whether they took gloves home daily. Of those who believed herbicides were not dangerous to their

health 80% took gloves home daily, compared to only 26% of those who believed they were (p=0.016) (Table 4).

Many of the participants (38%) described placing their PPE items in their home in an uncontained manner, such as on the couch or in the wardrobe. Some of the participants (21%) kept PPE items contained in a non-permeable bag they described using to carry the contaminated items home. Only 7% said they kept contaminated items outside or in the contractor’s car, and 10% said they left them in the bathroom, but 24% did not specify where they kept those items (Table 2). Where participants put the contaminated items did not differ much by location (Table 2) or by risk perceptions (Table 4). However, participants who lived in a shack were more likely to describe leaving contaminated items uncontained on the couch or with other clothes (44%) than those who lived in a permanent dwelling (27%)(Table 3).

Table 5 Perceived risk, PPE taken home and washing behaviors by age group

	Total N=29	Age >45 n=3 f (%)	Age 36-45 n=7 f (%)	Age 26-35 n=13 f (%)	Age <25 n=6 f (%)	p-value
Do you take PPE home daily?						
Yes	26 (90)	3 (100)	6 (86)	11 (85)	6 (100)	
No	3 (10)	0 (0)	1 (14)	2 (15)	0 (0)	1.000
Do you wear boots home?						
Yes	14 (56)	1 (33)	1 (14)	7 (70)	5 (100)	
No	11 (44)	2 (66)	6 (86)	3 (30)	0 (0)	0.010
Are contaminated items dangerous?						
Yes	19 (65)	3 (100)	4 (57)	8 (62)	4 (67)	
No	10 (35)	0 (0)	3 (53)	6 (38)	2 (33)	0.789
Where does PPE get washed?						
Bathroom	9 (32)	0 (0)	4 (57)	2 (16)	3 (50)	
Washroom	1 (3)	0 (0)	0 (0)	1 (8)	0 (0)	
Indoor unspecified	6 (21)	1 (33)	1 (14)	4 (32)	0 (0)	
Outdoor	12 (41)	2 (67)	2 (29)	6 (42)	2 (33)	
Work	1 (3)	0 (0)	0 (0)	0 (0)	1 (17)	0.380

*Significant p-values are in bold

Discussion

The finding that 90% of participating WfW workers take contaminated items home daily suggests that the occupational risks of exposure are carried into the home, and this puts them, and all household members at risk of exposure (27,29–32). The risks carried into the home could be reduced if facilities for cleaning and storing contaminated items were made available at the work place such that contaminated items would never enter the home (37). WfW workers, however, do not have access to such facilities at the work place (28) and challenges, such as the terrain and transient nature of the WfW projects (28,33,46,47), could make providing such facilities unfeasible. The fact that most participants take PPE home is likely a reflection of their limited alternative options. The contaminated items brought into the home by WfW workers could expose household members to pesticide residues. Members could therefore be at risk of the adverse health effects associated with prolonged low-dose exposures mentioned above. Equipping workers with recommendations for feasible at-home safety behaviors that keep contaminated items contained (such as using non-permeable transport bags, and cleaning items outside in buckets that are not used for any other purposes) would reduce the risks of residue exposure.

The PPE items participants were most likely to take home were spray-suits (65%) and boots (56%). Lozier and colleagues (2012) found that the more time workers spent spraying, the more residues were found in their homes (30). This would imply that the more opportunity PPE and clothing items get to collect residues, the more contaminated they become, and the higher the risk of cross-contamination. Spray-suits and boots are

PPE items that are worn during foliar spraying and are therefore likely to accumulate large amounts of residues. Those items could therefore pose a high risk of cross-contamination when workers take them home. Workers should be advised to remove such items before entering the home. Getting changed outside the home as opposed to inside the home can significantly reduce the risks of cross-contamination and therefore residue exposure (30,31). Workers and project managers should be made aware of the high cross-contamination risks associated with those items.

Over a third of the participants (37%) described placing their contaminated PPE with clean items and on clean surfaces, such as in the wardrobe or on the couch. This could be a low estimate, as 24% of participants did not specify where they placed contaminated items. Residue levels are generally higher in rooms where farm workers, who spray pesticides, get changed (30). This indicates that contaminated items passively leave residues through cross-contamination when they are brought into clean spaces. The implication of this is that over a third of the participants demonstrated a high risk of cross-contamination as a result of where they place contaminated items. Residues that are transferred into the home, and settle on surfaces or clean items, put all household members at risk.

The placement of contaminated items on a couch, or with clean clothes, was more frequent among workers who lived in a shack (44%) as opposed to a permanent dwelling (27%). This could be an example of the influence socio-economic status and housing conditions can have on the workers' safety behaviors regarding the handling of

contaminated PPE. The majority of workers who live in a shack were from the Tokai location, which is a city as opposed to a rural area. Housing conditions among those who live in a shack could be cramped and they may have less access to utilities. They may not be able to safely leave items outside the home, nor have a separate bathroom or space for a separate wardrobe in the home. It may thus be challenging for workers in a shack to keep contaminated items contained. Without convenient access to better storage options, workers living in a shack could be at an increased risk. However, the increased likelihood of high risk storing behaviors among workers who live in a shack as opposed to a permanent dwelling should be further investigated, in order to make appropriate recommendations and facilitate safer storage behaviors.

This study found that the dwelling type and access to amenities were significantly associated with where participants washed the contaminated items. This is evident in Figure 2, and is consistent with Levesque and colleagues (2012), who suggest that the workers' likelihood to engage in safety behaviors are largely determined by the amenities and resources they are given (40). However, this study furthermore reflects that it is also the nature of workers' risks of exposure that change in accordance with the amenities they have access to, and not just whether or not they are at risk of exposure. For instance, the 27% of participants who used their bath for cleaning PPE were workers with access to running water, but no washing machine. They likely use the bath to wash themselves too, which poses a great risk of exposure to residues on their skin. Workers should be strongly advised against using the bath for washing contaminated items. In contrast, workers who lived in a shack without running water in the home were more likely to wash

contaminated items in a bucket, outside, than those who lived in a permanent dwelling with access to running water. Although this is a positive step in that contaminated items are cleaned away from the home, there are risks associated with the disposal of the contaminated water (28,32). Furthermore, workers are at an even greater risk if the same buckets are used for carrying drinking water. Recommendations for safe washing behaviors need to be sensitive to the different risks associated with cleaning practices that are associated with the different amenities the workers have access to.

It is concerning that all five participants under the age of 26 wore contaminated boots home after foliar spraying, and participants under the age of 35 were significantly more likely to wear boots home than those over 35. This increased risk associated with younger workers could be a reflection of the communities and living conditions of the younger participants. Recognizing that the WfW programme has an emphasis on youth means that safety training, and the delivery of risk information, should be customized for this group.

The likelihood that contaminated PPE items were taken home daily had a significant inverse relationship with the worker's level of education ($p=0.02$). This finding is consistent with both Mancini and colleagues (2005) and Coetzer and colleagues (2012), who suggest that low levels of education are associated with poor safety behavior compliance by workers using pesticides (4,48). They suggest that undeveloped learning skills could make it more difficult for workers to process and learn safety behaviors. Coetzer and colleagues (2012) furthermore suggest that workers, who are not accustomed to learning in a classroom environment, may not be successful at retaining information

discussed in such a setting (48). WfW workers are supposed to be provided with induction training, which many do receive. Never the less, workers were still observed engaging in at-risk behaviors such as walking through the pesticide spray of other workers, not using gloves, or taking breaks and eating while sitting on contaminated overalls (28). The training provided does not appear to always translate into safety compliance. To improve safety behaviors may require the training to be provided in a manner that is sensitive to the workers' level of education, and in a style that is conducive to how the workers are best able to learn.

Non-permeable bags provide workers with a means to contain residue and transport PPE in a safe way. Several workers (20%) described using non-permeable bags. This was a behavior indicated by 4 out of the 18 (22%) participants who lived in a shack. Utilizing such bags thus appears to be a feasible option to reduce the likelihood of cross-contamination among all the WfW workers, regardless of dwelling type or access to amenities. Literature suggests that the likelihood that workers engage in safety behaviors is strongly influenced by empowering them with a sense of self-efficacy (49), ensuring that they have access to necessary resources (38,40), and allowing them to feel that they have control over their safety practices (50). Levesque and colleagues (2012) showed for instance that when workers had sufficient water for bathing and laundry, they took more responsibility over their safety, and were more likely to engage in other safety behaviors such as PPE use (40). In this manner factors that provide workers with control and self-efficacy create a positive safety culture. Safety cultures consist of the shared attitudes, beliefs and behaviors of workers within a work environment, and are influenced by the

resources they have access to (50,51). Ideally non-permeable transport bags would become part of the PPE provided by WfW to enable and empower workers to take control over their safety and reduce the risks of cross-contamination.

In this study, the participants' perceived risk of exposure and perceived dangers at work were not significantly associated with any of their safety practices. However, Mayer and colleagues (2010) found that workers who perceive that safety was important to supervisors were more likely to wash their hands (39). This was supported by Kearny and colleagues (2015) who found that working youth, who believed that their supervisors prioritized cheap and fast work over safety, were less likely to engage in safety behaviors such as hand-washing, despite having received training (38). Those studies reinforce the notion that perceptions and beliefs of other workers or supervisors within a work environment play an important role in shaping workers' own attitudes (43,51,42). This study did not measure whether workers believed that safety was important to supervisors. Taking into account all the factors that were considered in this study, dwelling type and access to running water were the biggest determining factors on participants' PPE handling behaviors.

Limitations

The main limitation of this study is the sample size. As this study is part of a pilot study intended only to explore risks of cross-contamination and direct areas of future research, only 29 participants were included. This sample size limits the generalizability of the findings. Convenience sampling was necessary in order to obtain consent from the

contractors, and to interview workers without disrupting daily work activities.

Questionnaires were administered at three different locations to increase the representativeness of the sample and to improve the generalizability of the findings.

Future research should include a larger sample size in order to draw more conclusive inferences.

Another limitation is that not all questions were answered. Some participants for instance did not specify where contaminated items were washed within the house. The unspecified responses limited the reliability of comparative interpretations to be made from specified responses. To remedy this, responses were collapsed at the time of analysis into indoor versus outdoors cleaning behaviors, as to enable inferences to be made regarding cross-contamination risk.

Additionally, participants were informed prior to participation that the study was focused on risks of pesticide exposure. This could have led to a response bias on questions pertaining to perceived risk or safety behaviors. To address this bias, and improve the reliability of the responses, it was explained to participants that truthful answers will help inform risk prevention strategies in the future, and were assured that their identities would remain confidential.

Conclusion

Strategies to reduce the risks of exposure in LMICs need to recognize the vulnerability of workers in LMIC settings. These strategies need to take account of the high risks of take-

home residue exposure among workers with limited access to amenities, especially running water. This study shows that the at-home environment has a greater impact on worker behavior than the workers' perceptions pertaining to the risks of exposure. It is therefore vital that governments play a role in setting policies and regulations to reduce the toxicity of pesticides, and how they are used in occupational settings. Furthermore governments could collaborate with forestry management to set guidelines for workers to ensure that they can limit contamination risk by containing used PPE. It is also necessary that safety training take account of the workers' level of education and the constraints they face in terms of the living conditions. Recommendations made to workers should not shift the risks of exposure, but actually reduce the risks.

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Data Availability

Data can be obtained by contacting the authors

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Part D Appendices

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Annex A Questionnaires

Personal Protective Equipment (PPE) Use and Washing Procedures

Questionnaire – August 2015

Name of Interviewer: _____

Date of interview:

Respondent number:

Read and completed Consent form: (Tick to confirm)

This questionnaire comprises four (4) sections: First I will ask you questions about yourself and your home and then about your use of Personal Protective Equipment at home and during work.

Demographic details

Gender: male female (Tick)

Year of birth

What is your home language? _____

Which other languages can you speak?

Which languages can you read?

Current job at Working for Water (Tick - can tick more than one)

General worker	<input type="checkbox"/>
Peer educator	<input type="checkbox"/>
First aider	<input type="checkbox"/>
Health and Safety representative	<input type="checkbox"/>
Herbicide applicator	<input type="checkbox"/>
Pest Control Operator (PCO)	<input type="checkbox"/>
Other: (explain in blank space on the right)	<input type="checkbox"/>

Year first started at WFW? _____

Highest educational qualification/standard/grade passed at school:

Where do you currently live?

Do you have the following at your house? (Tick - can tick more than one)

Running water in home	<input type="checkbox"/>
Electricity	<input type="checkbox"/>
Toilet indoor	<input type="checkbox"/>
Toilet outside	<input type="checkbox"/>
Outside tap near home (in yard)	<input type="checkbox"/>
Outside tap further away from home	<input type="checkbox"/>
Washing machine	<input type="checkbox"/>
	<input type="checkbox"/>

How many people currently live on the property where you live? ___ adults ___ children

Which of the following do you live in? (Tick) Permanent building Shack

Do you apply pesticides using a:

Backpack sprayer? Yes No

Handheld sprayer? Yes No

Who does the washing of clothes in your home?

Who washes your work clothes?

Residues and PPE Knowledge and Attitudes

Definition: PPE or work clothes are any clothes that you wear when you are out in the field foliar or stump spraying herbicides. This may include your yellow work shirt, your two piece Conti-suit (picture B & C) as well as boots, gloves, goggles and anything else that you are wearing during pesticide handling.

What do you think is the biggest danger to your health when working for Working for Water?

Do you think that there are any problems that could happen to you or others from wearing your PPE home?

Yes

No

Please explain. _____

Do you wash your PPE in the same way as you wash your other clothes?

Yes

No

Please explain. _____

When you get home after foliar spraying, how do you clean your clothes?

Please explain.

Do you ever wash your general clothes in a river? Yes *No*

If yes, which river do you wash your clothes in?

Do you wash your PPE in this river as well? Yes *No*

Cleaning and storage of PPE

When you go to work in the mornings, what clothes do you generally put on?

Do not ask these to the respondent, just tick what the respondent lists.

You may need to ask if they are clean or dirty (Can tick more than one).

	Daily	Once/ week		Daily	Once/ week
Clean blue work overalls			Used/dirty blue work overalls		
Clean yellow WFW shirts			Used/dirty yellow W4W shirts		
Work boots			Normal casual shoes		
Normal casual clothes			Other (please explain below)		

If you wear casual clothes to work, answer the following questions (if not, skip to 0).

a) What do you carry your PPE in when going to and from work?

-

b) What do you do with this bag? (Circle correct answer.) Wash / Store / Discard

Comments: (other things carried in the bag?)

Do you take or wear your PPE home with you every day?

Yes

No

If you said yes, what PPE do you generally take home?

If you said yes, where do you put your PPE when you get home?

If you said no, where do you store your PPE before going home?

If you change your work boots, where do you put your boots when you travel home?

Complete the table below related to the washing of PPE (please tick and write details):

<i>How do you wash PPE? (tick below)</i>			
<i>Water temperature: Hot</i>		<input type="checkbox"/>	<i>Water temperature: Cold</i>
<i>Machine wash</i>		<input type="checkbox"/>	<i>Hand wash</i>
<i>Where is the waste water thrown?</i>			
<i>Where do you wash PPE? (tick below)</i>			
<i>AT HOME</i>		<input type="checkbox"/>	<i>AT WORK</i>
		<input type="checkbox"/>	<i>OTHER (Give to someone)</i>
<i>Inside house</i>	<input type="checkbox"/>	<i>Outside house</i>	<input type="checkbox"/>
<i>Bathroom</i>	<input type="checkbox"/>	<i>house</i>	<input type="checkbox"/>
<i>Kitchen</i>	<input type="checkbox"/>	<i>(explain)</i>	<input type="checkbox"/>
<i>Washroom</i>	<input type="checkbox"/>		
<i>Bath</i>	<input type="checkbox"/>		
<i>Bucket</i>	<input type="checkbox"/>		









When your PPE is washed, do you rinse it? Yes *No*
When your PPE is washed, how is it dried?

Is your PPE ironed? Yes *No*

PPE Checklist




Give participant flash cards and tell participant: "Have a look at the pictures of these PPE and take out all the ones you use regularly." Then take of the cards the participant selected and ask the following 4 questions for each card the participant selected ONLY. Card numbers coincide with numbers of images/pictograms on the table. Tick appropriate boxes linked to the following questions.

Do you wear this when spraying herbicides?
 Do you wear this at home after spraying herbicides?
 How often do you clean this item?
 How do you clean this item?

PICTURE:	DESCRIPTION	1.Spraying herbicides	2.Wear at home	3.How often clean	4. How do you clean this item?
A 	T Shirts (Cotton)				
B 	2-piece Conti suit Top				
C 	2-piece Conti suit Pants				
D	Knapjacket				
E 	Rain suit				
F 	Hard Hat (SANS G.M.E HH33)				
G 	Gum Boots (steel toe/PVC moulded cap, where applicable)				
H 	Safety Boots (leather, steel toe/PVC moulded cap - SANS 741 2006)				
I 	Leather Gloves				
J	White Crayfish Gloves				

					
PICTURE:	DESCRIPTION	1.Spraying herbicides	2.Wear at home	3.How often clean	4. How do you clean this item?
K 	Rubber Gloves Wrist length - spraying				
L 	Rubber Gloves Elbow length - mixing				
M 	Safety Specs (Anti Fog lenses)				
N 	Chainsaw/Clearing saw Hard Hat (Earmuffs PrEN 352-3 + Visor EN 397)				
O 	Chainsaw/Clearing saw Tunic				
P 	Chainsaw/Clearing saw Pants (PrEN381-5:1993 - 11 layer)				
Q 	Chainsaw/Clearing saw Gloves				
R 	Leggings				
S 	Respirator				
T 	Dust Mask				
U 	 Carbon Filter Mask				
V 	Hearing Protector (O = if working within 20m of an operator)				
W 	Fall protection and fall arrest equipment				

The following questions are to be asked to the aquatic teams *ONLY*

PICTURE:	DESCRIPTION	1. Spraying herbicides	2.Wear at home	3.How often clean	4. How do you clean this item?
 <p>X</p>	Life Jacket				
 <p>Y</p>	Wader				
 <p>Z</p>	Rockies Shoes				

Annex B Consent Form

ASSESSING WORKING FOR WATER COMMUNITY WORKERS PESTICIDE EXPOSURES AND PREVENTION STRATEGIES CONSENT

Read to participant

Hello, my name is I am from the University of Cape Town. I am involved in a project that is studying the use of herbicides used by workers employed by the Working for Water programme.

Our research will be done during working hours at your place of work and you will still be paid your normal salary during this time. You will not be paid extra to participate but will receive something to eat. There is no risk to your continued employment with WFW if you participate in this study. We will also be providing training on safety while working with herbicides (see attached letter from WFW regarding continued employment).

I would like to ask your permission to watch you while you work and to interview you for a research study that is running from October 2011 to December 2012. The purpose of watching and the interview is to find out about the use of herbicides to clear alien vegetation and your understanding of health & safety issues related to these chemicals. I will also ask you some questions about other work which you may have done with herbicides as well as use of herbicides at home.

Your participation in this study is very important to us as a worker in the WFW programme and will assist us in understanding better about the use of herbicides by community workers. Your answers will help us to improve your own health and safety. This interview is confidential. Your name will not be linked to your responses as you will be identified only by a study number.

This is not a test and there are no right and wrong answers. Please try to answer these questions as truthfully as possible for us to better understand the use of herbicides. If you do not understand a question, please ask me to repeat it or explain it. The interview should take 30-45 minutes. We would like to tape record the interview if you comfortable with this. May we tape record the interview? Yes..... No.....

We will also have a group session called a focus group. Your participation is voluntary, which means that you can refuse to participate and you can stop the interview at any time. However we cannot control what members of the focus group say outside of the group so we cannot guarantee that what you say remains confidential. The focus group will be held during your work time and will take between 45 – 60 minutes. We would like to tape record the discussion if you comfortable with this. May we tape record our discussion? Yes..... No.....

We may also like to take photographs or video to show work practices. Is it ok if we take photographs or video while you work? Yes..... No.....

This study will not involve any harm or discomfort to you. May I watch you while you work and interview you? Yes..... No..... (If yes, please sign below.)

If you have any questions or want further information about the study, please contact:
Study Principal Investigator:

Dr. Andrea Rother School of Public Health and Family Medicine University of Cape Town, Anzio Rd., Observatory 7925 South Africa T: (021) 4066721; F: (021) 4066459; e-mail: Andrea.Rother@uct.ac.za

Or Professor M Blockman, Chairperson, Health Sciences Faculty Human Research Ethics Committee, University of Cape Town T: (021) 4066338; F: (021) 4066411, email: shuretta.thomas@uct.ac.za

Name of participant (print)

signature Date

Interviewer's name (print)

signature Date

Witness's name (print)

signature Date

Annex C Ethical approval for parent study



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6411
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

17 April 2015

HREC REF: 213/2015

A/Prof A Rother
Environmental Health Division
Room 4.28, level 4
Falmouth Building

Dear A/Prof Rother

PROJECT TITLE: ASSESSING WORKING FOR WATER WORKERS WASHING AND STORING OF HERBICIDE CONTAMINATED PERSONAL PROTECTIVE EQUIPMENT AND WORK CLOTHES: IDENTIFYING RISK PREVENTION MEASURES OF CROSS-CONTAMINATION FOR FAMILY MEMBERS AND HOME ENVIRONMENT

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30th April 2016.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH

HREC 213/2015

Annex D Ethical approval for this study



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6626
Email: shuretta.thomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

8 August 2017

HREC REF: 569/2017

A/Prof Andrea Rother
Public Health & Family Medicine
Falmouth Building

Dear A/Prof Rother

PROJECT TITLE: UNDERSTANDING SOUTH AFRICAN HERBICIDE WORKERS' RESIDUAL TAKE-HOME EXPOSURE RISKS FROM PERSONAL PROTECTIVE EQUIPMENT CLEANING AND STORING PRACTICES (SUB-STUDY LINKED TO 213/2015) MASTERS CANDIDATE - MS L ERLANK

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

Before formal approval, please address the following issue/s raised:

1. Please urgently update study 213/2015 and provide reason why it is expired by almost 1½ years.
2. We note the questionnaire is dated August 2015. Will the questionnaire be translated into all the appropriate languages and is it validated for those languages?
3. Please update the informed consent form to reflect this sub-study as per the HREC SOPs. The informed consent document submitted speaks to the main study and reflects 2011-2012.

Please note that no research may occur without formal written HREC approval.

Please quote the HREC reference number in all your correspondence.

Yours sincerely


PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Annex E Instructions to Authors

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

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Please include a word count for your paper.

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Please refer to these [quick style guidelines](#) when preparing your paper, rather than any published articles or a sample copy.

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Please use double quotation marks, except where “a quotation is ‘within’ a quotation”. Please note that long quotations should be indented without quotation marks.

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