Falling Through the Regulatory Cracks

Street Selling of Pesticides and Poisoning among Urban Youth in South Africa

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In South Africa, as in much of the developing world, youth participation in the informal, unregulated street pesticide market results in exposures and risks of acute and chronic effects, yet has gone largely undocumented. A conceptual framework for understanding youth involvement in street pesticide sales and use includes contextual factors, health outcomes, and externalities (unintended negative consequences). An exploratory study based on this framework shows that highly-toxic pesticides, such as aldicarb, methamidophos, and chlorpyrifos, are easily available in informal markets in Cape Town's urban periphery. Youth are involved in the sale, distribution, and use of street pesticides, and are exposed during handling, transportation, spillage, storage, use and other activities, with little safety information available. Demand and supply for street pesticides is driven by joblessness, poverty, and inadequate pest management strategies. National and international efforts addressing underlying contextual determinants are required to protect children from exposures to street pesticides. *Key words*: street pesticides; aldicarb; organophosphates; street vendors; child pesticide poisoning; informal sector; child labor; pesticide regulations; Cape Town, South Africa.

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INTRODUCTION

Pesticides intended for agricultural uses are being sold by informal adult and youth vendors for domestic use, which is resulting in child poisonings.[1] *Street pesticides* refers to pesticides (predominately registered for agricultural uses) that are decanted (that is, into used drink containers or medicinal bottles), and sold unlabelled for unregistered uses (predominately domestic pest control) at train stations, taxi stands, on trains, and door-to-door. The limited research that is currently available reveals that the sale of street pesticides, particularly to the urban poor for domestic pest control, is a global phenomenon, rife in, but not limited to, developing countries. Research has been conducted on this phenomenon in South Africa, Zimbabwe, Tanzania, Mozambique, the United States, Brazil, the Dominican Republic, and Israel.[1–10] These pesticides are cheaper than commercially available products, and at the same time are effective, highly toxic, illegal, readily available, and unregulated. Pesticide legislation and risk management strategies are failing to prevent the use of agricultural pesticides for non-agricultural purposes, particularly in poor urban communities in developing countries.

Research has shown that farmers and farmworkers are at a high risk of health effects from exposures to agricultural pesticides, where in most cases personal protective equipment (PPE) to prevent exposures is a necessity.[11,12] However, when agricultural pesticides are sold in informal markets for domestic pest control, PPE and safety training are neither required or encouraged nor made available, which results in unregulated and high exposures. Active ingredients in pesticides used for commercial agricultural applications generally contain higher concentrations of active ingredients or have a higher toxicity than those permitted legally for domestic use.[11] Selling agricultural pesticides for home use can therefore result in a chain of exposures and risks ranging from short-term acute health effects to long-term chronic effects.[13–16] Youth are extremely vulnerable to these risks not only because they are caught up in a web of exposure risks from selling, transporting, and using street pesticides, but also because they are at a higher risk of health consequences from these exposures than adults.[17–21] Thus, it is critically important to protect youth from street pesticides exposures and from documented health effects of such exposures, including asthma,[22] neurological effects,[23] hormone disruption effects,[19,24] and cancer,[25] as well as unknown health effects.

In this paper it is argued that unregulated use of street pesticides is a silent occupational and environmental health problem that is resulting in acute poisoning of youth as well as creating a high risk for long-term chronic health effects. Data from an exploratory

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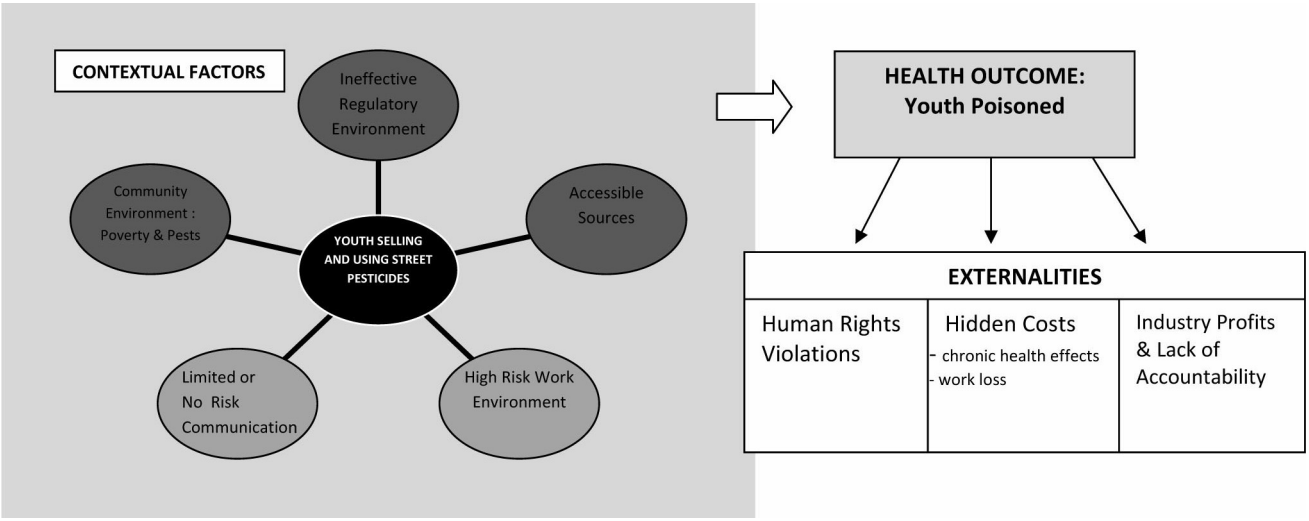

Figure 1—Conceptual model illustrating determinants of sale/use of street pesticides and youth poisonings.

study on the sale and use of street pesticides in peri-urban areas of Cape Town, South Africa were used to assist in understanding the pathways of youth pesticide exposures. The specific objectives of the exploratory study were:

1. To assess the nature of the problem with street pesticides;
2. To identify the informal vendor's role in selling street pesticides and in child poisonings;
3. To identify potential exposures and health risks;
4. To assess sellers' and consumers' access to pesticide risk information.

CONCEPTUAL FRAMEWORK

The conceptual framework for understanding the contextual determinants influencing youth selling/using street pesticides and resulting health outcomes is shown in Figure 1. The author developed this model based on a review of relevant published literature, pilot studies, and field observations.[1–7,26] This model shows the relationships between contextual factors influencing the sale and use of street pesticides and affecting youth vendors, as well as the externalities (unintended negative consequences) resulting from youth being poisoned by street pesticides. Youth sell and use street pesticides in a context, including the community environment, the regulatory environment, and access to sources of pesticides, that promotes such activities. Within this context additional factors, such as limited or no access to risk communication information and working in a high-risk environment (for example, poor storage facilities, lack of PPE, leaky packaging, and no access to washing facilities) compound the problem and result in negative health outcomes for youth and adults alike.

Contextual Factors

Community environment: poverty and pests. The community environment consists of poverty-related conditions which promote pest infestations and fuel the demand for cheap and effective pest control products. These include inadequate water, electricity, and sewerage provision; scarcity of flush toilets; uncollected rubbish; crowded living conditions; standing water; and poor quality housing which includes many of the elements already described (Figure 2). Pests cause enormous discomfort and health risks in already stressed poor communities by competing for food, biting and carrying disease, promoting a social stigma of "dirtiness," and annoying residents with their presence and behavior. The high use of street pesticides in poor urban communities is a result of efforts by community members to combat the escalating problem of poverty-related pests (such as rats, mice, flies, cockroaches, and bed bugs).[1,27] Thus the demand for street pesticides is high in peri-urban townships of South Africa where poverty-related pests are abundant.[1] As a result of this demand, street vendors are not only are a link in the supply chain, but are also creating jobs in a high unemployment context.

Ineffective regulatory environment. Despite the existence of pesticide regulations prohibiting the use of pesticides for purposes other than those for which they were registered, agricultural pesticides are being decanted and used for domestic pest control. In South Africa, the main pesticide legislation dates to 1947; it is out of date, poorly enforced, and results in minimal surveillance and control of pesticides.[28] Under this legislation, agricultural pesticides can be purchased and used without a license by anyone. The pesticide label is used as the main method for communicating pesticide risks to end-users.[29] End-users, however, are the most difficult group among which to enforce label compliance and ensure

Figure 2—Rubbish, poor sanitation and housing conditions in urban periphery of Cape Town, South Africa.

full comprehension of risk information. The result is that there is a tendency to speak of "misuse" by end-users of pesticides when poisonings occur, rather than focusing on the root causes of the problem. Regarding the use of street pesticides in South Africa, the government is failing to address the poverty-induced pest problem, as well as failing to target the pesticide industry for the lack of control of their products both in terms of what they are used for and how they are accessed.

Accessible sources of pesticides. Without access to agricultural pesticides, the sale of street pesticides would not be possible. Although there are international attempts to engage the pesticide industry in a life-cycle approach to pesticide management,[30] neither industry nor government have adequately controlled access to pesticides.[31]

Limited or no risk communication. Street vendors do not have access to pesticide Material Safety Data Sheets (MSDSs) or even labels in most cases. Thus they have limited access to risk information and exposure prevention strategies. Even if vendors had access to MSDSs and pesticides labels, they do not receive any formal training on how to use, understand, and apply the risk information and may not have adequate literacy to understand written warning materials. Even farmworkers with access to pesticide training have been shown to have limited understanding of this written risk information.[29]

High risk work environment. Assessment of the health effects and risks associated with those working in the informal sector is underresearched.[32] The informal sector work environment is unregulated, which results in a lack of occupational health and safety structures to protect the health of vendors. Consequently, these vendors are prone to high health risks from unsafe work practices owing to a lack of risk information and training, as well as easy access to highly toxic pesticides. Children selling alone or helping their parents at stalls are prone to increased risk compared to adult vendors.

Health Outcome

Youth poisoned. Contextual factors make youth vulnerable to acute and chronic poisonings. Pesticides may poison or even kill a child; children who survive or avoid acute poisoning face an increased risk of long-term health effects such as cancer.

Externalities

Human rights violations. Youth selling and exposed to street pesticides represent two clear human rights violations: child labor and childhood exposure to highly toxic pesticides. The issue of child labor in the informal sector in regard to buying, selling, and applying street pesticides is complex. In many developing countries unemployment is high and access to education costly. Thus the socioeconomic context is such that youth selling street pesticides, either by themselves or with their families, provides youth and/or their families with an income. However, this practice of hazardous work by children, particularly exposure to pesticides, violates children's human rights and falls under the International Labour Organization's (ILO) Convention on the worst forms of child labor (No. 182).

Aldicarb and methamidophos, pesticides with high acute and chronic toxicity, are commonly sold as street pesticides in South Africa. The unregulated sale and use of such pesticides violates the rights of the child to be protected from hazardous environments (Article 24,

United Nations (UN) Convention on the Rights of the Child).[33,34] Such use also violates the UN's International Code of Conduct on the Distribution and Use of Pesticides, which states that, "Prohibition of the importation, sale and purchase of highly toxic and hazardous products, such as those included in WHO classes Ia and Ib, may be desirable if other control measures or good marketing practices are insufficient to ensure that the product can be handled with acceptable risk to the user."[30,34]

At the same time, children's role in applying pesticides at home or purchasing these for parents raises the question of whether there exists an age at which a youth should be able to purchase and apply pesticides at home or whether such activity at any time prior to age 18 would constitute hazardous work under child labour laws. The ILO convention (No. 138) on "minimum age of admission to employment and work," requires a child to be 18 to work with (and presumably purchase) hazardous pesticides. Although pesticide labels on commercial products indicate "keep out of reach of children," there is no label information regarding the age at which a person can apply pesticides in the home—and assume the risks listed on the label. As there are currently no laws preventing children from buying legally registered pesticides in supermarkets, it would be almost impossible to impose restrictions on street vendors selling to children.

Hidden costs. When youth develop acute and chronic health effects from pesticides exposures, the cost of their illness puts a high burden on either a family already in a poverty-stressed situation or on the individual youth. Not only does this result in increased health care costs, but it also results in a loss of economic productivity when the youth cannot sell pesticides and other goods due to illness, or a family member has to care for the sick youth and is unable to work.

Industry profits and lack of accountability. The sale of street pesticides contributes to the profits realized by pesticide companies. Currently, research and information is unavailable as to the extent of this contribution, but in the case of aldicarb, which is sold extensively and globally on the informal market,[1–10] the assumption is that the contribution is not negligible. However, since the sale of street pesticides is classified as an "illegal activity" and is thus not acknowledged by governments as an economically viable platform for the pesticide industry, the latter is not held accountable for life-cycle management of these pesticides.

Although the pesticide industry has acknowledged the problem with aldicarb as a street pesticide, attempts to establish accountability have materialized as either promoting the arrest of informal vendors (which sidesteps industry accountability entirely), or adding a bitter agent, an emetic, or color to aldicarb (for poisoning prevention and/or to identify the manufacturer of street pesticides). Aldicarb is already coated with the bitter tasting agent, "Bitrex," in an attempt to prevent children (and others, particularly in cases of self harm) from eating and swallowing it. The Bayer corporation is in the process of adding an emetic to the formulation to cause vomiting on ingestion, along with a light blue color to the granule formulation (currently black) to allow the industry to identify whether the product sold by street vendors belongs to Bayer or not (Bayer is the only legal distributor of aldicarb in South Africa). Such measures do not take into account the full context within which street pesticides are sold and used; that is, that profits are being realized along the entire sales chain, from sellers, including informal street vendors, and distributors to the pesticide companies themselves. Adding emetics or bitter agents to pesticides aims prevention efforts at the end-user, perhaps adding a false sense of security or responsibility for various actors, but such measures are far too late in most cases to address the basic problem of exposure. The motivation to cut the sales source base is limited because the pesticide industry benefits from all sales of its products. The industry's efforts to prevent end-user ingestion are aimed at retaining permission to legally sell aldicarb-containing products in South Africa, resulting in no disruption in the illegal supply chain. Temik, Bayer's trade name for aldicarb, is one of their top selling pesticides.

METHODS

The findings presented here were part of a larger study linking street pesticides sales to child poisonings at a local hospital in Cape Town, South Africa. The methods for the larger study included data collection at a children's hospital, interviewing informal vendors, field observations, a household survey, and a rat-trap intervention (each of the 200 households interviewed were provided with two rat traps and six months after distribution a follow-up survey was conducted), for which findings are currently being analysed and written up. This paper only presents the findings from the street pesticide vendors' interviews and field observations highlighting youth exposures.

Initially a 6-page questionnaire was developed with the intention of formally interviewing street sellers to capture the following data: demographics; occupational information on pesticide seller; details of the pesticides they sold; information on storage, disposal, and transport; the profile of vendors' customers; health and safety perceptions; health and safety risk communication; and problems associated with selling pesticides. However, researching informal vendors of street pesticides proved to be complicated, raising questions such as: How does one research what appears to be the *unresearchable*? How does one research a heterogeneous population that is highly mobile and involved in a high-risk and illegal trade? Informal vendors were edgy and suspicious of outsiders for fear of being arrested (for being an informal worker and/or for selling illegal

products) and feared competition (there are many sellers since South Africa has a high unemployment rate). Because of these initial responses to conducting formal interviews with several vendors, we then used informal interviews and discussions based on a simplified questionnaire as well as field observations to obtain a snapshot of the situation and begin to analyze its complexity. Although the original intention of the research was to assess whether informal adult vendors were playing a role in child pesticide poisonings, the unexpected finding was that youth were also involved in either selling or buying street pesticides for home applications.

Study Site and Data Collection

The research was conducted on trains and around train stations and minibus taxi stands at local markets, as well in the streets where street pesticides were identified as commonly being sold. Data were collected in the peri-urban areas of Cape Town, South Africa between January and May 2008 by three field researchers (two male and one female) who spoke the local languages (IsiXhosa and Afrikaans) and lived in communities similar to the research area. One male fieldworker lived in the first research site (Khayelitsha Site B; see further information below) during the whole period of the research, interviewing and documenting observations in a journal. The two other fieldworkers travelled by trains from central Cape Town, stopping at randomly-chosen train stations along the route to assess if street pesticides were sold at most train stations in the various townships. After travelling by train and assessing where street pesticides were being sold, two further research sites were chosen—Khayelitsha Site C taxi stand and the Bellville train station—as these represented some of the contrasts in the poorer urban communities in terms of ethnicity, language, and location (for example, the former is an IsiXhosa speaking area and the latter, Afrikaans).

Khayelitsha is Cape Town's largest township and because of its size has been split into various sub-sections (examples of the names of these sub-sections are: Site B, Site C, Mandela Park, Enkanini, Harare). Site B and Site C are considered to be two of Khayelitsha's poorest sub-sections. Site B and Site C were chosen as study sites based on the fieldworker's familiarity with these areas, ability to gain access, and the abundance of sellers of street pesticides. Bellville train station is the second largest after the central Cape Town train station terminus. The Bellville station is a major terminus for a local bus company and has a large minibus taxi stand. Both sites were chosen because of their location and high levels of street pesticide activity and also because they are places where high volumes of people move through on a daily basis.

Weekly meetings were held with all fieldworkers and the author. At these meetings findings from the most recent field visit (or journal entry in case of the participant observation fieldworker) were presented, further probed, and discussed; areas for further questioning and observation were then identified.

Interviews

Due to the difficulty of obtaining participants, individual vendors were selected according to convenience sampling.

The fieldworker conducting participant observation research and living in the community would move daily through his community, observing and speaking to informal vendors. Once he gained the confidence of informal vendors he would conduct either a formal interview or an informal discussion, depending on how comfortable the respondent was. These formal interviews were recorded into the original long questionnaire and the simplified data sheets.

The non-resident fieldworkers approached an informal vendor either because they could see pesticides on display or to inquire if she or he sold any. Then an informal discussion would begin around purchasing a pesticide, which the fieldworkers bought in most cases. The fieldworkers would then ask the vendor if they were willing to be interviewed. Inclusion was based on the willingness to consent to be interviewed. One fieldworker asked questions, while the other took notes and completed a data sheet. Questions asked by the fieldworkers covered the following topics: demographics, type of seller (that is, mobile, stationary, or temporary), types of pesticide products available (for example, liquid or granules), which products worked for which pests, cost of products, source of products, storage practices, decanting and mixing practices, health and safety practices, customer profile, information (if any) provided from distributor, information provided to customers, other products sold along with street pesticides, and what information/material they would like to receive on occupational health and safety. After interviewing, data sheets of standardized questions were completed by fieldworkers. All street vendor participants provided verbal consent. Early in the project, written consent was requested, but given the nature of their work, street vendors were reluctant to sign any form. Approval for a verbal-only consent was granted by the University of Cape Town's (UCT) research ethics committee. A form was completed by the fieldworker for each person after the interview, with a check box indicating that consent had been given.

Field Observations

Two levels of field observations took place during this study. One was at a participant-observation level where a fieldworker lived in the community and kept a journal over a four-month period. The other level of observations occurred with two other fieldworkers who made

TABLE 1 Laboratory Results of Street Pesticides Purchased between January and May 2008

Sample Number	Description of Pesticide	Lab Results of Sample Analysis	Price Paid (South African Rand) (R 1.00 = US$ 0.14))
1	Clear liquid in clear plastic medicine type of bottle used for crawling insects (no water added).	29 mg methamidophos in 50 ml solution	R 25.00
2	Clear liquid in clear plastic medicine type of bottle used for crawling insects (no water added).	29 mg methamidophos in 50 ml solution	R 20.00
3	White liquid in a 200 ml glass brandy nip bottle (water added); applied on all pests.	66 mg cypermethrin & 0.2 mg chlorpyrifos in 200 ml solution	R 10.00
4	Clear liquid, very strong odor, in 200 ml glass alcohol bottle (water added); used on all pests.	4 mg methamidophos in 200 ml solution	R 10.00
5	Clear liquid, very strong odor, in 200ml alcohol bottle (water added); used on all pests.	3 mg methamidophos in 200 ml solution	R 5.00
6	White liquid in a 200ml glass alcohol bottle (water added); applied on all pests.	124 mg chlorpyrifos-methyl, 0.3 mg cypermethrin, and 5 mg chlorpyrifos in 200 ml solution	R 5.00
7	Black granules in 2-inch-long clear plastic straw-shaped sachet; used for rats.	52mg aldicarb in 0.3245 g	R1.00
8	Black granules in 2-inch-long clear plastic straw-like sachet; used for rats.	60mg aldicarb in 0.3619 g	R 0.50
9	Slightly yellow, strong-smelling liquid in brown medicine bottle; used on all pests.	700000.0 mg/kg metamidophos in 50 ml solution	R 20.00
10	Slightly yellow, strong smelling liquid in brown medicine bottle; used on all pests.	600000.0 mg/kg metamidophos in 50 ml solution	R 20.00

day trips into the research sites, conducting observations and recording these in reports.

The fieldworkers observed where street pesticides were being sold by travelling on trains, walking through townships, visiting informal markets at train stations and taxi stands, and inquiring where they could buy something to control pests. They also observed health and safety practices, handling of pesticides, interactions with customers, location of sellers, and products being sold. Fieldworkers recorded their observations using notes or a voice recorder. This information was then written into the fieldworkers' daily report.

Informal Discussions

Informal discussions were written up in the journal of the fieldworker living in the community. The other two fieldworkers also conducted informal discussions with customers on trains and at informal markets, especially when someone did not agree to be interviewed and sign a consent form but was willing to discuss the issue. On several occasions, a group of people would discuss these issues together. Fieldworkers made notes of these discussions immediately after leaving a research site and included them as part of their daily report.

Sources of Street Pesticides

One area of questioning during the interviews and informal discussions was where street vendors purchased their supply of street pesticides. A list was compiled of leads on the potential sources of street pesticides. The fieldworkers attempted to find as many of the sources as possible both physically and through phone calls.

Analysis of Street Pesticides

Field workers purchased street pesticides both from the street vendors they interviewed and from those they did not. They asked what pest the pesticide should be used for and how to apply it. Products were collected and sent for analysis to a private laboratory at UCT to determine which pesticide group they belonged to, their active ingredients, the WHO acute toxicity classification of those active ingredients, and potential chronic effects.

TABLE 2 Classification and Acute and Chronic Effects of Active Ingredients Found in Street Pesticides Purchased between January and May 2008

Active Ingredient	Pesticide Group	WHO Acute Toxicity Classification[35]	Potential Chronic Health Effects
Methamidophos	organophosphate	Highly Hazardous; Class Ib (oral LD_{50}: 30mg/kg)	Neurotoxic, reproductive toxic, developmental toxic
Cypermethrin	pyrethroid	Moderately Hazardous; Class II (oral LD_{50}: (c 250*)	Neurotoxic, reproductive toxic, developmental toxic, cancer
Chlorpyrifos	organophosphate	Moderately Hazardous; Class II Class U (LD_{50}: 135mg/kg)	Neurotoxic, dermatotoxic, birth defects
Chlorpyrifos-methyl	organophosphate	Limited acute hazards; Class U (LD_{50}: > 3000mg/kg)	Neurotoxic, dermatotoxic, birth defects
Aldicarb	carbamate	Extremely Hazardous; Class Ia (LD50: 0.93mg/kg)	Neurotoxic, reproductive toxic, developmental toxic, cancer, dermatotoxic

*c = toxicity data for pyrethroids is highly variable according to isomer ratios.
Adapted from Rother H-A. Poverty, pests and pesticides sold on South Africa's streets: Implications for Women and Health. Women & Environ. 2008; 76/77: 36-43.

Data Analysis

Fieldworker reports were analyzed by the author using a classification of themes approach. Quantitative data collected from street sellers interviewed and laboratory results of street pesticides were entered into SPSS and Excel.

RESULTS

Results from field observations during four months of participant observation and four weekly site visits, interviews (n=12), and informal discussions while travelling by train and walking through the townships from January to May 2008 are presented here thematically.

Analysis of Street Pesticides

Table 1 presents the laboratory results from 10 of the 20 samples of street pesticides purchased by the fieldworkers. Each pesticide is described based on the container, color, smell, recommended use of the pesticide by the vendor, and the concentration and type of each pesticide, as well as the cost paid for the product. The results illustrate that the concentrations and mixtures vary. We found high concentrations of methamidophos and aldicarb in a number of samples. The low cost of street pesticides (between R 0.50 and R 5.00) make them affordable for the poor.

Table 2 shows the pesticide group, WHO acute toxicity classification, and the potential chronic effects of the active ingredients of pesticide formulations purchased.

A major hurdle with the analysis of street pesticides was the high toxicity of these products. The laboratory conducting the analysis declined to conduct any further analysis after a methamidophos-containing street pesticide had such a high concentration that equipment became contaminated and required extensive and costly cleaning. Laboratory staff also complained that the smell from these pesticides was too strong and toxic. The result was that we were only able to analyse 10 out of 20 samples collected. Attempts were made to contact other laboratories, both government and private, however in the end none had either the capacity or time to analyze the samples.

Sources of Street Pesticides

Study participants described various sources from which informal vendors obtain pesticides. Many sellers were reluctant to mention their source for fear of competition, and a common response was that the source was from a city far from Cape Town, perhaps in an effort to conceal the true source. One informant reported that vendors purchased cypermethrin, chlorpyrifos, and methamidophos from local farmers' cooperatives. The fieldworkers followed up on this lead and visited a local agricultural/farmers' cooperative inquiring which pesticide they should purchase for selling on the streets for domestic use. The shop assistant provided them with a one liter bottle of cypermethrin indicating there were others that worked but that he preferred this product.

Chlorpyrifos is available in shops and ordinary supermarkets, which informal vendors also mentioned as a source. Some street vendors reported receiving their pesticides from informal distributors, often male youth, who provided the sellers with the concentrated pesticide that the sellers resell, either as-is or decanted and diluted. Many of the distributors asked the street vendors to return the empty container to be used again, which promoted discoloration and disintegra-

tion of the container. Some examples of inappropriate street pesticide containers are found in Figure 3.

Sources for highly-toxic aldicarb were the most difficult to identify and generally people indicated that the product came from across the border. Aldicarb was sold in connecting strips of 20 or more straws, which the vendor then cuts to sell individually (Figure 4).

Street Vendor Characteristics

Twelve street vendors were formally interviewed (six males and six females; nine South Africans and one Zimbabwean). Many respondents were reluctant to provide their ages, but the reported or estimated age of the majority was between the ages of 40 and 50. Observed youth street vendors seemed reluctant to speak to the fieldworkers and stood on the fringes listening to others being interviewed or having discussions with the fieldworkers.

Field observations and interviews revealed there were three main types of street vendors selling pesticides: stationary, mobile, and temporary sellers. Middle-aged and older women tended to be stationary and temporary vendors, while men and male youth tended to be mobile, selling on trains or while moving around streets. "Stationary vendors" sell continuously from the same place, for example at the taxi ranks or at train stations. Stationary sellers included people selling for their own profit, people employed to sell for others who owned the goods of the stall, and people who sold for others as a means to return favors. The stationary vendors had stands/stalls in informal markets or at the taxi ranks. These stationary vendors were more likely than other vendors to be accompanied by young children, who assisted with selling/packing of street pesticides and who were left in charge of these stalls when the adults were absent. One child who was estimated to be 12 to 14 years of age was seen assisting with the selling of street pesticides at one of the temporary stalls.

Figure 3—Street pesticides are sold in inappropriate and unsafe containers, often used beverage or medicinal bottles.

Figure 4—Aldicarb sold as a rodenticide by street vendors (mobile and stationary).

Male youth commonly appeared to be distributors to women in their forties to fifties who were stationary sellers. "Mobile vendors" carried their wares with them (including street pesticides which were generally cockroach chalks and aldicarb granules since they did not like the smell and spilling of the liquids). Such vendors moved through different trains and train stations; they also sold door-to-door in the various townships. Figure 5 shows the basket of a mobile vendor, with arrows indicating the presence of cockroach chalks. "Temporary vendors" only sold street pesticides (and other wares) on certain days of the month to coincide with people receiving various government support payments (such as child support, pension payments, and unemployment checks). These sellers set up stalls outside the payment distribution offices so that individuals had to pass by their stalls after receiving their payment. Many of these were middle-aged women who did not yet qualify for a pensioner's grant.

Figure 5—Goods of a mobile street vendor including pesticide cockroach chalks.

Pesticide Exposures

As shown in Table 3, fieldworkers observed a variety of occupational exposures among street vendors. Occupational exposures for the youth occurred predominately among mobile sellers, those assisting at their parents' stationary stalls, and those running the stall by themselves. Other exposures for children occurred from accompanying their parents at an early age to their stationary stalls (for example, one seller had two children under the age of two playing and eating at the stall around the street pesticides), being sent to buy pesticides, and applying street pesticides in their own household. Fieldworkers found one stall selling street pesticides attended by a two-year old child while the parent was away. Storing these highly toxic pesticides is problematic. Some stationary sellers left their products packed in a shopping cart along with all other wares sold (such as foodstuffs, clothing, and toiletries). These carts were then left in a store room at the train station with all the other sellers' goods as well. One woman stored her pesticides in her backyard because her children complained that the smell was too strong inside the house. Another street vendor stored products in a plastic bag that was placed in the house behind a suitcase.

Packaging of street pesticides resulted in high exposure risks. Every container purchased or observed in the field was inappropriate given the high toxicity of agricultural pesticides. The containers used for decanting ranged from used water bottles, juice bottles, and alcohol bottles, to small medicinal type bottles, and straws created from thin plastic wrap. Many of the containers that pesticides were decanted into carried the name of the original product with no reference made to the pesticide. One street vendor who decanted methamidophos into small medicinal bottles created his own label which stated in IsiXhosa "cockroach killer" and his telephone number. Street pesticides were displayed in full sun all day long, promoting evaporation and possibly the concentration and/or breakdown of the original product into a more toxic metabolite (especially for organophosphates). Some of the plastic bottles also began to disintegrate from repeated use of toxic chemicals. Aldicarb straws often began to separate; the tiny granules fell out on the floor, in bags, and onto other goods sold.

Youth working with their parents at stationary stalls were given the task of wrapping pesticides in newspaper or putting them in plastic bags. A girl estimated to be 12 to 14 years of age was observed putting a plastic bag over her hand before picking up pesticide bottles and then putting the plastic over the bottles, presumably in an attempt to avoid skin contact with the pesticide. Customers were observed putting aldicarb straws wrapped in small strips of newspapers in their handbags, shopping bags, or pockets.

Decanting and mixing street pesticides was also a major exposure risk. Street vendors did not sell street pesticides as the only product, but in conjunction with many other items, such as clothes, soap, table covers, earrings, diapers, fruit, biscuits, sweets, gum, and cigarettes. Several sellers mixed the pesticides with water and put it into containers while sitting at their stall, creating a risk of contaminating other goods they were selling (including food), as well as themselves and others nearby. Water

TABLE 3 Exposures for Street Vendors Exposed to Street Pesticides

	Pesticide Exposure Practices
At work	• Handling/selling • Decanting/mixing • Spillages • During transportation • Breathing in fumes (i.e., evaporation from improper containers or storage in home) • Cross-contamination of foodstuffs stored near pesticides • Contamination of food consumed by vendors eating at stalls • Improper storage facilities • Lack of facilities for hand washing • Children handling pesticides when assisting parents with selling • Inadequate containers (such as those that leak, disintegrate, promote evaporation)
At home	• Applying street pesticides • Eating aldicarb granules mixed with household food • Drinking liquid pesticides (for example, mistaking pesticides for milk or water) • Consuming and using contaminated food items and utensils • Easily accessible storage near food

was collected from public toilets for mixing. Sellers often did not wash their hands after mixing so as to avoid leaving the stall to walk to public facilities.

Exposures at home occurred from mixing, application, and storage procedures. Customers were instructed to mix concentrated pesticides with water to make between 1.5 and 4 liters. Informal vendors advised that liquid pesticides should be applied with small spray bottles bought in local supermarkets and then stored in accessible cupboards. Aldicarb was mixed with maize meal or bread and put on plates or dishes behind or in cupboards (Figure 6).

Socioeconomic Determinants

Several socioeconomic determinants influenced the high demand for, and sale of street pesticides: these included poverty-related pest infestations, the high profit margin from selling street pesticides, the low costs of these products to consumers, and product effectiveness as a result of their high toxicity. The townships were comprised of informal housing (shacks) and formal housing vulnerable to pest infestations (particularly the former). Poor sanitation, refuse collection, crowded townships, and poorly constructed homes all provided a breeding ground for pests, particularly cockroaches, rats, and flies. Several people interviewed either had a child or knew of a child or adult who had been bitten by a rat. In one community a child was brought to the author to reveal rat bites she had obtained as a baby on her face, arms, and legs. Several informants commented that they knew of people who had been bitten by rats or that they had been bitten themselves. Swarms of flies and cockroaches were visible in homes during interviews. One informal vendor stated in response to a question that he mostly sold his pesticides to "black people only. Those who has the problems with pests." Due to these conditions, there was a high demand for street pesticides, which were cheaper in comparison to commercially available (and legal) products. One street vendor indicated that he purchased cypermethrin for R 71.20 and made a profit of R 425 by decanting and reselling it.

Risk Communication and Understanding

All the vendors of street pesticides in this study indicated that they had not received any formal information about the pesticides they sold. Many knew via word of mouth or by knowing someone who had been killed that the products were dangerous and could kill them. One seller told the fieldworkers that a teaspoon of one of the liquid pesticides could be given to a problematic woman (that is, one causing difficulties for the man) who needed to be dealt with (that is, killed). Since surveillance of pesticide poisoning is grossly underreported in South Africa, it is not possible to assess how many suicides resulted from ingestion of street pesticides.[35] However, sellers did mention aldicarb being used for self-harm.[1]

Figure 6—Aldicarb mixed with maize meal, close up and placed in kitchen cupboard for rat control.

Some sellers provided limited health and safety information. However, the focus tended to be on making money rather than on health and safety. Several of the older informal vendors indicated that they would sell pesticides to anyone, including children.

One seller stated: "I sell these to them and whatever happens to them afterwards, be it their kids are poisoned, it is their own fault, because when I sell these things to them I tell them to be careful and to keep it out the reach of children, so whatever happens after I sold the product is their problem."

When the fieldworkers purchased pesticides at a local agricultural/farmers' cooperative they were not provided with any health and safety information. The salesperson indicated that they did not provide people purchasing pesticides with any safety information as the product did not come with information leaflets. One seller of liquid pesticides told customers to vacate the house for a few hours after applying and to be careful with the product.

DISCUSSION AND CONCLUSIONS

Controlling the sale of highly hazardous pesticides in informal markets in Africa through weak regulatory and enforcement structures is unrealistic. Countries with vibrant informal street pesticide markets, such as South Africa, should introduce regulations for withdrawing and phasing out the use of these products at all levels, to be replaced with less hazardous alternatives by supporting the "substitution principle," which disallows the use of hazardous chemicals when less-toxic alternatives exist.[36] Selling highly hazardous agricultural pesticides as street pesticides poses a dire human rights violation, especially in regard to protecting the health and rights of youth.

One area of special concern is the sale and use of aldicarb, classified by the WHO as extremely hazardous and one of the most acutely toxic pesticides in use; in March 2009 aldicarb was recommended by the Chemical Review Committee of the Rotterdam Convention for listing in Annex 3 of the Convention. In the EU, all uses of aldicarb were banned in 2007. Aldicarb has a LD_{50} of 1 mg/kg; the aldicarb sachets sold on the streets of Cape Town ranged from 50–60 mg/kg sachets, giving these the potential of killing five to six children weighing 10 kgs or less. The inability of national and international legislation to protect children from exposure to this chemical constitutes a gross human rights violation.

A common approach to dealing with the sale of agricultural pesticides for domestic control is to arrest street vendors because governments and industry see the problem as a lack of enforcement or "misuse." This approach shows a lack of understanding of the systemic problem of poverty-related pest infestations and the lack of effective and low-toxic pest management strategies; such an approach will therefore only aggravate the problem rather than solve it. Informal vendors of street pesticides, particularly youth and women, should not be arrested but instead brought into a dialogue offering an alternative to selling highly toxic pesticides. For example, the pesticide industry could be encouraged by governments to put in place a program to collect all unused aldicarb from street vendors in exchange for subsidized rat traps that are effective for killing urban-sized rats. This practice is currently being initiated in South Africa as a result of this study. Such programs would empower street vendors to promote alternatives while allowing them to make a profit.

Another alternative is to reduce demand for street pesticides through reducing pest populations. The WHO's report, the "Public Health Significance of Urban Pests"[37] highlights the ongoing threats created by urban pests globally and the need for effective policies to control them. Pest management and pest reduction needs to be a key element included in all poverty alleviation strategies by local and national governments, as well as internationally. Further, this issue should be addressed not only as a public health issue. For example, reducing the current rat populations by half in poverty-stricken areas could have been included in the United Nations Millennium Development Goals to end poverty.

Communication about the risks associated with street pesticides, particularly for non-literate populations, need to be improved. Programs could be run in local communities highlighting the risks associated with exposure to agricultural (and other) pesticides, particularly for the long-term health of youth. Drama productions, radio programs, and pamphlets are all risk communication strategies that could be employed.

This study presents findings on an underresearched topic with major health implications for youth. However, this study is limited by its descriptive, anecdotal, and exploratory nature. Further research is needed to highlight the extent of this silent occupational and environmental health problem globally. Analytical research focusing specifically on child and adolescent sellers of street pesticides should be carried out as well. In particular, an enormous benefit could come from an investigative journalistic approach to tracking down the source chain for aldicarb. This research needs to be made available to governments for use in policy-making, as well as for identifying the need for the pesticide industry to be involved in strategies to limit access to these pesticides. The plight of poor communities living with pests and exposed to hazardous pesticides needs to be recognized and dealt with in a sustainable and low-risk manner.

The unexpected findings from this research that youth are directly and indirectly exposed to street pesticides are extremely important given the highly dangerous nature of these pesticides. The street pesticide market is not static, and the profile of the active ingredients children are exposed to directly or indirectly will continue to change as new sources and new products enter the informal market. Recently, in fact, an imported Chinese pesticide containing the organophosphate acephate was found being sold in the informal pesticide study areas and widely used for cockroaches control. Children were already presenting at a local hospital for ingestion poisonings. The problem of street pesticides and child exposures is potentially massive in many developing countries. It is therefore para-

mount that further research should be conducted with a focus on children/adolescents.

Surveillance efforts need to incorporate innovative methods for assessing exposures to unlabelled and decanted street pesticides (for example, see http://www.coehr.uct. ac.za/publications/pestrel.php). Not only will identification of these products inform policy makers of the magnitude of the problem, but it will also serve as a means to improve treatment from health professionals presented with a youth poisoning. Surveillance efforts and further research is also crucial for examining risk factors for children working with these pesticides and for children's health outcomes as a result of exposures to street pesticides. These factors need to inform national and international regulatory efforts to improve the control and management of street pesticides.

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