Abstract

Children, mainly infants, are especially vulnerable to pesticides, as a result of physiological factors which facilitate absorption of chemicals and limit the ability to detoxify and eliminate them. Moreover, children exhibit mouthing activity with pesticide contaminated objects. Therefore, the rapid course of growth and development creates a time-frame of unique vulnerability, where exposed children are prone to develop delayed neurotoxic brain disorders.

Parents, childcare workers and staff are generally untrained in using pesticides and may not follow instructions or consider safer alternatives in efforts to provide a sanitary pest-free environment. A survey of 3364 Illinois childcare centers was conducted to assess the direct and indirect impact of a formal Integrated Pest Management (IPM) "Train the Trainer" program implemented by a non-governmental organization to childcare centers and supervisory agencies over a three year period. This survey determined that the training increased the level of confidence, positive attitudes (easy, controls pests, efficient) and implementation of IPM by childcare providers. Childcare staff were motivated primarily by how IPM protects children's health from exposure to pesticides, in which neurotoxic substances may play a major role.

Introduction

It is widely accepted that children are uniquely vulnerable to toxic exposures. Their very rapid metabolic rate, requirement for higher caloric intake and food consumption, as well as high respiratory and heart rates, facilitates absorption of chemicals (Bearer, 1995; Committee, 1993). Children and especially those more active are likely to absorb pesticide residues while playing in- and out-of-doors through their proportionately larger exposed and relatively permeable skin surface (Bearer, 1995; Cohen-Hubal et al., 2006; Landrigan et al., 1999). Moreover, children's exposures to toxicants are prone to be excessively higher than adults' exposures, due to their mouthing behavior - first and foremost during the oral stage of their mental and emotional development (Freeman et al., 2001, Garry, 2004; Lanphear et al., 2005). In addition, as children's metabolic pathways are not fully formed, their hepatic functions are immature hence their ability to detoxify and eliminate noxious substances is limited. For example, children up to the age of seven or longer lack the optimal activity levels of paraxonase, an important enzyme for detoxifying some organophosphorus toxicants (Huen et al., 2009; Nielsen et al., 2005).

Therefore, the rapid course of growth and development creates a time-frame of unique vulnerability. The toxic effects which are induced within this time frame might be irreversible with permanent sequelae for life, manifested primarily by central nervous system (CNS) disorders. Moreover, exposed children are prone to develop delayed toxic-induced disorders during their future years of life span, as CNS toxic disorders are specifically characterized by a long latency period. Consequently, children's exposure to toxic chemicals makes them and their surrounding society unduly bear the burden of developmental delays, decreased intelligence and neurobehavioral symptoms (Garry, 2004; Rohlman et al., 2005).

Pesticides and their degradation products are ubiquitous in homes, schools and the environment. The most commonly detected pesticides indoors, OP and pyrethroids, are

neurotoxicants that affect the ability to learn and process information yet are routinely applied in classrooms and playgrounds (Piper and Owens, 2002; Tulve et al., 2006). Illegal use of unregistered or outdated pesticides has been documented in and around schools (Green and Gouge, 2009; Lu et al., 2001; USEPA[a], 2009). In a 2001 national survey of 168 childcare centers, 63% reported using 1-10 types of pesticides 1 to 107 times annually, and at least one pesticide was detected in over 89% of the centers (Tulve et al., 2006). Yet parents, childcare workers and applicators are generally poorly informed and untrained in safe pesticide practices (Fournier and Johnson, 2003; Tulve et al., 2006).

Public health policies can reduce children's exposure to neurotoxicants, as demonstrated in the USA with the reduction in childhood poisoning after removing lead from paints and gasoline (Committee, 1993). Many states, while not mandated by the federal government, have enacted laws promoting safe pest control in and around schools and childcare facilities. Non-governmental organizations (NGO's) and academic institutions are partnering with government health and educational agencies to promote integrated pest management (IPM), defined as "an effective, economical approach to pest control. It involves identifying and correcting the problems that lead to pest problems and using non-chemical and least-hazardous control methods to address existing infestations." (SPCP, n.d.).

Several studies assess safer pest management in schools, but information is limited for childcare centers (Alarcon et al., 2005; Green and Gouge, 2009; Morgan et al., 2007; Tulve et al., 2006; Wilson and Schwarzman, 2009). Childcare centers report difficulties implementing IPM due to high management and staff turnover, a hectic work environment and poor coordination with cleaning and pest management contractors (Fournier and Johnson, 2003).

Studies of reported poisonings (hospitals or poison control center data) in Israel, Italy and the US indicated that most pesticide poisoning incidents involve children less than 5 years old (Finkelstein et al., 1989, Davanzo, 2001; Olsen et al., 1991). Alarcon et al. (2005)

noted a significant increase in low (0.1%), moderate (11%) and high (89%) severity pesticide related illnesses reported in US pre-school and school-aged children during 1998-2002, which may be due to increased awareness of pesticides affects and suburban sprawl.

Multiple risk factors and their potential synergism determine the impact of pesticides. Exposure is often underestimated as pesticides that degrade in sunlight may persist indoors and adhere to dust and surfaces (Cohen-Hubal et al., 2006; Fenske et al., 2000; Goldman et al., 2004). Salam (2004) found associations between early onset asthma (before 5 years) and exposure to cockroaches, herbicides, insecticides during the first year of life; and attendance at childcare within the first four months of life. Approximately 295,000 Illinois children spend up to ten hours daily in childcare (DCFS, 2007).

In 2004, the NGO Safer Pest Control Project (SPCP) partnered with the Illinois Department of Children and Family Services (DCFS) and Department of Health - Resource and Referral (R&R) network to promote IPM in licensed childcare facilities. The goals of the Train-the Trainer program were to comply with new legislation, reduce pest problems and pesticide use, and disseminate IPM into the childcare sector through training and technical assistance (USEPA[b], 2004). The uniqueness of the program is its efficiency (single meeting) and oversight provisions. This study assesses the adoption of IPM in childcare facilities and its impact on providers, and indirectly the influence of supervisory agencies.

Materials and Methods

The training program was developed and pre-tested internally by SPCP and partner organizations. A PowerPoint presentation addressed pest and pesticide health risks, the new regulations, IPM solutions and was followed by a question and answer session. Trainees received an IPM handbook (SPCP, n.d.) and were encouraged to complete an in-class assessment and background survey in exchange for an IPM toolkit (steel wool for blocking

rodent entry, caulk gun, caulking and "sticky traps" in an attractive reusable bag). Trainees were informed there would be evaluation post training.

The initial survey provided a baseline description of the childcare centers, current pest problems (infestation type and frequency) and management practices, interest in IPM adoption and reinforced the differences between traditional and IPM practices. The surveys utilized closed-ended or partially closed-ended categorical questions. Unordered questions targeted information such as the type of pests encountered, ordered questions ranked information, such as the relative frequency of pest incidents, and a Likert-scale was used for perceptions and beliefs (Dillman, 2000).

In 2007, a follow-up questionnaire was prepared that duplicated part of the initial survey with additional questions on: the source of IPM knowledge; interest and feasibility in future computer-based IPM training; current IPM practices such as parent notification and pest management contractor supervision; and staff knowledge and confidence in applying IPM. SPCP-trained childcare centers were queried on new actions or materials adopted post training, who they discussed IPM with and if they used IPM at home. The questionnaires were screened in a pilot survey of supervisory personal. Partially closed-ended questions were eliminated, while an "explanation" or "comments" lines were added to obtain additional insights and verification. The final survey included 24 questions.

In June 2007 a cover letter and the questionnaire were mailed to 3364 DCFS licensed Illinois childcare centers and group homes as well as to home childcare facilities previously trained by SPCP. A follow-up phone call was initiated first to all the SPCP-trained facilities and then to every tenth untrained childcare center (control). All surveys were entered into a drawing to win one of four gift cards. Two sets of populations were compared; childcare centers pre- and post-training (effect of training), and childcare centers who received IPM training with those that did not receive training (IPM diffusion in the childcare sector)

Data were verified where possible, by comparing self- reported SPCP training with attendance lists and reviewing comments. Nominal data was transformed to binomial and ordinal values prior to statistical analysis. Where questions had multiple possible answers, each item was assigned a unit value and added to produce a relative score. IPM practices were studied separately and also classified into three sub-groups (pest entry and establishment preventative, pest control and monitoring-administrative measures) and one inclusive group including all IPM behaviors surveyed.

A measure of association test (phi) was used to assess correlations between binomial variables in order to identify significant factors promoting IPM implementation pre- and post training. Spearman's rho was used for ordinal data. The Wilcoxon signed-rank test (2-tailed) was used to compare pest type and frequency and IPM knowledge, attitudes and practices in childcare centers pre- and post-training (paired data) (Agresti and Finlay, 2009).

Results

During 2003-6, SPCP provided IPM training to 892 licensed childcare centers as well as Illinois DCFS caseworker and state nurses. Of the 3364 post-training surveys mailed, 316 (9.4%) of the licensed childcare centers responded, ten percent of whom were SPCP trained. The mean number of children per facility was 87.06 (s.d. 119.104) and the median 63.0, reflecting the large numbers of children reported in some childcare centers. Most childcare providers learned about IPM training through their local R & R, other childcare providers or from the SPCP website. The majority (82%) of childcare centers had heard about IPM from multiple sources (training, their pest contractor, DCFS, R&R, and brochures) while 18% had no knowledge of IPM. Only 69 childcare centers submitted questionnaires pre- and post-SPCP training, while 90 centers submitted post-SPCP training surveys.

When providers were asked about the potential for on-site IPM instruction, 69% expressed interest in computer-based future training, 7.5% were not interested and the remainder was unsure or didn't respond.

SPCP Trained versus Non-SPCP Trained Groups

The data were analyzed for 3 groups ("verified SPCP training"(N=90), "received IPM information elsewhere" (N=170) and "received no IPM information" (N=55)). There was no significant difference among the three groups in the frequency of pest problems, or in the type of pest problems for ants (p=0.284), rodents (p=0.897), birds (p=0.929), spiders (p=0.822), stinging insects (p=0.616), flies (p=0.931) or termites (p=0.631). There was a significant difference for roaches (N=316, phi = 0.166, sig. = 0.034) where childcare centers trained by SPSS or unfamiliar with IPM reported fewer roach problems.

Respondents who "received IPM information elsewhere" (not SPCP trained) reported low adoption rates of IPM, understanding or compliance with the IPM law; 1% appointed an IPM coordinator, 4.5% used pest logs, 3.5% pest monitors, 5% notification procedures and 7% practiced IPM at home. Respondents who "received no IPM information" had even lower rates of IPM practices.

SPCP trained providers were more confident in their knowledge of IPM and correct implementation of the IPM regulations. There was a negative correlation between the level of IPM training and the use of pesticide sprays, and a positive correlation with the use of rodent monitoring traps. There was a significant correlation between the degree of training and attributing benefits to using IPM over traditional pest control methods (easy to use>controls pests>takes little time>saves money) (Table 1). Paradoxically, 57% of childcare providers unfamiliar with IPM were confident in their knowledge of the IPM law.

No correlation was found between training and "informing parents prior to applying pesticides", a requirement of the IPM law. Accompanying comments pointed to different

interpretations of the question. Respondents wrote they would inform parents if needed, but hadn't yet, and that it wasn't necessary to inform parents when using baits. Many comments stated pesticides were applied in the absence of children (after hours, on weekends, or during vacations), sometimes referring to DCFS guidelines. A variety of notification methods were used, including letters home, bulletin board postings, signs on the front door, calls and personal discussions. Most notifications were within 48 hours prior to the pest treatment.

IPM Understanding, Attitudes and Practices (Pre- and Post-SPCP Training)

Table 2 compares incentives to implement IPM with IPM practices for childcare centers pre- and post-SPCP training. There was a significant difference in the type but not frequency ($p=0.316$) of pest problem; knowledge of IPM law, select IPM practices and IPM use at home between the two groups.

Table 3 compares intended IPM actions (pre-training) and IPM actions (post-training) to the extent of pest problems, knowledge of IPM legal requirements, and home adoption of IPM separately for each group. There was correlation between intentions to adopt select IPM practices and reported implementation post-training, with the exception of IPM use at home.

Table 4 presents new actions adopted post-training in pest prevention, control and management practices; items used from the SPCP training kit and with whom respondents discussed IPM (dissemination). The most common IPM practices adopted (>50%) were cleaning behind appliances and controlling clutter, followed by usage of baits instead of sprays (41%) and patching holes (38%). Approximately one-third of trained childcare centers instituted IPM management program elements; 59% reported implementing IPM at home.

Discussion

The study found that traditional pesticide application practices persist in childcare facilities despite growing consensus on the vulnerability of young children to even very low concentrations of their residues (Garry, 2004; Lanphear et al., 2005; Olson et al., 1991;

Rohlman et al., 2005; Sanborn et al., 2004). Untrained childcare providers had low awareness of the risks and alternative effective pest control methods that can reduce exposure (Alarcon, 2005; Shour, 2007).

States vary considerably in their interpretation and implementation of school and childcare IPM with regard to key components. Information on childcare facility IPM is limited to pest management survey data and program recommendations (Beyond Pesticides, n.d.; Green and Gouge, 2009; Shour, 2007). Piper and Owens (2002) found that laws recommending, but not mandating IPM, were less effective, with the exception of Indiana's Monroe School IPM Model, characterized by intensive record-keeping and government and academic oversight (Fournier and Johnson, 2003). The Train-the-Trainer program differs from the Monroe model as it focuses on a dispersed population of micro and small childcare facilities with high staff turnover; and uses existing licensing and professional networks (DCFS, R&R) to supervise and support the childcare providers (Fournier and Johnson, 2003).

This study found that IPM training reduced pest problems, and increased the providers' understanding, confidence and implementation of IPM and oversight of pest control contractors; though not all practices subscribed and tools provided were used, especially training materials (Tables 1, 2). The lack of internal training, especially considering the high staff turnover and interest in computerized IPM training, suggests an opportunity to develop IPM and IPM refresher courses; possibly in the framework of Resource and Referral (R&R) professional development.

Childcare providers tended to implement those practices they had initially expressed interest in during training (Table 3). The most common IPM practices were familiar preventive activities to prevent pest entry and establishment, reduced spraying, increased use of baits and traps, and oversight of pesticide control contractors (Table 4). Thus, once

childcare providers were aware of the health hazards and legal requirements and offered manageable solutions; approximately one-third adopted key IPM practices.

While the results of this survey demonstrate that formal IPM training was effective in promoting safer pest management in the childcare industry, the study was not without limitations. The first obstacle was the low return rate of surveys, which could have been improved by calling or sending an explanatory postcard prior. All too often providers ignored the survey, some explaining they thought it was a sales pitch for IPM training. Others did not recognize this was the SPCP post-training survey and were reluctant to respond. Another issue was the perceived time investment of the survey, which led to it being discarded. An important consideration was timing. Due to logistical constraints, the surveys went out at the beginning of June, to be returned within approximately two weeks. Unfortunately many childcare centers were closed for summer break and surveys were unopened, or rerouted to corporate offices for the larger childcare centers. Finally, the data were self reported without on-site verification, though responses were triangulated when possible.

Regardless of these limitations, this survey confirms the willingness of trained childcare providers to make necessary changes to reduce children's exposure to pesticides, depending also on the type of pest problems (Tables 1 and 2). Not only did many trained providers share their knowledge with other workers, providers and parents; they also reported using IPM at home (Table 2 and 4). Furthermore the continuum of knowledge and positive perceptions relative to exposure to IPM information suggests diffusion is taking place and safer pest management is becoming a standard practice in the childcare sector.

The study has further implications on the impact of focused training on changing environmental health practices in a large sector of mostly female managed micro-enterprises (MEP) and small businesses. MEPs are generally vulnerably compliant with a poor understanding of their environmental impacts and regulations while inspectors are less likely

to target dispersed low impact firms in the absence of complaints or licensing requirements. In this case, the training provided multiple incentives for IPM adoption, including regulatory pressure through ongoing contact with familiar government supervisors as well as ethical and market opportunities (Mir, 2006).

The study results suggest that after the training, childcare providers internalized the importance of adopting IPM. Through unsolicited written and telephone comments, they shared the sentiment that of utmost importance was using IPM to protect the health and safety of the children under their care. While this study makes a very strong statement for continued IPM training we need to remember why this is so important. The 316 childcare facilities that responded to this survey are in charge of the health and neurological development of approximately 27,424 children, in only 9.2 % of Illinois day cares facilities (DCFS, 2007).

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