**Evidence summary Title:**
**Interventions in reducing pesticide overexposure and poisonings: Evidence and implications for public health**

**Review Quality Rating:** 5 (moderate)

**Review on which this evidence summary is based:**

**Review author contact information:**
M.C. Keifer, MD, MPH, Box 359739, University of Washington, Seattle, WA 98195. mkeifer@u.washington.edu

This is an evidence summary written to condense the work of the authors of this systematic review, referenced above. The intent of this summary is to provide an overview of the findings and implications of the full review. For more information on individual studies included in the review, please see the review itself.

**Review content summary**
This systematic review of 17 studies aimed to determine the effectiveness of interventions to reduce pesticide overexposure and poisonings among workers and the general population. Participants studied were: workers (mixers, loaders, sprayers, general farm workers), and the general population. To be included, studies were: epidemiologic designs of interventions or field trials of protective equipment, if methods were clearly described and data were presented that objectively measured exposure or a surrogate for exposure. Interventions described in this review included: a) use of personal protective equipment (PPE) such as gloves, coveralls, shoes, and facial scarves; b) changes to pesticide handling (mixing, loading, or packaging) techniques or procedures, such as not eating on the job, showering after work, washing work clothes, and off-site container disposal, and c) biomonitoring programs; as well as d) pesticide safety training. Outcomes measured include: an objective measure of pesticide poisoning (e.g., changes in surveillance data) or some measure of pesticide exposure as determined by biological monitoring or exposure monitoring. No studies measured poisonings as an outcome. Authors report that under controlled conditions, changes in application procedures, packaging, mixing, use of PPE, and biological monitoring reduced pesticide exposure. However, few interventions were tested in actual workplace programs.

**Comments on this review's methodology**
This is a methodologically moderate systematic review. A focused clinical question was clearly identified. Appropriate inclusion criteria were used to guide the search. A comprehensive search was not employed using as database searches were limited to health databases, although they also reviewed reference lists of primary studies and contacted key informants. The search was limited by language (English). Primary studies were not assessed for methodological quality. The methods were not described in sufficient detail so as to allow replication and two reviewers were not involved in quality appraisal. The results of this review were not transparent. Results were clearly presented in graphical form so as to allow for comparisons across studies. Heterogeneity was assessed. Appropriate analytical methods (fixed effects, random effects) were not employed to enable the synthesis of study results due to the high variability between studies.

**Why this issue is of interest to public health**
The public, health professionals and organizations are becoming increasingly concerned regarding the use of pesticides and the associated health risks. Canadians are exposed to pesticides through various sources: dietary (on food and in water via agricultural use), residential, as bystanders, and through work (e.g., agriculture, forestry). While scientific uncertainty remains as to the health and related risks associated with exposure to pesticides, people whose exposure occurs through the workplace have been shown to be at moderately increased risk (as compared to the general public) for certain cancers, impacts to the reproductive (e.g., fertility problems, birth defects, and adverse pregnancy outcomes) and neurological (e.g., polyneuropathy, neuropsychological effects, or neurodegenerative conditions such as Parkinson's disease) systems, and possibly the immune and endocrine systems.\(^1\)\(^2\)

**Evidence and implications**

Evidence points are not in order of the strength of evidence

<table>
<thead>
<tr>
<th>What’s the evidence?</th>
<th>Implications for practice and policy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Personal protective equipment (PPE) (13 studies)</td>
<td>1. PPE</td>
</tr>
<tr>
<td>1.1. Results were mixed regarding the effectiveness of PPE in reducing workers’ exposure to pesticides. Variation was noted</td>
<td>1.1. PPE can be effective in reducing but not eliminating pesticide exposure among workers. Thus, in order to</td>
</tr>
</tbody>
</table>
across type of PPE, type of pesticide, method of detection, type of worker (mixer, applicator), study design and methodological quality, outcome measure

1.2. Gloves (7 studies)
   1.2.1. In 5 studies glove use was associated with reductions in pesticide exposure among workers
   1.2.2. In 3 studies glove use was not effective in reducing exposure. In two of these studies glove use was associated with increased exposure.
   1.2.3. In one study glove use combined with other equipment was effective in reducing exposure (greater than gloves or other equipment alone).

1.3. Coveralls (7 studies)
   1.3.1. Coveralls allowed penetration of pesticides of 3%-39% in 2 studies
   1.3.2. In 5 studies, workers who wore coveralls were exposed to a lesser extent than comparison workers
   1.3.2.1. Overall use was more effective among workers who sprayed pesticides more frequently. (1 study)
   1.3.3. Coveralls provided better protection (77% reduction) than work shirts (45% reduction) (1 study)
   1.3.4. Comparisons of protection based on coverall material (3 studies) revealed that
   1.3.4.1. Disposable polypropylene coveralls were less effective than reusable 35% cotton/65% polyester ones (1 study)
   1.3.4.2. Standard Kleenguard coveralls are more effective than Tyvek ones, both of which allow less penetration than washed Kleengard coveralls (1 study)
   1.3.4.3. No difference in pesticide exposure according to coverall material

1.4. Work shirts (3 studies) and work pants (2 studies)
   1.4.1. Work shirts (reducing exposure by 45%) were less effective than coveralls (77% reduction)
   1.4.2. Work pants (2 studies) provided greater protection against exposure (11.5 fold protective factor) as compared to work shirts (3.4 fold exposure).
   1.4.3. Work pants allowed less pesticide penetration (2.1%-3.5%) than did work shirts (13.3%-16%)

1.5. Respirators
   1.5.1. Respirators reduced pesticide exposure (2 studies)

1.6. When reported, compliance with use of some PPE (cotton coveralls) was mixed (3 studies). Non-compliance was reported to be attributed to heat (1 study)

2. Ventilation (during application) (2 studies)
   2.1. Unidirectional ventilation reduced workers’ exposure
   2.2. Pesticide exposure was highest with multidirectional ventilation

3. Pesticide handling procedures
   3.1. Mixing
      3.1.1. Water soluble packets offered the greatest protection as compared with open pouring of liquid concentrate or open dumping of wettable powder or closed system pumping (1 study). Water-soluble packaging is a special pesticide container or package that allows both the package and the pesticide to dissolve the package is placed.
      3.1.2. Closed pumping systems (e.g., Liquid pumping systems) resulted in lower (in one study by 5x) exposure as compared with open pouring or pouring of wettable powder (3 studies). A “closed system” is a machine that takes the pesticide out of its container for you and then rinses the container. It also moves the

   1.1.1. use of the most effective PPE components and the most effective combination of those components
   1.1.2. use of other protective strategies (e.g., the development, implementation, and monitoring of handling and application procedures) in combination with PPE
   1.1.3. the identification of workers at greatest risk (as determined by biological testing of exposure) and require the use of specific PPE strategies
   1.1.4. monitoring of PPE and other pesticide-related protection strategies to evaluate their effectiveness in practice
   1.1.5. the training of workers regarding the proper use of PPE

2. To be effective PPE resources must be used and thus acceptable to workers.
   2.1. Focus testing products with workers may be warranted.
   2.2. Evaluating product effectiveness should be conducted in real work settings rather than only in highly controlled research environments,

1.3. High quality research studies and rigorous program evaluations are needed to determine

3.1. In order to protect workers by reducing workers’ exposure, public health should develop worker protection standards that require
   3.1.1. water soluble pesticide packaging
   3.1.1.1. closed pumping systems
   3.1.2. enclosed cabs
   3.1.2.1. lower application pressure
   3.1.3. and recommend the avoidance of
   3.1.3.1. hand wand applications
   3.1.4. high application pressure
   3.2. High quality research studies and rigorous program evaluations are needed

3.3.
pesticide into the application tank and then rinses the hoses.

3.2. Application

3.2.1. The most effective method for worker protection involved ground boom sprayers with enclosed cabs (1 study). An “enclosed cab” is a place where workers can sit and be protected while pesticides are being applied around them.

3.2.2. Hand wand application was associated with highest exposure levels (1 study)

3.2.3. Higher application pressure increased worker exposure to pesticides.

4. Monitoring programs

4.1. Biological monitoring with cholinesterase testing resulted in the removal of 24% of workers

4.2. A relative risk of 9.4 for subsequent “toxic AChE depression” found for subjects with early evidence of depressed AChE levels.

5. Training (1 study)

5.1. Trained (safety) workers were found to have 16% higher AChE levels than workers who had not received safety training.

6. Methodological Issues with the Primary Studies in the Review

The methodological quality of the primary studies included in the review varied. Issues identified included:

6.1. study design
   6.1.1. many of the studies lacked control groups
   6.2. small sample size
   6.3. intervention components
   6.4. outcome measures
      6.4.1. No studies measured poisoning as an outcome
      6.4.2. The use of self report
      6.4.3. Lack of biochemical validation
   6.5. Failure to report on the statistical significance of findings.

6. Implications for Future Research

High quality research studies and rigorous program evaluations are needed. These studies should include:

6.1. randomization and control groups
6.2. large enough sample sizes to determine a statistically significant treatment effect
6.3. report on outcomes in terms of statistical significance
6.4. determination of the relative impact of various intervention components
6.5. valid outcome measures (e.g., biological measures)

7. Cost Benefit or Cost-effectiveness Information

7.1. No cost related information was included in the review.

General Implications

- In order to protect workers by reducing workers’ exposure, public health should develop worker protection standards that promote the use of effective PPE; pesticide handling procedures; safe pesticide use training for workers; and biological monitoring.
- High quality research studies and rigorous program evaluations are needed.

Legend: CI – Confidence Interval; OR – Odds Ratio; RR – Relative Risk
**For definitions see the healthevidence.org glossary** [http://www.healthevidence.org/glossary.aspx](http://www.healthevidence.org/glossary.aspx)

References used to outline issue


Other quality reviews on this topic


Related links

Suggested citation

The opinion and ideas contained in this document are those of the evidence summary author(s) and healthevidence.org. They do not necessarily reflect or represent the views of the author's employer or other contracting organizations. Links from this site to other sites are presented as a convenience to healthevidence.org internet users. Healthevidence.org does not endorse nor accept any responsibility for the content found at these sites.