The use of personal protective equipment in pregnant greenhouse workers

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Aim To determine the use of personal protective equipment (PPE) among pregnant greenhouse workers in Italy and to identify risk factors related to the non-use of appropriate preventive measures.

Methods A structured questionnaire was administered by trained interviewers, to Italian female greenhouse workers regarding their use of PPE and the occurrence of adverse pregnancy outcomes in their first pregnancy.

Results Two hundred and thirty-two workers participated. Although most pregnant women used at least one form of PPE while working, there were differences in PPE use in different social groups. Overall, the protection was inadequate in the south of Italy and among the less educated. Pregnant women performing the most dangerous jobs often did so without using PPE. Even the use of gloves was absent in 50% of pregnant women who during their pregnancy prepared and mixed pesticides, and among 38% of those who applied pesticides directly.

Conclusions The use of protective measures was inadequate in the south of Italy and among less educated women. The study indicates the need for urgent interventions aimed at improving PPE use during pregnancy.

Key words Greenhouse work; pesticides; pregnancy; safety behaviours.

Introduction

Greenhouse work usually involves exposure to environmental contaminants, in particular pesticides [1–3]. An increasing number of studies conducted in the last two decades among greenhouse workers found that exposure to pesticides may occur both directly during treatments and indirectly from contact with treated fruits and vegetables and during re-entry activities [3–5]. Reducing exposure to pesticides is possible not only through environmental control measures but also by the use of personal protective equipment (PPE) to cover the hands, the respiratory tract and the whole body. Other important preventative measures include frequent changes and washing of work clothes and education and training of workers in correct preventive behaviours.

In Italy, pesticide safety education is officially required for all agricultural workers handling pesticides, but greenhouse workers (who are mostly temporary female labourers) are often excluded from training programmes. Even less attention has been paid to the safety behaviours of pregnant greenhouse workers, who might have a higher risk than the rest of the population for adverse pregnancy outcomes and reduction in fertility. Increased risk of adverse pregnancy outcomes (in particular spontaneous abortion) was observed in the study of greenhouse floriculture workers in Colombia [6], in Finland [7] and in Ontario [8]. A study among the members of the Danish Gardeners Trade Union showed that female greenhouse workers handling cultures and spraying pesticides without protection experienced a significant reduction in fertility [9].

Data on the degree of adherence to correct safety practices by pregnant agricultural workers are practically non-existent. Even the data on the safety behaviours of agricultural workers in general are limited, and what is available shows that safety precautions are often scarce [10–12]. McCauley et al. [13], studying 166 agricultural workers in Oregon (USA), found that only 18% used some type of protective clothing, while 75% went home with their work clothes, with 33% changing these clothes.
fungicides (Mancozeb, Metalaxyl) and acaricides were the most numerous. In addition, it was felt that one pregnancy per subject and because first pregnancies by the need to obtain independent observations by using Methiocarb, Methomyl, Cyromazine, 20–30 treatments per year) were nine agrochemical prod-
main pesticides used in the greenhouses (with at least pesticides belonging to different chemical classes. The in this study were exposed to complex mixtures of minding of plants and flowers. The female workers included ties involved application of pesticides and manual han-
domestic greenhouses (with at least 21 000 hectares, with a total of 22 299 greenhouse enterprises producing horticulture crops and 11 000 producing flowers [16]. In particular, flower green-
houses produce $>3 \times 10^9$ pieces per year, mainly roses, carnations, chrysanthemums and lilies [17]. Use of pesticides in flower production is not considered an important health risk because flowers are non-edibles. Consequently, flower production in greenhouses is not subject to control by the authorities. However, many of the greenhouse workers are females of reproductive age and ~20% of greenhouse enterprises are managed by women [16]. At present, there is no information on the degree of adherence of these women to safety standards and in their use of PPE. In the present study, we focused attention on one high-risk group of greenhouse workers: pregnant women. This paper has two main objectives: first to determine the use of PPE among pregnant greenhouse workers in Italy and second to evaluate the factors that influence the use of PPE.

Methods

This study is based on the data obtained from women working in 34 Italian enterprises that cultivated flowers in greenhouses. These were three large enterprises located in southern Italy (province of Ragusa, Sicily) and 31 mostly family-run ones in the north-central part of Italy (Provinces of Lucca and Rome). Their main activities involved application of pesticides and manual handling of plants and flowers. The female workers included in this study were exposed to complex mixtures of $>20$ pesticides belonging to different chemical classes. The main pesticides used in the greenhouses (with at least 20–30 treatments per year) were nine agrochemical products and included insecticides (Abamectin, Acephate, Methiocarb, Methomyl, Cyromazine, $\alpha$-Cypermethrin), fungicides (Mancozeb, Metalaxyl) and acaricides (Achrinatrin).

The selection of first pregnancies only was motivated by the need to obtain independent observations by using one pregnancy per subject and because first pregnancies were the most numerous. In addition, it was felt that subjects were likely to recall better the work circumstances of their first pregnancy. The 10-year period limit and the age limit were adopted because we assumed that time length beyond 10 years would negatively influence the reliability of information about working conditions during pregnancy. Therefore, the analysis reported here concerns women with the following characteristics (inclusion criteria): (i) at least one pregnancy experienced during the 10-year period preceding the interview, (ii) age at interview 49 or less and (iii) the first pregnancy occurring while working in a greenhouse.

The data collected by the interviewers included socio-demographics and work histories, pregnancy outcomes and safety behaviours during the first pregnancy. Adverse pregnancy outcomes included spontaneous abortions, ectopic pregnancies and neonatal deaths. Spontaneous abortion according to the Italian legislation was defined as a natural failure of pregnancy before the 26th week of gestation and neonatal death as the death of the newborn within 7 days after birth. The demographic characteristics we considered included age, educational level categorized as primary (8 years or less in the Italian school system) and secondary or above, geographical location in Italy (north-central and south) and working years in greenhouse.

The type of PPE used during first pregnancy was item-
ized and included protective textile uniforms, work shoes, rubber boots, rubber gloves, face shields, protective masks and respirators.

The relationship between sociodemographic and job characteristics of greenhouse workers during pregnancy and prevalence of use of PPE were evaluated by $\chi^2$ test. We attempted to determine the characteristics of greenhouse workers who during their pregnancies consistently used PPE compared to those who did not. Statistical analysis was conducted using the SPSS statistical software package version 13.0. The level of significance was taken as $P < 0.05$.

Results

In a first phase of the study, a short questionnaire was administered to 910 female greenhouse workers, identified through personnel registers. A total of 717 female workers agreed to answer an in-depth questionnaire on their work and reproductive history (response rate 79%). This group reported a total of 1699 pregnancies, 655 of which were excluded because they had occurred $>10$ years before the interview. Of the remaining 1024 pregnancies, 375 were first pregnancies. On the basis of the work history, we identified 232 female greenhouse workers aged 49 years or younger whose first trimester of pregnancy occurred within the last 10 years and while working in a greenhouse. Of the 232 first pregnancies included in the study, 22 ended in spontaneous abortion,
one in ectopic pregnancy and one ended in neonatal death, with a total of 208 successful live births.

At the time of the interview, the mean age of the participating women was 33.1 (SD 5.6). The majority of them (58%) lived in the Northern-central regions of Italy and had worked in greenhouses for an average of 13.5 years (SD 8.4). All subjects had at least one child and 60% had more than one child. Table 1 shows the sociodemographic and work characteristics of the women included in the study during their first pregnancy. The mean age of the first pregnancy was 24.1 (SD 4.2). Their educational level was relatively low with 80% having attended primary school only. A secondary education was more frequent in the Northern-central region (31%) and less common in the South (6%).

Table 1 indicates that the use of PPE was different in different social groups of pregnant women. Protective uniforms for example were rarely (4%) used in the greenhouses of the south, but significantly more among the women of north-central region (37%) and among those with secondary education (47%). Similar differences are observed in relation to the use of work shoes. The use of protective uniforms and work shoes were more frequent if the first pregnancy occurred after the age of 25. Rubber boots were used more often in the south (34%) and among younger women (29%) and those with lower education (27%). Overall, the use of gloves was very common in all groups, especially among the women born before 1965. The majority of the women in all subgroups shown in Table 1 reported changing their work clothing at the end of the working day and reported frequent washing of their work clothes, although this was significantly less common in the greenhouse of the south. Overall, it appears that most women used at least one form of PPE while working, but in general the use of PPE was more inadequate in the south and among the less educated women.

The use of PPE in association with the various work activities is shown in Table 2. It is interesting to note that pregnant women performing the most dangerous jobs (such as preparing pesticide mixtures, applying pesticides directly or restarting work immediately after the treatment) very often did so without using any PPE. Fifty per cent of the pregnant women who during their pregnancy prepared and mixed pesticides did not use gloves. Additionally, gloves were not used by 38% of women who applied pesticides directly. Even some of those entering the greenhouse immediately after a pesticide treatment did not always use gloves (18% of the subjects).

**Discussion**

Our study showed that the women working in greenhouses in Italy were inadequately protected especially in the south and those with less education. It is interesting to note that pregnant women performing the most dangerous jobs, such as preparing pesticide mixtures, applying pesticide directly or restarting work immediately after the treatment, very often did so without using any form of PPE.

Rubber gloves had the highest compliance rate of any of the forms of PPE, with 74% usage. This is the same as that reported in 885 Californian farmers by Schenker

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**Table 1.** Sociodemographic characteristics of greenhouse workers and use of PPE during their first pregnancy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total N</th>
<th>All behaviours</th>
<th>Use of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Protective uniform, n (%)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤25 years</td>
<td>153</td>
<td></td>
<td>22 (14)</td>
</tr>
<tr>
<td>&gt;25 years</td>
<td>79</td>
<td></td>
<td>31 (39)**</td>
</tr>
<tr>
<td>Year of birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1965</td>
<td>79</td>
<td></td>
<td>21 (27)</td>
</tr>
<tr>
<td>1965–1990</td>
<td>153</td>
<td></td>
<td>32 (21)</td>
</tr>
<tr>
<td>Geographical location (Italy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North-central</td>
<td>134</td>
<td></td>
<td>49 (37)**</td>
</tr>
<tr>
<td>South</td>
<td>98</td>
<td></td>
<td>4 (4)</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>185</td>
<td></td>
<td>31 (17)</td>
</tr>
<tr>
<td>Secondary</td>
<td>47</td>
<td></td>
<td>22 (47)**</td>
</tr>
<tr>
<td>All</td>
<td>232</td>
<td></td>
<td>53 (23)</td>
</tr>
</tbody>
</table>

Significance of χ² test: *P < 0.05, **P < 0.01, ***P < 0.001.
et al. [18]. However, gloves were not used in 50% of the women who during their pregnancy prepared pesticides and in 38% of those who applied pesticides directly.

In comparison to a study of 153 Latino pregnant farm-workers and 248 non-farmworkers from California [11], a higher proportion of pregnant workers in our study reported changing of work clothing immediately after work (85 versus 55%) and using some form of protection (82 versus 67%). None of our greenhouse workers used a face shield or a respirator and only 2% used a protective mask. Although pesticide absorption occurs more through the skin rather than the respiratory system, other studies have shown a higher use of goggles, masks and cartridge respirators. Schenker et al. [18] reported that 56% of farmers in California used a face shield more than half the time and 38% a cartridge respirator. Even in Ethiopia, of the 136 pesticide sprayers, 56% were appropriately provided with respirators and 60% with goggles [19].

The insufficient protection of pregnant greenhouse workers is a source of concern because of the growing evidence that exposure to pesticides may induce reproductive damage, increasing the risk of subfertility [20,21] and adverse pregnancy outcomes, in particular spontaneous abortion [6–8].

Previous studies have shown that the use of PPE devices in greenhouses (gloves, breathing mask and boots) seemed to protect the workers by reducing both genotoxic effects (i.e. micronuclei frequencies) [22,23] and negative reproductive effects [20,21], while the absence of PPE was associated with an increased reproductive risk. A study in Italy among male greenhouse workers showed a longer delay in conception among those not using PPE [20]. A similar study in Finland showed a non-statistically significant reduction of fertility among male greenhouse workers not using PPE during application [21]. In the Danish Gardeners’ Trade Union Study, women who never used gloves when in contact with plants showed a significant decrease in fertility compared with those who always used gloves [9].

Subjective data on past exposures are subject to recall bias. This is in fact a real problem in retrospective studies of adverse pregnancy outcomes. We have tried to reduce the potential recall bias through selection criteria which included using pregnancies which are usually better recalled by women (i.e. first pregnancies). We did find that the answers of the women on work conditions and use of PPE were more complete for the first pregnancy and scarce for the subsequent pregnancies. Consequently, we believe that the responses of the subjects furnish a relatively truthful picture of reality.

Pesticide safety behaviours vary vastly from country to country probably depending on the level of development achieved. Studies on practices indicate that unsafe use of pesticides is common in developing countries. Insufficient legislation combined to illiteracy, poverty and unfavourable weather conditions result in higher health risks from occupational exposure. The study from Ethiopia mentioned earlier shows that the majority of pesticide sprayers were unable to read instructions on safety practices and reluctant to wear gloves in hot weather [19]. In Turkey, use of protective measures among greenhouse workers is still poor and there is no current legislation for those who grow greenhouse vegetables and flowers [15]. Similar findings have been reported among agricultural workers in Lebanon [24].

In the more industrialized countries, pesticide safety behaviour often depends on workers’ perceived susceptibility, educational level and safety training, rather than on economic or legal requirements. A study in the UK found that the main determinant of safe behaviour with respect to pesticide use was a person’s approach to safety in other

Table 2. Work activities of greenhouse workers and use of PPE during their first pregnancy

<table>
<thead>
<tr>
<th>Activities</th>
<th>Total N</th>
<th>All behaviours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Use of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>uniform,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparates pesticide mixtures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>14</td>
<td>3 (21)</td>
</tr>
<tr>
<td>No</td>
<td>218</td>
<td>50 (23)</td>
</tr>
<tr>
<td>Applies directly pesticides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>23</td>
<td>4 (17)</td>
</tr>
<tr>
<td>No</td>
<td>209</td>
<td>49 (23)</td>
</tr>
<tr>
<td>Starts to work after pesticide application within 1 day</td>
<td>97</td>
<td>25 (26)</td>
</tr>
<tr>
<td>&gt;1 day</td>
<td>135</td>
<td>28 (21)</td>
</tr>
</tbody>
</table>

Significance of χ² test: *P < 0.05.
situations and that by appropriate training it is possible to improve the use of protective equipment [12]. Similarly, educational campaigns such as those undertaken in the USA in the 1990s have shown that pesticide safety practices can improve by appropriate educational interventions [25–27].

However, other studies among farm workers in the USA show that safety training increased knowledge, but did not necessarily result in appropriate safety behaviours often because of language and educational barriers [28]. A study among New York farmers for example showed that having at least a high school education was positively associated with the belief that PPE are useful [29]. Our results confirm the previous studies on a positive role of educational level in accepting use of PPE. The difference of educational level also explains, at least in part, the differences between north-central and southern Italy regarding the adherence to pesticide safety behaviours. While pesticide safety education is formally required in Italy for agricultural workers, the information and education of female greenhouse workers during their pregnancies about their potential exposure is neglected. Considering the European Union legislation requiring particular protection for pregnant women, our findings raise concern.

In conclusion, the present study indicates that the use of PPE is different in different social groups of pregnant women in Italy. Overall, it appears that most women used at least one form of PPE while working, but the protection was inadequate in the south and among less educated women.

According to current national regulations, all women should have access to PPE in all phases of their work and particularly during their pregnancy. However, adherence to these regulations appears poor. The lack of adherence is probably due to both individual factors (educational level, previous work experience) and the degree to which safety regulations are enforced in the individual greenhouse setting. Since the available evidence suggests that the use of PPE can reduce the risk of negative pregnancy outcomes, these results point to the urgent need for the enforcement of environmental and personal preventive measures and education and training of female greenhouse workers.

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**Conflicts of interest**

None declared

**References**


