Contact dermatitis in *Alstroemeria* workers

I. A. F. van der Mei, E. M. de Boer and D. P. Bruynzeel

Department of Occupational Dermatology, Free University Academic Hospital, De Boelelaan 1117, NL-1081 HV Amsterdam, The Netherlands

Hand dermatitis is common in workers in the horticultural industry. This study determined the prevalence of hand dermatitis in workers of *Alstroemeria* cultivation, investigated how many workers had been sensitized by tulipalin A (the allergen in *Alstroemeria*) and took stock of a wide range of determinants of hand dermatitis. The 12-month period prevalence of major hand dermatitis amounted to 29.5% whereas 7.4% had minor dermatitis. Of these workers, 52.1% were sensitized for tulipalin A. Several personal and work-related determinants played a role in the multifactorial aetiology of hand dermatitis. Factors which showed a significant relationship with major hand dermatitis were: female sex, atopic dermatitis, chapped hands and the frequency of washing hands. It may be concluded that the *Alstroemeria* workers are a population at risk of developing contact dermatitis and it might be useful to carry out an educational campaign to lower the high prevalence.

**Key words:** Allergic contact dermatitis; *Alstroemeria*; irritant contact dermatitis; occupational; patch testing; prevalence; tulipalin A.

INTRODUCTION

Contact dermatitis of the hands is common in workers in the horticultural industry. Risk factors include plant materials, pesticides, wet work and intensive contact with soil, skin cleansers and many products used for the maintenance of machinery and buildings.

Allergic contact dermatitis by *Alstroemeria* is well-known. Tulipalin A (α-methylene-γ-butyrolactone) has been identified as the responsible allergen. Little is known about the prevalence of contact dermatitis among *Alstroemeria* growers, although the popularity and economical importance of *Alstroemeria* is still increasing, due to its natural beauty, wide variety in colour and long storage life.

Bruynzeel et al. determined the prevalence of hand dermatitis in the flower-bulb industry; in this study, a distinction was made between major and minor dermatitis. A significant difference was found in prevalence of minor dermatitis between flower-bulb workers and a control population (30% and 8%, respectively), whereas no difference (11% and 10%, respectively) was found in the prevalence of major dermatitis between both populations. This suggests that minor dermatitis symptoms are abundant among horticulture workers.

The aim of the present study was to determine the prevalence of hand dermatitis in workers of *Alstroemeria* cultivation, to determine how many workers have been sensitized by tulipalin A and to take stock of a wide range of determinants of hand dermatitis.

Work activities and work-related risk factors

The *Alstroemeria* cultivation is a year round culture. There is seasonal variation and therefore extra (part-time) employees are employed during busy periods. Although *Alstroemeria* is the main crop, about half of the growers cultivate other plants as well.

The most important activities are maintaining the crop, harvesting and preparing the flowers for auction. To maintain the crop, the top of the shoots have to be broken off (heading down), thin, loose and/or old shoots have to be removed (thinning out) and stalks leaning over the path have to be placed between horizontal netting. To prepare the flowers for auction, 10 flowers are sorted out for a bunch, the lowest leaves of the bunch are removed by a machine and the bunch is wrapped in a plastic sleeve.

The exposure of the hands to the sap is most extensive during harvesting and thinning. The stalks of the flowers can be cut off with a small knife or extracted with the fingers. The mechanical and chemical insults to the skin are less for extracting compared with cutting off with a knife. A few years ago almost all cultivated varieties had to be cut off, but recently more and more varieties are bred which can be extracted. Other activities which...
expose the hands to sap are heading down, sorting out and wrapping the bunch in a plastic sleeve.

In *Alstroemeria* cultivation a number of work-related factors occur which might cause or contribute to the existence of contact dermatitis: sap (tulipalin A: the allergen, irritation, wetness of the skin: skin barrier damage); pesticides (irritation, allergy); *Alstroemeria* varieties; other plant material; use of gloves; use of soap; mechanical insults (stalks of the flowers, knife, maintenance machinery, soil); climatic circumstances (high temperatures, high relative humidity) and dirt (plant material, soil).

**MATERIALS AND METHODS**

**Design and population**

The investigation consisted of three parts in which the prevalence of hand dermatitis, risk determinants and the percentage of workers who were sensitized by tulipalin A were investigated.

To determine the prevalence, a questionnaire-based cross-sectional study was carried out in combination with a dermatologic examination. The same questionnaire and the dermatologic examination investigated a number of risk determinants of contact dermatitis. A number of descriptive determinants of the general work situation could not be investigated by the questionnaire. These factors were examined by visiting 12 *Alstroemeria* companies and interviewing both employers and employees.

A simple random sample of 51 *Alstroemeria* companies was drawn from the registers of the Flower Auction of Holland and the Flower Study Club of north-west Holland. A total of 220 questionnaires were sent to all persons working at these companies. The sample size of 220 persons was calculated using the formula of Coenraads and the general population results of Smit. Persons younger than 15 years, persons working less than 3 months or working less than 8 hours a week were excluded. The subpopulation of workers who scored positively for hand dermatitis on the questionnaire were dermatologically examined.

The percentage of workers who were sensitized by tulipalin A was determined by patch testing. This was carried out in the subpopulation of workers who were classified during the dermatologic examination as having 'major hand dermatitis' or 'minor hand dermatitis' (the first symptoms of dermatitis).

**Questionnaires**

The questionnaire on the prevalence and some risk determinants of hand dermatitis was based on the validated questionnaire of Smit. It included questions about hand dermatitis, age, sex, skin type, atopy, the use of skin care products, soap and protective gloves, absenteeism, medical consultation, the opinion of the workers as to the cause of their symptoms, exposure to different plants and *Alstroemeria* varieties which cause most complaints.

For identification of cases with hand dermatitis, the short self-administered questionnaire of Smit was included (Appendix A). Based on these questions, a person with a positive questionnaire diagnosis of hand dermatitis was defined as: a person who answered positively to one or more of the questions 1a through 1e (symptoms) and who answered positively to either question 2 (symptoms for more than three consecutive weeks) or question 3 (recurrence of symptoms).

The skin type was conducted from question 4 and 5 (Appendix A). The following score was used:

- question 4 about dry skin: dry = 1, normal = 2, greasy = 3 points
- question 5 about chapped hands: yes = 0, no = 2 points

A dry, chapped skin would score 1 point, while a greasy, non-chapped skin would score a maximum of 5 points.

Atopy was split in atopic mucosal symptoms (asthma, bronchitis, hayfever) and atopic dermatitis. The workers were asked about their use of skin care products at work and at home. In addition, they were asked how often they washed their hands (<5 times, 5–10 times, 11–20 times or >20 times a day) and what kind of soap was used (tablet soap, liquid soap and/or scouring soap). The questions about the use of gloves included the frequency of use (often, sometimes, never), type of gloves, activities used for and frequency of using new or clean gloves.

The interviews on work circumstances contained questions about climatic influences (temperature and relative humidity), mechanical insults and exposure to the sap of the plants, pesticides, other chemicals, soil and dirt.

**Dermatologic examination**

All individuals with a positive questionnaire diagnosis for hand dermatitis were asked to co-operate in a dermatologic examination. It included a standardized interview and registration of objective skin symptoms of the hands. The symptoms were ranged using the following classification: 'active hand dermatitis' (= 'major' dermatitis), 'the first symptoms of dermatitis' (= 'minor' dermatitis), 'no hand dermatitis' and 'other skin disorders'. The symptoms of major dermatitis were defined as erythema, papules, vesicles and fissures, comprising a clear eczematous picture. Minor dermatitis was exhibited as erythema, slight chapping of the skin and scaling. Smit found in her validation study of the questionnaire with nurses, a sensitivity of 100%. Thus, nobody with a negative questionnaire diagnosis had a positive diagnosis at the dermatologic examination. For that reason, we did not do a dermatologic examination in individuals with a negative questionnaire diagnosis.

During this examination the workers were asked for their opinion on the benefit of wearing gloves. In addition, workers were scored on the basis of the standardized interview in combination with the information from the questionnaire as 'possibly sensitized', 'dubious' and 'probably not sensitized' for tulipalin A. These scores were compared with the results of the patch tests.

**Patch testing**

Patch testing was done in the subpopulation of workers who were classified as having major and minor dermatitis.
The patch tests were performed with a routine series (TRUE® Test Pharmacia), sesquiterpene lactone mix 0.1% pet., parthenolide 0.1% pet., 2,6-di-tert-butyl-p-cresol 2% pet. and two preparations of tulipalin A [α-methylene-γ-butyrolactone 0.01% pet. (Chemotechnique), α-methylene-γ-butyrolactone 0.005% aq. (Aldrich Chemie)].

Sesquiterpene lactone mix and parthenolide were added, as some growers cultivated other plants (e.g., Chrysanthemum). Tulipalin A in aqua was tested in a concentration of 0.005%, because 0.01% gave good but strong reactions in an earlier study in our clinic. α-Methylene-γ-butyrolactone (Aldrich Chemie) contains 2,6-di-tert-butyl-p-cresol (0.01%) as a stabilizer. This chemical was thus added to the test series in the usual test concentration of 2%.

The materials were applied to the upper back using Van der Bend Square Chambers® (Van der Bend) and Fixomull® (Beiersdorf) adhesive tape. The workers were instructed to remove the patches at 48 h after application. Readings were carried out at the workplace at 72 h and graded according to the ICDRG.14

Prevalence estimation

The questionnaire asked for symptoms during the previous year, which gave the 12-month period prevalence. The clinical presence of hand dermatitis at the moment of the dermatologic examination determined the point prevalence.

Statistical methods

All results were analysed with the statistical program SPSS. Relationships between major hand dermatitis of the previous 12 months and some personal and work-related determinants were calculated with a χ²-test (significance level: p < 0.05). The period prevalence of this study was compared to the Dutch general population (95% confidence interval of the standardized prevalence ratio.)15 For this purpose the results of Smit12 were used. Her study and our study used the same questions in order to identify cases with hand dermatitis. However, Smit12 did not use a dermatologic examination, but accentuated the definition of hand dermatitis ['a person who answered positively to two or more of the questions 1a through 1e (symptoms) and ...']. The prevalences found by Smit12 were consistent with five major population-based studies.16-20

RESULTS

Response and characteristics study population

A total of 79.5% (175/220) of the workers of 49 (96.1%) companies returned the questionnaire. Seventeen respondents who did not fulfil eligibility criteria were excluded from the study population. One company (five persons) was excluded, because the work activities differed too much from those of the other companies. Thus, the total study population consisted of 153 workers (Table 1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-20</td>
<td>12</td>
<td>7.9</td>
</tr>
<tr>
<td>21-30</td>
<td>41</td>
<td>27.0</td>
</tr>
<tr>
<td>31-40</td>
<td>25</td>
<td>16.4</td>
</tr>
<tr>
<td>41-50</td>
<td>41</td>
<td>27.0</td>
</tr>
<tr>
<td>51-60</td>
<td>31</td>
<td>20.3</td>
</tr>
<tr>
<td>61 +</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>Persons per company</td>
<td>4(2)**</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>111</td>
<td>72.5</td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
<td>27.5</td>
</tr>
<tr>
<td>Hours working a week*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 t/m 20</td>
<td>22</td>
<td>14.5</td>
</tr>
<tr>
<td>21 t/m 32</td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>33 t/m 40</td>
<td>44</td>
<td>28.9</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>70</td>
<td>46.1</td>
</tr>
</tbody>
</table>

* Data from 1 person unknown. **Average (standard deviation).

Sixty-seven of the workers had a positive questionnaire diagnosis, of whom 63 (94.0%) were dermatologically examined. The subpopulation eligible for patch testing (major and minor dermatitis) consisted of 55 out of 63 workers. A total of 47 out of 55 workers agreed to be patch tested. Moreover, the results of one further person were added, because she was already patch tested by her dermatologist.

Hand dermatitis

The period prevalence of major dermatitis of the entire study population amounted to 29.5%, whereas 7.4% had minor dermatitis and 62.4% had no hand dermatitis at all. The period prevalence for women (41.5%) was significantly higher than for men (25.0%) (χ² = 3.87, p = 0.049) (Table 2). Both prevalences differed significantly from the general population (Table 3).

The point prevalence of major dermatitis of the entire study population was 18.1% (Table 2). In contrast to the significant difference of the period prevalence between men and women, no difference was found in the point prevalence (χ² = 0.074, p = 0.79).

Although individuals with a negative questionnaire diagnosis should not be dermatologically examined, eight respondents with a doubtful negative questionnaire diagnosis were called or visited. It was found that four subjects had a positive 12-month diagnosis and three of these four had a positive diagnosis at the moment of the dermatologic examination as well. Because of the subjectivity of the 'doubtful cases', they were still registered as having a negative questionnaire diagnosis.

A relatively large number of workers had a clinical picture that was characterized with hyperkeratosis and fissures on the palms and the palmar sides of the fingers and fingertips. This corresponded with the picture of 'chronic palmar irritant dermatitis'.13 At the moment of the dermatologic examination 12 workers from the 27
(44.4%) workers who were classified as having major dermatitis showed this type of dermatitis. The first signs of it were seen in six out of 15 (40.0%) workers who were classified as having minor dermatitis.

A positive patch test reaction for tulipalin A 0.01% pet. was found in four (8.3%) workers. However, 28 (58.4%) workers responded positively on tulipalin A 0.005% aqu. Three of the eight 3+ reactions were regarded as irritative and for that reason 25 (52.1%) workers were interpreted as being sensitized for tulipalin A, which is 17.1% (25/146) of the total population (Table 4).

There was no significant difference in sensitization between men and women ($\chi^2 = 2.01, p = 0.16$), although the percentage sensitized for tulipalin A was somewhat higher for men. Half of the employers with 'chronic palmar irritant dermatitis' were sensitized.

Three of the eight 3+ reactions were regarded as irritative and for that reason 25 (52.1%) workers were classified as having minor dermatitis. The first signs of it were seen in six out of 15 (40.0%) workers who were classified as having major dermatitis.

Table 2. Hand dermatitis according to the questionnaires ($n = 153$) and the dermatological examination (67/149*) for the entire population and for men and women separately.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>All workers</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major hand dermatitis</td>
<td>44 (29.5%)</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>Minor hand dermatitis</td>
<td>11 (7.4%)</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>No hand dermatitis**</td>
<td>93 (62.3%)</td>
<td>72</td>
<td>21</td>
</tr>
<tr>
<td>Other skin disease</td>
<td>1 (0.7%)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>149*</td>
<td>108***</td>
<td>41***</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>All workers</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major hand dermatitis</td>
<td>27 (18.1%)</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>Minor hand dermatitis</td>
<td>15 (10.1%)</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>No hand dermatitis**</td>
<td>106 (71.1%)</td>
<td>80</td>
<td>26</td>
</tr>
<tr>
<td>Other skin disease</td>
<td>1 (0.7%)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>149*</td>
<td>108***</td>
<td>41***</td>
</tr>
</tbody>
</table>

*4 individuals refused cooperation for the dermatological examination.
**Summation of negative questionnaire and dermatological diagnosis.
***Data from 1 or more persons unknown.

Table 4. Results of the patch tests for tulipalin A of workers with major or minor hand dermatitis ($n = 48$) and the figures of those who were regarded as sensitized.

<table>
<thead>
<tr>
<th>Patch test</th>
<th>Tulipalin A pet.</th>
<th>Tulipalin A aqua</th>
<th>Accepted as sensitized</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>36 (75.0%)*</td>
<td>7 (14.6%)*</td>
<td></td>
</tr>
<tr>
<td>? +</td>
<td>8 (16.7%)</td>
<td>13 (27.1%)</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>4 (8.3%)</td>
<td>15 (31.3%)</td>
<td>15 (31.3%)</td>
</tr>
<tr>
<td>??</td>
<td>5 (10.4%)</td>
<td>5 (10.4%)</td>
<td></td>
</tr>
<tr>
<td>++</td>
<td>8 (16.7%)</td>
<td>5 (10.4%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>48</td>
<td>25 (52.1%)</td>
</tr>
</tbody>
</table>

*The result of the worker who had already had patch tests by her dermatologist was negative. The result was added to the group with a negative patch test diagnosis and interpreted as 'not sensitized'.

Determinants of hand dermatitis

Person-related determinants. Sex showed a significant relationship with the period prevalence ($\chi^2 = 3.87, p = 0.049$); significantly more women than men suffered from major hand dermatitis. However, no significant relationship was demonstrated with the point prevalence ($\chi^2 = 0.074, p = 0.79$) and sensitization for tulipalin A showed an even higher occurrence in men than in women, although this difference was not significant ($\chi^2 = 2.01, p = 0.16$).

Age showed no significant relationship with major dermatitis ($\chi^2 = 1.24, p = 0.54$).

Table 3. Period prevalence and standardized prevalence ratio (SPR) in the general population and study population with 95% confidence interval (CI)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>SPR</td>
<td>95% CI</td>
</tr>
<tr>
<td>General population*</td>
<td>5.2%</td>
<td>1</td>
</tr>
<tr>
<td>Alstroemeria workers</td>
<td>25.0%</td>
<td>4.8</td>
</tr>
</tbody>
</table>

*Data investigation Smit (1993).
Atopic mucosal symptoms were found in 13.2% of the workers and atopic dermatitis in 6.6% of the workers. Workers with past or present atopic dermatitis showed significantly higher major dermatitis ($\chi^2 = 4.42, p = 0.035$) compared to workers without atopic dermatitis. Such a relationship was not found with atopic mucosal symptoms ($\chi^2 = 1.88, p = 0.17$).

Skin type, according to the combination of question 4 and 5 (Appendix A) did not show a relationship with hand dermatitis (the number of persons in some groups were too small to draw a conclusion). However, there was a clear relationship between chapped hands according to question 5 and major dermatitis ($\chi^2 = 10.36, p = 0.0013$): more workers with chapped hands experienced hand dermatitis compared to workers without.

Skin care products were used by 54.1% of the workers at home and by 24.8% at work (at work alone or in combination with home). A significantly higher number of workers using skin care products had major dermatitis compared to those who did not use such products (relationships $\chi^2 = 18.24, p = 0.00002$ and $\chi^2 = 6.37, p = 0.012$ respectively).

**Work-related determinants.** There are many work-related factors that can be involved in hand dermatitis. *Alstroemeria* sap has a sensitizing effect (tulipalin A). Moreover, this sap has, according to some workers, an irritating effect. The barrier function of the skin is moistened by the continuous contact with the sap in periods of cutting and extracting the flowers. Contact with plants made the hands dirty (green/black). Workers with mechanically insulted hands and fissures had difficulties removing this dirt.

There was a significant relationship between the frequency of washing the hands and major dermatitis ($\chi^2 = 6.99, p = 0.03$): 86.4% of the group workers who washed their hands 5–10 times a day had hand dermatitis compared to 6.8% of the group who washed their hands < 5 times a day. The type of soap did not show a relationship with hand dermatitis ($\chi^2 = 0.40, p = 0.53$).

Workers only came into incidental contact with soil during *Alstroemeria* activities. It is possible that this contact was more important in other cultivations.

Approximately half of the companies cultivated other plants apart from their main crop of *Alstroemeria*. The workers indicated other plants 13 times as a cause of hand dermatitis: *Tulipa* (7 times), *Zantedeschia* (3), *Nerine* (1), *Narcissus* (1) and *Aster* (1).

During sunny days the temperature in the greenhouses could rise beyond 30°C. Workers noticed an increased sweat production of the hands, especially when gloves were worn.

A total of 31.1% of all workers wore protective gloves all or most of the time, whilst 15.9% of the workers sometimes wore gloves during crop activities (like harvesting, thinning out and heading down). Of the workers who were dermatologically examined and who used gloves, 75.6% (34/45) noticed relief from wearing gloves, while 24.4% (11/45) experienced no benefit or inadequate/unclear benefit. From the 34 persons who noticed relief, 28 persons were patch tested. Sixteen of these 28 persons were sensitized for tulipalin A. Of the 11 persons who did not experience relief, eight persons were patch tested of whom four were sensitized for tulipalin A.

The use of pesticides in *Alstroemeria* culture is very low. During autumn and winter, pesticides are rarely necessary and during spring and summer, the growers only use pesticides as a curative.

Finally, workers were asked to give their opinion as to the causes of their complaints. This is shown in Table 5.

### Table 5. Frequency of causes according to workers with skin complaints

<table>
<thead>
<tr>
<th>Cause</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Alstroemeria</em> sap</td>
<td>49 (45.8%)</td>
</tr>
<tr>
<td>Wet work</td>
<td>17 (15.9%)</td>
</tr>
<tr>
<td>Other plants</td>
<td>13 (12.1%)</td>
</tr>
<tr>
<td>Soil</td>
<td>12 (11.2%)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (7.5%)</td>
</tr>
<tr>
<td>I don't know</td>
<td>7 (6.5%)</td>
</tr>
<tr>
<td>Pesticides</td>
<td>1 (0.9%)</td>
</tr>
</tbody>
</table>

**DISCUSSION**

**Response and bias**

A total of 175 (79.5%) workers from 49 (96.1%) companies returned the questionnaire. Reasons for non-response were mostly unknown.

A bias due to the use of the cluster sample method was probably small because the number of randomly drawn companies was large, while the number of persons working at the companies was small. The chance of selection bias in the form of 'healthy worker effect', which could lead to an underestimation of the prevalence, was estimated as small, as not many people stop working because of a skin disease.

Smitt found a sensitivity of the questionnaire of 100%, meaning that nobody with a negative questionnaire diagnosis had a positive diagnosis at the dermatologic examination. In this study, at least four workers with a doubtful negative questionnaire diagnosis had a positive 12-month diagnosis at the dermatologic examination and three of them had a positive diagnosis at the moment of the dermatologic examination as well. This resulted in an underestimation of the period and point prevalence. The fact that Smitt did not find false negative cases, may be explained by the different study population, consisting of nurses who were probably able to report even minimal symptoms. *Alstroemeria* workers probably did not report minimal symptoms, because it did not bother them or they interpreted it as a normal part of the job.

**Hand dermatitis**

The period and point prevalence of the entire study population amounted to 29.5% and 18.1%, respectively. The determination of the point prevalence is more reliable than the period prevalence. The period prevalence was based on the history, while the point
prevalence was based on clinical examination as well. A disadvantage of the point prevalence is its instantaneous picture, while symptoms might not be continuously present. The period prevalence avoids this problem and gives a better indication of the number of cases of hand dermatitis. The dermatologic examinations were carried out in May and June, a rather busy period. It is quite conceivable that the point prevalence is lower at other times of the year.

The period prevalence for men and women was significantly higher than the period prevalence for the general population (men respectively 25.0% and 5.2%; women respectively 41.5% and 10.6%). This shows that the Alstroemeria workers are a population at risk for hand dermatitis. The period prevalence for women was significantly higher compared to men. This is in accordance with the study of Smit and other studies. It is believed to be due to a higher background exposure of women to harmful skin contacts in household activities. The point prevalences did not differ significantly. It is possible that during the determination of the period prevalence women overreported and/or men underreported symptoms.

A relative high proportion of workers had a clinical picture, known as 'chronic palmar irritant dermatitis'. The cause of this kind of dermatitis is a combination of chemical and mechanical factors. However, an allergic component played a role in 50.0% (10/20) of these workers, as they were allergic for tulipalin A. The most important chemical factor was probably the irritative effect of the sap, while mechanical insults were mainly caused by cutting and extracting the flowers during harvesting and thinning out.

**Patch testing with tulipalin A**

In our clinic, tulipalin A is normally tested with tulipalin A in pet. (0.01%) (Chemotechnique) and tulipalin A in aq. (0.01%) (Aldrich Chemie). Both materials gave good results, although tulipalin A in aq. gave rather strong reactions. Thus, a lower test concentration (0.005% aq.) was chosen for this field work. Unfortunately this concentration still resulted in some strong reactions. Although there were some strong reactions, there were no real problems in drawing conclusions about sensitization. Three superficial, bullous reactions without any erythema were regarded as toxic. We have noticed this patch test effect before in persons who worked during patch testing in humid and hot conditions. An extra contributing factor is the selective high pressure of the test chamber on the back skin due to the bending posture during work.

A problem was the preparation of tulipalin A in pet. It gave good results in the limited amount of people who were tested with it in the clinic. However, in this study the results were far too weak. Only four persons had a 1+ reaction and there were no 2+ or 3+ reactions. This raises questions about stability and bioavailability of tulipalin A in pet.

The comparison of the patch tests results with the probability of sensitization on the basis of the history and the dermatologic examination showed that a total of 15 workers (31.3%) were misinterpreted (eight false positives and seven false negatives). This leads to the conclusion that a history alone is not satisfactory for determining sensitization for a material in population-based studies. This is in accordance with the common dermatologic knowledge that it is generally not possible to distinguish allergic and irritant contact dermatitis on the basis of history and clinical picture.

**Determinants of hand dermatitis**

Hand dermatitis is a disease with a multifactorial aetiology. Personal and work-related factors interact in a complex manner. Tulipalin A seems to be a main factor with 52.1% of the workers with major or minor hand dermatitis being sensitized for tulipalin A. In these workers, this allergen elicits hand dermatitis to a lesser or larger extent in combination with irritative factors. The sap seems to have an irritant effect as was mentioned by several workers. However, the pH is practically neutral (6.6). The hands of the workers became moistened by the sap of Alstroemeria through intensive contact all day. Wet hands are more liable to skin damage due to maceration of the skin and better penetration of chemicals.

Mechanical insults by the knife and stalks were another important determinant. The combination of mechanical insults and chemical factors probably caused the clinical picture of 'chronic palmar irritant dermatitis'. The findings that dry, chapped hands showed a significant relationship with hand dermatitis while skin type did not, suggest that this condition was caused by work-related factors (like washing hands and climatic circumstances). However, no definite conclusions can be drawn with regard to the causal relationship. Dry, chapped hands might be a predisposing factor for the development of hand dermatitis, but it may also be an early manifestation or a consequence of hand dermatitis, or a feature of atopic dermatitis. The same problem applied for the frequency of washing hands. Washing the hands more often than five times a day could contribute to hand dermatitis. It is also possible that minor hand dermatitis resulted in washing the hands more often, because dirt was more difficult to remove.

The cultivation of other plants could influence hand dermatitis as well, not only due to the plant itself but also to circumstances which differed from the cultivation of the Alstroemeria. Contact with pesticides or soil were, for instance, factors of minor importance in the cultivation of the Alstroemeria, but they might play a more important role in other cultivations.

Some Alstroemeria varieties were mentioned as causing more symptoms than other varieties. A reason for this could be that these cultivated varieties (or some of them) could not be extracted, but had to be cut off, which resulted in a higher exposure to sap. Other reasons could be a more sapful plant and a higher concentration of tulipalin A. If this last suggestion is correct, it may be worthwhile breeding varieties with a low content of tulipalin A.

The findings that atopic dermatitis showed a significant relationship with major hand dermatitis and that atopic
mucosal symptoms did not, is in accordance with the literature. Nilsson et al.\textsuperscript{27} and Rystedt et al.\textsuperscript{28} demonstrated that atopic dermatitis is a more important determinant than atopic mucosal symptoms.

Age did not show a significant relationship with hand dermatitis. In the literature there is no agreement regarding this determinant.\textsuperscript{19,26,24,29} However, one of these studies\textsuperscript{24} showed that the age effect disappeared when correcting for occupation. This is in accordance with our results, because our study is carried out within one occupation.

The use of skin care products showed a significant relationship with hand dermatitis. It is possible that skin care products cause hand dermatitis, but it is more likely that hand dermatitis leads to an increase in use of skin care products.

Rubber gloves, even from household thickness, are penetrated easily by tulipalin A in a short time.\textsuperscript{30} This type and comparable gloves were often used, especially in those with hand dermatitis. Despite that, 75% noticed protection from the gloves. A reason could be that penetration of tulipalin A is hampered by dirt on the gloves. Nitril or 4H-gloves do give longer protection; they have a break-through time of approximately 4 h.\textsuperscript{30}

CONCLUSIONS

This study reported a period prevalence of major hand dermatitis in \textit{Alstroemeria} workers of 29.5\% and showed that these workers are a population at risk. It justifies efforts for preventive measures.

It is demonstrated that several personal and work-related determinants play a role in the multifactorial aetiology of hand dermatitis (e.g., sex, skin atopy, repeated mechanical injuries, irritation). The allergen, tulipalin \(A\), was demonstrated to be of major importance since approximately 50\% of the workers with hand dermatitis were sensitized. It might be interesting to cultivate \textit{Alstroemeria} varieties with a low concentration of tulipalin A.

A history alone as a method of deciding upon a possible sensitization for tulipalin A proved to be insufficient compared to a combination of history and patch tests.

To lower the high prevalence of hand dermatitis, it would be useful to carry out an educational campaign regarding points such as: hygiene at work, hand cleaning and the proper use of gloves.\textsuperscript{31}

ACKNOWLEDGEMENTS

We would like to thank the Environmental & Occupational Dermatology Foundation (Groningen, The Netherlands) for providing financial support.

REFERENCES

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APPENDIX A

Questions on hand dermatitis and type of skin

1. Have you had one of the following symptoms at your hands or fingers in the past 12 months:
   a. red and swollen hands or fingers (yes/no)
   b. red hands or fingers and fissures (yes/no)
   c. vesicles on the hands or on the sides of the fingers (yes/no)
   d. scaling hands or fingers with fissures (yes/no)
   e. itching hands or fingers with fissures (yes/no)

2. Did one or more of these symptoms last for more than 3 weeks? (yes/no/I don’t know)

3. Did one or more of these symptoms occur more than once? (yes/more than once/yes, once/no)

4. How would you describe your skin type? (normal/dry/greasy)

5. Do you often have complaints of dry and chapped hands? (yes/no)