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# Hand eczema among Dutch beekeepers – a cross-sectional study

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## Summary

**Background and objectives:** Studies of beekeepers have mostly focused on contact allergy to propolis. The overall prevalence of hand eczema (HE) in beekeepers has not been studied. Our objectives were to gain insight into the prevalence of HE in the Dutch beekeeper population; to define the impact of beekeeping activities on HE and vice versa; and to determine associated factors.

**Patients and methods:** We used a cross-sectional online survey. Dutch beekeepers answered questions on beekeeping activities, the prevalence and characteristics of HE, including severity, and the impact of the disease on beekeeping.

**Results:** We analyzed 833 surveys (12 % of Dutch beekeepers). The one-year prevalence of HE was 13.2 %, and the lifetime prevalence was 20.5 %. In 28 patch-tested beekeepers with hand eczema, eight (28.6 %) were allergic to propolis. Atopic dermatitis was the only variable associated with HE: the odds ratio was 4.53 (95 % confidence interval 2.78–7.38). One in three beekeepers reported that HE was caused or worsened by beekeeping, although only 3.8 % reported working less at beekeeping because of HE, and the impact of HE on beekeeping activities (as perceived by beekeepers) is low.

**Conclusions:** In this sample of Dutch beekeepers, hand eczema was more prevalent than in the general population, but seems to have had little impact on the beekeeping activities of the majority of beekeepers.

## Introduction

Hand eczema is a common skin disease with a one-year prevalence of 9.1 % in the general population (10.5 % in women, 6.4 % in men) [1]. It is the most common occupational skin disease [2]. A trade that might impose an increased risk of developing hand eczema is that of beekeepers (apiarists). Beekeepers frequently wear gloves, which can contribute to developing hand eczema [3, 4]. Furthermore, the skin of beekeepers who do not (always) wear gloves is regularly exposed to contact allergens, of which propolis is the best known. Propolis, also known as bee glue, is a substance produced by bees from parts of living plants mixed

with an enzyme that is present in bee saliva. Among the population of consecutively patch-tested patients with dermatitis, the rate of sensitization to propolis is about 3.0 % [5, 6]. As yet, studies in beekeepers have mostly focused on (possible) contact allergies to propolis [3, 7–10]. However, the overall prevalence of hand eczema in beekeepers, involving both irritant and allergic etiology, has not been studied. The main aim of this study was to gain insights into the prevalence of hand eczema in the Dutch beekeeper population. Secondly, we focused on beekeepers with hand eczema to define the impact of beekeeping activities on hand eczema and vice versa. Thirdly, we compared beekeepers with and without hand eczema to determine factors

associated with hand eczema. Lastly, we focused on the population of ex-beekeepers and their reasons for quitting their occupation as apiarists.

## Patients and methods

### Study design

This was a cross-sectional study using an online questionnaire. The Medical Ethical Review Board of the University Medical Center Groningen reviewed and approved the study (METc 2017/020).

### Study population and recruitment

All Dutch (ex-)beekeepers were welcome to participate in our study. We strived to include as many beekeepers as possible, irrespective of whether they had hand eczema or not. This was specifically mentioned in the invitation to participate. The number of active beekeepers in the Netherlands is estimated to be around 7,000 (Dutch national monitoring survey on honey bee colonies, 2014) [11]. Beekeepers were recruited in two rounds. Initially, respondents were recruited via the largest Dutch beekeeper society (Nederlandse bijhoudersvereniging [NBV]). This organization has 7,243 members who are all current or ex-beekeepers [12]. A link to the online questionnaire was distributed to the members of this organization with digital newsletters in January and February 2017. An invitation to participate was also placed in the paper version of the NBV magazine (January issue).

No time limit or deadline was set; the questionnaire was closed when no new responses had been registered for two weeks. Data were collected between 16 January and 8 April 2017. To increase the response rate, we subsequently sent an email to all responders who provided us with their email address in the first round, requesting that they forward the questionnaire to all their beekeeper colleagues. The questionnaire was reopened on 28 August and closed on 17 October when no new responses had been registered for two weeks.

### Measurements

For this study we developed a new questionnaire in Dutch. The questionnaire was pilot tested for comprehensibility by two beekeepers. It was developed using online survey software from Qualtrics (Qualtrics, Provo, UT, USA; <https://www.qualtrics.com>). All concepts are briefly described below. For a comprehensive overview of the definitions and categorization used in the analyses, see Online-Supplement S1.

### Socio-demographic factors and work-related characteristics

The following demographic and work-related factors were assessed: sex; age at the time of completing the questionnaire; working in an additional occupation and if so, whether or not this was a high-risk occupation; performing wet work in the other occupation; number of working hours per week in the other occupation; number of years working in the other occupation.

### Beekeeping characteristics

Factors relevant to beekeeping were: number of years of active beekeeping [10]; mean number of hours beekeeping per week, both in the winter rest and the beekeeping season; number of bee colonies [10]; glove-wearing during beekeeping (currently/past/never); and percentage of total beekeeping time that gloves were worn [13]. Questions on bee venom allergy [10] and whether the allergy was diagnosed by a physician were also included.

### Characteristics of hand eczema

To define the lifetime prevalence of hand eczema among Dutch beekeepers, we asked all current beekeepers the following question: “*Hand eczema is a skin disease of the hands that exists of redness, scaling, a dry skin and sometimes vesicles and/or fissures. Hand eczema can cause itching or pain. Have you ever had hand eczema?*” [13, 14]. To define the one-year prevalence of hand eczema, we subsequently asked: “*Have you had hand eczema during the last 12 months?*” [13]. Other characteristics were: age at onset of hand eczema; frequency during the past year; atopic dermatitis (lifetime); and contact allergies. These were all assessed using the Nordic Occupational Skin Questionnaire (NOSQ) [13]. We also added a question on whether the hand eczema was diagnosed by a physician.

### Beekeepers with hand eczema – impact of beekeeping activities on hand eczema and vice versa

The following concepts were assessed: number of years working as a beekeeper at the onset of hand eczema; improvement of hand eczema when not beekeeping (for example during holidays or winter rest); hand eczema subjectively worsened by beekeeping; hand eczema subjectively caused by beekeeping. We also assessed the self-reported influence of hand eczema on beekeeping activities (scale from 0–10) and whether respondents spent less time on beekeeping activities because of their hand eczema (absenteeism). To address presenteeism, we asked if respondents performed beekeeping

activities despite feeling that they should not have done so because of the hand eczema [15]. Hand eczema severity was self-assessed by beekeepers, using the photographic guide of Coenraads et al. [16, 17].

### Ex-beekeepers

Respondents were asked whether or not they were actively beekeeping at the time that they completed the questionnaire. If so, they completed the entire questionnaire. All ex-beekeepers were asked whether they had stopped working as a beekeeper because of their hand eczema. If not, their reason for quitting was subsequently asked with an open-ended question.

### Statistical analysis

Before analyzing the results, we applied two exclusion criteria:

1. Working in a wet work occupation as well as working as beekeeper. Wet work was assessed using the following three questions [15]:
  - a) On an average working day, while working, for how many hours do your hands come into direct contact with water, fluids and/or moist products? Never/less than 0.5 hours/0.5–1 hour/1–2 hours/more than 2 hours.
  - b) On an average working day, while working, for how many hours do you wear gloves that are impermeable to fluids? Never/less than 0.5 hours/0.5–1 hour/1–2 hours/more than 2 hours.
  - c) On an average working day, while working, how often do you wash your hands? Never/less than 5 times/5–10 times/10–20 times/more than 20 times.“Wet work” was defined as at least two answers from the second-highest answer category (1–2 hours/ between 10 and 20 times) or at least one from the highest answer category (more than 2 hours / more than 20 times).
2. Performing a high-risk occupation for developing hand eczema according to the list of high-risk occupations from the European hand eczema guideline by Diepgen et al. [18]. Healthcare workers who did not work in a wet work occupation according to the wet work definitions were kept in the study (although they appear on the list of high-risk occupations as a group).

Analysis was mostly focused on descriptive statistics. Normally distributed variables are reported as mean  $\pm$  standard deviation, non-normally distributed variables as median and interquartile range. To compare the severity of hand eczema during winter rest with the severity during the beekeeping season, we used the Wilcoxon signed rank test.

Regression analysis was performed to look for associations, comparing beekeepers with and without hand eczema in the last 12 months. Many respondents only completed a (very) minor part of the questionnaire. Because of this, we excluded all respondents who did not complete the full questionnaire ( $n = 250$ ). This meant that our analysis did not include missing values. A  $p$ -value  $< 0.05$  was considered statistically significant. Data analysis was performed using SPSS version 23.0 (IBM Corp. Armonk, NY, USA).

## Results

### Study population

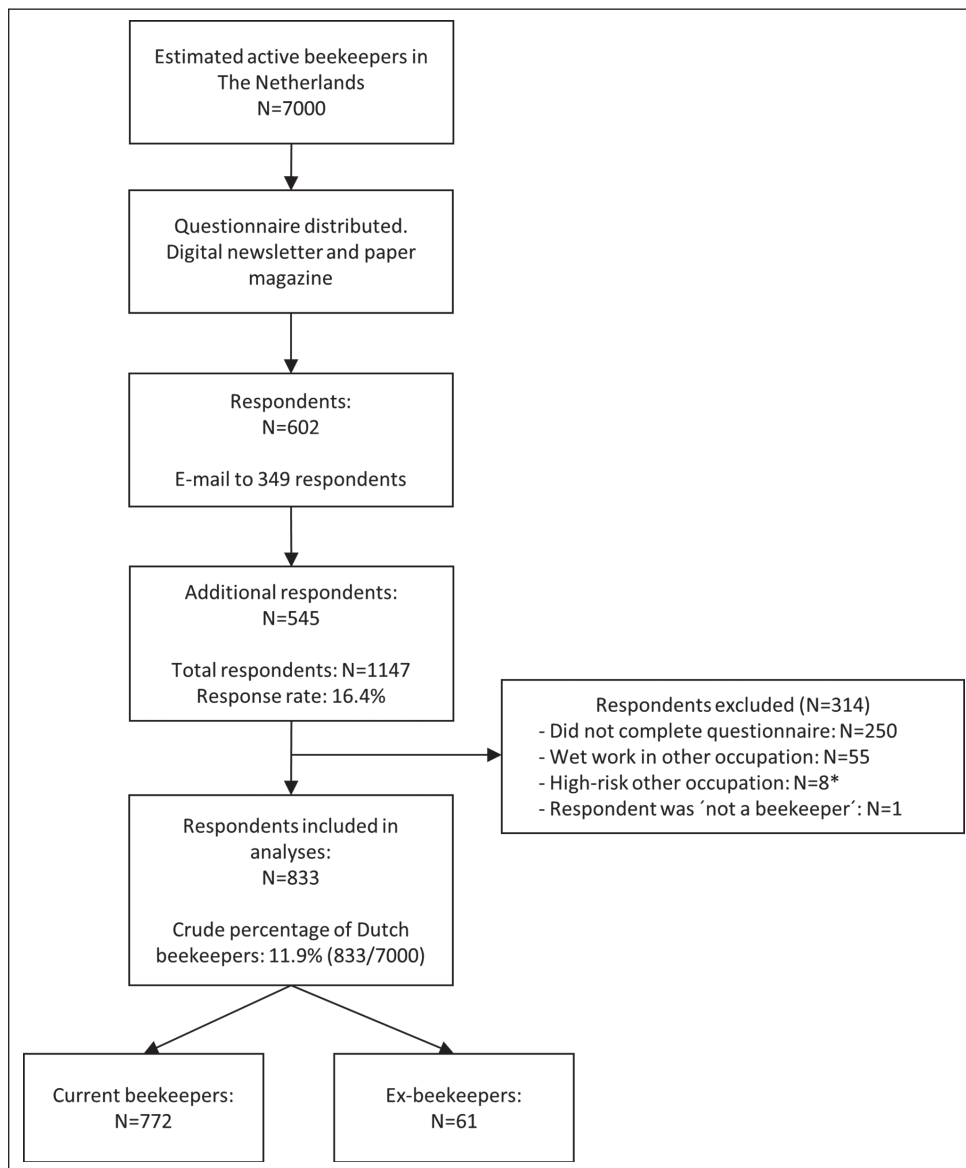
From the approximately 7,000 (ex-)beekeepers who could theoretically have received the electronic and/or paper newsletter of the NBV, 602 (ex-)beekeepers responded. The 349 respondents who shared their email addresses were asked to distribute the questionnaire among their colleagues, which led to an extra 538 responses. This amounted to a total of 1,147 responding (ex-)beekeepers (response rate 16.4 %). In total, 314 respondents were excluded for reasons shown in the flow chart in Figure 1. Our final study population consisted of 833 Dutch (ex-)beekeepers. This means that an estimated 11.9 % (833/7000) of all beekeepers in the Netherlands participated in our study.

### Socio-demographic factors and work-related characteristics

From the total study population of 833 respondents, 772 were active beekeepers and 61 had stopped their beekeeping activities. Basic characteristics of the active beekeepers are shown in Table 1. The beekeepers were predominantly male and the median age was relatively high at 61 years. Over 40 % of the responding beekeepers had no other occupation and worked solely as beekeepers.

### Prevalence and characteristics of hand eczema

The overall percentage of beekeepers who had ever had hand eczema was 20.5 % (158/772). Of these beekeepers with hand eczema, 64.6 % (102/158) reported having had hand eczema within the past 12 months. In the population of active beekeepers who responded to our survey, this results in a one-year prevalence of hand eczema of 13.2 % (102/772). Of the 28 beekeepers with hand eczema in whom patch tests had been performed, a contact allergy was demonstrated in 78.6 % (22/28). Eight out of 28 patch-tested beekeepers (28.6 %) reported a contact allergy to propolis. All characteristics are shown in Table 2.



**Figure 1** Study flow diagram. \*High-risk other occupations: baker (2), cashier (1), florist (2), machine operator (3).

### Impact of beekeeping activities on hand eczema and vice versa

In 57.6 % (91/158) of the beekeepers with hand eczema, the hand eczema began after they started working as beekeepers. In 22.8 % (36/158) this was after more than 10 years of beekeeping. Around one third of the beekeepers with hand eczema indicated a relationship between their hand eczema and beekeeping activities; they reported worsening of hand eczema or even saw beekeeping as the cause of their hand eczema. Nevertheless, their hand eczema did not seem to greatly influence their activities. Only 3.8 % (6/158) reported less beekeeping because of hand eczema, and the self-reported impact of hand eczema on beekeeping activities was low. However, 15.2 %

(24/158) performed beekeeping activities despite feeling that they should not have done so because of their hand eczema (presenteeism); see Table 3. Also, 12.0 % (19/158) scored the impact of hand eczema on their beekeeping activities as 5 or higher on a scale ranging from 0–10 (data not shown). A notable finding is that the overall severity of hand eczema was significantly higher during the beekeeping season than during the winter rest ( $p < 0.001$ ); see Figure 2.

### Associations between hand eczema and beekeeping

Several continuous variables were compared to assess differences between beekeepers with and without hand eczema

**Table 1** Basic characteristics of the study population.

	Currently active beekeepers (n = 772)
<i>Demographics</i>	
Male, n (%)	596 (77.2)
Age (years), median (IQR)	61.0 (51.0–68.0)
<i>Hand eczema</i>	
Hand eczema, lifetime, N (%)	158 (20.5)
<i>Occupation (in addition to beekeeping)</i>	
Other profession (not high risk for HE), n (%)	450 (58.3)
Hours per week in other profession, median (IQR)	36.0 (30.0–40.0)
Years in other profession, median (IQR)	21.5 (11.8–32.0)

*Abbr.:* HE, hand eczema; IQR, interquartile range.

during the past 12 months. No significant differences were found. Most beekeepers wear gloves during their beekeeping activities. Beekeepers with hand eczema work just as many

**Table 2** Hand eczema characteristics in beekeepers with hand eczema (lifetime).

	Total n = 158 % (n/n <sub>total</sub> )
Age at onset HE < 18 years	20.3 (32/158)
Visit to physician due to HE (lifetime)	58.2 (92/158)
Physician’s diagnosis of HE	71.7 (66/92)
Patch tests performed	30.4 (28/92)
Contact allergy in patch-tested population	78.6 (22/28)
Contact allergy to propolis in patch-tested population	28.6 (8/28)
<i>Past year</i>	
HE during the past 12 months	64.6 (102/158)
<i>Frequency during past year</i>	
HE only once during < 2 weeks	13.7 (14/102)
HE only once during ≥ 2 weeks	17.6 (18/102)
HE more than once	34.3 (35/102)
HE (nearly) all the time	34.3 (35/102)

*Abbr.:* HE, hand eczema.

**Table 3** Impact of beekeeping activities on hand eczema and vice versa in 158 beekeepers with hand eczema (lifetime).

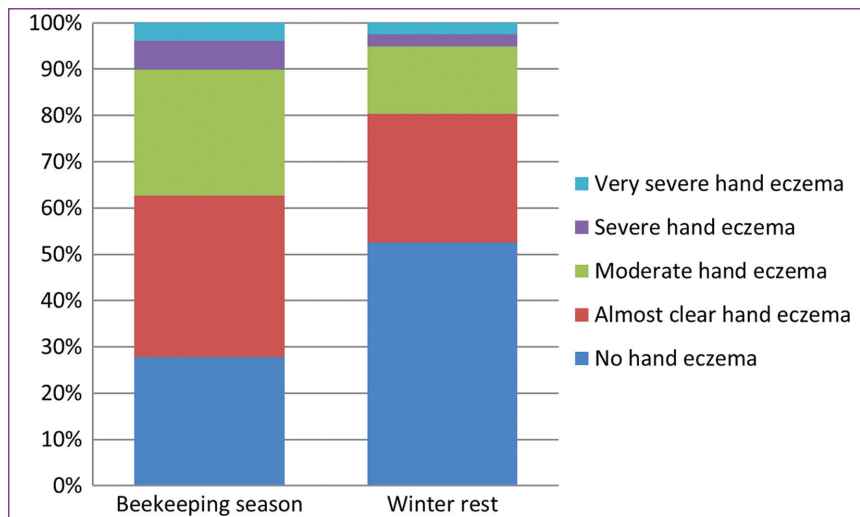
	n (%)
Beekeepers with HE onset after starting beekeeping	91 (57.6)
<i>Years working as a beekeeper at HE onset</i>	
Not yet working as beekeeper	67 (42.4)
Less than 1 year	13 (8.2)
1 to 5 years	25 (15.8)
5 to 10 years	17 (10.8)
More than 10 years	36 (22.8)
<i>Improvement of HE when not beekeeping</i>	
No	49 (31.0)
Yes, most of the time	41 (25.9)
Yes, sometimes	16 (10.1)
Don’t know	52 (32.9)
Beekeeping worsens HE (self-reported)	60 (38.0)
Beekeeping cause of HE (self-reported)	49 (31.0)
Less beekeeping because of HE	6 (3.8)
<i>Presenteeism</i>	
Prevalence during the past 12 months	24 (15.2)
<b>Median (IQR)</b>	
Self-reported impact of HE on beekeeping activities (scale: 0–10)	0 (0–1)

*Abbr.:* HE, hand eczema; IQR, interquartile range.

hours as beekeepers without hand eczema during the season and winter rest (Table 4). A regression analysis was performed to investigate whether individual nominal variables were associated with hand eczema. The only factor found to be significantly associated with hand eczema was a lifetime history of atopic dermatitis ( $p < 0.001$ ); see Table 5.

### Ex-beekeepers

In the group of ex-beekeepers 65.6 % (40/61) were male. The mean age was  $63.9 \pm 14.8$  years. Hand eczema was the reason for quitting beekeeping activities in 6.6 % (4/61) of the ex-beekeepers. In total, 52 ex-beekeepers described their reason for quitting. The most frequently reported reasons were: allergy/anaphylaxis (25.0 %, 13/52), old age and lack of time (both 15.4 %, 8/52).



**Figure 2** Severity of hand eczema during the beekeeping season versus the winter rest (n = 158). The difference is significant (p < 0.001).

## Discussion

The lifetime and one-year prevalence of hand eczema found in our study were higher than those previously reported for the general population, especially considering that the majority of our study group were males, for whom Thyssen et al. reported a lifetime prevalence of 10.0 % and a one-year prevalence of 6.4 % [1]. The question we used to assess self-reported hand eczema has been validated in various occupational groups. It was found to have a sensitivity of 53.0–70.3 % and a specificity of 96.0–99.8 % [19, 20]. This suggests that the self-reported one-year prevalence of hand eczema probably underestimates the true prevalence, suggesting that the real prevalence could be even higher. However, some false-positive answers might have been given to the self-assessment question in case of psoriasis, pustulosis palmoplantaris, or tinea infections [19, 21].

In almost 60 % of the beekeepers with hand eczema, the disease developed after the respondent started to work with

bees. This does not necessarily indicate an association. However, about one third of the beekeepers with hand eczema reported that the disease was caused or worsened by beekeeping activities. In 36 %, the hand eczema improved during a period free of beekeeping. The severity of hand eczema was also significantly higher during the beekeeping season than during the winter rest. However, it must be noted that it has not yet been established whether hand eczema is more frequent or severe in a particular season.

Contrary to the findings described above, only 3.8 % of the beekeepers with hand eczema spent less time on their beekeeping activities because of their hand eczema. Beekeepers are probably quite dedicated to their profession/hobby and accept worsening of their hand eczema, even though they know that it might improve if they were to stop their beekeeping activities. However, this behavior may lead to hand eczema-related presenteeism. One might conclude that hand eczema is not an issue that greatly impacts beekeepers as a group, but it is important to keep in mind the small subgroup

**Table 4** Comparison of continuous variables in cases with and without hand eczema during the past 12 months.

	Hand eczema during past 12 months		
	Yes (n = 102) Median (IQR)	No (n = 670) Median (IQR)	p-value
Age (years)	58.0 (49.8–67.0)	61.0 (51.0–68.0)	0.10
Years working as a beekeeper	8.0 (3.8–35.3)	8.0 (4.0–30.0)	0.95
Mean weekly working hours (season)	7.5 (3.0–16.0)	6.0 (3.0–11.0)	0.23
Mean weekly working hours (winter rest)	1.0 (1.0–3.3)	1.0 (1.0–3.0)	0.85
Amount of bee colonies	8.0 (3.0–14.0)	6.0 (3.0–13.0)	0.50
Percentage of beekeeping time wearing gloves	90.0 (71.0–100.0)	84.5 (65.0–100.0)	0.16

*Abbr.*: HE, hand eczema; IQR, interquartile range.



**Table 5** Univariate binary logistic regression analysis with hand eczema during the past 12 months as dependent variable (n = 102).

	Total % (n/n <sub>total</sub> )	Hand eczema during past 12 months % (n/n <sub>total</sub> )	Crude OR (95 % CI)	p-value
<i>Socio-demographics</i>				
Sex				0.49
Male	77.2 (596/772)	12.8 (76/596)	1.00 (ref.)	
Female	22.8 (176/772)	14.8 (26/176)	1.19 (0.73–1.92)	
<i>Clinical features</i>				
Atopic dermatitis ever				< 0.001
No	87.4 (675/772)	10.2 (69/675)	1.00 (ref.)	
Yes	12.6 (97/772)	34.0 (33/97)	4.53 (2.78–7.38)	
<i>Beekeeping characteristics</i>				
Glove wearing during beekeeping				0.52
Yes, currently	70.9 (547/772)	13.7 (75/547)	1.00 (ref.)	
In the past or never	29.1 (225/772)	12.0 (27/225)	1.17 (0.73–1.87)	
Bee venom allergy (self-reported)				0.73
No	62.3 (481/772)	12.9 (62/481)	1.00 (ref.)	
Yes	37.7 (291/772)	13.7 (40/291)	1.08 (0.70–1.65)	
Bee venom allergy (physician confirmed)				0.08
No	82.5 (240/291)	15.4 (37/240)	1.00 (ref.)	
Yes	17.5 (51/291)	5.9 (3/51)	0.34 (0.10–1.16)	
Other (non-high risk) occupation				0.23
No	41.7 (322/772)	11.5 (37/322)	1.00 (ref.)	
Yes	58.3 (450/772)	14.4 (65/450)	1.30 (0.85–2.00)	

of beekeepers with hand eczema (12.0 %) for whom the disease does have a more profound impact.

The only factor that was associated with hand eczema was a history of atopic dermatitis. This was a predictable finding, since atopic dermatitis is a well-known risk factor for hand eczema [22]. No other associated factors were found. Considering the fairly low mean number of weekly working hours, we regard glove use as a protecting factor against exposure to allergens rather than a potential harmful factor due to irritation. However, this was not demonstrated by our data.

Of the beekeepers with hand eczema who had been patch tested, 78.6 % indicated that they had a contact allergy. A contact allergy to propolis was reported by 28.6 %. The real figure is probably even higher, considering that propolis is

not routinely tested in the Netherlands, so not all patch-tested beekeepers may have been tested with propolis. This rate of contact allergy to propolis is considerably higher than the average rate of around 3.0 % found with patch-tested dermatitis patients, which was reported in a review of 22 studies and again confirmed in a large study by the European Surveillance System on Contact Allergies (ESSCA) [5, 6]. The most likely reason for the high sensitization rate we found is that the extent of propolis exposure is much greater in beekeepers than in a population of patch-tested dermatitis patients.

The sensitizing potential of propolis is closely related to the compounds present in the mixture. The ingredients depend on the geographical location, because they are largely determined by the presence of different species of the genus



*Populus* (poplar) [5, 23]. The finding that almost 25 % of the beekeepers in our study developed hand eczema after more than ten years of beekeeping suggests that either beekeepers protect themselves well, thereby limiting potential exposure to allergens; or the sensitizing potential of propolis in The Netherlands is not very high because of its composition; or there are other factors, unrelated to beekeeping activities, that contribute to the development of hand eczema after more than ten years.

A major limitation of our study is the low response rate, which affects the generalizability of our results. Since recruitment was carried out online, beekeepers throughout the Netherlands were reached. However, the final study population that was analyzed contained only 12 % of the population of beekeepers in the Netherlands. This means that the non-response bias is large. Beekeepers with hand eczema might be more inclined to participate than beekeepers without hand eczema, which could lead to overrepresentation of this group in our sample. A likely cause for the low response rate is that many recipients of the digital newsletter that contained our invitation to participate did not read it. For future research, it would be advisable to draw a sample from the total beekeeper population and approach individuals personally. However, this was not possible for us because the beekeeper organization could not provide personal information about their members. Nonetheless, our response rate was higher than that of the only previous study in a similar population [10]. Although the prevalence rate we found cannot be extrapolated to the whole beekeeper population, this study offers some insight into the characteristics of hand eczema in beekeepers, and may offer avenues that could be explored by future research in this occupational group.

In conclusion, the prevalence of hand eczema in Dutch beekeepers in this study was higher than in the general population. A small subset of beekeepers with hand eczema experiences a large impact of hand eczema on their beekeeping activities, but this impact is small in most beekeepers.

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