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Risk Assessment and Recommendations for Forester Exposure to Hymenoptera

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ABSTRACT

Objective: Ants, bees, hornets, wasps, and yellow jackets (insects in Order Hymenoptera) are potentially a serious concern to outdoor workers, as the venom from their stings can cause life-threatening allergic reactions. This study assessed the impacts of Hymenoptera stings and related worker training regimes of forestry workers across the United States (US).

Methods: A survey was distributed to nearly 2,000 outdoor workers in the forestry industry from four US regions (South, West, Northeast, and Midwest).

Results: Ants are a primary concern in the South, with >75% of participants reporting ant stings within the last 5 years. Bees, hornets, wasps, and yellow jackets are a concern for surveyed foresters in all US regions, with 60–70% and 75–93% of participants, respectively, having been stung by bees or hornets/wasps/yellow jackets within the last 5 years. Despite such a large number of participants experiencing stings, nearly 75% of participants were not concerned about being stung or their reaction to stings. Approximately, 70% of participants reported not having received any safety training related to Hymenoptera from their employers.

Conclusion: No significant difference was shown in the number of foresters stung at work between safety trained and non-safety trained participants. However, it was significantly more likely for participants to carry a first aid kit if they had received Hymenoptera safety training. Consequently, more comprehensive and frequent training should be considered to help reduce risk of exposure to Hymenoptera.

KEYWORDS

Sting; injury; occupational health; outdoor worker; forester

Introduction

Risks associated with Hymenoptera

Many insects in Order Hymenoptera are beneficial; however, venom from stings may cause sensitization or allergic reactions. Because exposure to Hymenoptera occurs at a higher rate in outdoor workers compared to the general public, foresters and other outdoor workers may be at a greater risk for stings. The Centers for Disease Control and Prevention's Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) database identified that from 1999 to 2015, 987 people in the United States (US) died from interactions with hornets, wasps, and bees.¹ Stings may result in a variety of symptoms including local (itching or swelling in a small area), large local (affecting a larger area such as an entire arm or leg), and systemic reactions (such as anaphylaxis) that can be life threatening.² Reactions to stings can vary depending on immune response and type of

Hymenoptera sting. It is not necessary for someone to have a history of reactions to stings for a fatal allergic reaction to happen, and symptom onset can occur rapidly.³ When a victim experiences a severe reaction, 50% of deaths occur within 30 minutes, and 75% of deaths occur within 4 hours of the sting.⁴ Local allergic reactions may have delayed onset and can last up to 10 days.⁵ Approximately, 25% of the human population experience large local reactions to stings.⁶ Large local reactions include swelling of extremities that may negatively impact work activities.⁷ Given the potential for negative reactions, the study of Hymenoptera stings in foresters throughout the US may improve preventive measures to protect worker health, safety, and productivity.

Regional incidence

Hymenoptera is the third largest order of insects with 70 different families and nearly 18,000

different species in North America.⁸ The most easily recognized families in Order Hymenoptera are Apidae (bumblebees and honeybees), Vespidae (yellow jackets, hornets, paper, and potter wasps), and Formicidae (ants). Vespidae, Formicidae, and Apidae species are responsible for the highest number of stings in humans, and this varies by region.⁹ Whether working in wooded areas or open fields, foresters are likely to encounter bees, yellow jackets, wasps, or ants.

Hymenoptera as occupational hazard

Data on fatalities caused by Hymenoptera related injuries were collected by the US Bureau of Labor Statistics between 2003 and 2010 and analyzed.¹⁰ The same study found that of 83 fatal occupational injuries during this time period (involving insects, arachnids, and mites), most (N = 52) were caused by bee stings. In addition to the fatal bee stings, 11 workers died from wasp-related injuries, with 3 of these deaths involving yellow jackets.¹⁰ Most deaths were associated with jobs such as farming, construction, and landscaping.¹⁰ In contrast, there are no known published studies focusing on occupational risk assessment of Hymenoptera exposure in foresters in the US.

One study showed that working in occupations such as bee keeping, bumblebee farming, greenhouse maintenance, agriculture, parks, forestry, gardening, landscaping/grounds keeping, construction, aquaculture facilities (typically surrounded by wooded areas), or transportation increased the risk of anaphylaxis due to the increased potential exposure to Hymenoptera and other insect bites/stings.⁴ Foresters and workers in similar outdoor occupations engage in a variety of activities that can result in unintended exposure to Hymenoptera. There also may be nests camouflaged in forester work areas; hence, they must remain vigilant at all times and cautiously approach areas so nest disturbance is minimized. The increased potential occupational hazard of encountering Hymenoptera sting(s), coupled with a lack of immediate medical resources to respond to envenomation, leads to potentially dangerous situations for foresters working at remote locations. Therefore, it is essential for foresters working in rural, remote locations to have access to necessary medical supplies when the risk of encountering Hymenoptera is present.

Sting precautions

Recommended preventive measures vary depending on the insects to which the workers are at risk of being exposed. Issues of recognition, prevention, and reporting may be complicated by the various Hymenoptera species distributed in different regions and lack of standardized reporting requirements for occupational sting events between agencies. Primary prevention is important to focus efforts on reducing exposure.¹¹ The National Institute for Occupational Safety and Health (NIOSH) recommends that workers wear light-colored, smooth-finished clothing, avoid perfumed soaps/shampoos/deodorant, avoid cologne/perfume, wear clean clothing, bathe daily, and wear clothing that covers as much of the body as possible (long sleeved pants and shirts).¹² Foresters usually wear uniforms, so the light-colored clothing recommendation may not apply to them in some cases. NIOSH also recommends keeping work areas clean, remaining calm if a single stinging insect is flying around, running away if attacked by multiple stinging insects at once, and using caution near ant mounds and/or when lifting items off the ground where ants may be present.¹²

Secondary preventive measures should also be considered so workers can respond effectively to avoid or minimize reactive response to Hymenoptera envenomation. For example, first aid measures after a sting/bite vary, but most often include washing the affected site with soap and water, applying ice to reduce swelling, and applying or ingesting antihistamines.¹² Workers should understand the potential for allergic reactions to stings and know how to recognize symptoms.¹¹ Workers should alert others to potential reactions to insect stings so medical help can be provided immediately, if necessary. One of the most important precautions for those who are severely allergic to Hymenoptera venom is to carry self-injectable epinephrine medication with them at all times. Tertiary prevention measures include first aid training for all workers and wearing a medical alert bracelet if a worker has a known allergy.¹¹

Occupational training

The occupational implications of Hymenoptera hazard-related training for each region are unclear at this time. Given the dangers of Hymenoptera

exposure, it is important that employers provide adequate training to employees about risks of exposure to stinging and biting insects. Employees with greater occupational exposure to Hymenoptera would benefit from learning how to assist coworkers known to experience severe allergic reactions in properly utilizing epinephrine. Workers should also be trained to conduct work during periods when nests/hives are least active to prevent unnecessary exposure.

Even one Hymenoptera sting can evoke a systemic reaction. Occurrence of a severe systemic reaction takes place in approximately 70% of adults who have previously experienced systemic reactions, making occupational training that focuses on protective attire, recognition, and avoidance of contact with Hymenoptera species essential to the health and well-being of workers.¹³ The ability of foresters to correctly identify and respond to Hymenoptera dangers could potentially translate to reduced injuries, increased productivity, and increased morale in the workplace.

Study objectives

The purpose of the current study was to assess exposure risk of foresters to Hymenoptera in the US and provide a basis for recommendations for occupational health and safety training. The study objectives include: 1) quantify the self-reported 5-year history and knowledge of Hymenoptera stings and allergic reactions in foresters working in the US; 2) assess the extent to which the frequency of Hymenoptera stings experienced by foresters differs between regions; and 3) assess the extent to which employer-provided worker training on Hymenoptera exposure risk and prevention varies.

Methods

Participant recruitment

Subjects for this study included consulting/state foresters, parks/recreation employees, and/or National Parks Service employees who had accessible phone/email addresses and who are/were employed in one of 39 states throughout the US in one of four regions: *South*: North Carolina, South Carolina, Virginia, West Virginia, Florida, Georgia, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana; *West*:

Washington, Oregon, California, Idaho, Arizona, Montana, Utah, Colorado, New Mexico, Wyoming; *Northeast*: New York, Pennsylvania, New Jersey, Maine, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont; and *Midwest*: North Dakota, South Dakota, Iowa, Kansas, Nebraska, Ohio, Michigan, and Illinois. These states represent each region and division of the US as it has been split into boundaries by the US Census. States were selected based on regional distribution and the availability of online databases for forestry personnel. Subject selection was generated through online research of forestry employees and members of major government, public corporations, private corporations, clubs, service organizations, and professional organizations.

A total of 1,999 subjects were invited to participate in the study (Invited: South, N = 889; West, N = 438, Northeast, N = 483, Midwest, N = 189). Participants were placed into four groups based on the US region in which they were employed. Informed consent was obtained from all candidates who volunteered to participate in the study (ECU Institutional Review Board #15-001105). Participants were de-identified, and aggregated results were reported.

Survey development and distribution

A 29-question survey (available as a supplemental file) was developed in Qualtrics (Seattle, WA) and distributed to participants via email. Participants were provided a description of the study and asked to give consent to participate before beginning the survey. Two weeks after the initial invitation was sent, the same participants were emailed a reminder to complete the survey. Four weeks after the initial distribution, the survey was closed.

Data analyses

A cross-sectional study was used, and the survey was analyzed assessing the stings over a specified period of time (within the last 5 years from the time the survey was distributed). Statistical analysis software SPSS (IBM, Armonk, New York) was used to conduct chi-square tests of independence to assess: 1) differences between safety trained and non-safety trained employees in sting incidence at work; 2) differences between safety trained and

non-safety trained employees in carrying a medical first aid kit; and 3) differences between allergic and non-allergic employees in carrying a medical first aid kit. P -values < 0.05 were considered statistically significant. The prevalence of participants being stung and number of Hymenoptera stings by each type of Hymenoptera were analyzed between regions using descriptive comparisons. Types of stings (ie., bee, ant, hornet/wasp/yellow jacket) within each region were identified by percentage (total reports of specific type of sting/total responses within the region) and compared to one another to assess where each type of Hymenoptera stings were most prevalent.

Results

Participant demographics

There was a 23.7% (474/1999) total response rate. The total response rate varied by region where participants work/live: South (198/1999; 9.9%), West (94/1999; 4.7%), Northeast (132/1999; 6.6%), and Midwest (60/1999; 3.0%). Of the 474 participants included in the study, 433 (91.7%) were men, 39 (8.2%) were women, and 2 ($<1\%$) had no response. Participants were from the following regions: 198 (41.8%) South, 94 (19.8%) West, 132 (27.9%) Northeast, and 60 (12.7%) Midwest. It is important to note that 31 participants did not specify the geographic location where they work, so these participants were labeled as “unknown” in calculations regarding geographic location. If a participant worked in more than one region, they were counted as an individual person for each region. Therefore, for some calculations, the total number of participants exceeded 474, since some participants were counted multiple times if they worked in more than one region.

Hymenoptera stings

A large portion of participants ($>90\%$) reported experiencing Hymenoptera stings at work. However, despite a large portion of participants experiencing Hymenoptera stings, most ($N = 428$, 90.3%) reported that being stung did not cause them to change their job tasks. Only 34 (7.2%)

participants reported changing their job tasks due to a Hymenoptera sting; ie., going to the hospital/doctor or leaving the area where the Hymenoptera were located and coming back later to complete their task. One participant reported changing their career focus due to Hymenoptera stings; however, this participant remained in forestry, but started buying/selling timber instead of cruising timber regularly. A small portion of participants ($N = 14$, 3.0%) reported suffering economic loss due to Hymenoptera stings (ie., leaving work early because of pain/swelling from stings). Two of the participants had to visit a doctor/hospital due to sting(s); one of these two participants reported having to go to the hospital on two separate occasions. Fewer participants reported being stung by Hymenoptera during recreational activities ($N = 354$, 76.5%) compared to during work ($>90\%$).

Participants were asked to specify how many times they had been stung by an ant, bee, or hornet/wasp/yellow jacket within the last 5 years. These questions refer to the actual number of times the participant had been stung by each type of Hymenoptera and not the rate (number of days) at which stings occurred (Figure 1). Participants reported having been stung by each type of Hymenoptera while at work, with ant stings being the least common ($N = 122$ of 348, 35.1%), bee stings ($N = 192$ of 366, 52.5%) occurring a large portion of the time, and hornet/wasp/yellow jacket stings occurring the majority of the time ($N = 292$ of 419, 69.7%). The Hymenoptera type of greatest concern was determined by calculating which type was responsible for the most reported stings per region (Figure 2). Ant stings were commonly reported in the South, and bees, hornets, wasps, and yellow jackets were commonly reported in all four regions.

Participants were asked to report what type of immune response(s) they experienced if they were stung by an ant, bee, hornet, wasp, or yellow jacket (Table 1). The most common reported symptom for all kinds of Hymenoptera stings was a local skin reaction, with 198 ($N = 289$ reactions, 68.5%) participants reporting such reaction from an ant sting, 277 ($N = 364$ reactions, 76.1%) from a bee sting, and 357 ($N = 468$ reactions, 76.3%) from a hornet, wasp, or yellow jacket sting (Table 1).

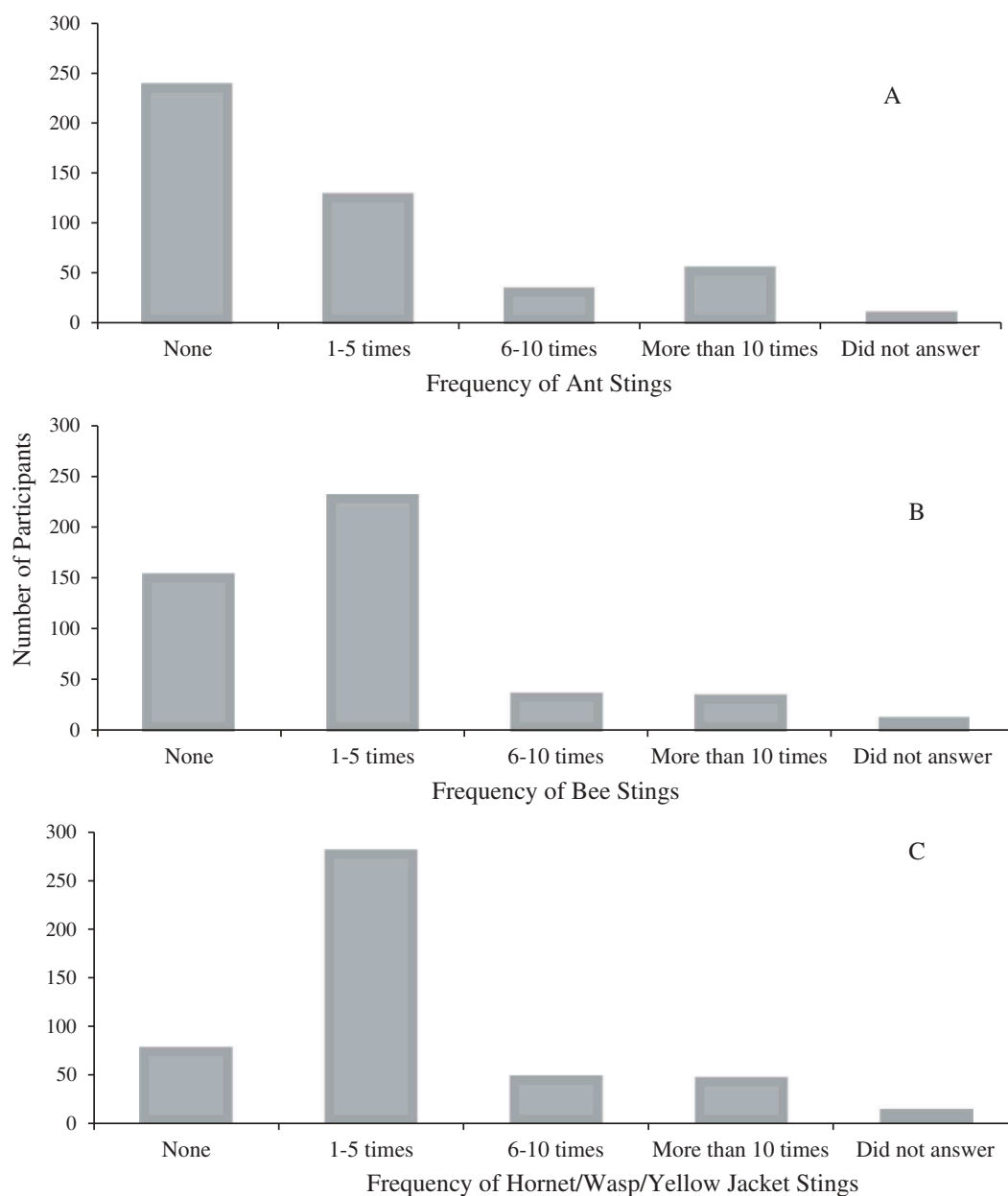


Figure 1. Frequency of stings by a) ants, b) bees, or c) hornet/wasp/yellow jacket in the last five years (all regions, N = 474).

Worker training and safety

Foresters were asked if they received any type of Hymenoptera safety training from their employers. This training would generally involve education on risk of exposure to Hymenoptera, how to protect oneself from Hymenoptera, and what to do if stung/exposed to various types of Hymenoptera. A majority of the participants (N = 329, 69.4%) reported not having had this type of safety training, with only 132 participants (27.8%) reporting having had this type of safety training: 13 participants (2.7%) did not specify whether or not

training had been provided by their employer. Participants were also asked to specify the topics that were covered in their safety training (if they had training) and how long the training lasted. Of the 132 participants that reported having had training, 122 (95.3%) reported the training lasted less than one day, 4 (3.1%) reported the training lasted one day, and 2 (1.6%) reported the training lasted more than 2 days. Topics covered in training included: what should be done when stung/bitten (24%), risk of exposure to Hymenoptera (22%), adverse effects of Hymenoptera stings

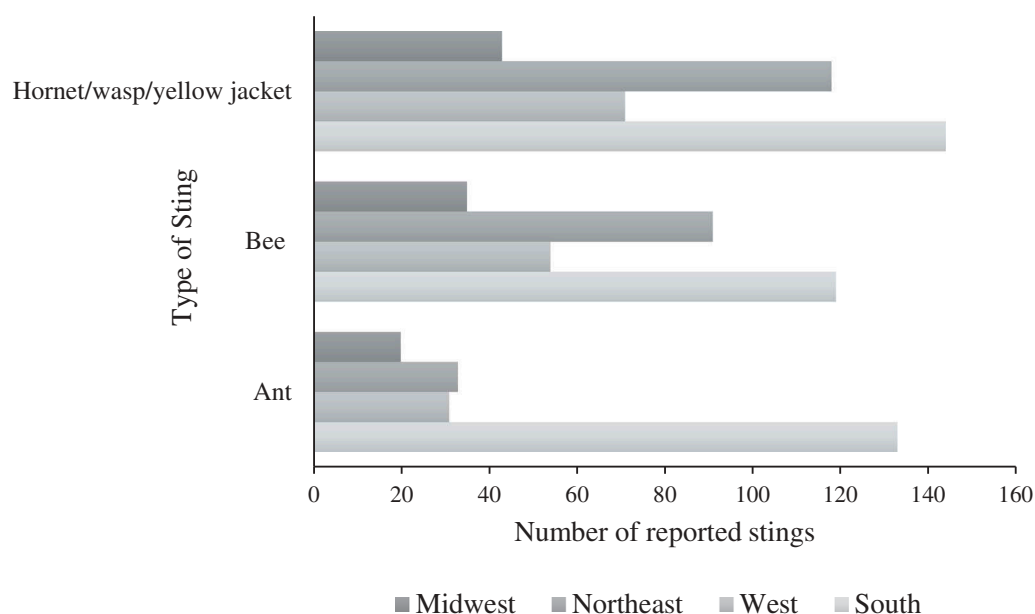


Figure 2. Types of Hymenoptera stings by region.

Table 1. Reported symptoms associated with various types of Hymenoptera stings.

Symptom	Ant Sting N (% out of 289 responses)	Bee Sting N (% out of 364 responses)	Hornet/Wasp/Yellow Jacket Sting N (% out of 468 responses)
No Reaction	74 (25.6)	40 (11.0)	27 (5.8)
Local Skin Reaction	198 (68.5)	277 (76.1)	357 (76.3)
Large Local Reaction	5 (1.7)	24 (6.6)	47 (10.0)
Gastrointestinal Reaction	0 (0)	2 (0.6)	5 (1.1)
Respiratory Reaction	1 (0.4)	3 (0.8)	5 (1.1)
Cardiovascular Reaction	0 (0)	1 (0.3)	4 (0.9)
Other*	9 (3.1)	10 (2.7)	17 (3.6)
Not Applicable	1 (0.4)	7 (1.9)	6 (1.3)

*"Other" reactions listed by participants included: pain, dizziness, feeling lightheaded, anger, itching, swelling, panic attack, fainting, bruising, fatigue, chills, irritation, stiff joints, and weird dreams.

(21%), what should be done to prevent stings/bites (19%), insect identification (11%), and other (3%).

Protective measures taken by participants to limit exposure to Hymenoptera were also assessed and included: wearing long pants (70.3%), wearing long-sleeved shirts (53%), other (34%), using insect repellent (33.5%), avoiding wearing cologne/perfume (25.7%), wearing gloves (21.5%), and wearing light colored clothing (20.3%). More than half of the participants reported not carrying a first aid kit. Foresters that did report carrying a first aid kit with supplies to treat Hymenoptera stings (N = 221, 47.7%) reported the most common supplies carried to treat stings were antihistamines, epi-pen (injectable epinephrine), and sting relief cream.

Participants' opinions on Hymenoptera were also assessed (Table 2). The largest percentage of participants (34.9%) agree that Hymenoptera are

a nuisance where they live as well as where they work (38.6%). Many participants (32.7%) disagreed that they are concerned about their physical reaction to Hymenoptera stings, and (34.0%) also disagreed that they are anxious about Hymenoptera stings. Lastly, the largest percentage of participants (40.9%) were neutral in regards to wanting to know more about how to identify Hymenoptera and their habitats in the field.

There was no significant difference ($X^2 = 1.436$, $P = 0.230$) among those being stung at work between those that received Hymenoptera safety training and those that did not receive training. However, participants receiving Hymenoptera training were significantly ($X^2 = 30.367$, $P < 0.001$) more likely to carry a medical first aid kit with supplies to treat injuries resulting from

Table 2. Opinions on Hymenoptera.

	Strongly agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly disagree N (%)
Hymenoptera are a nuisance where I live	29 (6.1)	163 (34.9)	126 (26.6)	115 (24.3)	26 (5.5)
Hymenoptera are a nuisance where I work	37 (7.8)	183 (38.6)	109 (23.0)	104 (21.9)	26 (5.5)
I am concerned about my physical reaction to Hymenoptera stings	19 (4.0)	86 (18.1)	127 (26.8)	155 (32.7)	69 (14.6)
I am anxious about Hymenoptera stings	11 (2.3)	56 (11.8)	109 (23.0)	161 (34.0)	118 (24.9)
I would like to learn more about how to identify Hymenoptera and their habitats in the field	18 (3.8)	122 (25.7)	194 (40.9)	87 (18.4)	36 (7.6)

Hymenoptera stings compared to those that did not receive training. Participants with known allergies to stings ($N = 50$ of 474, 10.6%) were significantly ($X^2 = 8.685$, $P < 0.001$) more likely than non-allergic individuals to carry a medical first aid kit that included supplies to treat stings.

Discussion

In the current study, we quantified the 5-year self-reported history of Hymenoptera exposure. Foresters working in the South experienced the highest prevalence of Hymenoptera stings (>70% for each type of Hymenoptera surveyed). However, this should be interpreted with caution, since a higher number of survey participants were from the South, as forestry is a large industry in the South compared to other regions of the US. However, foresters surveyed throughout the US (all regions) experienced negative side effects from Hymenoptera stings, suggesting that all regions should provide outreach to the foresters on preventing stings.

A large number of participants in this study reported not receiving employer training about Hymenoptera. Hence, this is one area where change could occur. Another study showed that, in general, the general public (not specifically foresters) are not efficient at distinguishing stinging insects and their nests, with the exception of the honeybee.¹⁴ Foresters should be trained on Hymenoptera and habitat identification to inform them about potential encounters with stinging Hymenoptera.

The ability to treat injuries from Hymenoptera stings on site when they occur is another area that may improve worker health and safety. It is necessary for foresters to have the supplies needed to treat these potential sting reactions. Most participants in this study did not carry a medical first aid kit and/or did not have supplies for treating stings

(eg., antihistamines such as Benadryl® [diphenhydramine], anti-itch cream, or an injectable epinephrine kit such as an Epi-pen®). Training on administration of injectable epinephrine is another area that needs improvement to protect worker health. Training should include a discussion of drowsiness side effects of some oral antihistamines and caution about operating heavy/dangerous equipment if taking oral antihistamines. Here, participants receiving Hymenoptera training and those with known allergies were significantly more likely to carry a medical first aid kit than those that did not receive training. This suggests an increased level of awareness of the potential dangers of stings can lead to increased preventative measures. More work should be done to evaluate the extent to which carrying a medical first aid kit mitigates harm that occurs after Hymenoptera stings. Furthermore, the current study did not assess whether foresters chose to carry their own kits versus having kits required/provided for them by employers (nor whether or not kits contained Benadryl® and/or Epi-pen®), therefore, this could be investigated further. A future study could investigate the potential financial burden resulting from Hymenoptera stings to analyze medical costs, repercussions of lost work time, and other related factors. A majority of participants (>50%) in this study reported not being concerned about their physical reaction to Hymenoptera stings. One way to address attitude change is with education. Considering the small number of participants that reported having Hymenoptera safety-related training provided by employers, it is clear that employers must increase educational programs on Hymenoptera risk and worker safety.

One important strength of this study is the analysis of participants from different US regions. This is

helpful in determining patterns about various Hymenoptera that may vary between regions. However, there was a low overall response rate, and the responses were not distributed equally for all regions. Obtaining contact information online for foresters was difficult, as some states had forester contact databases while others did not. Consequently, this selection process could have excluded foresters that did not have contact information in online databases. Other possible limitations of the study include the age and gender of participants represented, as well as participants' ability to correctly identify various types of Hymenoptera. Most (67%) participants were between 50 and 69 years old, and their age/experience could have influenced their opinions compared to younger/inexperienced foresters. The retrospective and self-reporting nature of the survey could have also been a limitation, as participants could have had difficulty recalling their history of stings. A large percentage (>90%) of respondents reported being stung by Hymenoptera at work; therefore, responses were potentially biased toward this group. Only 48 (10.1%) of the participants were women, so this is possibly an underrepresented group, depending on the gender distribution of foresters, in general. A larger scale study focusing on age and gender of foresters could determine a more accurate representation and general distribution of these factors in forestry. This study did not assess participants' ability to correctly identify insects, so it is possible the reported number of stings by type of Hymenoptera could be inaccurate if a participant confused the different types.

Conclusion

Hymenoptera such as ants, bees, hornets, wasps, and yellow jackets are found throughout the US and pose a threat to outdoor workers such as foresters. This study shows that employers should consider increasing worker education on Hymenoptera identification and exposure risk. Employees should consider carrying a medical first aid kit, learning how to identify the various Hymenoptera and their nesting habits, as well as learning how to administer an injectable epinephrine in case of an emergency situation. Future studies could be conducted focusing on specific

regions of the US to better identify specific regional issues. It would also be beneficial to focus on factors contributing to Hymenoptera exposure so that training could be tailored to specific situations. More work should be done to evaluate how training, medical first aid kits, and other safety measures mitigate potential harm caused by Hymenoptera stings. Future research might include a prospective, randomized controlled trial of specific interventions to decrease foresters' risk of exposure to Hymenoptera.

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Institution and Ethics Approval and Informed Consent

This study was approved by East Carolina University Institutional Review Board project #15-001105. Participant information was de-identified and results were reported in aggregate to ensure confidentiality.

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- (3) What is your age?
 - a. 18–19
 - b. 30–39
 - c. 40–49
 - d. 50–59
 - e. 60–69
 - f. ≥70
 - (4) What is your gender?
 - a. Male
 - b. Female
 - c. Other
 - (5) What is your ethnicity?
 - a. Caucasian
 - b. African American
 - c. Latino
 - d. Asian American
 - e. Pacific Islander
 - f. Native American
 - g. Multiracial
 - h. Other, please list _____
 - (6) Please list types of work activities you commonly carry out.

 - (7) Do you have any known allergies to Hymenoptera (e.g. ant, bee, hornet, wasp, yellow jacket)?
 - a. No (skip to Question 9)
 - b. Yes. If so, please specify. _____
 - (8) If you answered yes to Question 7, when (e.g. as an adult or as a child) and how (e.g. at home or at work) did you discover this allergy?

 - (9) Have you ever been stung by Hymenoptera (e.g. ant, bee, hornet, wasp, yellow jacket) at work?
 - a. No
 - b. Yes. If so, what work activity were you doing when the sting occurred?

 - (10) Did you change your job tasks because of Hymenoptera sting reaction?
 - a. No
 - b. Yes. If so, please explain. _____
 - (11) Did you change your career focus because of Hymenoptera sting reaction?
 - a. No
 - b. Yes. If so, please explain. _____
 - (12) Did you suffer economic loss because of Hymenoptera sting reaction?
 - a. No
 - b. Yes. If so, please explain. _____
 - (13) Please list types of outdoor recreational activities in which you commonly participate.

 - (14) Have you ever been stung by Hymenoptera (e.g. ant, bee, hornet, wasp, yellow jacket) during recreational activities (home or vacation)?

Appendix

(ECU UMCIRB Approval #15–001105)

Survey Instrument (will be translated into Spanish)

- (1) What is your household street address and city where your gift card should be mailed (when you win in the drawing)?

- (2) Please list the county or counties and state(s) where you primarily carry out forestry work?

- a. No
b. Yes. If so, what recreational activity were you doing when the sting occurred?

- (15) Within the last five years, how many times have you been stung by an ant?
a. None
b. 1–5 times
c. 6–10 times
d. >10 times
- (16) If you have been stung by an ant within the last five years, did the sting occur while you were at work?
a. No
b. Yes. If so, please describe the activity you were doing at the time of the sting.

- (17) If stung by an ant, your symptoms included: (Check all that apply)
a. No reaction
b. Local skin reaction (e.g. minor swelling, redness, itching)
c. Large local reaction (e.g. swollen appendage [e.g. arm, leg])
d. Gastrointestinal reaction (stomach pain, nausea, vomiting)
e. Respiratory reaction (e.g. difficulty swallowing, hoarseness)
f. Cardiovascular reaction (e.g. hypotension)
g. Other. Describe _____
- (18) Within the last five years, how many times have you been stung by a bee?
a. None
b. 1–5 times
c. 6–10 times
d. > 10 times
- (19) If you have been stung by a bee within the last five years, did the sting occur while you were at work?
a. No
b. Yes. If so, please describe the activity you were doing at the time of the sting.

- (20) If stung by a bee, your symptoms included: (Check all that apply)
a. No reaction
b. Local skin reaction (e.g. minor swelling, redness, itching)
c. Large local reaction (e.g. swollen appendage [e.g. arm])
d. Gastrointestinal reaction (stomach pain, nausea, vomiting)
e. Respiratory reaction (e.g. difficulty swallowing, hoarseness)
f. Cardiovascular reaction (e.g. hypotension)
g. Other. Describe _____
- (21) Within the last five years, how many times have you been stung by a hornet, wasp, or yellow jacket?
a. None
b. 1–5 times
c. 6–10 times
d. > 10 times
- (22) If you have been stung by a hornet, wasp, or yellow jacket within the last five years, did the sting occur while you were at work?
a. No
b. Yes. If so, please describe the activity you were doing at the time of the sting.

- (23) If stung by a hornet, wasp, or yellow jacket, your symptoms included: (Check all that apply)
a. No reaction
b. Local skin reaction (e.g. minor swelling, redness, itching)
c. Large local reaction (e.g. swollen appendage [e.g. arm])
d. Gastrointestinal reaction (stomach pain, nausea, vomiting)
e. Respiratory reaction (e.g. difficulty swallowing, hoarseness)
f. Cardiovascular reaction (e.g. hypotension)
g. Other. Describe _____
- (24) How do you protect yourself from stings from Hymenoptera? Check all that apply.
a. Wear long-sleeved shirt
b. Wear long pants.
c. Wear light-colored clothing.
d. Wear gloves.
e. Apply insect repellent.
f. Avoid wearing cologne or perfume.
g. Other. Please specify. _____
- (25) While at work, do you carry a first aid kit or other medical supplies to treat Hymenoptera bites/stings if they were to occur?
a. No
b. Yes. If so, please describe the types of medical supplies.

- (26) Did you undergo any training from your employer related to risk of exposure to Hymenoptera and/or how to protect yourself from them at work?
a. Yes
b. No (skip to Question 29)
- (27) If you answered yes to Question 26, how long was your Hymenoptera-related training?
a. Less than 1 day
b. 1 day
c. 2 days
d. More than 2 days
- (28) If you answered yes to Question 26, what topics were covered in your Hymenoptera-related training? Check all that apply.
a. Risk of exposure to Hymenoptera (e.g. how you get exposed)
b. Insect identification
c. Adverse effects of Hymenoptera stings
d. What you should do when you get stung or bitten

- e. What you should do to prevent getting stung or bitten
- f. Others. Please specify. _____
- (29) Indicate your level of agreement or disagreement for the following statements:
- a. Hymenoptera are a nuisance where I live.
Strongly Agree Agree Neutral Disagree
Strongly Disagree
- b. Hymenoptera are a nuisance where I work.
Strongly Agree Agree Neutral Disagree
Strongly Disagree
- c. I am concerned about my physical reaction to Hymenoptera stings.
Strongly Agree Agree Neutral Disagree
Strongly Disagree
- d. I am anxious about Hymenoptera stings.
Strongly Agree Agree Neutral Disagree
Strongly Disagree
- e. I would like to learn more about how to identify Hymenoptera and their habitats in the field.
Strongly Agree Agree Neutral Disagree
Strongly Disagree