**Title:**

Knowledge of preventive measures against occupational asthma and allergies in Bavarian agriculture apprentices.

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**Background**

Occupational asthma and allergies are potentially preventable diseases{Tarlo:2014bt}. However, 5-15% of asthma cases in the adulthood are due to the occupation, and estimates for allergies are moving at a similar pace{Peden:2010cz}. Occupational asthma is defined as a disease attributable to the occupational environment and not to stimuli outside the workplace, and characterized by variable airflow limitation as well as hyperresponsiveness under inflammatory conditions{Baur:2012ew}. Similarly, occupational allergies -such as occupational rhinitis- are inflammatory diseases of the nose, also characterized by variable nasal airflow limitation and/or hypersecretion due to conditions of the occupational environment{Ameille:2013jv}. In Bavaria, at least 21,000 apprentices are trained every year in occupations with an increased risk of allergies, i.e. farmers, hairdressers, bakers and metalworkers (citation needed), and for many of these trainees, presenting allergic symptoms means a premature end of training. About 9% of young Bavarians drop out of training{Patuzzi:2012ux}, and approximately one-third of the young people who drop out due to health reasons suffer from skin and respiratory diseases{Thomas:2005ut}. Respiratory causes, including as thma and allergies, are the most common occupational diseases in industrialized countries{Peden:2010cz}, and generate great costs: Current estimates from the UK on direct and indirect lifetime costs per average case of occupational asthma range from £120k to £130k (170.000 to 185.000€) .{Ayres:2011ki} Generally speaking, the higher the exposure, the higher the risk of disease.

The development of work-related allergies or asthma not only has consequences in terms of health status, but can also make re-training necessary. Unemployment is very common due to the lack of alternatives for a job in the same area without known asthma and allergy risk {Mahmud:2010tw, Vandenplas:2011wt}. In addition to technical and organizational measures at the workplace, personal protective measures are recommended in order to prevent the occurrence or limit the damage of work-related allergies and asthma{Moscato:2011vc, Tarlo:2005ua}. Unfortunately, the acceptance of these measures -especially during training age- is often low. This is probably related to a lack of interest and personal relevance. As young adults do not commonly present severe symptoms of allergic reactions, they do not feel the need to change their behavior regarding the use of personal protective equipment. Currently, only about a third of employees adhere to the recommended preventive measures{Kutting:2009bd}. Unfortunately, there is not specific data in this context, but it is assumed that the use of personal protective equipment among trainees is no better than that of those who have been longer active in the profession. Occupational asthma and allergies have not been yet systematically integrated to study curricula of German general education and vocational schools. This is due, among other things, to the fact that teachers consider themselves not sufficiently competent on the subject. The Social Security of Agriculture, Forestry and Horticulture (SVLFG) provides vocational schools with the required study curriculum for occupational safety and health. It has not yet been studied whether trainees effectively implement preventive measures recommended by the SVLFG.

Therefore, we designed an educational intervention using mobile communication technologies (mHealth) aimed at young trainees in agricultural settings in Bavaria, with the objective of improving primary prevention measures against asthma and allergies from a current 30% to at least 60%.

**Methods**

Design and Participants

Agriculture students on their second and third year of training from Upper Bavaria (Töging a. Inn, Rosenheim, Miesbach, Ebersberg, Fuerstenfeldbruck and Ingolstadt) were personally invited to participate from March to April 2014 in this 6-month, two-armed, prospective, controlled interventional study. All students were asked to fill out a questionnaire and a consent form. Before the beginning of the study, twelve dates were set for visiting the students at their place of study as part of their training. The recruitment of participants for the control and intervention groups was performed during theses visits, and the number of participants, as well as the region, was considered in order to rule out systematic error.

On dates that served to recruit participants in the intervention group, and after participants had completed the questionnaire, an educational film on the subject of allergies and asthma in farmers was shown to the students. Following the intervention, all participants received weekly reminders by SMS about the implementation of preventive measures. The control group received no specific information. Six months after recruitment (September – October 2014), all study participants were contacted for a telephonic post-intervention survey.

Inclusion of Study Participants

All trainees from the agriculture field in Upper Bavaria who had already turned 18 years of age were eligible to participate. Since the implementation of the intervention and the post-intervention survey was only possible after providing personal information (name, address, phone number, email address and date of birth), only those who signed the informed consent and successfully completed the questionnaire could be included.

Questionnaire

The baseline questionnaire included sociodemographic factors (year of birth and school), smoking behavior, contact with animals and plants, as well as personal and family history of respiratory problems. Additionally, everyday work behavior and personal views and knowledge regarding prevention of allergies and asthma were interrogated.

The post-intervention survey matched the baseline questionnaire, and questions regarding the extent of the use of various media (especially smart phones, Internet, e-mail) were added. Furthermore, each type of intervention was evaluated (film, SMS reminders, questionnaire). Finally, participants were enquired on their attitude towards health.

Statistical Analysis

Data were analyzed using descriptive statistics. For categorical variables, absolute and relative frequencies were calculated, and hypothesis testing was performed using Pearson’s chi-squared test or Fisher’s exact test accordingly. Continuous variables are presented as mean ± standard deviation. Univariate and multivariate logistic regression models were performed to assess factors such as baseline survey response and intervention allocation on post-intervention knowledge of preventive measures against asthma and allergies. All statistical analyses were performed using R Statistical Software version 3.1.3.

Ethics Approval (pending)

**Results**

Between March and April, a total of 314 second- and third-year agriculture students were personally invited, and 238 of them agreed to participate (75.80%). However, out of these 238 students, 121 could not be included in the intervention due to required missing information on the consent form. Therefore, intervention analyses were only performed on 117 students, which represent a response rate of 37.26% (See Figure 1). There were no statistically significant differences regarding baseline characteristics between subjects included and not included in the intervention (Table 8).

The complete baseline sample included 238 subjects, whose characteristics are summarized in Table 1. Overall, the baseline sample were mostly men (91.56%), with a mean age of 20.61 (*sd* 2.77), and non-smokers (63.87%). About a third of respondents stated they had presented at least one episode of allergic rhinoconjunctivitis in the past year, and about a fifth answered positively to parental asthma (Table 2). Table 3 shows statistically significant differences between smokers and non-smokers regarding parental asthma (53.96% vs. 46.94%, respectively, chi-squared *p-*value = 0.01). Regarding risk perception, the majority of the baseline sample thinks it is very bad to get allergies (86.55%), while believing it unlikely to get allergies in the next 5 years (89.92%) (Table 5). At least 70% of the baseline study population answered correctly when asked about knowledge of preventive measures against asthma or allergic rhinitis (Table 4). In fact, about 86% of respondents stated that they do not wear work clothes at home, making it the highest rate of correct answers on knowledge of preventive measures. Table 6 shows no statistically significant differences on the correct answer of preventive measures between those who answered positively to asthma symptoms, allergic rhinoconjunctivitis, or parental asthma, and those who answered negatively. However, there were statistically significant differences on risk perception among subjects who do not wear work clothes at home, specifically between those who think it is very bad to get allergies and those who think otherwise (88.35% vs. 28.12%, Fisher’s exact test *p*-value = 0.02) (Table 7).

Table 8 shows no statistically significant differences on the baseline characteristics between those who dropped out from baseline and those who followed up and joined the intervention phase, except on the place of study. In those who joined the intervention phase (n=117), the highest participation rate was in Rosenheim (29.91%) and the lowest in Ingolstadt (2.56%). Subjects were on average 20.64 years old (*sd* 3.03 years), and mostly men (88.79%). A third of the subjects stated that they had presented allergic rhinoconjunctivitis in the past year, and about 6% of them had been diagnosed with asthma by a physician (Table 8).

Similarly as the baseline sample and regarding the preventive behavior against asthma or allergic rhinitis, at least 70% of respondents stated the correct response (Table 8). In fact, 86% of subjects also reported the correct answer for *not wearing work clothes at home*. Seventy out of these 117 subjects were randomized to the intervention group, while 47 were randomized to the control group. However, only 49 out of these 117 subjects completed the intervention phase (18 subjects in the intervention group and 31 subjects in the control group). Table 9 shows statistically significant differences between subjects who completed the intervention phase and those who did not, in several baseline characteristics, such as place of study, educational level, parental asthma, and age (*p*-values: < 0.001, 0.04, 0.02 and 0.01, respectively). These differences pose some limitations to this study (see the Discussion section).

Table 10 shows baseline characteristics for the intervention (n=18) and control groups (n=31), and reports no statistically significant differences between them (except for place of study). Furthermore, there were no statistically significant differences on the proportions between the intervention and the control groups at baseline and follow-up (Table 11). (Adjusted and unadjusted) logistic regression analyses of the odds of a correct answer on knowledge of preventive measures against asthma and allergies at follow-up, given intervention status are displayed in Tables 12 and 13, (respectively). The adjustment of each model was performed on the answer to that same question at baseline. Both the adjusted and unadjusted model for wearing work shoes at home show approximately a statistically significant 80% reduction in the risk of answering it wrong when in the intervention group (unadjusted OR: 0.21, 95% CI: 0.06-0.77, *p*-value: ; adjusted OR: 0.19, 95%CI 0.05-0.75, *p*-value: ). The rest of the odds ratios, although non-significant, show an effect in the desired direction, namely that the odds of providing a correct answer increases in the intervention group.

**Discussion (pending)**

**Aknowledgements (pending)**

**Tables and Figures:**

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| **Table 1.** Sociodemographic characteristics of the study population (n = 238). | | | |
| **Total, n (%)** | | **238** | **(100)** |
| Sex, n (%) | |  |  |
|  | Male | 217 | (91.56) |
|  | Female | 20 | (8.44) |
| Age, mean (SD) | | 20.61 | (2.77) |
| Educational level, n (%)\* | |  |  |
|  | Hauptschulabschluss | 101 | (43.35) |
|  | Realsch. + Fachhochschulreife + Abitur | 132 | (56.65) |
|  |  |  |  |
| Smoking status, n (%) | |  |  |
|  | Non-smoker | 152 | (63.87) |
|  | Smoker | 86 | (36.13) |
|  |  |  |  |
| Asthma Symptoms §  Rhinoconjunctivitis  Parental Asthma | | 19 | (7.98) |
| 75 | (31.51) |
| 49 | (20.68) |
|  | |  |  |
| Risk perception | |  |  |
|  | How likely will it be to get allergies in the next 5 years? (Very likely) | 24 | (10.08) |
|  | How bad is it to get allergies? (Very bad) | 206 | (86.55) |
| NA: missing value.  \* pending: translation for these terms.  § Defined as self-reported wheezing or buzz in chest during the past year, wheezing or buzz in chest without a cold during the past year, or currently taking medication for asthma. | | | |

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| **Table 2.**  Knowledge of preventive measures against respiratory symptoms (n = 238). | | | | | | | | | | | | | | | |
|  | Total, n (%) | |  | Asthma symptoms§, n (%) | | |  | Rhinoconjunctivitis, n (%) | | |  | Parental Asthma, n (%) | | |  |
|  |  | |  | Yes | No | *p*-value |  | Yes | No | *p*-value |  | Yes | No | *p*-value |  |
| Hair washing after work (yes) | 167 | (70.17) |  | 14 (73.68) | 153 (69.86) | 1.00 |  | 59 (78.67) | 108 (66.26) | 0.07 |  | 40 (81.63) | 127 (67.55) | 0.08 |  |
| Use of work shoes (no) | 52 | (21.85) |  | 18 (94.74) | 168 (76.71) | 0.08 |  | 62 (82.67) | 124 (76.07) | 0.33 |  | 39 (79.59) | 146 (77.66) | 0.92 |  |
| Keeping work clothes away (yes) | 199 | (83.61) |  | 15 (78.95) | 184 (84.02) | 0.53 |  | 62 (82.67) | 137 (84.05) | 0.94 |  | 39 (79.59) | 160 (85.11) | 0.47 |  |
| Disinfecting stables (no) | 79 | (33.19) |  | 15 (78.95) | 144 (65.75) | 0.31 |  | 54 (72.00) | 58 (64.42) | 0.31 |  | 36 (73.47) | 122 (64.89) | 0.34 |  |
| Use of protective goggles (no) | 45 | (18.91) |  | 14 (73.68) | 179 (81.74) | 0.37 |  | 58 (77.33) | 135 (82.82) | 0.41 |  | 38 (77.55) | 154 (81.91) | 0.62 |  |
| Not wearing work clothes at home (yes) | 205 | (86.13) |  | 17 (89.47) | 188 (85.84) | 1.00 |  | 66 (88.00) | 139 (85.28) | 0.72 |  | 41 (83.67) | 164 (87.23) | 0.68 |  |
| § Defined as self-reported wheezing or buzz in chest during the past year, wheezing or buzz in chest without a cold during the past year, or currently taking medication for asthma. | | | | | | | | | | | | | | | |

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| **Table 3 – Logistic regression results for subjects who answered all 6 preventive measures correctly (n = 53).** | | | | | | |
|  | | **Knowledge**  **(n, %) (yes to all 6)** | | **Crude OR (95% CI)** | **Adjusted OR (95% CI)** | |
| **Age** | **Younger (18-24 yo)** | 50 | 22.32 | 1 | 1 | |
|  | **Older (25-44 yo)** | 3 | 25.00 | 1.12  (0.29 – 4.30) | 0.88  (0.22 – 3.59) | |
|  | | | | | | |
| **Sex** | **Female** | 8 | 40.00 | 1 | 1 | |
| **Male** | 45 | 20.74 | 0.41  (0.16 – 1.06) | 0.40  (0.15 – 1.08) | |
|  | | | | | | |
| **Smoking status** | **Non-smoker** | 32 | 21.05 | 1 | 1 | |
| **Smoker** | 21 | 24.42 | 1.19  (0.63 – 2.23) | 1.24  (0.63 – 2.44) | |
|  | | | | | | |
| **Ed. level** | **Hauptschulabschluss** | 18 | 17.82 | 1 | 1 | |
| **Realschulabschluss + Fachhochschul. + Abitur** | 35 | 26.52 | 1.64  (0.86 – 3.11) | 1.60  (0.81 – 3.16) | |
|  | | | | | | |
| **Risk perception** | **High level** | 18 | 26.87 | 1 | 1 | |
|  | **Low level** | 35 | 20.47 | 0.72  (0.37 – 1.40) | 1.05  (0.50 – 2.21) | |
|  | | | | | | |
| **Asthma or Rhinoconjunctivitis** | **No** | 31 | 19.62 | 1 | 1 | |
| **Yes** | 22 | 27.50 | 1.62  (0.86 – 3.04) | 1.37  (0.68 – 2.78) | |
|  | | | | | | |
| **Parental asthma** | **No** | 37 | 19.68 | 1 | | 1 |
| **Yes** | 16 | 32.65 | 2.04  (1.01 – 4.11)\* | | 1.89  (0.88 – 4.05) |
|  | | | | | | |
| \* Statistically significant. | | | | | | |

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| **Appendix Table 1 – Sensitivity analysis for subjects who answered 4 or more preventive measures correctly (n = 206).** | | | | | | |
|  | | | **Knowledge**  **(n, %) (yes to at least 4)** | | **Crude OR (95% CI)** | **Adjusted OR (95% CI)** |
| **Sex** | | **Female** | 17 | 85 | 1 | 1 |
| **Male** | 188 | 86.54 | 1.31  (0.36 – 4.77) | 1.34  (0.36 – 17.41) |
|  | | | | | | |
| **Smoking status** | | **Non-smoker** | 130 | 85.53 | 1 | 1 |
| **Smoker** | 76 | 88.37 | 1.25  (0.54 – 2.90) | 1.32  (0.55 – 5.02) |
|  | | | | | | |
| **Ed. level** | | **Hauptschulabschluss** | 84 | 83.17 | 1 | 1 |
| **Realschulabschluss + Fachhochschul. + Abitur** | 119 | 90.15 | 1.62  (0.73 – 3.58) | 1.64  (0.72 – 3.18) |
|  | | | | | | |
| **Risk perception** | | **High level** | 59 | 88.06 | 1 | 1 |
|  | | **Low level** | 147 | 85.96 | 0.81  (0.33 – 2.00) | 0.96  (0.36 – 3.74) |
|  | | | | | | |
| **Asthma or Rhinoconjunctivitis** | **No** | | 135 | 85.44 | 1 | 1 |
| **Yes** | | 71 | 88.75 | 1.56  (0.63 – 3.84) | 1.38  (0.52 – 2.56) |
|  | | | | | | |
| **Parental asthma** | **No** | | 164 | 87.23 | 1 | 1 |
| **Yes** | | 42 | 85.71 | 1.21  (0.43 – 3.37) | 1.05  (0.35 – 3.67) |
|  | | | | | | |

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| **Appendix Table 2 – Sensitivity analysis for subjects who answered 5 or more preventive measures correctly (n = 146).** | | | | | |
|  | | **Knowledge**  **(n, %) (yes to at least 5)** | | **Crude OR (95% CI)** | **Adjusted OR (95% CI)** |
| **Age** | **Younger (18-24 yo)** | 137 | 61.16 | 1 | 1 |
| **Older (25-44 yo)** | 9 | 75.00 | 1.88  (0.49 – 7.14) | 1.95  (0.48 – 7.97) |
|  | | | | | |
| **Sex** | **Female** | 15 | 75.00 | 1 | 1 |
| **Male** | 130 | 59.91 | 0.52  (0.18 – 1.49) | 0.61  (0.20 – 1.82) |
|  | | | | | |
| **Smoking status** | **Non-smoker** | 97 | 63.82 | 1 | 1 |
| **Smoker** | 49 | 56.98 | 0.77  (0.45 – 1.34) | 0.81  (0.45 – 1.47) |
|  | | | | | |
| **Ed. level** | **Hauptschulabschluss** | 50 | 49.50 | 1 | 1 |
| **Realschulabschluss + Fachhochschul. + Abitur** | 94 | 71.21 | 2.40  (1.39 – 4.14)\* | 2.13  (1.21 – 3.77)\* |
|  | | | | | |
| **Risk perception** | **High level** | 49 | 73.13 | 1 | 1 |
|  | **Low level** | 97 | 56.73 | 0.47  (0.25 – 0.88)\* | 0.58  (0.29 – 1.16) |
|  | | | | | |
| **Asthma or Rhinoconjunctivitis** | **No** | 89 | 56.33 | 1 | 1 |
| **Yes** | 57 | 71.25 | 1.96  (1.08 – 3.56)\* | 1.46  (0.76 – 2.81) |
|  | | | | | |
| **Parental asthma** | **No** | 113 | 60.11 | 1 | 1 |
| **Yes** | 33 | 67.35 | 1.56  (0.78 – 3.12) | 1.37  (0.64 – 2.94) |
|  | | | | | |
| \* Statistically significant. | | | | | |