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Abstract	Allergies are increasing in prevalence worldwide, with socioeconomic impacts and effects on quality of life. The aim of this study was to explore the health behavior and the utilization of different treatment options via questionnaires and to investigate for relationships of the above with socioeconomic factors. This cross-sectional survey was carried out among pollen allergic subjects in 2016, using questionnaires. A total of 679 Allergics participated in the study (61.2% females). Their average age was 26.8 ± 8.8 years. Their symptom severity was 6.1 ± 1.9, measured on a 10-step scale and symptoms lasted for 9.0 ± 6.8 weeks during pollen season. Of all allergics, 9.1% were not aware of the causative agent of their allergy and 17.4% had never undergone allergy testing. Symptoms, especially in females, had strong impact on social life, everyday routines and sleep quality. Almost half of the participants treated their allergy without medical supervision, while only 32.3% sought medical support. Nevertheless, three quarters reported self-management of their allergies with oral antihistamines. Compared to males, females sought significantly more medical support, medications and allergen avoidance strategies. Knowledge about allergy increased the likelihood of treatment under supervision of a medical expert than no treatment, as well as symptom severity and interaction between female gender and symptom severity. The attitude of not considering allergy as a serious disease significantly reduced the likelihood of undergoing specific immunotherapy. This survey not only highlights the negative impact of pollen allergies on everyday life of allergics, but also that allergies are often neglected and untreated because of their trivialization by allergic subjects themselves.

Keywords (separated by '-')	Allergy impairment - Allergy management - Allergy treatment - Health behavior - Pollen allergy
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ORIGINAL PAPER

Pollen allergy and health behavior: patients trivializing their disease

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Abstract Allergies are increasing in prevalence worldwide, with socioeconomic impacts and effects on quality of life. The aim of this study was to explore the health behavior and the utilization of different treatment options via questionnaires and to investigate for relationships of the above with socioeconomic factors. This cross-sectional survey was carried out among pollen allergic subjects in 2016, using questionnaires. A total of 679 Allergics participated in the study (61.2% females). Their average age was 26.8 ± 8.8 years. Their symptom severity was 6.1 ± 1.9, measured on a 10-step scale and symptoms lasted for 9.0 ± 6.8 weeks during pollen season. Of all allergics, 9.1% were not aware of the causative agent of their allergy and 17.4% had never undergone allergy testing. Symptoms, especially in females, had strong impact on social life, everyday routines and sleep quality. Almost half of the participants treated their allergy without medical supervision, while only 32.3% sought medical support. Nevertheless, three quarters reported self-management of their allergies with oral antihistamines. Compared to males, females sought significantly more medical support, medications and allergen avoidance strategies. Knowledge about allergy increased the likelihood of treatment under supervision of a medical expert than no treatment, as well as symptom severity and interaction between female gender and symptom severity. The attitude of not considering allergy as a serious disease significantly reduced the likelihood of undergoing specific immunotherapy. This survey not only highlights the negative impact of pollen allergies on everyday life of allergics, but also that allergies are

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often neglected and untreated because of their trivialization by allergic subjects themselves.

Keywords Allergy impairment · Allergy management · Allergy treatment · Health behavior · Pollen allergy

1 Background

Allergic diseases such as allergic rhinitis (AR) and allergic asthma have been increasing in industrialized countries over the last decades (Ring et al. 2012; Traidl-Hoffmann 2017). The current prevalence rates of allergic rhinitis stagnate on a high level ranging from 15 to 25% worldwide (Passali et al. 2018).

Allergy can reduce health-related quality of life because of the profound physical and psychosocial complications and for sure because of the allergy itself. Many studies have shown that allergic symptoms impair the usual performance of daily activities, quality of sleep, work productivity (Blaiss et al. 2018; Jernelöv et al. 2013; Meltzer 2016; Muñoz-Cano et al. 2018; Schoenwetter et al. 2004; Vuurman et al. 2014) and also have an impact on psychological well-being and perceived quality of life (Devillier et al. 2016b; Haanpää et al. 2018; Leynaert et al. 2000; Meltzer 2001). Furthermore, allergies are associated with embarrassment by allergic symptoms and being troubled by frustration and missing work or class time, the so-called absenteeism (Goetzel et al. 2004). Allergy affects the ability to learn, mainly as the result of frequent sleep disturbances, which, in turn, are responsible for daytime sleepiness, fatigue, headache or cognitive impairment (Jáuregui et al. 2009). But also the accompanying allergy manifestations, like allergic conjunctivitis, can lower the performance of daily activities and reduce workplace productivity, because of pruritic or watery eyes and consequently blurred sight (Klossek et al. 2012). Also, atopic dermatitis and associated skin itching have a substantial impact on sleep quality of concerned people, causing sleep deprivation and consequent daily tiredness and mood changes (Simpson et al. 2016). Because atopic dermatitis starts even as a childhood disease, parents might just as well negatively affected (Carroll et al. 2005). Finally, asthma episodes, being the most severe manifestation of atopic disorders, are accompanied by airway obstruction and hinder asthmatics in everyday activities at school and work, and worsen their social life. An asthma attack may cause an urgent need for the allergic person to be immediately treated, even hospitalized (Asher and Pearce 2014).

Apart from direct health effects, allergic disorders and asthma are considered responsible for high socioeconomic impacts due to presenteeism and absenteeism. Presenteeism is defined as the loss of productivity because of the presence of symptoms of a disease (Blaiss 2007). Vandenplas et al. (2018) reviewed the productivity burden of allergic rhinitis and found a substantial effect of this chronic condition on absenteeism and presenteeism. The overall economic impact of allergies accounted for 35.9% of impaired at-work productivity and 3.6% missed work time (Vandenplas et al. 2018). Allergies are the second most frequent contributor to the total costs of health-related absenteeism and presenteeism in Germany (Badura et al. 2010). The rate of absenteeism among employed allergic subjects in Germany accounts to 3 days per year. The rate of productivity loss due to presenteeism ranges between 10 and 20% (Zuberbier et al. 2014). Moreover, the majority of economic burden of pollen allergies is to a larger extent due to high levels of absenteeism and presenteeism in pollen allergic subjects, rather than treatment cost itself (Linneberg et al. 2016).

Proper and timely treatment of allergy can lead to relief of symptoms and consequently minimizes the negative socioeconomic burden of the disease. Allergy is a chronic disease, hence requiring a long-time therapy. There are three main possibilities for treatment of allergic disorders: allergen avoidance, symptomatic pharmacotherapy and specific immunotherapy (May and Dolen 2017). Allergen avoidance may significantly reduce the severity of symptoms, but it is seldom sufficient alone for controlling allergic symptoms, as it is very difficult to completely avoid allergen exposure. Oral antihistamines remain the most effective method against the major symptoms of allergy. However, they are not consistently effective against all kinds of symptoms. So, additional use of topical medication might still be needed. Furthermore, all available drugs offer only temporary relief and, hence, specific immunotherapy is the only curative treatment for allergic disorders with relevant socioeconomic implication (Meadows et al. 2013).

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Many people with pollen allergy do not manage their disease under medical supervision, but only by use of over-the-counter antihistamines, which are selected based on the patient's own perception of medication effectiveness (Tan et al. 2017). Due to this fact, many AR treatments are taken only occasionally and when seeking immediate relief of more severe symptoms, although regular intake is normally recommended in such cases. Non-adherence to AR medical treatment has not been thoroughly investigated, probably as a result of AR trivialization, compared to other allergic diseases (Bender 2015). Effective allergy management largely depends on the selection of and adherence to the most appropriate treatment and consequently on the health behavior of the allergic patient. To elucidate this, the aim of this study was to analyze and evaluate the health-related behavior of allergic subjects, including awareness and utilization of different treatment options as well as adherence to chosen treatment methods. To achieve this, potential behavioral patterns were examined for relationships with demographic factors, allergy characteristics and adopted attitudes toward the patient's own disease. Such patterns in allergy treatment behavior and adherence to management methods can contribute, in the longer-term, to the development of operational health information services and most efficient health care delivery.

2 Materials and methods

This cross-sectional, explorative survey was conducted between June 02 and July 12, 2016. We defined our target group to be pollen allergic subjects. The inclusion criteria were defined as follows: the participants had to have exhibited allergic reactions during the year of the study or the year before and not being additionally sensitized against dust mites. All previous information was self-reported. The study participants not fulfilling the inclusion criteria were excluded from the data analysis. Questionnaires were disseminated by an online survey tool among all test persons, recruited in the course of a first, preliminary, study, conducted in October 2015, aiming to evaluate the benefit of the application-based pollen information. In addition, we invited all matriculated students of the University of Augsburg, along with the university's personnel, scientific or not. We received 698 filled out questionnaires. Of them, 19 were excluded since they did not fulfill the inclusion criteria. Consequently, 679 datasets were included in the data analysis.

The questionnaire was designed aiming to collect information on the health behavior of allergic persons, and, in this respect, it was divided into seven thematic areas. In the first part, demographic data like gender and age and the highest acquired educational degree were requested. Items of the next sector inquired general information about the perception of the allergy and its occurrence, like agents causing allergic reaction, severity of symptoms (10-step scale) and their persistence within the pollen season and also the duration of the allergic disease in general. Note that for polysensitized participants we asked to indicate only the strongest allergy. In the third part, participants were asked to provide information on several allergen avoidance strategies that they are aware of and that they use during the pollen season. One of the core parts of the questionnaire represented the items investigating the treatment and management of the allergic disease by asking for medical assistance, as seeking medical support for new prescription, medication or advice, or conducting specific immunotherapy. In the fifth part of the questionnaire, we collected the information about the use of pollen information services and also the study participants were asked to evaluate their state of knowledge about allergy on a 10-step scale. In the sixth part, the respondents were asked to recall how affected they had been by their allergic symptoms and which kinds of limitations they had experienced while being symptomatic. To quantify this, they were called to estimate their impairment on a 4-step scale (1 = never, 2 = seldom, 3 = sometimes, 4 = often). Moreover, they were asked to approximate the loss of productivity by recording the estimated performance on days with and without the presence of allergic symptoms. The difference between those two instances was evaluated. The seventh part was developed in order to gather information on personal attitude toward allergy and consisted of 12 5-step-scaled items (1 = totally disagree, 2 = rather disagree, 3 = neutral, 4 = rather agree, 5 = totally agree). This category includes such attitudes like considering the own allergy as a chronic and serious disease or a challenge someone wants to master, or, on the other hand, attitudes of the allergic

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subjects as if they were not allergic or as if they had the allergy well under control.

3 Data analysis

All included questionnaires (n = 679) were analyzed using SPSS 24 (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, USA). Data were statistically described in terms of mean or median and standard deviation (SD) for interval-scaled and ordinal-scaled values and frequencies (number of cases as absolute numbers or percentages) when appropriate, for nominal scaled values. Correlation analysis between two and more variables was performed by applying Spearman's rho and Kendall's tau coefficients, depending on the scale of measurement and due to the missing normal distribution of the data. Comparison of the mean values between two unpaired groups was done using Mann–Whitney U test and Wilcoxon test for paired samples. Comparison between more than two groups was conducted by Kruskal–Wallis test. For comparing categorical data, Chi-square (χ^2) test was performed. (Multinomial) logistic regression was applied to investigate the relationship between categorically scaled dependent variables and relevant independent variables. Eighteen independent variables were included in the primary model considering main effects as well as all 2-way interactions. Backward elimination was used for variable selection. Statistical significance was considered at the 0.95 level ($p < 0.05$). As the present survey was explorative in nature and presupposed testing many hypotheses, we had to correct our results by multiple testing in order to check for false positives. Hence, all p values were adjusted using the Benjamini–Yekutieli step-up procedure.

4 Results

4.1 Participants' characteristics

Females constituted 61.2% (n = 414) of the total number of the participants. The mean age of the participants was 26.8 ± 8.8 years. In addition, the majority of 96.2% (n = 650) reached university level of education. The allergic participants exhibited symptoms for 12.7 ± 9.3 years on average, and the symptom severity was 6.1 ± 1.9, based on a 10-step scale. Allergic symptoms on average commenced at the age of 14.2 ± 7.5. Within the pollen season, participants showed allergic symptoms for approximately 9.0 ± 6.8 weeks.

The allergologically relevant pollen types were grasses, followed by birch and hazel, with a contribution to the total of 78.3% (n = 529), 51.8% (n = 350) and 37.6% (n = 254), respectively. Approximately 20.0% (n = 132) of the participants were allergic against only one pollen type, and 22.6% (n = 153) against two pollen types. A relatively high proportion of allergic subjects (9.1% of the total) did not know their causative agent and 17.4% (n = 122) of the sample had never undergone allergy testing. The part of the cohort not aware of what pollen type they were allergic to, usually had not acquired confirmed allergy diagnosis [χ^2 (1) = 142.2, $p < 0.01$]. All previous information was self-reported by participants.

Table 1 displays the correlation coefficients of four allergy characteristics and shows that nearly all inquired allergy features were related to each other. The strongest correlations were observed between either symptom severity and symptom duration, or symptom severity and multiple responses to different pollen types.

Regarding gender-specific differences in allergy characteristics (Table 2), women exhibited significantly higher values in cross-reactive responses and duration of symptoms. However, perceived symptom severity and years of disease did not significantly differ between genders [U (412, 256) = 48,246, p = 0.09]. For further data analysis, we assumed that symptoms were of the same severity in both males and females.

4.2 Avoidance strategies

In general, participants were sufficiently informed concerning possible avoidance strategies, like "keep windows closed," "do not stay outside for long time" and "shower daily before sleep". On average, they were aware of 6.7 ± 2.1 of the 10 mentioned strategies. Nevertheless, they used only half of them to avoid allergen exposure (3.4 ± 2.0), which makes a significant difference in comparison with the known strategies (Wilcoxon, Z = 21.48, $p < 0.01$).

Analysis of dependencies between known and used strategies and allergy characteristics (Table 3) showed

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Table 1 Spearman-correlation matrix of four allergy characteristics

	(1)	(2)	(3)	(4)
(1) Responses to multiple pollen types	1			
(2) Symptom severity	0.37**	1		
(3) Years of disease	0.26**	0.09	1	
(4) Duration of symptoms	0.23*	0.41**	0.06	1

*Significance level $p < 0.05$, **significance level $p < 0.01$

Table 2 Self-reported allergy characteristics by gender

	Males		Females		p value
	Mean ± SD	Median	Mean ± SD	Median	
Responses to multiple pollen types	2.3 ± 1.9	2.0	2.7 ± 2.0	2.0	$p < 0.01$
Symptom severity (10-step scale)	5.9 ± 1.8	6.0	6.2 ± 1.9	6.0	$p = 0.09$ (n.s.)
Disease duration (in years)	13.6 ± 0.4	11.5	12.2 ± 0.5	10.0	$p = 0.02$ (n.s.)†
Duration of symptoms (in weeks within the pollen season)	7.7 ± 5.4	6.0	9.8 ± 7.5	8.0	$p < 0.01$

n.s. Not significant, †not significant due to multiple testing

Table 3 Spearman correlations between allergy characteristics and avoidance strategies

	Responses to multiple pollen types	Symptom severity	Years of disease	Duration of symptoms
Strategies known to the respondent	0.25**	0.12*	0.20**	0.14**
Strategies used by the respondent	0.25**	0.26**	0.12*	0.15**

*Significance level $p < 0.05$, **significance level $p < 0.01$

that used avoidance strategies correlated stronger with the severity of symptoms, whereas the known strategies correlated more with the years of disease. Furthermore, female subjects followed approximately 3.6 ± 2.0 avoidance strategies and men fewer, 3.0 ± 1.9, which highlights a significant difference between genders [U (414, 254) = 43,317.5, $p < 0.01$].

4.3 Allergy treatment

Almost half of the participants suffering from hay fever (n = 318) treated themselves without medical supervision and 20.7% (n = 140) did not treat their allergy at all (Fig. 1). Only one-third (n = 218) was treated by a medical doctor. Compared to women, men were less treated by a doctor [χ^2 (1) = 11.79, $p < 0.01$].

The main reasons for those respondents treating their pollen allergy without any medical supervision were low severity of occurring symptoms (42.8%), low treatment expectations (16.0%) and lack of time (15.6%). The cohort of not treated allergic subjects stated the same two main reasons for no treatment, namely low severity of symptoms and low treatment expectations with a frequency of 44.2% and 15.6%, respectively. Additional causes of non-treatment were

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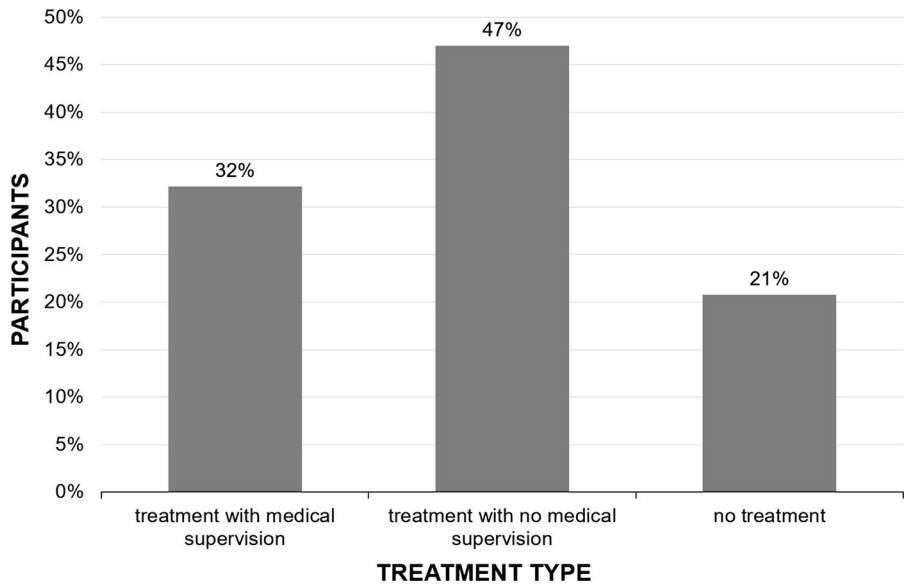

Fig. 1 Self-reported pollen allergy treatment type

lack of information on the therapy possibilities (13.9%) and lack of curative therapy methods (13.4%).

Despite the low rate of respondents treated by a doctor, still three quarters of the total number of respondents (n = 503) were taking medication against allergic symptoms. The frequency and distribution of different medications among hay fever sufferers are shown in Fig. 2. About 90.0% (n = 442) of participants treated their pollen allergy with oral antihistamines, whereas throat spray seemed to be the least popular and was used only in 9.0% (n = 39) of cases. The frequency of anti-allergic medication use varied from every day to maximal 3 days per week. The majority of the participants that did not take medication regularly preferred to take it only on demand. The amount of different medicines used by allergic subjects on average accounted to 2.1 $\pm$ 0.9, with women using on average more medication than men [U (175, 323) = 19,968, $p < 0.01$]. Among the participants that treated their allergy under medical supervision, 86.7% (n = 189) were taking anti-allergic medication, with almost half of them (n = 89) taking it daily. A similar percentage (88.7%, n = 282) of pollen allergic patients that treated their disease without medical supervision were anyway receiving this kind of medication, with only one-third of them (n = 91) taking it daily. Regarding the third category of allergic individuals in our survey, those claiming not treating their allergy at all, about one-fifth (n = 32) still responded that they were taking medication against allergic symptoms.

The oral antihistamines were taken on average for 8.5 $\pm$ 7.4 weeks within the pollen season, which almost matches the mean persistence of allergic symptoms in hay fever sufferers. Specific immunotherapy was received by only 35.0% (n = 237) of the participants. Allergic subjects that perceived their symptoms as more severe were more likely to undergo specific immunotherapy [U (232, 442) = 38,145, $p < 0.01$]. Of those following immunotherapy, 53.4% (n = 124) reported reduction of their symptoms and a positive overall effect on their well-being. Nonetheless, 40.6% of the respondents (n = 94) did not notice any difference and 6.0% (n = 14) claimed that their symptoms even worsened.

A relatively big group of 43.5% (n = 294) of the hay fever sufferers in the survey reported that they did not usually seek medical attention during the pollen season. Another 33.7% (n = 228) attended the doctor when only being symptomatic, but this was rarely. The most common reasons for visiting a medical doctor were the prescription of new medication (26.1%), seeking for alternative treatment methods (26.7%) and general advice for hay fever management (26.5%). Females were more likely to decide to be supervised by a medical expert and consequently visited a doctor more often than males [U (254, 414) = 42,922, $p < 0.01$].

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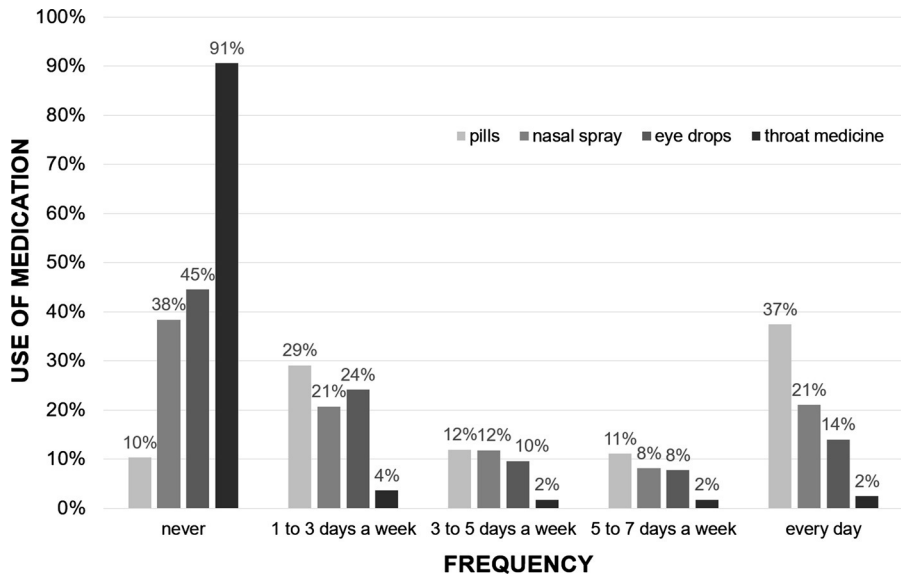

Fig. 2 Frequency of the utilization of different kinds of anti-allergic medication

4.4 Awareness and perception of allergy

Overall awareness of hay fever general knowledge was 5.9 ± 2.0 on a 10-step scale and correlates with known strategies of allergy avoidance ($r = 0.39$, $p < 0.01$). At the same time, 66.7% ($n = 451$) of respondents stated that they were looking for additional information about hay fever. A comparably big proportion of respondents ($n = 470$) indicates that they were seeking advices on pollen allergy and its management and 59.3% ($n = 401$) of respondents tended to exchange their knowledge regarding hay fever with other persons concerned.

About 70.0% ($n = 471$) of the survey participants did not make use of any pollen information services. The biggest part of those, namely 40.5% ($n = 243$), claimed not to be interested in this kind of services because they perceived their allergy symptoms as tolerable whatsoever. Another 32.5% ($n = 195$) reported not to know how to use pollen forecasting for their own benefit. The rest and smallest proportion, either was not aware of such an information service or considered the relevant pollen season predictions as not reliable, with 15.0% ($n = 90$) and 12.0% ($n = 72$), respectively. Among those who regularly used pollen information services (30.0%, $n = 205$), almost half (52.0%, $n = 160$) needed this information about future airborne pollen concentrations so as to prepare mentally for the next day. The rest used this information to adjust their medication (26.6%, $n = 82$) or to plan their daily activities (21.4%, $n = 66$).

Frequencies of adopted attitudes of survey participants toward pollen allergy are presented in Fig. 3. The majority of the survey respondents seemed to have accepted their allergies as part of their life, having learnt to live with them or believing that they manage their disease satisfactorily. On the other hand, a relatively high proportion (about one-third) tended to trivialize their condition by stating that allergy is not a serious disease or even did not acknowledge that allergy is a chronic disease. AQ2

4.5 Social life implications

The frequency of occurring social life implications while being symptomatic can be seen in Table 4. Significant differences in social life implications were observed among men and women: allergy seemed to have a more pronounced negative effect on women's social life, manifested as social life limitations [U (253, 413) = 43,113.5, $p < 0.01$], daily routine limitations [U (254, 411) = 42,204, $p < 0.01$] and as bad night sleep [U (254, 413) = 43,285, $p < 0.01$]. Moreover, women experienced a significantly sharper decline in work productivity than men [U (254, 414) = 41,555, $p < 0.01$] accounting for an average of 2.7 ± 1.8 in females and 2.2 ± 1.6 in males on a 10-step scale. In general, 92.3% ($n = 626$) of allergic participants stated that they exhibited at least

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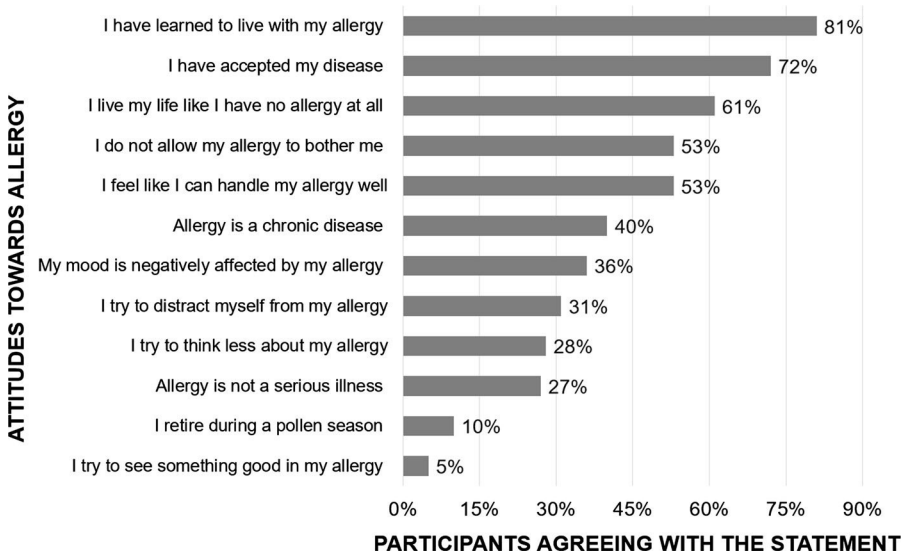

Fig. 3 Adopted attitudes toward pollen allergy (% of survey participants)

Table 4 Self-reported frequency (%) of social life implications by gender

	Never	Seldom	Sometimes	Often
Missing meetings with friends				
Females	60.5	27.4	11.0	1.0
Males	70.5	21.0	7.9	0.4
Limitation in social life				
Females	25.9	38.0	30.5	5.6
Males	39.1	37.9	17.4	5.5
Limitation in daily routines				
Females	8.8	28.5	44.3	18.5
Males	16.9	37.0	33.9	12.2
Sleep disturbance				
Females	17.7	31.2	33.4	17.1
Males	28.0	34.6	26.6	10.1

occasionally reduced productivity while being symptomatic.

There is a statistically significant relationship between all questioned implications and symptom severity, with the strongest correlation being with impairment of everyday activities (Kendall's tau, $\tau = 0.40$, $p < 0.01$). The mean loss of productivity while being symptomatic amounts to 2.4 ± 1.7 points on a 10-step scale, which corresponds to a significant fall of productivity because of pollen exposure (Wilcoxon, $Z = -21.49$, $p < 0.01$). Loss of productivity also significantly correlated with symptom severity ($r = 0.40$, $p < 0.01$).

4.6 Factors influencing allergy treatment

Differences between allergy management options that depend on external factors are presented in Table 5. It seems that gender alone did not significantly influence the way the allergic disease was managed, that is whether under medical supervision or without. Nonetheless, the interaction effect of gender and allergy severity affected females' decision to be supervised by a medical expert. As the symptom severity rose, females exhibited increased chance to seek medical attention by 53.0%, than to not treat their condition at all. Other factors positively influencing the preference of the treatment by a medical expert over no treatment at all were knowledge about allergy as well as severity of perceived symptoms, with knowledge exhibiting an even stronger effect than severity of the illness.

Particularly regarding specific immunotherapy, females were less keen on using it as an allergy management option (Table 6). Nonetheless, this pattern changed when their symptoms increased in severity and then they were more likely than men to treat their allergies using specific immunotherapy. Interestingly, this interaction between female gender and allergy severity increased the likelihood of undergoing the curative treatment by 39.0%. Moreover, the likelihood for using this method was higher when an allergic exhibited symptoms for more years or if they presented cross-reactive allergies. Whenever

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Table 5 Logistic regression of factors influencing the choice of the treatment type

	B	95% CI for odds ratio		
		Lower	Odds ratio	Upper
Treatment by a doctor versus no treatment				
Intercept	− 4.40**			
Gender (female)	− 2.00	0.02	0.15	0.82
Knowledge about allergy	0.48**	1.40	1.61	1.84
Symptom severity	0.20*	1.11	1.37	1.70
[Gender (female)] × [symptom severity]	0.42*	1.13	1.53	2.06
Treatment on their own versus no treatment				
Intercept	− 1.93**			
Gender (female)	− 0.75	0.12	0.47	1.88
Knowledge about allergy	0.30**	1.20	1.35	1.52
Symptom severity	0.19	1.01	1.20	1.44
[Gender (female)] × [symptom severity]	0.20	0.96	1.23	1.57

*Significance level $p < 0.05$, **significance level $p < 0.01$

$R^2 = 0.23$ (Cox and Snell). Model χ^2 (10) 176.60, $p < 0.01$

Table 6 Logistic regression of factors influencing the utilization of specific immunotherapy

	B	95% CI for odds ratio		
		Lower	Odds ratio	Upper
Yes versus no				
Constant	− 2.38**			
Gender (female)	− 4.07**	0.01	0.02	0.11
Years suffering from hay fever	0.12*	1.05	1.14	1.21
Cross-reactive responses	0.23**	1.13	1.28	1.39
Hay fever is not a serious illness	− 0.42**	0.51	0.66	0.85
[Gender (females)] × [symptom severity]	0.32**	1.11	1.38	1.73

*Significance level $p < 0.05$, **significance level $p < 0.01$

$R^2 = 0.19$ (Cox and Snell). Model χ^2 (10) 134.28, $p < 0.01$

allergic subjects tended to trivialize their disease, they did not consider undergoing immunotherapy.

Moreover, allergic subjects tended to seek for medical assistance more often, either whenever they had an increased allergy burden (i.e., reduced productivity) or when they were more self-aware and knowledgeable regarding their disease (Table 7). When they seemed to trivialize their condition, they were less keen on asking for medical support and it seemed to make no difference if they tried to ignore their disease.

5 Discussion

The present cross-sectional, explorative study provides relevant information on the distribution of allergic characteristics among pollen allergy sufferers in Augsburg including information on their health behavior and utilization of different treatment options. With the present study, it is confirmed that pollen allergies remain a serious health problem with a profound effect on the health-related quality of everyday life of allergic individuals, with negative implications in social life, everyday activities but also work productivity. Nonetheless, it was found that approximately half of the participants surprisingly and persistently preferred to treat their allergies without medical supervision and almost one-third completely dispensed with the treatment. Interestingly, though, this effect seemed to differ between genders, as males tended to trivialize their disease, to ignore their symptoms and not to seek medical advice or treatment.

When considering these survey results, it must be noted that participation in this study was on a voluntary basis and that the survey was distributed to all students and personnel of the University of Augsburg via an online tool. It is acknowledged that

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Table 7 Logistic regression of factors influencing the frequency of received medical help

	B	95% CI for odds ratio		
		Lower	Odds ratio	Upper
Never versus seldom				
Intercept	− 1.60			
I try not to think about my allergy	0.33**	1.17	1.39	1.64
Knowledge about allergy	0.25**	1.16	1.29	1.42
Never versus sometimes				
Intercept	− 3.19			
Knowledge about allergy	0.35**	1.26	1.42	1.60
Never versus often				
Intercept	− 1.74			
Knowledge about allergy	0.75**	1.51	2.11	2.95
Loss of productivity	0.65*	1.37	1.91	2.66
I live like I do not have hay fever	− 2.96**	0.01	0.05	0.27
My mood is negatively affected by my symptoms	− 2.15**	0.03	0.12	0.52
[I live my life like I do not have a hay fever] × [My mood is negatively affected by my symptoms]	0.77**	1.37	2.16	3.42

*Significance level $p < 0.05$, **significance level $p < 0.01$

$R^2 = 0.23$ (Cox and Snell). Model χ^2 (18) 174.96, $p < 0.01$

the highest proportion of the participants had a high school diploma and were relatively young, mainly comprising students. Consequently, there is a certain extent of bias in the respondents' answers in this survey, as the study population represents a convenience sample. However, given the sample size and the significance levels in most of the findings, we do not expect that this "bias" altered the results significantly whatsoever. Moreover, our study's average age group (young students) exhibits the highest prevalence of allergic sensitization compared to other age groups (Blomme et al. 2013). Furthermore, there has been evidence that patients with high level of education tend to be more adherent (Ocak et al. 2017). We preferred not to collect any information on the specific symptoms of the allergic subjects, i.e., allergic bronchial asthma, allergic rhinitis and allergic conjunctivitis, as this would complicate the definition and characterization of symptomatology. We therefore preferred to keep the questionnaires as simple as possible so as to ensure high comprehension rate by the participants.

In our study, the mean reported disease duration of collective questioned was 12.7 years, which sits below the value found by Petersen et al. (2008), namely 17.4 years. This can be partly attributed to the average younger age of our study population, as our cohort was on average aged 26.8 years, in contrast to 33.6 years of that of Petersen et al. (2008). In comparison with the survey of Lombardi et al. (2015) with 39% of non-confirmed diagnoses, the proportion of not attested pollen allergies in the present sample is even small (17.4%) and might be attributed to the specific characteristics of the sample collected.

Symptoms of allergic disorders were found to be troublesome for the majority of allergic persons and to impair several dimensions of everyday life. Meltzer et al. (2017) reported a similar result in their survey of AR sufferers in the USA, where more than 50% of the respondents indicated impairment of daily activities and increased level of fatigue. The survey of Tanner et al. (1999) documented insights, which are even closer to that of our study: 96% of allergic subjects reporting impairment in daily activities, 93% in classroom productivity and 91% observed fall of

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workplace productivity. In our study in Augsburg, a significant loss of productivity was found in 92.3% of questioned pollen allergic subjects. Allergy sufferers declared to be symptomatic for 9 weeks inside the pollen season and to experience a productivity loss of about 2.4 scores on a 10-step scale. This score would correspond to a 24% productivity reduction rate, considering a typical 8-h workday, which accounts for 1.9 lost work hours. Similar results have been reported also by Tanner et al. (1999), who documented 96% of allergic subjects declaring impairment in daily activities, 93% in classroom productivity and 91% observed fall of workplace productivity. Likewise, Lamb et al. (2006) found that employees suffering from allergic rhinitis had allergic symptoms for 52.5 days per year coming up for nearly 7.5 weeks and were unproductive for 2.3 h per typical 8-h workday, while they were symptomatic.

A unique feature of our study is that the human cohort questioned consisted mainly of students. Therefore, immediately a question is raised regarding relevant implications of reduced class/workplace productivity of this specific population group. Bensnes (2016) documented that students with allergies might suffer a temporary reduction in cognitive abilities if exposed to pollen. It was found that high-education students, even after a short-interval of allergen exposure, can have long-run implications in terms of failing exams or of poor performance in classroom. Marcotte (2015) investigated the impact of pollen exposure on achievements in schools and found a robust correlation between increased pollen concentrations and reduced ability to perform on state assessments. This impact might be attributed to reduced cognitive abilities during the high-allergy-symptom period. Likewise, Trikojat et al. (2017) reported poorer performance of allergic patients in word list-based learning and a general slowing in information processing speed while being symptomatic. Moreover, according to Devillier et al. (2016a), work/classroom impairment seems to correlate strongly with perceived health-related quality of life, which tends to be lower in allergic persons while being symptomatic.

The present study provided evidence that the female subjects were significantly more burdened by hay fever symptoms in terms of loss of productivity, limitations in both, daily routines and social life, although the perceived allergy severity does not significantly differ. In the survey of Kalpaklioglu and Baççioglu (2008), female gender was found to be a determinant of impaired quality of life in subjects with allergic rhinitis or asthma in all measures of the health-related quality of life, except for social functioning. Also in the study of Valls-Mateus et al. (2017), female subjects suffering from nasal obstructive disorders reported statistically lower health-related quality of life compared to men. Bedolla-Barajas et al. (2017) have reported that allergic rhinitis is associated with anxiety and depression in women.

From the viewpoint of the health sciences, there are no straightforward reasons that can be responsible for poorer health-related quality of life in women suffering from the same illness of the same severity. Therefore, it is worth investigating other reasons, for instance personality. First of all, self-reported allergy prevalence has been found to be considerably higher in females than in males (Atzpodien and Lampert 2009; Langen et al. 2013), although it remains controversial whether this discrepancy does exist. The possible reason for this tendency could lie in the higher awareness of allergy among women, or in the fact that women generally take care their health more. The GEDA-survey in 2012 showed that the females of the same age group estimate their health to be worse than that of men, and, furthermore, revealed that significantly more women than men referred to themselves as psychologically burdened (Lange 2014). Although self-evaluation does not always correspond to an objective state of health, it determines the participation in social life. If women perceive themselves as more burdened, they might feel more limited in everyday life. Moreover, mental health, together with physical health, is crucial for individual quality of life. Some interesting insights have been provided by Axelsson et al. (2014), who managed to partly explain the gender-specific discrepancy. Among others, they investigated the relationship between personality and health-related quality of life. They have shown that neuroticism is negatively related to mental quality of life and negatively correlated with physical health-related quality of life. Due to descriptive results of the survey, women scored significantly higher on neuroticism than men did (Axelsson et al. 2014).

The present survey showed that a considerably large share of allergic subjects do not treat their allergy properly and prefer to self-manage their disease. The most common reason for this tendency is low symptom severity. Nearly 74% of respondents claimed to

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take allergic medication to relieve their symptoms and most of them preferred oral antihistamines, as has been shown also by other scientists (Demoly et al. 2002; Lombardi et al. 2015; Schramm et al. 2003). As the biggest part of the pollen allergy sufferers was treating their disease when symptomatic with over-the-counter medication, this made likely to show relatively low treatment satisfaction, as reported before by Meltzer et al. (2017). Likewise, Horn et al. (2016) have documented that unspecific symptomatic medication actually provides no improvement in the perceived health-related quality of life in allergic patients. The utilization rate of specific immunotherapy remained as low as 35.0% of our total cohort size, a percentage similar to that of previous researches (i.e., 31.7% by Weberschock et al. 2014).

The present study has shown that adequate treatment of allergy is rare so it is important to look for the reasons responsible for this tendency. The first evident reason has been highlighted: those allergic subjects who develop only weak symptoms do not consider their illness as a serious health problem and are not willing to make necessary effort for the treatment. This insight was verified by the correlation between increased symptom severity and the consequent decision to treat allergy and to undergo specific immunotherapy. The cause for untreated or inadequately treated hay fever can lie in the lack of information about the etiology and nature of allergic diseases, as also proven by the significant relationship between increased knowledge state and increased probability of seeking medical attention and undergoing specific immunotherapy. The study population stated their level of knowledge to be relative low. In view of the survey of Marple et al. (2007), an even lower level of knowledge can be assumed. According to its results, the majority of respondents (94%) considered themselves at least somewhat knowledgeable about seasonal allergies; however, their responses about the nature of their condition and its treatment suggested otherwise (Marple et al. 2007). Besides this, the majority of the study population stated to be looking for additional information about hay fever and seeking advises about self-management of allergic diseases.

Based on these findings, one of the most important aspects in the improvement of allergy management is patient empowerment through education. Patients should be educated about their health condition, different treatment options of their disease and the correct use of pharmacotherapy, as well as be educated to achieve allergen avoidance and prophylaxis. Adherence to the treatment is another crucial aspect of successful allergy treatment. In our cohort, an approximate 40% of all allergic patients were taking oral antihistamines on a daily basis. Those who were not taking their illness seriously and were seeking medical support, were also most likely not fully satisfied with the current treatment, especially when also considering the fact that doctors tend to rate allergy as less severe than patients do (Marple et al. 2007). Hence, the patient–doctor relationship and close communication are of crucial importance and the allergic patient's personality and gender ought to be also taken into account when planning allergy management.

6 Conclusion

The current research is an excellent paradigm of how pollen allergies may have a profound health effect on allergic individuals and clearly highlights that allergic symptomatology can be exacerbated not only by the disease per se, but also because the disease has not been taken seriously by the patient. The latter seems to be the result of multiple, interacting and complex social and environmental factors. Selection of and adherence to the most appropriate treatment and consistent consultation of medical experts are some of the typical health behavior characteristics that need to be adopted by the allergic patient so as to maximize the effectiveness of allergy management.

A holistic approach toward personalized medicine is recommended to more effectively confront pollen allergies. A prerequisite for this is to integrate factors like personality traits, psychological factors and self-perception level, which would ultimately involve proper education and empowerment of allergic individuals.

Availability of data and material The datasets used/analyzed during the current study will be available upon request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Informed consent Informed consent was obtained from all individual participants included in the study.

Human and animal rights statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. AQ3

Ethical approval No clinical study was conducted, or biosamples have been used in this survey. All used personal data were ensured to remain anonymized. The University of Augsburg has accepted the lack of need for such ethical approval.

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