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Self-reported rhinitis of students from different universities in the Netherlands and its association with their home environment

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ABSTRACT

Background: While the indoor environmental quality of student homes is a potential issue since it may affect the wellbeing of the students, the relations are still poorly studied. This study aimed to investigate the relations between home building characteristics and rhinitis in students.
Material and methods: A questionnaire was distributed among four groups of students from three different universities in The Netherlands. Self-reported characteristics of 396 students and their homes were linked to self-reported rhinitis. Logistic regression modelling was applied to explore relations between building characteristics and rhinitis.
Results: Among the students studied, 33% declared to suffer from rhinitis in the last 12 months. After full adjustment, the regression model revealed that having relatives with rhinitis was positively associated with rhinitis (OR:5.27, CI: 3.02–9.21) as well as the presence of less than one-year old furniture made of MDF in the bedroom (OR:2.26, CI: 1.17–4.37). Both working out and having no pets was negatively linked to rhinitis (respectively OR:0.50, CI: 0.25–0.99 and OR: 0.37, CI: 0.18–0.74). Opening the window in the bedroom more than once a week also reduced the risk for rhinitis (OR: 0.55, CI: 0.31–0.98).
Conclusions: The study shows that biological pollutants (caused by pets), chemical pollutants (caused by MDF in bedroom), ventilation (opening window in bedroom) and workout, were associated with rhinitis in students. Further studies are needed to investigate the underlying causes to prevent rhinitis in young adults.

1. Introduction

There is an increasing concern about the quality of the indoor environment in homes and the rising prevalence of allergic and respiratory diseases. The indoor residential risk factors of primary interest for asthma, allergies and respiratory health, include allergens (e.g. dust-mites, cockroaches and pet dander), moisture, mould and endotoxin, combustion products from appliances, tobacco or other combustion sources (e.g. traffic), and indoor chemical emissions or emission-related materials or activities (e.g. formaldehyde or particleboard, phthalates or plastic materials, and volatile organic compounds or recent painting), renovation and cleaning activities, new furniture, carpets or textile wallpaper (e.g. reviews in Refs. [1–3]), and several building factors (building location, type of construction and design of the heating, cooling and ventilation systems applied, furnishings and furniture) (e.g. Refs. [4,5]). Besides the environmental risk factors, potential risk factors for asthma, allergies and respiratory health are personal factors (e.g. sex, age, genetics, educational level), lifestyle-related behaviours (e.g. smoking, alcohol use, physical activity, sedentary behaviour) and psychosocial factors (e.g. mood).

Up to now, very few studies have investigated simultaneously the impact of environmental and individual factors on health, while it is important to consider physical, physiological, psychological and social factors to explain the responses of people [6]. Moreover, indoor environmental studies in homes mainly involve children (e.g. Refs. [7–11]). However, indoor environmental quality may also affect the well-being of students [12,13]. Studies involving this population have focussed mainly on their school environment, but not their home environment. Therefore, a survey was performed among students from different universities in the Netherlands [14]. In this survey, rhinitis was reported to be the most prevalent health condition. Rhinitis is a worldwide health problem with negative impacts on quality of life [15]. There exist several forms of rhinitis: allergic rhinitis, caused by an immune response against allergens

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(e.g. indoor allergens such as dust mites, moulds, insects -cockroaches- and animal dander) and non-allergic rhinitis, caused by non-allergic conditions resulting in similar symptoms (e.g. infections, emotional, physical and chemical factors, and use of certain drugs) [4]. The relations between environmental factors, individual factors and rhinitis are not clearly understood.

In this context, using the large database from the survey conducted in Dutch universities, this study aimed to explore the associations between the indoor environment of the students' homes and rhinitis, taking into account all potential confounders, as a first important step towards unravelling the indoor environmental causes of rhinitis in students.

2. Methods

2.1. Study design

In the spring of 2015, four groups of students from three different universities in the Netherlands were recruited for a survey on their health and comfort in relation to their homes: the universities were the Delft University of Technology (TUD) (including two groups: bachelor and master students), Wageningen University (WUR) (bachelor students), and the Technical University of Technology (TU/e) (master students), located in the West, East and South of the Netherlands, respectively.

In all cases, the procedure was similar. At least three weeks before the lecture, the students of the specific courses received an invitation by e-mail with a link to the digital on-line questionnaire. In the e-mail the purpose and the procedure of the survey were explained and the deadline for completing the questionnaire was given (in general one week before the lecture). All students who were registered to the course received an invitation. It was estimated that the questionnaire would take about 30 min to complete and respondents could save the survey at any time and resume it later.

2.2. Data collection

The electronic-based questionnaire was voluntary, anonymous and in English. It was based on the OFFICAIR questionnaire [16], while also including the International Positive and Negative Affect Schedule Short Form, I-PANAS-SF [17], the Emocards tool to assess the self-reported emotional status at the moment of filling in the questionnaire [18], the dwelling questionnaire [19], and the HOPE checklist for homes [20]. In total, the questionnaire included 125 questions at the most (without skip-logic questions) and one optional question about the respondents' interest in the questionnaire and ease of filling it in. It included questions to collect socio-demographic data about the respondent (e.g. gender, age, marital status, educational level), life-style information (e.g. time spent inside the home, workout, smoking status, and alcohol habits), psycho-social aspects (e.g. mood via Emocards, recent positive and negative events - such as birth, wedding, death, accident, severe illness -, and general positive and negative affects via I-PANAS-SF), health and medical history (e.g. personal medical history, family medical history, health at home), and comfort data (e.g. overall comfort, indoor comfort perception). Additionally, the questionnaire included a checklist to collect information about different types of occupants of the home environment (e.g. people, pets and pests), the systems and activities (e.g. heating, cooling and cooking, do-it-yourself activities, cleaning activities, consumer products), the presence of materials, coverings and furniture (e.g. asbestos, lead, floor and wall coverings, ceiling surface, painting, new carpeting, particle board, open shelves), the ventilation type and window characteristics (e.g. natural ventilation, mechanical ventilation, maintenance, window frame, window opening), and humidity problems (e.g. humidity signs, condensation, washer and/or drying).

The I-PANAS-SF is composed of 5-item positive affect subscales (alert, inspired, determined, attentive and active) and 5-item negative affect subscales (upset, hostile, ashamed, nervous, and afraid). Each item is rated from 1 'never' to 5 'always'. The Emocards tool includes eight cards with facial expressions for distinct emotional expressions varying on the basis of the dimensions 'pleasantness' and 'arousal' (physical state of activation). The cards are presented with a female or a male cartoon character, appropriately for both female and male participants [18].

Concerning health data, the following question was asked for a number of diseases, including allergic rhinitis: 'Have you suffered from *disease/disorder*?' The following options were the possible answers: 'Never', 'Yes, in the last 12 months', 'Yes, but not in the last 12 months'. To identify health symptoms that the students suffered from, the following was asked: 'In the past 3 months, how often have you suffered from *Health symptom* while you have been in your home (on average)?' The possible answers were: 'every day', '3–4 days a week', '1–2 days a week', 'once every 2–3 weeks', 'less often or never'. If the answer was 'once every 2–3 weeks' or more often, the following additional question was asked: 'Do you think that this is because of your indoor environment?' with possible answers: 'yes', 'no', 'partly'.

2.3. Ethical aspects

The students were asked to give an informed consent to start the survey. Participants were able to skip any question that they were not comfortable answering. To decrease involuntary missing answers, an automatic check of completeness was performed, and missing answers were pointed out to the participant at the end of each page of the questionnaire.

2.4. Data management

All data were digitally completed and stored in Collector© (an online questionnaire tool).

Data were prepared by removing incomplete questionnaires (e.g. 7 from TUE who answered only the first ten questions), a questionnaire of a non-student (teacher from TUD BSc) and one respondent from TUD MSc, who answered the questions in a non-serious way.

2.5. Statistical analysis

2.5.1. Descriptive analysis

Descriptive statistics such as percentages, range (minimum–maximum), or arithmetic mean with standard deviation (SD) were used to summarize the characteristics of the students and their homes. Since there was no overall difference between the different student groups, data were pooled for further analyses.

2.6. Associations between building characteristics and rhinitis

The relations between building characteristics and rhinitis ('yes in the last 12 months' equalled yes; while 'yes, but not in the last 12 months' and 'never' equalled 'no') were examined using unconditional logistic regression modelling.

Potential personal factors were: gender, parental history of rhinitis, smoking status (yes versus no), alcohol consumption (yes versus no), and psychological aspects (PANAS negative and positive). Age was not considered because the standard deviation was small.

Concerning the building characteristics: building type 'detached' versus 'not detached' (as a measure for density of buildings), construction date (before 1945 versus after 1945), building location (urban –combining mixed area, city centre, town, versus rural area –combining suburban, village or rural area), and outdoor pollution sources were analysed.

Heating and cooking amenities ('gas' versus 'no gas'), type of wall/floor coverings, furniture and presence of plants, cleaning activities ('at least once a week' versus 'less than once a week'), use of consumer products ('at least once a week' versus 'less than once a week'), ventilation systems, humidity signs and opening of windows ('more than once a week' versus 'once per week or less'), were also taken into account.

Variables associated with a P-value of less than 0.20 and with well-known risk factors were included in the multivariate analysis. The final model was obtained by eliminating variables associated with a P-value greater than 0.20. Collinearity among variables in the model was measured by the variance inflation factor (VIF). No multicollinearity was detected (VIF<4). No potential modification effect of parental history of rhinitis or negative events was identified. Results are expressed as adjusted odds ratios (OR) with their confidence intervals at 95% (95% CIs).

Data were analysed using SPSS Version 23.0 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Participation rate and characteristics of the study respondents

Overall, the response rate was 78% (ranging from 26 to 98.5%) (Table 1). Table 2 shows the characteristics of the respondents. While about half of the respondents from both technical universities were female, at the WUR only one male student participated. The mean (SD) age of the respondents for all groups was 22 (3) years, with a range of 18–45 years. Concerning their lifestyle, 76% and 5% were never, and were former smokers, respectively. Current smokers consumed on average 8.6 (5.1) cigarettes per day, with a range of 2–22 cigarettes per day. A total of 16% of the students were exposed to second-hand smoke (SHS) at home. Daily or occasional alcohol consumption was declared by 84% of the respondents, while 16% drank no alcohol at all. On average students reported to drink 10 beers per week, with a maximum of 100 beers per week. On average, 84% reported to do some form of exercise for 4 days a week.

About 35% and 34% of the respondents experienced a recent positive and a negative event, respectively. On average 23% of the respondents were tense, irritated, sad, or bored at the time they filled in the questionnaire.

On average students scored 17 for the positive affect with a range from 6 to 24; and 11 for the negative affect with a range from 5 to 22.

Concerning their health, about 33% of the respondents suffered from rhinitis in the last 12 months. While 36% declared that their relatives suffered from rhinitis. The most prevalent symptoms experienced in the last 3 months (at least once every 2–3 weeks), related to the indoor environment, were sneezing (30%) and blocked or stuffy nose (27%).

3.2. Characteristics of the student homes

Self-reported characteristics of the homes of the respondents, which might be related to rhinitis, is presented in Table 3.

The buildings were located in different areas: 29% in town with no or small gardens, 22% in city centre with densely packed housing, 21% in suburbs with large gardens, 20% in mixed areas (industrial, commercial, residential) and 8% in village or rural areas. For nearby sources of pollution, 58% of the respondents declared busy road, 43% cars parked close to the building, 20% a railway station, 13% an attached garage, 8% industrial and agricultural sources and 5% a direct access from a basement or a roof car park.

The main floor covering in the students' homes was wood (41%), followed by synthetic smooth floor covering (27%) and carpet (15%). Exposed concrete/plaster was the main wall covering for 34%, wall paper for 26%, and dispersion/emulsion paint for 20% of the homes. The main ceiling surface was exposed/concrete plaster (45%), followed by paint (31%). Less than one-year furniture made of MDF was declared by 23% in the bedroom, 22% in the living room and 16% in the kitchen. Natural decorative plants were reported by 55% of the students.

With respect to (un)wanted occupants in their homes, 76% of the students reported to have no pets, 45% declared to have no problems with pests, while 20% did have problems with mice. Do-it-yourself activities performed most involved the use of paint (14%) and model glues (12%). 51% declared to have performed recent painting/remodelling of their home. At least once per week, floors/carpets were swept/vacuumed by 72%, while 64% dusted the surfaces and 46% washed the floors. Mattresses were turned at least once per month by 25% of respondents. Consumer products most used (at least once per week) were air fresheners (32%), hair sprays (18%) and window cleaners (16%). 70% of the students used a gas cooker (cooks on gas), 13% used an unvented gas water heating system, and 23% a dryer vented outdoors.

93% of the students reported to have operable windows, while opening of bedroom windows (more than once per week) was declared by 67%, by 60% in kitchen and by 58% in the living room. 35% reported to have a ventilation grille as ventilation type, and 23% had mechanical ventilation, while air conditioning was present in 12% of the homes.

Finally, 58% reported no humidity signs. Among potential humidity signs, water leakage or water damage indoors was reported the most (25%), followed by visible mould growth (24%). 33% declared condensation on the inside of the windows, while 47% had no condensation on either inside, between or outside the glazing.

3.3. Relations between building factors and rhinitis

Table 4 presents the results from the univariate analyses and the results with adjustment for gender, smoking, family rhinitis and negative events. Rhinitis was negatively associated with workout, absence of pets, opening of windows in bedroom more than once a

Table 1
Number of investigated students and response rate (total sample and by course).

University course	Students on list	Completed questionnaires	Response rate (%)
TUD BSc	270	266	98.5
TUD MSc	73	51	66.9
WUR	72	19	26.4
TU/e	93	60	64.5
Total	**508**	**396**	**78.0**

Table 2
Characteristics of the study population (overall and by group).

Characteristics	TUD BSc n[a] (%)	TUD MSc n[a] (%)	WUR n[a] (%)	TU/e n[a] (%)	Total n[a] (%)
Personal					
Gender[b]					
Female	134 (50.6)	27 (52.9)	18 (94.7)	33 (55.0)	203 (51.4)
Male	131 (49.4)	24 (47.1)	1 (5.3)	27 (45.0)	192 (48.6)
Age (in years)					
Mean (sd)	20.4 (2.3)	24.6 (2.4)	20.7 (1.4)	25.3 (3.5)	21.7 (3.2)
Marital status					
Single	260 (98.1)	46 (90.2)	18 (94.7)	48 (80.0)	372 (94.2)
Married/living together	5 (1.9)	5 (9.8)	1 (5.3)	12 (20.0)	23 (5.8)
Lifestyle					
Time spend at home – in hours					
Weekday: mean (sd)	14.2 (2.6)	13.3 (3.3)	15.0 (3.8)	13.9 (3.5)	14.1 (2.9)
Weekend: mean (sd)	14.5 (6.1)	15.2 (4.8)	13.2 (6.2)	14.5 (6.3)	14.5 (6.0)
Workout					
Yes	216 (81.2)	47 (92.2)	18 (94.7)	51 (85.0)	332 (83.8)
No	50 (18.8)	4 (7.8)	1 (5.3)	9 (15.0)	64 (16.2)
Days/week: mean (sd) (of Yes)	3.7 (1.7)	4.0 (2.0)	4.2 (2.0)	3.8 (1.8)	3.8 (1.8)
Time (minutes per session)					
Less than 30 min	37 (17.1)	12 (25.5)	13 (72.2)	11 (21.6)	60 (18.1)
31–60 min	93 (43.1)	20 (42.6)	0	18 (35.3)	144 (43.4)
More than 60 min	86 (39.8)	15 (31.9)	5 (27.8)	22 (43.1)	128 (38.6)
Smoking status					
Current, daily	25 (9.4)	4 (7.8)	1 (5.3)	0	30 (7.6)
Current, occasionally	34 (12.7)	9 (17.6)	0	5 (8.3)	48 (12.1)
Former	13 (4.9)	1 (2.0)	1 (5.3)	3 (5.0)	18 (4.5)
Never	194 (72.9)	37 (72.5)	17 (89.5)	52 (86.7)	300 (75.8)
Cigarettes/day current smoker					
Mean (sd)	9.1 (5.4)	7.3 (3.2)	3.0 (–)	9.0 (5.2)	8.6 (5.1)
Tobacco smoke present (SHS)					
Yes	45 (16.9)	10 (19.6)	1 (5.3)	5 (10.6)	61 (15.9)
No	221 (83.1)	41 (80.4)	18 (94.7)	42 (89.4)	322 (84.1)
Alcohol consumption	222 (83.1)	45 (88.2)	16 (84.2)	52 (83.9)	335 (84.0)
Number of beers/week: Mean (sd)	10.9 (13.4)	8.1 (16.2)	7.5 (4.7)	7.6 (8.3)	9.9 (13.0)
Psychological characteristics					
Positive Events	92 (34.6)	17 (34.0)	5 (26.3)	23 (40.4)	137 (34.9)
Negative events	90 (33.8)	17 (34.0)	5 (26.3)	20 (36.4)	132 (33.9)
Mood (male and female combined)					
Excited	7 (2.6)	1 (2.0)	0	1 (1.7)	9 (2.3)
Cheerful	35 (13.2)	7 (13.7)	1 (5.3)	9 (15.0)	52 (13.1)
Relaxed	56 (21.1)	9 (17.6)	6 (31.6)	10 (16.7)	81 (20.5)
Calm	65 (24.5)	13 (25.5)	7 (36.8)	20 (33.3)	105 (26.5)
Neutral	38 (14.3)	6 (11.8)	4 (21.1)	10 (16.7)	58 (14.6)
Tense	22 (8.3)	6 (11.8)	0	4 (6.7)	32 (8.1)
Irritated	2 (0.8)	1 (2.0)	0	0	3 (0.8)
Sad	10 (2.8)	2 (3.9)	0	4 (6.7)	17 (4.3)
Bored	30 (11.3)	6 (11.8)	1 (5.3)	2 (3.3)	39 (9.8)
PANAS Positive: mean (sd)	17.1 (2.5)	17.5 (2.4)	18.2 (2.6)	16.7 (3.0)	17.1 (2.6)
PANAS Negative: mean (sd)	11.1 (2.9)	11.8 (2.9)	10.6 (2.5)	11.8 (2.8)	11.3 (2.9)
Health in the last 12 months					
Allergic rhinitis	91 (35.1)	17 (34.7)	5 (26.3)	15 (26.8)	128 (33.3)
Allergic rhinitis (relatives)	104 (40.0)	16(32.7)	6(33.3)	12 (22.2)	138 (36.2)
Health symptoms (at least once every 2–3 weeks), related to indoor environment (yes and partly)					
Blocked or stuffy nose	66 (24.8)	19 (37.3)	5 (26.3)	18 (30.0)	108 (27.3)
Sneezing	70 (26.3)	19 (37.3)	8 (42.1)	22 (36.7)	119 (30.1)

[a] Number of students may vary because of missing information: sd = standard deviation.
[b] Only gender showed dependence in the comparison of means between the different groups with $p < 0.05$.

week, natural plants and agricultural sources of pollution. A tendency was observed with presence of rodents (mice and rats), with mattresses turned at least once a month, with opening of windows in living room more than once a week, with air conditioning and with SHS exposure. Rhinitis was positively associated with the home location in an urban area. less than one-year old furniture made of MDF in the bedroom and the direct access to the basement/roof car park, tended to be positively associated with rhinitis.

Table 5 shows the results from the multivariate logistic regression model. Having relatives with rhinitis was positively associated with rhinitis (adjusted OR: 5.27, CI: 3.02–9.21). Working out (OR: 0.50, CI: 0.25–0.99), having no pets (OR: 0.37, CI: 0.18–0.74), and opening windows in the bedroom at least once a week or more (OR: 0.55, CI: 0.31–0.98), were negatively linked to rhinitis. Presence of less than one-year old furniture made of MDF in the bedroom was positively linked to rhinitis (OR: 2.26, CI: 1.17–4.37).

4. Discussion

4.1. Strength and limitations

The study is based on the survey among students from different universities collecting data on a broad range of relevant stressors for this population group (students with a mean age of 22 years

Table 3
Self-reported characteristics of the homes of the respondents.

	TUD BSc	TUD MSc	WUR	TU/e	Total
	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)
Building					
Building type					
Apartment complex	79 (29.7)	24 (47.1)	7 (36.8)	23 (46.0)	133 (34.5)
Gallery complex	21 (7.9)	5 (9.8)	1 (5.3)	0	27 (7.0)
Row-house	101 (38.0)	13 (25.5)	3 (15.8)	18 (36.0)	135 (35)
Semi-detached house	39 (14.7)	3 (5.9)	4 (21.1)	5 (10.0)	51 (13.2)
Detached house	19 (7.1)	2 (3.9)	2 (10.5)	4 (8.0)	27 (7.0)
Other	7 (2.6)	4 (7.8)	2 (10.5)	0	13 (3.4)
Construction date					
Before 1945	68 (25.7)	8 (16.0)	2 (10.5)	12 (24.0)	90 (23.4)
1945–1965	31 (11.7)	7 (14.0)	1 (5.3)	6 (12.0)	45 (11.7)
1966–1981	56 (21.1)	13 (26.0)	3 (15.8)	13 (26.0)	85 (22.1)
1982–1990	27 (10.2)	4 (8.0)	3 (15.8)	4 (8.0)	38 (9.9)
1991–1999	21 (7.9)	3 (6.0)	2 (10.5)	4 (8.0)	30 (7.8)
2000 or later	31 (11.7)	13 (26.0)	4 (21.1)	10 (20.0)	58 (15.1)
I don't know	31 (11.7)	2 (4.0)	4 (21.1)	1 (2.0)	38 (9.9)
Building location					
Mixed area (industrial, commercial, residential)	52 (19.5)	14 (27.5)	2 (10.5)	9 (18.4)	77 (20)
City centre, densely packed housing	54 (20.2)	12 (23.5)	5 (26.3)	15 (30.6)	86 (22.3)
Town, with no or small gardens	77 (28.8)	17 (33.3)	7 (36.8)	10 (20.4)	111 (28.8)
Suburban, with larger gardens	60 (22.6)	7 (13.7)	4 (21.1)	11 (22.4)	82 (21.3)
Village or rural area	23 (8.6)	1 (2.0)	1 (5.3)	4 (8.2)	29 (7.5)
Outdoor pollution sources					
Cars parked close to building	95 (35.7)	47 (92.2)	8 (42.1)	17 (34.7)	167 (43.4)
Attached garage	33 (12.4)	7 (13.7)	2 (10.5)	9 (18.4)	51 (13.2)
Direct access from basement or roof car park	13 (4.9)	5 (9.8)	0	2 (4.1)	20 (5.2)
Busy road	154 (57.9)	23 (45.1)	13 (68.4)	35 (71.4)	225 (58.4)
Industry	16 (6.0)	8 (15.7)	2 (10.5)	6 (12.2)	32 (8.3)
Power station	10 (3.8)	3 (5.9)	0	1 (2.0)	14 (3.6)
Built on a landfill site	5 (1.9)	1 (2.0)	0	0	6 (1.6)
Waste management site	4 (1.5)	2 (3.9)	0	4 (8.2)	10 (2.6)
Agricultural sources	19 (7.1)	2 (3.9)	3 (15.8)	5 (10.2)	29 (7.5)
Rail station	59 (22.1)	5 (9.8)	0	7 (14.3)	66 (19.8)
Other	16 (6.0)	6 (11.8)	1 (5.3)	4 (8.2)	27 (7.0)
Occupants and activities					
Pets in your home					
None	201 (75.6)	43 (84.3)	16(84.2)	40 (66.7)	300 (75.8)
Dog	17 (6.4)	1 (2.0)	3(15.8)	5 (8.3)	26 (6.6)
Cat	28 (10.5	4 (7.8)	0	2 (3.3)	34 (8.6)
Rabbit/hamster/guinea pig	16 (6.0)	0 (0)	0	1 (1.7)	17 (4.3)
Bird	10 (3.8)	1 (2.0)	0	2 (3.3)	13 (3.3)
Other	14 (5.3)	3(5.9)	0	0	17 (4.3)
Pests in your home					
None	120 (45.1)	30 (58.8)	7 (36.8)	20 (33.3)	177 (44.7)
Cockroaches	2 (0.8)	1 (2.0)	0	0	3 (0.8)
Ants	20 (7.5)	1(2.0)	1 (5.3)	7 (11.7)	29 (7.3)
Mice	59 (22.2)	11 (21.6)	2 (10.5)	15 (25.0)	87 (22.0)
Rats	7 (2.6)	0	0	0	7 (1.8)
Ladybugs	10 (3.8)	0	1 (5.3)	1 (1.7)	12 (3.0)
Silverfishes	76 (28.6)	0	9 (47.4)	18 (30.0)	103 (26.0)
Moths	16 (6.0)	0	0	1 (1.7)	17 (4.3)
Other	17 (6.4)	10 (19.6)	2 (10.5)	2 (3.3)	31 (7.8)
Exposure to second hand tobacco smoke					
Yes	45 (16.9)	10 (19.6)	1 (5.3)	5 (10.6)	61 (15.9)
Do-it-yourself activities					
Welding	2 (0.8)	0	0	0	31 (7.8)
Spray paint	7 (2.6)	1 (2.0)	1 (5.3)	2 (3.3)	11 (2.8)
Heating	3 (1.1)	1 (2.0)	0	1 (1.7)	5 (1.3)
Model glues	35 (13.2)	7 (13.7)	0	7 (11.7)	49 (12.4)
Wood finishing	5 (1.9)	1 (2.0)	1 (5.3)	3 (5.0)	10 (2.5)
Soldering	7 (2.6)	0	0	2 (3.3)	9 (2.3)
Paint	42 (15.8)	4 (7.8)	2 (10.5)	9 (15.0)	57 (14.4)
Other	5 (1.9)	0	0	0	5 (1.3)
Recent painting, remodelling within the last year					
Yes	160 (60.2)	16 (31.4)	10 (52.6)	15 (34.9)	201 (53.0)
Cleaning activities (at least once a week)					
Floors/carpets swept/vacuumed	205 (77.1)	37 (72.5)	13 (68.4)	28 (46.7)	283 (71.5)
Smooth floors washed	136 (51.3)	22 (43.1)	7 (36.8)	17 (28.3)	182 (46.0)
Surfaces dusted	183 (68.8)	30 (58.8)	16 (84.2)	26 (43.3)	255 (64.4)
Surfaces polished	68(25.6)	8 (15.7)	4 (21.1)	6 (10.0)	86 (21.7)
Surfaces cleaned	177 (66.5)	31 (60.8)	0	21 (35.0)	244 (61.6)
Other items dusted	100 (37.6)	14 (27.5)	8 (42.1)	9 (15.0)	131 (33.1)
Mattress turned (once per month)	71 (26.7)	14 (27.5)	3 (15.8)	9 (15.0)	97 (24.5)

Table 3 (*continued*)

	TUD BSc	TUD MSc	WUR	TU/e	Total
	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)
Use of consumer products (at least once a week)					
Air fresheners	96 (36.1)	14 (27.5)	6 (31.6)	11 (18.3)	127 (32.1)
Insecticides	5 (1.9)	2 (3.9)	0	1 (1.7)	8 (2.0)
Disinfectants	43 (16.2)	5 (9.8)	1 (5.3)	5 (8.3)	54 (13.6)
Window cleaners	45 (16.9)	13 (25.5)	2 (10.5)	5 (8.3)	65 (16.4)
Spray on oven cleaners	44 (16.5)	6 (11.8)	2 (10.5)	2 (3.3)	54 (13.6)
Nail polish removers	38 (14.3)	5 (9.8)	3 (15.8)	6 (10.0)	52 (13.1)
Hair sprays	51 (19.2)	11 (21.6)	2 (10.5)	6 (10.0)	70 (17.7)
Incense sticks	15 (5.6)	3 (5.9)	0	4 (6.7)	22 (5.6)
Opening of windows in winter (more than once a week)					
Kitchen	169 (63.5)	32 (62.7)	11 (57.9)	27 (45.0)	239 (60.4)
Living room	167 (62.8)	32 (62.7)	10 (52.6)	21 (35.0)	230 (58.1)
Bedroom	188 (70.7)	35 (68.6)	17 (89.5)	25 (41.7)	265 (66.9)
Furnishing and furniture					
Main floor covering					
Carpet	41 (15.4)	6 (11.8)	9 (47.4)	3 (5.0)	59 (14.9)
Wood	115 (43.2)	22 (43.1)	3 (15.8)	24 (40.0)	164 (41.4)
Stone/ceramic	23 (8.6)	3 (5.9)	1 (5.3)	4 (6.7)	31 (7.8)
Synthetic smooth floorcovering	77 (28.9)	17 (33.3)	4 (21.1)	10 (16.7)	108 (27.3)
Exposed concrete	2 (0.8)	2 (3.9)	0	1 (1.7)	5 (1.3)
Other	8 (3.0)	1 (2.0)	2 (10.5)	1 (1.7)	12 (3.0)
Main wall covering					
Wall paper	70 (26.3)	14 (27.5)	8 (42.1)	12 (20.0)	104 (26.3)
Wood/sealed cork	5 (1.9)	2 (3.9)	0	1 (1.7)	8 (2.0)
Stone/tile	19 (7.1)	0	4 (21.1)	3 (5.0)	26 (6.6)
Exposed concrete/plaster	91(34.2)	18 (35.3)	4 (21.1)	22 (36.7)	135 (34.1)
Enamel/gloss paint	14 (5.3)	3 (5.9)	1 (5.3)	1 (1.7)	19 (4.8)
Dispersion/emulsion paint	62 (23.3)	11 (21.6)	2 (10.5)	4 (6.7)	79 (19.9)
Porous fabric incl. textiles	1 (0.4)	1 (2.0)	0	0	2 (0.5)
Other	4 (1.5)	2 (3.9)	0	0	6 (1.5)
Main ceiling surface					
Exposed concrete/plaster	125 (47.0)	19 (39.6)	7 (36.8)	26 (43.3)	177 (44.7)
Synthetic material	11 (4.1)	3 (6.3)	2 (10.5)	3 (5.0)	19 (4.8)
Wood fibre tiles	12 (4.5)	4 (8.3)	2 (10.5)	1 (1.7)	19 (4.8)
Mineral fibre tiles	8 (3.0)	3 (6.3)	0	1 (1.7)	12 (3.0)
Paint	94 (35.3)	17 (35.4)	4 (21.1)	8 (13.3)	123 (31.1)
Wood	11 (4.1)	1 (2.1)	3 (15.8)	4 (6.7)	19 (4.8)
Other	5 (1.9)	1 (2.1)	1 (5.3)	0	7 (1.8)
Furniture made out of MDF (yes, at least < 1 year)					
Bedroom	69 (26.5)	13 (27.7)	2 (10.5)	5 (8.3)	89 (22.5)
Kitchen	45 (17.9)	11 (22.9)	2 (10.5)	4 (6.7)	62 (15.7)
Bathroom	26 (10.0)	4 (8.9)	1 (5.3)	3 (5.0)	34 (8.6)
Living room	66 (25.6)	12 (24.5)	2 (10.5)	5 (8.3)	85 (21.5)
Natural decorative plants					
Yes	156 (58.6)	24 (47.1)	12 (63.2)	24 (40.0)	216 (54.5)
Systems					
Heating system					
Radiators	232 (87.9)	46 (90.2)	17 (89.5)	42 (89.4)	337 (88.5)
Floor heating	18 (6.8)	3 (5.9)	2 (10.5)	4 (8.5)	27 (7.1)
Air heating	3 (1.1)	1 (2.0)	0	0	4 (1.0)
Convectors	1 (0.4)	0	0	0	1 (0.3)
Electric heater	2 (0.8)	0	0	0	2 (0.5)
Other	8 (3.0)	1 (2.0)	0	1 (2.1)	10 (2.6)
Water heating system					
Electric	86 (32.7)	13 (26.0)	9 (50.0)	11 (23.9)	119 (31.6)
Gas vented	131 (49.8)	23 (46.0)	5 (27.8)	25 (54.3)	184 (48.8)
Gas unvented	31 (11.8)	7 (14.0)	2 (11.1)	8 (17.4)	48 (12.7)
Other	15 (5.7)	7 (14.0)	2 (11.1)	2 (4.3)	26 (6.9)
Cooking appliance					
Only electric	57 (21.4)	22 (43.1)	11 (57.9)	12 (20.0)	102 (25.8)
Coal or wood fired oven	0	0	0	0	0
Gas cooker	206 (77.4)	28 (54.9)	8 (42.1)	34 (56.7)	276 (69.7)
Other	0	1 (2.0)	0	1 (1.7)	5 (1.3)
Air conditioning					
Yes	36 (13.6)	4 (8.2)	2 (10.5)	2 (4.3)	44 (11.6)
Ventilation					
Operable windows	253 (95.1)	45 (88.2)	19 (100.0)	37 (84.1)	354(93.2)
Ventilation grille	93 (35)	24 (47.1)	2 (10.5)	13 (29.5)	132 (34.7)
Other natural ventilation	29 (10.9)	3 (5.9)	1 (5.3)	3 (6.8)	36 (9.5)
Mechanical ventilation	61 (22.9)	12 (23.5)	3 (15.8)	11 (25.0)	87 (22.9)
Humidity					
Humidity signs					
Water leakage or water damage indoors in walls, floor, ceiling	64 (24.1)	16 (31.4)	6 (31.6)	10 (22.7)	96 (25.3)

(*continued on next page*)

Table 3 (*continued*)

	TUD BSc	TUD MSc	WUR	TU/e	Total
	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)	n[a] (%)
Bubbles or yellow discoloration on plastic covering or black discoloration on a parquet floor	8 (3.0)	4 (7.8)	1 (5.3)	0	13 (3.4)
Visible mould growth indoors on walls, floor, ceiling	56 (21.1)	17 (33.3)	3 (15.8)	14 (31.8)	90 (23.7)
The smell of mould in one or more rooms (excl. basement)	12 (4.5)	4 (7.8)	0	4 (9.1)	20 (5.3)
None	160 (60.2)	28 (54.9)	13 (68.4)	21 (47.7)	222 (58.4)
Condensation on windows					
Yes, on outside	27 (10.3)	7 (13.7)	2 (10.5)	3 (5.0)	39 (9.8)
Yes, on inside	96 (36.6)	17 (33.3)	4 (21.1)	12 (20.0)	129 (32.6)
Yes, in between glazing	14 (5.3)	0	1 (5.3)	5 (8.3)	20 (5.1)
No	125 (47.7)	27 (52.9)	11 (57.9)	23 (38.3)	186 (47.0)
Dryer vented to outdoors					
Yes	69 (26.1)	8 (16.0)	5 (26.3)	7 (11.7)	89 (22.5)
No	71 (26.9)	11 (22.0)	4 (21.1)	8 (13.3)	94 (23.7)
I do not have a dryer	124 (47.0)	31 (62.0)	10 (52.6)	28 (46.7)	193 (48.7)

[a] Number of homes may vary because of missing information.

old), including personal factors, other factors of influence, and events. The response rate of 78% was high, even though the data were collected via an on-line questionnaire. This could be related to the fact that the survey was connected to a university course and to a small guide explaining the requested information [21].

The study sample was not representative of students attending Dutch universities in general (approximately 250,000). All students attended the course of Prof. Bluyssen and all students were enrolled at a Technical university (total number of students: cc. 25,000 at TU Delft, 8000 at TU/e and 10,000 at WUR), which can introduce a potential bias in the results, and the results cannot be generalized to the entire student population.

Because of the cross-sectional nature of the study, no causal pathway could be established. Additionally, the study comprised of self-reported data only. Notwithstanding, self-administered questionnaires have shown a good agreement between self-reported Sick Building Syndrome symptoms and a medical interview [22], however, for a correct diagnosis of rhinitis, clinical diagnoses are more reliable [4].

4.2. (Allergic) rhinitis

In the Netherlands, Droste et al. [23] investigated nasal symptoms in 2167 subjects with an age between 20 and 70 years old. 29.5% suffered from nasal symptoms, which is comparable to the self-reported symptoms such as sneezing (30%) and blocked or stuffy nose (27%), reported by the students. In our study, 78% of the students who declared to suffer from rhinitis also reported blocked/study nose ($P < 0.001$) and 72% reported also sneezing ($P = 0.005$), which confirms previous studies [6].

Dykewicz and Hamilos [24] estimated that 10–25% of the population in Western societies have rhinitis. Bousquet et al. [4] indicated a range of 17–28.5% in Europe, while Wheatley and Togias [25] presented a range of 15–30% for the population of the USA. The self-reported 'allergic' rhinitis of the students, 33% with a range of 26%–35% was even higher than that. It should be noted that the prevalence of rhinitis differs in the literature due to health outcome definition.

Multivariate analysis in the underlying study confirmed an association of rhinitis with both allergic and non-allergic conditions: biological allergens from the presence of pets and chemical pollutants (e.g. formaldehyde) emitted by less than one-year old furniture made of MDF in the bedroom, ventilation by opening window in bedroom more than once per week, and physical conditions by working out (exercise). The strongest association was found for students that have relatives who suffer from rhinitis ($P < 0.001$), with an adjusted OR of 5.27 (CI = 3.02–9.21). This is consistent with the statement that 'Rhinitis is a multifactorial disease induced by gene-environment interactions' [4].

4.3. Personal factors

Besides a family connection (genes from parents), several other personal factors have been shown to be associated with rhinitis. Age, gender, and smoking and/or being exposed to second-hand-smokie (SHS) are well-known personal factors [26]. In this study no gender difference was statistically identified, and age was not considered because it was rather narrow (SD = 3; mean = 22).

The counter-intuitive tendency of association between SHS exposure and rhinitis (OR: 0.46, CI: 0.21–1.02) may be explained by the fact that when people smoke indoors, windows are opened. Indeed, among 61 students who reported SHS exposure, 77% declared opening windows in the living room, and from those who did not report SHS exposure (322 students), 56% declared opening windows in the living room ($p = 0.003$).

It is known that negative events influence one's general feeling of wellbeing. In a postal survey on risk factors for asthma and atopic diseases among 10,667 Finnish first-year university students aged 18–25 years, it was found that stressful life events increased the risk of manifestation of allergic rhinoconjunctivitis (or rhinitis) when adjusted for parental atopic disease, education, and passive smoking [27]. In the underlying study, a tendency of an increase was observed for negative events ($P = 0.054$) by a student population with a mean age of 22 years of age.

Working out was negatively associated with rhinitis (OR: 0.50, CI: 0.25–0.99), indicating that the more one works out, the smaller the risk of acquiring rhinitis. Recent studies show that physical activity could reduce respiratory health diseases or conditions. Swimming pool attendance was documented as a protective factor for rhinitis in children [28]. However, we cannot exclude the fact that students who suffered from rhinitis are potentially less engaged in physical activity.

4.4. Biological pollutants

Allergic pollutants that have been associated with rhinitis are: animal dander and secretions (e.g. cats, dogs, rodents and others), waste from insects (e.g. cockroaches, house dust mites), and fungal allergens from moulds [26].

It has been well-established that the presence of pets can cause allergic responses in both children and adults [26]. In this study 'not having pets' resulted in a decreased risk for rhinitis (OR: 0.37, CI: 0.18–0.74), confirming earlier findings.

The counter-intuitive tendency of association between the

Table 4
Association between rhinitis and self-reported building characteristics (results from logistic regression analyses).

Factor	No rhinitis n/N	Rhinitis n/N	Unadjusted		Adjusted[a]	
			OR (95% CI)	P	OR (95% CI)	P
Personal						
Sex: female vs. male	116/235	70/128	1.24 (0.81–1.91)	**0.332**	–	–
Workout: yes vs. no	204/236	101/128	0.59 (0.33–1.03)	**0.064**	0.48 (0.26–0.89)	**0.020**
Smoking yes vs. no	56/236	33/128	1.12 (0.68–1.84)	0.664	–	–
Family rhinitis: yes vs. no	56/229	72/128	4.07 (2.56–6.46)	**<0.001**	–	–
Positive events: yes vs. no	85/236	39/127	0.79 (0.50–1.25)	0.310	0.72(0.44–1.19)	**0.199**
Negative events: yes vs no	71/240	49/125	1.49 (0.95–2.35)	**0.086**	–	–
PANAS pos.: 16–25 vs. 5-14	31/229	18/125	0.93 (0.50–1.74)	0.822	0.76 (0.39–1.50)	0.435
PANAS neg.: 16–25 vs. 5-14	33/229	19/125	1.06 (0.58–1.96)	0.841	0.99 (0.51–1.92)	0.974
Building						
Attached vs. detached	177/227	94/119	1.06 (0.62–1.83)	0.827	0.95 (0.53–1.71)	0.871
Built before 1945 vs. after 1945	61/232	26/125	0.74(0.44–1.24)	0.250	0.78 (0.44–1.38)	0.388
Location: urban vs. rural	161/233	99/125	1.70 (1.02–2.85)	**0.042**	1.89 (1.08–3.31)	**0.027**
Outdoor pollution sources						
Cars parked close to building vs. no	105/233	51/125	0.84 (0.54–1.31)	0.438	0.82 (0.51–1.31)	0.402
Attached garage yes vs. no	27/233	19/125	1.37 (0.73–2.57)	0.332	1.29 (0.65–2.57)	0.468
Access basement/roof car park vs. no	8/225	11/114	2.71 (1.06–6.94)	**0.037**	2.27 (0.83–6.18)	**0.109**
Busy road vs. no	133/233	79/125	1.29 (0.83–2.02)	0.262	1.07 (0.66–1.73)	0.800
Agricultural sources vs. no	22/233	6/125	0.48 (0.19–1.23)	**0.126**	0.37 (0.14–0.99)	**0.047**
Railway station vs. no	43/202	19/108	0.79 (0.43–1.44)	0.439	0.77 (0.41–1.46)	0.421
Occupants and activities						
No pets vs. yes	60/232	19/125	0.51 (0.29–0.91)	**0.022**	0.38 (0.20–0.72)	**0.003**
Rodents vs. no	61/232	23/125	0.63 (0.37–1.08)	0.095	0.56 (0.31–1.01)	**0.052**
Smoking (SHS exposure) vs. no	42/231	15/125	0.61 (0.33–1.16)	**0.132**	0.53 (0.26–1.08)	**0.081**
Recent refurbishment vs. no	117/230	67/122	1.18 (0.76–1.83)	0.469	1.02 (0.64–1.65)	0.928
Do-it-yourself activities						
Spray paint vs. no	4/231	1/125	0.46 (0.05–4.14)	0.487	0.38 (0.04–3.88)	0.412
Heating vs. no	24/231	19/125	1.55 (0.81–2.95)	**0.186**	1.75 (0.86–3.54)	**0.122**
Model glues vs. no	30/231	21/125	1.35 (0.74–2.48)	**0.328**	1.35 (0.70–2.60)	0.376
Paint vs. no	4/231	1/125	0.46 (0.05–4.14)	0.487	0.38 (0.04–3.88)	0.412
Cleaning activities (at least once a week vs. less often (ref.))						
Floors/carpets swept/vacuumed	170/230	95/123	1.19 (0.72–2.00)	0.492	0.99 (0.56–1,74)	0.986
Smooth floors washed	113/227	60/123	1.04 (0.67–1.61)	0.858	1,22 (0.75–1,97)	0.406
Surfaces dusted	153/229	89/122	1.34 (0.82–2.17)	0.237	1.29 0.77–2.18)	0.330
Surfaces polished	52/226	28/122	0.99 (0.59–1.68)	0.990	0.98 (0.55–1.73	0.933
Other items dusted	147/229	81/122	0.90 (0.57–1.44)	0.681	0.76 (0.46–1.26)	0.290
Mattress turned (once a month)	65/236	25/128	0.64 (0.38–1.08)	**0.092**	0.60 (0.34–1.06)	**0.077**
Use of consumer products (at least once a week vs. less often (ref.))						
Air fresheners	78/236	42/128	0.99 (0.63–1.56)	0.963	0.91 (0.55–1.49)	0.700
Insecticides	209/236	107/128	1.52 (0.82–2.81)	**0.183**	1.18 (0.61–2.29)	0.625
Disinfectants	38/236	24/128	1.20 (0.68–2.11)	0.521	1.18 (0.64–2.18)	0.598
Window cleaners	33/236	16/128	0.88 (0.46–1.67)	0.692	0.68 (0.34–1.36)	0.270
Spray on oven cleaners	32/236	16/128	0.91 (0.48–1.73)	0.776	0.66 (0.33–1.36)	0.262
Nail polish removers	37/236	28/128	1.51 (0.87–2.60)	**0.142**	1.25 (0.69–2.25)	0.458
Hair sprays	12/236	7/128	1.08 (0.41–2.82)	0.875	0.80 (0.29–2.25)	0.677
Incense sticks	78/236	42/128	0.99 (0.63–1.56)	0.963	0.91 (0.55–1.49)	0.700
Opening of windows in winter (more than once a week vs. less often (ref.))						
Kitchen	145/236	75/128	0.89 (0.57–1.38)	0.596	0.81 (0.50–1.31)	0.391
Living room	141/236	71/128	0.84 (0.54–1.30)	0.430	0.66 (0.41–1.06)	**0.088**
Bedroom	167/236	79/128	0.67 (0.42–1.05)	**0.079**	0.55 (0.33–0.91)	**0.020**
Furnishings and flooring						
Floor covering carpet vs. no	36/230	18/122	0.93 (0.51–1.72)	0.824	0.96 (0.50–1.85)	0.907
Wall cover exposed concrete vs no	88/230	40/122	0.79 (0.50–1.25)	0.310	0.82 (0.50–1.35)	0.430
Furniture made out of MDF (yes, at least < 1 year)						
Bedroom yes vs. no	191/225	88/115	1.72 (0.98–3.03)	**0.059**	1.80 (0.98–3.31)	**0.057**
Kitchen yes vs. no	33/217	25/114	1.57 (0.88–2.79)	**0.128**	1.57 (0.85–2.91)	**0.148**
Bathroom yes vs. no	15/223	12/114	1.63 (0.74–3.61)	0.228	1.54 (0.65–3.63)	0.325
Living room yes vs. no	195/220	98/119	1.67 (0.89–3.14)	**0.109**	1.26 (0.63–2.50)	0.509
Natural plants yes vs. no	91/230	62/141	0.63 (0.41–0.99)	**0.043**	0.57 (0.35–0.93)	**0.024**
Systems						
Cooking appliance gas vs. no gas	163/231	94/125	1.27 (0.77–2.08)	0.352	1.36 (0.79–2.33)	0.266
Air conditioning vs. no	32/226	9/125	0.47 (0.22–1.02)	**0.056**	0.50 (0.22–1.14)	**0.099**
Ventilation system						
Operable windows vs. no	215/230	114/123	0.88 (0.38–2.08)	0.777	0.93 (0.36–2.43)	0.889
Ventilation grille vs. no	79/230	42/123	0.99 (0.63–1.57)	0.970	1.04 (0.63–1.71)	0.890
Mechanical ventilation vs. no	54/230	23/123	0.75 (0.43–1.29)	0.301	1.12 (0.63–2.02)	0.698
Humidity						
Humidity signs						
Water leakage or damage vs. no	59/230	33/123	1.06 (0.65–1.75)	0.810	0.92 (0.54–1.58)	0.767
Visible mould growth vs. no	48/230	34/123	1.45 (0.87–2.41)	**0.152**	1.21 (0.70–2.09)	0.506
Condensation windows vs. no	116/228	56/119	0.86 (0.55–1.34)	0.500	0.76 (0.47–1.24)	0.273
Dryer vented outdoors vs. no	59/227	27/122	0.81 (0.48–1.36)	0.425	0.93 (0.53–1.63)	0.791

-: adjusted factors.
P-values below 0.20 are in bold.
[a] Adjusted for gender, smoking, family allergic rhinitis and negative events.

Table 5
Multivariate logistic regression model of the relations between rhinitis and building characteristics.

Risk factor	Adjusted OR (95% CI)	P
Gender (female vs. male)	1.06 (0.62–1.80)	0.841
Family rhinitis vs. no	5.27 (3.02–9.21)	**<0.001**
Smoker vs. no	1.54 (0.83–2.85)	0.172
Working out vs. no	0.50 (0.25–0.99)	**0.046**
Negative events vs. no	1.74 (0.99–3.06)	0.054
Agriculture sources	0.46 (0.16–1.33)	0.152
Rodents vs. no	0.58 (0.31–1.11)	0.101
No pets vs. pets	0.37 (0.18–0.74)	**0.005**
Exposure to SHS vs. no	0.46 (0.21–1.02)	0.056
Opening windows (>1/week) bedroom vs. less	0.55 (0.31–0.98)	**0.041**
MDF furniture in bedroom (<1 year) vs. no or yes (>1 year)	2.26 (1.17–4.37)	**0.015**
Plants vs. no	0.61 (0.36–1.05)	0.075
Air conditioning vs. no	0.48 (0.19–1.21)	0.121

OR = odds ratio; SHS = second hand smoke; MDF = medium density fibreboard; VIF = variance inflation factor.
P-values below 0.05 are in bold.

presence of rodents (mice and/or rats) and rhinitis (OR: 0.58, CI: 0.31–1.11), may be explained by the fact that when students know they have rodents pests, they clean more (60% of the students having rodents washed their floor more than once a week versus 45% of the students who did not declare to have rodents pests, P = 0.014). Another explanation is the floor level on which they live. A higher percentage of students living on the groundfloor or first floor, declared to have rodents (53%) than students not having declared to have rodents (38%) (P = 0.014). Also, the age of the building can have an influence. From the students who declared to have rodents, 40% live in a building constructed before 1945, versus 18% who declared not to have rodents (P = 0.001).

Although indoor mould and dampness in buildings have been associated with multiple allergic and respiratory effects, it has been difficult to explain this association with specific chemical or microbial factors [29]. Visible mould growth is used as an indicator for dampness in buildings [30]. Moulds can produce spores, MVOCs (Microbial volatile organic compounds), mycotoxins, and other toxic compounds [31]. In this study, no statistical association was found between visible mould growth and rhinitis. Lorentzen et al. [32] suggested that annoying odour (from mould) may also contribute to adverse health effects. However, the smell of mould was not found to be related to rhinitis.

Although the normal amount of plants present in a space has not shown to contribute to less indoor air pollutants, positive effects of plants on people's perception of an indoor environment such as how stressful the space is perceived, have been found in several studies [33]. In this study, a tendency of a decrease in rhinitis (OR: 0.61, CI: 0.36–1.05, P = 0.075) was observed.

4.5. Chemical pollutants

An increased risk of rhinitis was found with the presence of less than one-year old furniture made of MDF in the bedroom (OR: 2.26, CI: 1.17–4.37), while a reduced risk was found for opening windows (more than once per week) in the bedroom (OR: 0.55, CI: 0.31–0.98). Additionally, a tendency of a reduced risk of rhinitis was observed for having air conditioning (OR: 0.48, CI: 0.19–1.21, P = 0.121), indicating that with more ventilation in the bedroom, the risk decreases. Less than one-year old furniture made of MDF, has the potential of specifically emitting aldehydes (e.g. formaldehyde) [34]. This emission increases as humidity increases, another indicator for a damp building.

In order to study the effect of outdoor pollutants on rhinitis, such as exhaust fumes from traffic, the risk of living in an urban vs. rural area (assuming less outdoor pollutants) was tested. No significant association was found. However, a tendency was observed with the presence of agricultural sources (OR: 0.46, CI: 0.16–1.33, P = 0.152), which could be a surrogate for living in a rural area.

5. Conclusions

The findings of this study show that rhinitis was associated with biological pollutants (presence of pets) and chemical pollutants (presence of MDF from less than one-year old furniture), ventilation (opening windows in bedroom more than once a week), and with personal factors, working out (physical activity).

Besides genetics, this study confirms that rhinitis is a multifactorial disease; as both personal and environmental factors are linked to this disease in young adults.

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