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Research Article

Respiratory Health and Housing for University Undergraduate Students

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Abstract

Background: Diverse factors affect the overall health of undergraduate students. These factors pertain to multiple physical and social environmental exposures, individual behaviours, and genetic predispositions. Research generally recognizes that the most common illnesses experienced by this population are respiratory-related. Within the home, exposures may include indoor air pollutants including environmental tobacco smoke and other ubiquitous chemicals, mould from water damage, and allergens. Although individuals may engage in behaviours to reduce these exposures, these exposures persist and can negatively impact respiratory health.

Objectives: To assess the prevalence of wheezing and whistling symptoms, dry cough, and difficulties breathing, in relation to environmental exposures from housing accommodations among the undergraduate university population; and to explore predictors on these health outcomes, as well as the role of three housing types (on-campus, off campus, with family).

Methods: We developed an online health questionnaire to collect data related to the sociodemographic and respiratory health of the study population. Spirometry was also conducted to collect lung function (FVC, FEV1, PEF, and FEV1%).

Results: A total sample of 213 participants completed the questionnaire, of which 180 also underwent spirometry testing. Overall, 40% of university undergraduate students reported being sick within the last 30 days with 36% reporting that their sickness was respiratory-related. Type of housing accommodation did not appear to affect wheezing and whistling symptoms or difficulties breathing, however participants who indicated living in a housing accommodation older than 11 years were 3.28 times more likely to experience dry cough at night than those living in a housing accommodation 1-10 years old. Based on spirometry, no participants had restrictive or obstructive lung disease.

Conclusions: This study suggests there are no significant differences in respiratory health based on type of housing accommodation. However, this study suggests the age of the housing accommodation is a predictor of dry cough. Furthermore, the prevalence of wheezing/whistling symptoms, dry cough, and difficulties breathing does not appear to be correlated with the type of housing accommodation resided in. This implies that the type of housing accommodation does not have an impact on respiratory health symptoms for this population.

Introduction

Canadians spend approximately 87% of their time indoors [1] a percentage that has steadily increased over the years especially amongst the adolescent population. According to the Youth Engagement with Nature and the Outdoors Survey 2012©, this high proportion of time spent indoors is mainly attributed to substantial school and work commitments that make it difficult to spend time outdoors. Indoor environments are enclosed, which allows environmental exposures such as mould and air pollutants to exist in significantly higher concentrations [2].

University undergraduate students have an increased susceptibility to acute and chronic respiratory illnesses due to their unique heightened stress levels, lack of sleep, and changes in diet and physical activity levels. However, interacting with socioeconomic status, individual behaviours, and genetic predispositions, these risks are greatly increased [3]. For example, the effects of exposure to particulate matter in the home on respiratory mortality and morbidity have been documented [4]. Alternatively, positive personal behaviours such as engaging in sufficient physical activity has shown to improve respiratory function [5]. Adverse respiratory symptoms including wheezing and whistling, dry cough, and difficulties breathing have been identified as the most common cause of missed school days [6].

Research has mildly focused on the relationship between physical environments of student housing, social environments, and personal behaviours in relation to adverse respiratory health outcomes for the university undergraduate population [7]. However, to date research studies have been conducted in very different populations and geographical locations compared to the population currently being studied in Oshawa, Ontario. It is important to consider potential differences in a predominantly suburban area with varying housing accommodation styles, with students of varying experiences. Moreover, it is vital to study physical, social, and biological aspects simultaneously. This research is guided by the Population Health Framework [8]. The framework is a conceptual model that describes the interaction between determinants of health, for the purpose of understanding the health of a given population beyond the bounds of the health care system [8]. The Population Health Framework is divided into several components, including the physical environment, the social environment, genetic endowment, individual response, and health care, all of which impact health and disease. The physical environment includes factors related to housing accommodations. This conceptual model can be utilized to examine the links between environmental exposures and the health of undergraduate university students (Figure 1).

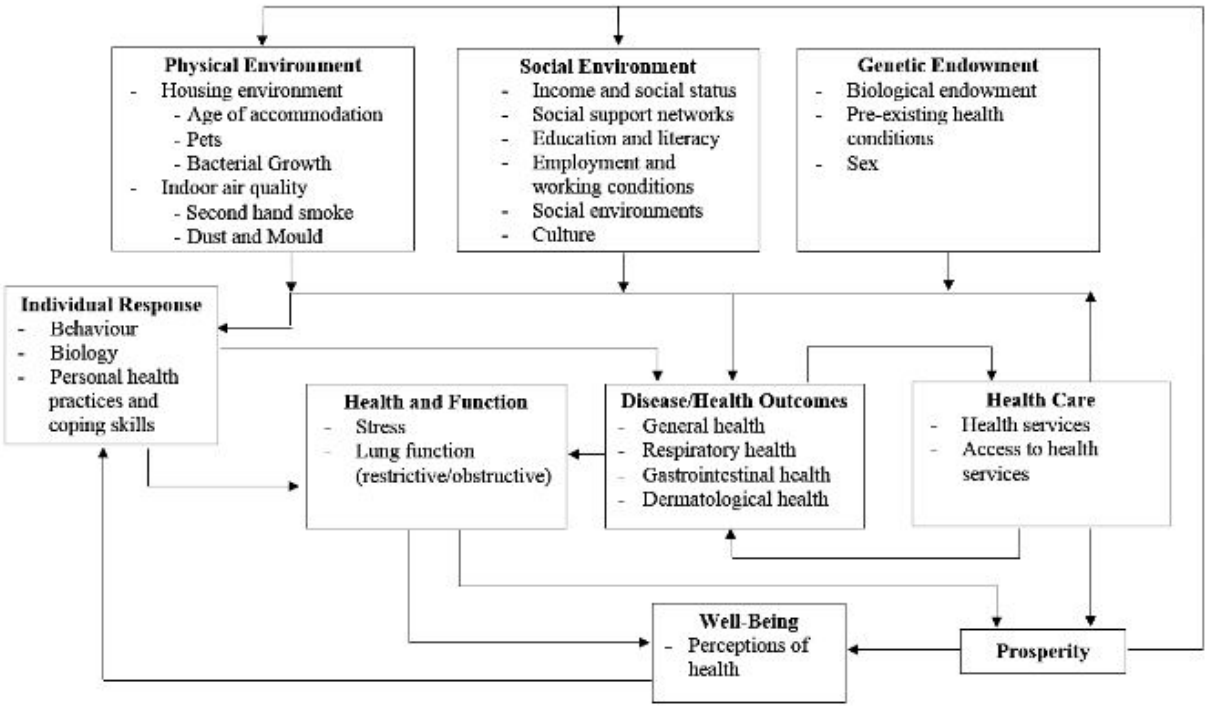

Figure 1: Applying the Population Health Framework to examine research on housing and health of university undergraduate students.

Literature has documented the risks of environmental exposures on respiratory health [9]. However, studies have not been conducted in relation to various housing accommodations in the university undergraduate population. It is important to consider differences in types of housing accommodations of students and lifestyles. This research allows for multidimensional exploration of physical, social, and biological variables simultaneously, which can help in understanding health outcomes for the university undergraduate population. This research focuses on the undergraduate population of the University of Ontario Institute of Technology (UOIT). The research objectives are:1) to determine the prevalence of respiratory related symptoms, wheezing and whistling, dry cough, and difficulties breathing, 2) to describes parametric lung function and prevalence of restrictive and obstructive lung disease, and 3) to explore predictors of wheezing and whistling, dry cough, and difficulties breathing in relation to type of housing accommodation.

Methods

Data Source

This study was conducted at the UOIT using a cross-sectional health questionnaire and spirometry. The health questionnaire was developed for the purpose of this research and emailed for self-administration to 213 university undergraduate students, from all years of study. The health questionnaire collected data on demographics, physical exposures, personal behaviours, and biological endowment Spirometry was conducted after the health questionnaire was completed, using a portable Vitalograph Micro (Vitalograph Medical, Lenexa) and standard data collection tool from the Canadian Lung Association™ to record spirometry measures (FVC, FEV1, PEF, and FEV%), and information necessary to perform the testing (age, sex, height, weight, ethnicity, adherence to appointment instructions, smoking history, relative contraindications, medical history and medications)

Outcome Variables

In addressing the research objective to explore the role of housing types on health, the health questionnaire, included original items and items from the following validated questionnaires: The International Study of Asthma and Allergies in Childhood (ISAAC) [10], Environmental Health Survey for Central and Western Minnesota [11], Households and the Environment Survey (HES) [12], and Student Health and Lifestyle Questionnaire [13]. The questionnaire also utilized guidelines from the Canadian Society for Exercise Physiology's (CSEP) Canadian Physical Guidelines [14]. Participants were asked if they had pre-existing health conditions including any respiratory conditions such as asthma, which may impact their results in the research. Furthermore, participants were asked if they experienced respiratory symptoms in the past month, including wheezing/whistling symptoms, dry cough, and difficulties breathing.

Explanatory Variables

In relation to environmental exposures, participants were categorized based on their living arrangements: home with family, on-campus residence, and off-campus housing. Regarding the physical environment, participants were asked about: the physical conditions of their housing accommodation, the age of the accommodation, the amount of people residing in the home, pets in the home, exposure to second hand smoke, visible mould and/or mildew, and air quality within the home. Sociodemographic variables include: if the property is owned or rented by, the student's year of study, income, parental education, and employment status. Individual responses and personal behaviors were measured by the following variables: cleaning practices in several areas of the home, methods to improve air quality in the home, physical activity levels, alcohol consumption, and smoking or non-smoking habits.

Genetic endowment was assessed with demographic information including: age, gender, ethnicity, basic anthropometric measures, and pre-existing health conditions. The use of the health care system was explored with the following variables: if the student has coverage through the Ontario Health Insurance Plan (OHIP), how often the health care system is used, the approximate date of the student's last general physical check-up, and if the participants has ever been used the internet to self-diagnose any symptoms experienced. Health and function includes health outcomes including but not limited to: if respiratory illnesses were the cause of missed academic commitments, wheezing/whistling in the lungs, wheezing attacks, dry coughing symptoms, or difficulties breathing.

Statistical Analysis

Data were analyzed using IBM SPSS Version 23 was used for the analysis (IBM Corporation, 2016). Descriptive statistics (frequency and descriptive) were calculated for outcome and explanatory variables. Depending on the data type, chi-square statistics and independent t-test were used to compare participants who reported respiratory health outcomes to those who did not. Independent variables that were deemed significant in the univariate and bivariate analysis ($p \leq 0.05$), were entered into logistic regression models to analyze binomial outcomes with multiple explanatory variables as well as reveal significance of fair/poor respiratory health outcomes Health outcomes modeled for this study include: wheezing/whistling within 12 months, dry cough at night within 12 months, and difficulty breathing within 12 months. For each of the modelled health outcomes, backward step-wise entry groups of variables were conducted; and explanatory variables were entered into the model one step at a time to identify significant predictors of the health outcomes using a Significance level of $p \leq 0.05$for categorical variables, one category was chosen

to be the reference category, with each category of the variable then compared to the reference category. This method resulted in a model that included significant explanatory variables that explain the health outcomes.

The specificity and sensitivity, along with the Hosmer-Lemeshow test values were noted. To determine if housing accommodation affected the health outcomes, the type of housing accommodation variable was forced into the best-fit model to create a new model. The statistical significance of each predictor, and the odds ratio were presented for each model. An odds ratio (OR) greater than one indicates an increased likelihood and an odds ratio less than one indicates a decreased likelihood. The Hosmer-Lemeshow test was used as a goodness-of-fit-measure.

Results

Participant Characteristics

This manuscript is based on responses from 213 participants attending year 1 (10%), year 2 (19%), year 3 (58%), and year 4 (13%). Participants were enrolled in the following programs of study: Business and Information Technology, Engineering and Applied Sciences, Energy Systems and Nuclear Science, Health Sciences, Science, Social Sciences and Humanities who attend UOIT in Oshawa, Ontario. A total of 180 participants completed spirometry testing. No participants presented with restrictive or obstructed lung patterns. Moreover, participants that indicated being a current or previous smoker had lower than normal values. Similarly, participants that indicated being physically active had higher than normal values. Table 1 summarizes the distribution of sociodemographic characteristics for the study sample. Overall, 58% of students were female, and 27% of participants in the study were male with a mean age of 22 years. With respect to ethnicity, the majority of participants were of Caucasian descent (42%). Results indicate that most participants lived at home with their families (66%), with 8% of participants living in on-campus residence and 26% living in off-campus residence. Of the total sample, most participants were employed (60%) in various sectors including health care (19%), food industry/accommodation (15%), and retail (11%). Participants typically worked 11-20 hours per week and indicated employment is their main source of income.

Variable	Classification	Sample n (%)
Sex	Male	57 (26.8)
	Female	123 (57.7)
	Missing Data	33 (15.5)
Ethnicity	Caucasian	90 (42.3)
	Indian	18 (8.5)
	Arab	16 (7.5)
	Asian	16 (7.5)
	Black	13 (6.1)
	Sri Lankan	9 (4.2)
	European	8 (3.8)
	Pakistani	4 (1.9)
	Filipino	3 (1.4)
	Persian	2 (0.9)
	Hispanic	1 (0.5)
	Missing Data	33 (15.5)
Year of Study	1	22 (10.3)
	2	40 (18.8)
	3	123 (57.7)
	4	28 (13.1)
Housing Accommodation	Home with family	140 (65.7)
	On-campus residence	17 (8.0)
	Off-campus housing	56 (26.3)
Employment Status	Employed	128 (60.1)
Type of Student Employment	Agriculture	2 (0.9)
	Business/Office Setting	22 (10.3)
	Contracting/Trades	2 (0.9)
	Educational Services	18 (8.5)
	Food industry/accommodation	31 (14.6)
	Health Care	41 (19.2)
	Retail	24 (11.3)

Hours Worked per Week	0-10	41 (19.2)
	20-Nov	50 (23.5)
	21-30	22 (10.3)
	31-40	15 (7.0)
Main source of Student Income	OSAP	107 (50.2)
	Employment	142 (66.7)
	Scholarships/Bursaries	47 (22.1)
	Assistance from Family	92 (43.2)
Family's Annual Income	Less than $20,000	13 (6.1)
	$20,000-$40,000	14 (6.6)
	$40,000-$60,000	22 (10.3)
	$60,000-$80,000	31 (14.6)
	$80,000-$100,000	27 (12.7)
	More than $100, 000	61 (28.6)
	I do not know/ I do not wish to answer	45 (21.1)
Father's Education	Did not attend school	2 (0.9)
	Elementary school	10 (4.7)
	Secondary school	40 (18.8)
	Community college, technical school, apprenticeship	27 (12.7)
	College or university	90 (42.3)
	Post-graduate education	26 (12.2)
	I do not know/I do not wish to answer	18 (8.5)
Mother's Education	Did not attend school	3 (1.4)
	Elementary school	4 (1.9)
	Secondary school	50 (23.5)
	Community college, technical school, apprenticeship	27 (12.7)
	College or university	102 (47.9)
	Post-graduate education	19 (8.9)
	I do not know/I do not wish to answer	8 (3.8)
Health Care Coverage (OHIP)	Yes	197 (92.5)

Table 1: Distribution of Sociodemographic Characteristics (n=213).

From an economic standpoint, 29% of participants indicated their family's annual income is greater than $100, 000. With regards to participants' parental education, 42% and 47% specified the highest level of education was college or university respectively. Overall, 93% of participants had access to health care coverage through Ontario Health Insurance Plan (Table 1)Overall, 36% of the total sample reported to have experienced some type of respiratory illness. Specifically related to the study objectives, 18.3% of participants reported experiencing wheezing or whistling within the last 12 months, 31.5% of participants reported experiencing dry cough at night within the last 12 months, and 15% of participants reported difficulties breathing within the last 30 days (Table 2).

Variable	**Classification**	**Home with Family**	**On-Campus Residence**	**Off-Campus Residence**	**Total**	**p-**
		(n=140),n (%)	**(n=17),n (%)**	**(n=56),n (%)**	**n (%)**	**value**
General Health	Excellent/ Very Good/ Good	127 (90.7)	12 (70.6)	51 (91.1)	190 (89.2)	0.097
	Fair/Poor	13 (9.3)	5 (29.4)	5 (8.9)	23 (10.8)	
Health issues for anyone in the home	Yes	13 (9.2)	1 (5.8)	3 (5.3)	17 (7.9)	0.024
Pre-existing health conditions	Yes	15 (10.7)	2 (11.7)	7 (12.5)	24 (11.3)	0.974
Sick within 30 days	Yes	60 (42.8)	3 (17.6)	22 (39.2)	85 (39.9)	0.133
Frequency of Health Affecting Academics**	Never	125 (89.2)	15 (88.2)	50 (89.2)	190 (89.2)	0.008
	Seldom	6 (4.2)	0 (0.0)	3 (5.3)	9 (4.2)	
	Occasionally	9 (6.4)	0 (0.0)	2 (3.5)	11 (5.1)	
	Regularly	0 (0.0)	2 (11.7)	1 (1.7)	3 (1.4)	

Respiratory Illnesses	Yes	53 (37.8)	2 (11.7)	21 (37.5)	76 (35.7)	0.225
Ever had Wheezing or Whistling	Yes	54 (38.5)	6 (35.2)	15 (26.7)	75 (35.2)	0.296
Wheezing or Whistling within 12 months	Yes	26 (18.5)	4 (23.5)	9 (16.0)	39 (18.3)	0.777
Frequency of Wheezing attacks within 12 months (days)	None	2 (1.4)	2 (11.7)	1 (1.7)	5 (2.3)	0.744
	3-Jan	18 (12.8)	1 (5.8)	6 (10.7)	25 (11.7)	
	12-Apr	3 (2.1)	0 (0.0)	2 (3.5)	5 (2.3)	
	More than 12	3 (2.1)	1 (5.8)	0 (0.0)	4 (1.8)	
	N/A	114 (81.4)	13 (76.4)	47 (83.9)	174 (81.6)	
Sleep disturbed by Wheezing or Whistling within 12 months	Never woken with wheezing	16 (11.4)	3 (17.6)	5 (8.9)	24 (11.2)	0.268
	Less than 1 night/week	9 (6.4)	1 (5.8)	1 (1.7)	11 (5.1)	
	1 or more nights/week	1 (0.7)	0 (0.0)	3 (5.3)	4 (1.9)	
	N/A	114 (81.4)	13 (76.4)	47 (83.9)	174 (81.6)	
Speech limited by Wheezing or Whistling within 12 months	Yes	2 (1.4)	1 (5.8)	4 (9.1)	7 (3.3)	0.176
Wheezing after exercise within 12 months	Yes	21 (15)	3 (17.6)	7 (12.5)	31 (14.6)	0.846
Dry cough at night within 12 months	Yes	39 (27.8)	7 (41.1)	21 (37.5)	67 (31.5)	0.282
Difficulty breathing within 30 days	Yes	23 (16.4)	2 (11.7)	7 (12.5)	32 (15.0)	0.727
Student ever had asthma	Yes	34 (24.2)	5 (29.4)	9 (16.0)	48 (22.5)	0.359
* p<0.05; **p<0.01; ***p<0.001						

Table 2: Health Outcomes by Type of Housing Accommodation (n=213).

Furthermore, univariate analyses show 19% of participants perceive their adverse health is due to stress, 13% believe their adverse health is due to diet, and 6% believe their adverse health is due to their level of exercise (Table 3).

Variable	Classification	Home with Family (n=140), n(%)	On-Campus Residence (n=17), n(%)	Off-Campus Residence (n=56), n (%)	Total n (%)	p-value
Perceived adverse health due to smoking	Yes	0 (0.0)	0 (0.0)	1 (1.7)	1 (0.4)	0.539
Perceived adverse health due to cold/flu	Yes	6 (4.2)	1 (5.8)	3 (5.3)	10 (4.7)	0.946
Perceived adverse health due to travel	Yes	2 (1.4)	0 (0.0)	0 (0.0)	2 (0.9)	0.744
Perceived adverse health due to stress	Yes	11 (7.8)	1 (5.8)	7 (12.5)	19 (8.9)	0.863
Perceived adverse health due to pregnancy	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.743
Perceived adverse health due to contaminated food/water	Yes	1 (0.7)	1 (5.8)	1 (1.7)	3 (1.4)	0.437
Perceived adverse health due to diet choices	Yes	8 (5.7)	0 (0.0)	5 (8.9)	13 (6.1)	0.699
Perceived adverse health due to level of exercise	Yes	4 (2.8)	0 (0.0)	2 (3.5)	6 (2.8)	0.897

Housing Accommodations and Health Outcomes

Bivariate analysis on physical environmental exposures resulted in statistically significant differences between housing accommodations for: the age of the housing accommodation, the number of individuals residing in the home, pets in the home, exposure to ETS in the home, frequency of dusting common surfaces, frequency of disinfecting surfaces, frequency of mopping/vacuuming, frequency of disinfecting kitchen surfaces, frequency of disinfecting bathroom surfaces, frequency of cleaning bedrooms, home filters cleaned within 12 months, and the use of higher quality filters (Table 4).

Variable (n, %)	Classification	Home with Family (n=140), n(%)	On-Campus Residence (n=17), n(%)	Off-Campus Residence (n=56), n(%)	Total n(%)	p-value
Age of Housing (years)***	5-Jan	18 (12.8)	2 (11.8)	21 (37.5)	41 (19.2)	0
	6+	113 (80.7)	6 (35.3)	20 (35.7)	139 (65.3)	
	I do not know/I do not wish to answer	9 (6.4)	9 (52.9)	15 (26.8)	33 (15.5)	
# of Individuals Residing in the Home***	2-Jan	6 (4.2)	9 (52.9)	11 (19.6)	26 (12.2)	0
	3+	134 (95.7)	8 (47.1)	45 (80.4)	187 (97.8)	
Pets in the Home*	Yes	65 (46.4)	5 (29.4)	14 (25.0)	84 (39.4)	0.014
Exposure to ETS in the Home**	Never	116 (82.8)	11 (64.7)	35 (62.5)	162 (76.1)	0.005
	Sometimes/Always	24 (17.1)	6 (35.3)	21 (37.5)	51 (23.9)	
Visible Mould in the Home	Yes	25 (17.8)	2 (11.8)	13 (23.2)	40 (18.8)	0.51
Frequency of dusting common surfaces*	Never/Once every 4+ months/ Once every 2-3 months	37 (26.4)	10 (58.8)	14 (25.0)	61 (28.6)	0.016
	Monthly/ Weekly/Daily	103 (73.6)	7 (41.2)	42 (75.0)	152 (71.4)	
Frequency of disinfecting surfaces***	Never/Once every 4+ months/ Once every 2-3 months	24 (17.1)	8 (47.1)	1 (1.8)	33 (15.5)	0
	Monthly/ Weekly/ Daily	116 (82.3)	9 (52.9)	55 (98.2)	180 (84.5)	
Frequency of mopping/ vacuuming*	Never/Once every 4+ months/ Once every 2-3 months	5 (3.6)	3 (17.6)	6 (10.7)	14 (6.6)	0.03
	Monthly/ Weekly/ Daily	135 (96.4)	14 (82.4)	50 (89.3)	199 (93.4)	
Frequency of disinfecting kitchen surfaces	Never/Once every 4+ months/ Once every 2-3 months	14 (10.0)	5 (29.4)	6 (10.7)	25 (11.7)	0.061
	Monthly/ Weekly/ Daily	126 (90.0)	12 (70.6)	50 (89.3)	188 (88.3)	
Frequency of disinfecting bathroom surfaces***	Never/Once every 4+ months/ Once every 2-3 months	10 (7.1)	6 (35.3)	5 (8.9)	21 (9.9)	0.001
	Monthly/ Weekly/ Daily	130 (92.9)	11 (64.7)	51 (91.1)	192 (90.1)	
Frequency of cleaning bedroom	Never/Once every 4+ months/ Once every 2-3 months	25 (21.7)	5 (29.4)	4 (7.1)	34 (16.0)	0.052
	Monthly/ Weekly/ Daily	115 (82.1)	12 (70.6)	52 (92.9)	179 (84.0)	

Filter cleaned within 12 months***	Once in the past year or more frequently	72 (51.4)	4 (23.5)	10 (17.9)	86 (40.4)	0
	Did not change filter/Not responsible for changing filter/ I do not know/ I do not wish to answer	68 (48.6)	13 (76.5)	46 (82.1)	127 (59.6)	
Perceptions of air quality in home within 30 days*	Excellent/Very good/Good	130 (92.9)	12 (70.6)	48 (85.7)	190 (89.2)	0.013
	Fair/Poor	10 (7.1)	5 (29.4)	8 (14.3)	23 (10.8)	
Opening windows	Yes	119 (85.0)	12 (70.6)	42 (75.0)	173 (81.2)	0.136
Use of ceiling/floor fan	Yes	60 (42.9)	9 (52.9)	27 (48.2)	96 (45.1)	0.629
Use of air conditioner	Yes	46 (32.9)	8 (47.1)	15 (26.8)	69 (32.4)	0.288
Use of dehumidifier	Yes	28 (20.0)	1 (5.9)	8 (14.3)	37 (17.4)	0.271
Use of humidifier	Yes	39 (27.9)	3 (17.6)	9 (16.1)	51 (23.9)	0.178
Use of air cleaning system	Yes	8 (5.7)	2 (11.8)	4 (7.1)	14 (6.6)	0.624
Use of higher quality filters**	Yes	37 (26.4)	0 (0.0)	5 (8.9)	42 (19.7)	0.002
Use of furnace fan	Yes	25 (17.9)	2 (11.8)	13 (23.2)	40 (18.8)	0.51
Use of air fresheners	Yes	86 (61.4)	7 (41.2)	36 (64.3)	129 (60.6)	0.218

Table 4: Physical Environmental Exposures by Housing Accommodation (n=213).

There were no statistically significant variables within the individual response and health care categories in relation to housing accommodations (Tables 5-6).

Variable	**Classification**	**Home with Family (n=140), n(%)**	**On-Campus Residence (n=17), n(%)**	**Off-Campus Residence (n=56), n(%)**	**Total n(%)**	**p-value**
Level of physical activity (PA)	I do not engage in PA/ I engage in light PA	61 (43.6)	8 (47.1)	16 (28.6)	85 (39.9)	0.464
	I engage in moderate PA/ I engage in vigorous PA	79 (56.4)	9 (52.9)	40 (71.4)	128 (60.1)	
Total length of PA/ week	Less than 150mins per week/ N/A	80 (57.2)	8 (47.1)	23 (41.0)	111 (52.1)	0.074
	150+ per week	60 (42.9)	9 (52.9)	33 (58.9)	102(47.9)	
Moderate/Vigorous PA in bouts of 10 mins	Never	5 (3.6)	1 (5.9)	5 (8.9)	11 (5.2)	0.369
	Sometimes	46 (32.9)	4 (23.5)	19 (33.9)	69 (32.4)	
	Always	28 (20.0)	4 (23.5)	16 (28.6)	48 (22.5)	
	N/A	61 (43.6)	8 (47.1)	16 (28.6)	85 (39.9)	
Frequency of hands washed with soap (per day)	0-3	20 (14.3)	5 (29.4)	11 (19.6)	36 (16.9)	0.363
	6-Apr	46 (32.9)	7 (41.2)	21 (37.5)	74 (34.7)	
	9-Jul	35 (25.0)	4 (23.5)	13 (23.2)	52 (24.4)	
	10+	39 (27.9)	1 (5.9)	11 (19.6)	51 (23.9)	
Use of alcohol based sanitizers	Yes	105 (75.0)	11 (64.7)	33 (58.9)	149(70.0)	0.076

Frequency of vitamin/supplement consumption	Never	21 (15.0)	3 (17.6)	13 (23.2)	37 (17.4)	0.358
	Rarely	51 (36.4)	4 (23.5)	11 (19.6)	66 (31.0)	
	Few times per week	32 (22.9)	5 (29.4)	17 (30.4)	54 (25.4)	
	Daily	36 (25.7)	5 (29.4)	15 (26.8)	56 (26.3)	
Frequency of alcohol consumption	I do not consume alcohol/ Once a year or less/	122 (87.1)	12 (70.5)	41 (73.3)	175 (82.1)	
	>once a year but <once a month/ Once a month but <once a week					0.429
	Once a week but not every day	18 (12.9)	5 (29.4)	15 (26.8)	38 (17.8)	
Average drinks at any one time	<1/ N/A	40 (28.6)	5 (29.4)	10 (17.9)	55 (25.8)	0.785
	1 or 2	44 (31.4)	3 (17.6)	22 (39.3)	69 (32.4)	
	3 or 4	34 (24.3)	6 (35.3)	13 (23.2)	53 (24.9)	
	5 or 6	17 (12.1)	2 (11.8)	7 (12.5)	26 (12.2)	
	6+	5 (3.6)	1 (5.9)	4 (7.1)	10 (4.7)	
Stress level (scale from 0-10)	0	0 (0.0)	1 (5.9)	1 (1.8)	2 (0.9)	0.142
	1	4 (2.9)	0 (0.0)	0 (0.0)	4 (1.9)	
	2	5 (3.6)	0 (0.0)	8 (14.3)	13 (6.1)	
	3	13 (9.3)	3 (17.6)	5 (8.9)	21 (9.9)	
	4	12 (8.6)	1 (5.9)	7 (12.5)	20 (9.4)	
	5	18 (12.9)	3 (17.6)	11 (19.6)	32 (15.0)	
	6	23 (16.4)	4 (23.5)	8 (14.3)	35 (16.4)	
	7	30 (21.4)	2 (11.8)	7 (12.5)	39 (18.3)	
	8	20 (14.3)	3 (17.6)	6 (10.7)	29 (13.6)	
	9	8 (5.7)	0 (0.0)	2 (3.6)	10 (4.7)	
	10	7 (5.0)	0 (0.0)	1 (1.8)	8 (3.8)	
Hours of sleep per night	0-2/ 3-5	22 (15.7)	1 (5.9)	5 (8.9)	28 (13.2)	0.095
	6-8/ 8+	118 (84.3)	16 (94.1)	51 (78.6)	185 (86.8)	
Difficulty sleeping in the last 30 days	Not at all/ No more than usual	101 (72.2)	11 (41.2)	38 (67.9)	150 (70.3)	0.434
	Rather more than usual/ Much more than usual	39 (27.8)	6 (23.5)	18 (32.1)	63 (29.6)	
Tobacco smoking	Yes	12 (8.6)	1 (5.9)	1 (1.8)	14 (6.6)	0.222

Frequency of tobacco smoking (days)	5-Jan	4 (2.9)	0 (0.0)	0 (0.0)	4 (1.9)	0.579
	10-Jun	4 (2.9)	0 (0.0)	0 (0.0)	4 (1.9)	
	15-Nov	2 (1.4)	0 (0.0)	0 (0.0)	2 (0.9)	
	16-20	1 (0.7)	0 (0.0)	1 (1.8)	2 (0.9)	
	21-25	1 (0.7)	1 (5.9)	0 (0.0)	2 (0.9)	
	26-30	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Non-tobacco smoking	Yes	17 (12.1)	2 (11.8)	6 (10.7)	25 (11.7)	0.961
Frequency of non-tobacco smoking	5-Jan	11 (7.9)	1 (5.9)	3 (5.4)	15 (7.0)	0.145
	10-Jun	5 (3.6)	1 (5.9)	2 (3.6)	8 (3.8)	
	15-Nov	1 (0.7)	0 (0.0)	0 (0.0)	1 (0.5)	
	16-20	0 (0.0)	0 (0.0)	1 (1.8)	1 (0.5)	
	21-25	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
	26-30	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
E-cigarette smoking	Yes	0 (0.0)	0 (0.0)	2 (3.6)	2 (0.9)	0.059

Table 5: Individual Response and Personal Behaviours by Housing Accommodation.

Variable	Classification	Home with Family	On-Campus Housing	Off-Campus Housing	Total	p-
		(n=140), n(%)	(n=17), n(%)	(n=56), n(%)	n(%)	value
Frequency of use of health care system in the last 12 months	Never/Seldom	43 (37.7)	8 (47.1)	25 (44.6)	76 (35.7)	0.11
	Occasionally/Regularly	97 (62.3)	9 (52.9)	31 (55.4)	137 (64.3)	
General physical checkup in the past 2 years	Yes	84 (60.0)	7 (41.2)	28 (50.0)	119 (55.9)	0.198
Approximate date of last physical check up	Within the last month+	84 (60.0)	7 (41.2)	8 (14.3)	119 (46.5)	0.198
	Never had a physical check up	56 (40.0)	10 (58.8)	28 (50.0)	94 (44.1)	
Use of Internet for Self-Diagnosis*	Yes	93 (66.4)	6 (35.2)	33 (58.9)	132 (61.9)	0.038

Table 6: Health Care by Housing Accommodation (n=213).

Regarding health outcomes based on housing accommodations, low sample sizes resulted in skewed p-values and did not allow for an accurate assessment for: health issues for anyone in the home and frequency of health affecting academics.

Associations of Wheezing/ Whistling Within 12 Months

Participants that reported having asthma were 4.42 times (95% CI: 1.52, 12.88) more likely to experience wheezing and whistling than those who do not have asthma. Participants with higher BMIs were 1.12 times (95% CI: 1.03, 1.23) more likely to have wheezing or whistling than those who are underweight or normal. Participants that had difficulties breathing within 30 days were 3.76 times (95% CI: 1.08, 13.05) more likely to experience wheezing or whistling than those who did not have difficulties breathing. Participants who reported experiencing wheezing or whistling after engaging in physical activity were 19.12 times (95% CI: 5.76, 63.45) more likely to experience wheezing or whistling within the last 12 months (Table 7A).

	Variable (Reference)	Classification	Wheezing/ Whistling		Dry Cough at Night		Difficulty Breathing	
			Within 12 Months		Within 12 Months		Within 12 Months	
			OR	95% CI	OR	95% CI	OR	95% CI
Physical Environment	Age of Housing Accommodation (1-10 years)	11+ years			3.28	(1.32, 8.15)		
	Perceived Air Quality in the Home Within 30 Days (Excellent/Very Good/Good)	Fair/Poor			7.23	(1.45, 36.06)		
Social Environment	Current Property Owned/ Rented (Own)	-Rent			4.92	(1.91, 12.65)		
		-I do not know/ I do not wish to answer			4	(.57, 28.29)		
	Employment Income (No)	Yes			2.62	(1.04, 6.61)		
Individual Response	Frequency of Cleaning Bedroom (Never/ Once every 4 months/ Once every 2-3 months/ Monthly)	Weekly/Daily			2.51	(1.03, 6.16)		
	Frequency of Disinfecting Common Surfaces (Never/ Once every 4 months/ Once every 2-3 months/ Monthly)	Weekly/Daily			2.49	(.98, 6.29)		
Genetic Endowment	Asthma (No)	Yes	4.42	(1.52, 12.88)				
	BMI		1.12	(1.03, 1.23)			1.01	(.92, 1.11)
Health Care	General Physical Check Up Within 2 Years (Yes)	No			2.19	(.97, 4.95)		

Health and Function	Difficulty Breathing Within 30 Days (No)	Yes	3.76	(1.08, 13.05)				
	Health Affected by Academic Commitments (Occasionally/ Regularly)	Never/Seldom					8.57	(2.07, 35.48)
	Perception of General Health (Excellent/ Very good/ Good)	Fair Poor			4.23	(1.24, 14.42)		
	Wheezing After Exercise Within 12 Months (No)	Yes	19.12	(5.76, 63.45)	8.46	(2.91, 24.62)		
	Wheezing/ Whistling Within 12 Months (Yes)	No					9.33	(3.44, 25.33)
Specificity (%)/ Sensitivity (%)			96.6/50.0		92.8/56.4		8.0/100.0	
Hosmer and Lemeshow Test								
Chi-square			6.17		7.32		6.92	
p-value			0.63		0.5		0.55	

Table 7A: Best-fit Model for Respiratory Health Outcomes.

In relation to dry cough at night within the last 12 months, results suggest participants living in a housing accommodation greater than 11 years were 3.28 times (95% CI: 1.32, 8.15) more likely to experience a dry cough. Similarly, participants that perceived the air quality in their home to be fair/poor were 7.23 times (95% CI: 1.45, 36.06) more likely to experience a dry cough compared to participants who believe their air quality to be excellent, very good, or good (Table 7A).Participants that rented were 4.92 times (95% CI: 1.91, 12.65) more likely to experience a dry cough compared to students who owned their current housing accommodation. Participants that were employed were 2.62 times (95% CI: 1.04, 6.61) more likely to experience a dry cough than those who were unemployed (Table 7A). Participants who cleaned their bedrooms on a weekly or daily basis were 2.51 times (95% CI: 1.03, 6.16) more likely to experience a dry cough compared to those who cleaned their bedrooms less frequently than once every 4 months. Participants who reported to have fair or poor health were 4.23 times (95% CI: 1.24, 14.42) more likely to experience dry cough at night than those who perceive their health to be excellent, very good, or good. Participants who reported experiencing wheezing or whistling after engaging in physical activity were and 8.46 times (95% CI: 2.91, 24.62) more likely to experience a dry cough than those who did not.

Participants that reported never or seldom having health affected by academic commitments were 8.57 times (95% CI: 2.07, 35.48) more likely to have difficulties breathing within the past 12 months than those who occasionally or regularly are affected. Participants that reported they did not have wheezing or whistling within the last 12 months were 9.33 times (95% CI: 3.44, 25.33) more likely to have difficulties breathing within 12 months than those who did have wheezing or whistling symptoms (Table 7A). When the type of housing accommodation variable was forced into the above-described models, the best-fit model did not improve. This suggests that type of housing accommodation is not a significant factor in relation to wheezing and whistling, dry cough, or difficulties breathing (Table 7B).

	Variable (Reference)	**Classification**	**Wheezing/ Whistling**		**Dry Cough at Night**		**Difficulty Breathing**	
			Within 12 Months		**Within 12 Months**		**Within 12 Months**	
			OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Physical Envir onment	Age of Housing Accommodation (1-10 years	11+ years			3.33	(1.28, 8.68)		
	Air Quality in the Home Within 30 Days (Excellent/Very Good/Good)	Fair/Poor			6.64	(1.32, 33.42)		

Social Environment	Type of Housing Accommodation (On-campus Residence)	-Off-campus Housing	2.12	(.22, 20.56)	2.14	(.24, 18.98)	0.94	(.26, 3.40)
		-Home with Family	1.95	(.24, 15.84)	1.76	(.18, 16.86)	0.85	(.26, 2.79)
		-Rent			4.49	(1.91, 12.65)		
	Current Property Owned/Rented (Own)	-I do not know/I do not wish to answer			4.08	(.54, 30.73)		
	Employment Income (No)	Yes			2.62	(1.02, 6.74)		
Individual Response	Frequency of Cleaning Bedroom (Never/ Once every 4 months/ Once every 2-3 months/ Monthly)	Weekly/Daily			2.33	(.91, 5.99)		
	Frequency of Disinfecting Common Surfaces (Never/ Once every 4 months/ Once every 2-3 months/ Monthly)	Weekly/ Daily			2.41	(.97, 6.01)		
Genetic Endowment	Asthma (No)	Yes	4.78	(1.59, 14.35)				
	BMI		1.12	(1.03, 1.23)			0.98	(.92, 1.05)
Health Care	General Physical Check Up Within 2 Years (Yes)	No			2.21	(.97, 5.04)		
Health and Function	Difficulty Breathing Within 30 Days (No)	Yes	3.78	(1.09, 13.15)				
	Health Affected by Academic Commitments (Occasionally/ Regularly)	Never/ Seldom					0.36	(.10, 1.25)
	Perception of General Health (Excellent/ Very good/ Good)	Fair/Poor			4.32	(1.26, 14.81)		
	Wheezing After Exercise Within 12 Months (No)	Yes	19.92	(5.93, 66.93)	8.37	(2.89, 24.20)		
	Wheezing/ Whistling Within 12 Months (Yes)	No					1.09	(.47, 2.54)
Specificity (%)/ Sensitivity (%)			97.3/50.0		92.8/56.4		96.0/10.9	
Hosmer and Lemeshow Test								
Chi-square			4.14		6.94		2.19	
p-value			0.84		0.54		0.98	

Results for physical environmental exposures that were analyzed by housing accommodation (Table 4) and health care analyzed by housing accommodation (Table 6) were re-categorized based on small sample sizes. To re-categorize, similar categories were combined, which increased the n value, and allowed for better analysis. These results are presented in Table 4 and Table 6.

Discussion

This research highlights the importance of the social determinants of health in affecting both overall health, and specific health outcomes including respiratory health outcomes such as wheezing and whistling in the lungs, dry cough, and difficulties breathing. Community-based research is essential in health-related fields. Respiratory illnesses are commonly seen in the university undergraduate population, and result in absences and decreased productivity at school [15]. This study shows respiratory symptoms such as wheezing, and whistling, dry cough, and difficulties breathing are prevalent among UOIT students and thus should be a public health concern. Specifically, the prevalence of the studied health outcomes is comparable to trends of respiratory infections presenting as a public health problem in Canada (26%) [16].

The main study objective was to assess the relative role of types of housing accommodations on respiratory health of UOIT students. Based on participant responses, there was no health concerns based on the types of housing, whether it be at home with their families, on-campus residences, or off-campus housing. Although there does not appear to be significant differences in respiratory health based on types of housing, there was a trend toward positive health outcomes for students living in on-campus residences. This is in contrast to a study by [17]. That found student's overall health suffering, including respiratory health outcomes such as difficulties breathing, from living in residence. Stress, depression, problems with diet, and financial problems were seen to be the cause of deteriorating health. International students were at an increased risk due to factors such as culture shock, stress from being away from their families, and language barriers [17].

The findings in this study (the UOIT population), may be contributed to decreased stress levels from being in close proximity to academic commitments. Being on-campus likely allowed students to get more sleep, eliminate stressors related to preparing meals as many purchase meal plans, and promoted support from students in similar situations as themselves. However, some literature surrounds the post-secondary student population and indicates that these students experience several mental health conditions including depression, anxiety, and stress [18]. It was found that maladaptive coping was the main predictors of the listed health outcomes, and type of housing accommodation did not impact overall health.

Socio-economic status and housing are directly related [19]. Likely, this results in better housing conditions for those who are well-educated and have stable finances. Literature documents the health implications of living in developed areas compared to living in areas with inadequate housing [20]. The Oshawa, Ontario area is considered to be a developed city, and generally, living conditions are adequate. The physical environmental exposures based on housing accommodations showed those who lived in older housing accommodations were 3.28 times more likely to experience dry cough than those living in newer homes. The literature supports this finding, as the quality of housing is bound to deteriorate over long periods of time. Older housing accommodations are more likely to be damp, cold, moldy, and have inadequate ventilation, which are all associated with asthma and other chronic respiratory symptoms [18].

In addition, participants who perceived the air quality in their home to be fair/poor were 7.23 times more likely to experience a dry cough than those who perceived the air quality to be excellent, very good, or good. This finding is not surprising, as there is literature that assesses different populations' perception of air quality and the effect this has on actual health. It has been found that the stress from perceiving increased levels of air pollution and poor air quality causes negative health outcomes, regardless of the air quality [21]. It is possible that in the UOIT population, the negative perception of the conditions of housing accommodations may be the cause behind reported health outcomes. Alternatively, it is also possible that the actual air quality and physical housing accommodation is the cause behind reported fair/poor respiratory health. For these reasons, it is important to further study the physical environment. Specifically, air quality should be measured and compared with perceived air quality data to definitively understand this relationship.

Results from the social environment found that participants who rented their housing accommodation were 4.92 times more likely to experience dry cough than those who owned their property. Participants that did not know or did not want to comment on the status of the property, in which they lived, were 4 times more likely to experience a dry cough than those who owned their property. It is possible that those who rent their properties are unaware or unable to change exposures in the home that cause symptoms such as dry cough. It is also possible that those who are renting do not have the finances to support an alternate housing accommodation [22]. With respect to employment, participants whose main income was from employment were 2.62 times more likely to experience dry cough than those who have income from other sources. This may be attributed to concern and stress from added responsibilities since the university undergraduate population is already vulnerable and more susceptible to adverse health outcomes due to changes in physical environments, lack of sleep, and changes in dietary patterns (World Health Organization, 2016).

Participants who more frequently cleaned their bedrooms and disinfected common surfaces in the home were more likely to experience dry cough than those who cleaned these areas less frequently. Although this finding may sound surprising, one possible explanation to this might be related to the exposure of cleaning supplies and/or chemicals. The American Lung Association reported that many cleaning supplies and household

products can irritate the throat [23]. Furthermore, some products release harmful chemicals, including volatile organic compounds. These compounds and other chemicals released during cleaning contribute to chronic respiratory illnesses [24].

Genetic endowment is a predisposing factor that for the most part is uncontrollable. Participants that indicated having asthma were 4.42 times more likely to have wheezing or whistling symptoms compared to those who do not have asthma. This supports the fact that wheezing and whistling are typical features of asthma [25]. Pertaining to BMI, participants who were classified in higher BMI brackets were 1.12 times more likely to have wheezing symptoms than those in lower brackets. The literature consistently finds significant negative associations between spirometry outcomes and BMI [26].

Participants that indicated they did not have a general physical check-up within the last 2 years were 2.19 times more likely to experience dry cough. Research appears to be controversial in this area. Some research concludes yearly general check-ups are important to identify risk factors that may lead to illnesses in the future [27]. Alternatively, some research suggests this is an added burden on the health care system, and does not prove to have noteworthy benefits. Specifically, it was shown that regular general check-ups did not impact health outcomes [28]. It is difficult to state reasoning behind participants' dry cough, or of this health outcome would be altered after a general physical check-up. Much evidence in this area suggests that annual examinations will not reduce morbidity or mortality rates for more serious health conditions such as cardiovascular disease and cancer. Furthermore, general physical check-ups are not likely to positively impact asymptomatic individuals [29]. These findings are likely representative of the UOIT undergraduate population.

Generally, participants that reported having difficulties breathing, having fair/poor health, or wheezing symptoms were more likely to experience respiratory health outcomes compared to those who did not. These associations are consistent with literature in the area, where individuals with recurrent wheezing or asthma reported significantly more episodes of rhinitis and cough [26]. In contrast, those who indicated never or seldom having their academic commitments affected by health were 8.57 times more likely to experience difficulties breathing than those who stated occasionally or regularly having their academic commitments affected by health. Also, those who reported no wheezing symptoms were 9.33 times more likely to experience difficulties breathing than those who did experience wheezing symptoms. These results present as counterintuitive, and may require further investigation.

One possible reason for these results may be symptoms manifesting in an uncommon manner. Participants may not experience wheezing symptoms; however, they may be experiencing symptoms in an area of the body that was not addressed in the health questionnaire. Another possible explanation may be that those who reported experiencing wheezing symptoms are better able to cope with their respiratory illnesses. It is likely that if a respiratory illness is reoccurring, individuals will have visited their family physician and may have been provided with information on managing their condition and treatment. It may be important to increase the spectrum of items to address additional aspects of health. This study was subject to several limitations. Data are mainly self-reported, and thus may be subject to response bias. Although an "I do not know/ I do not wish to answer" option was provided for each question and the health questionnaire was completely anonymous, students may have felt inclined to answer inaccurately in fear of being judged, or trying to answer questions in a manner they believed the researcher wanted to observe. Sampling and recruitment led to unequal representations of students. As indicated in Table 1, most students were in their third year of study at UOIT. Many of the students were also in the health sciences program, and thus are more likely to be aware of good health practices. The total number of participants may not be representative of the population. Overall, the smaller sample size may have reduced the power of this study, especially when further divided into type of housing accommodation. Despite these limitations, this study contributed to an important area of research. The study provides a detailed profile of a smaller Canadian University, as well as environmental predictors of respiratory conditions and health conditions.

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