EXPLORING THE HEALTH OF UNIVERSITY UNDERGRADUATE STUDENTS IN RELATION TO HOUSING ACCOMMODATIONS

By

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ABSTRACT

This thesis examines the links between type of housing and health of university undergraduate students (n=213) at the University of Ontario Institute of Technology (UOIT). Housing was classified into three categories of housing accommodations: at home with their families, on-campus residences, and off-campus housing.

A self-administered health questionnaire was developed for the purpose of this research. The research objectives include: 1) to assess the environmental and personal lifestyle exposures of UOIT undergraduate students, in relation to the three different types of housing accommodations; 2) to assess the general health of UOIT undergraduate students, with a focus on respiratory, gastrointestinal, and dermatological health; and 3) to examine predictors of related health outcomes.

Guided by the Population Health Framework, the health questionnaire collected data related to the students' physical environments, social environments, genetic endowment, individual and behavioral responses, health and function, and health care.

Results indicate that most participants live at home with their families. Students living at home reported higher stress levels compared to those living in an on-campus residence building. The prevalence of the studied symptoms are as follows: fair or poor self-rated health (10.8%), respiratory related illness (35.7%), nausea and vomiting (37.6%), and skin irritations (42.3%). Results suggest there are no significant differences in health based on type of housing accommodation.

Keywords: Health, Housing, Respiratory, Gastrointestinal, Dermatological, University, Students

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This thesis is dedicated to my brother Brandon, who continues to show me the true meaning of strength and determination. Thank you for being my inspiration.

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LIST OF ABBREVIATIONS

BMI: Body Mass Index

ETS: Environmental Tobacco Smoke

FVC: Forced Vital Capacity

FEV1: Forced Expiratory Volume Exhaled for 1 Second

FEV%: Forced Percentual Expiratory Volume

LLN: Lower Limit of Normal

MRSA: *Methicillin-resistant Staphylococcus aureus*

PEF: Peak Expiratory Flow

PHF: Population Health Framework

UOIT: University of Ontario Institute of Technology

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CHAPTER ONE- INTRODUCTION

RESEARCH CONTEXT

Canadians spend approximately 87% of their time indoors where air pollutants tend to accumulate to levels that may be detrimental to health (van Kamp, van Loon, Droomers, & de Hollander, 2004; Klepeis et al., 2001). Housing accommodations particularly in cold climates tend to be tightly sealed, and therefore may offer perfect grounds for contaminant exposures to increase to levels higher than outdoor environments, especially in the absence of proper ventilation. For example, sources of indoor pollutants identified as being present in greater than expected concentrations include: coal combustion, tobacco smoke, wall dust, soil particles, and wooden furniture (Chauhan, Gupta, Suryawanshi, & Verma, 2016). Housing accommodations are typical indoor environments where contaminants such as air pollutants and many different strains of bacteria may accumulate. Exposures to these contaminants can result in acute and chronic health, respiratory, gastrointestinal, and dermatological illnesses (World Health Organization, 2016).

The health impacts of these exposures can be greatly magnified when in combination with other personal factors such as sociodemographic, individual behavioral, genetic disposition, and lifestyle choices. For instance, some sub-populations such as the post-secondary undergraduate population may be at a relatively heightened risk for experiencing the negative health impacts of housing accommodations (Nightingale & Fischhoff, 2001). Literature has documented several reasons behind this added susceptibility. First, many undergraduate students may have to relocate to new housing accommodations in order to pursue post-secondary education at distant universities (Bifulco, R., Fletcher, J., Ross, S., 2011). Second, most undergraduate students also encounter many changes to their physical and social environments,

such as new social circles and transport needs. Moreover, new undergraduate students become exposed to increased responsibilities beyond what they have been accustomed to in previous years. For many undergraduate students, these new circumstances may lead to inadequate sleep patterns from dynamic academic and personal schedules, heightened psychological stress levels, new and potentially relatively unhealthier eating habits, as well as potentially higher engagement in risky behaviours such as consuming increased levels of alcohol or tobacco smoking (Smith, 2012). These aspects are unique to the undergraduate population, and should be addressed in the interest of aiding a healthy transition during a critical point in life.

A considerable amount of literature focuses on relationships between two single variables, for example: physical features of substandard housing, including lack of safe drinking water, ineffective waste disposal, intrusion by disease vectors, and inadequate food storage; and how these contribute to the spread of infectious and chronic diseases and their impact on health (Krieger, J and Higgins, D., 2002). However, it is necessary to account for the multidimensional nature of health. Health is the result of continuous interactions between numerous environments at once, and it is important to consider these factors together to truly understand the health outcomes experienced by populations (McElroy, 2002).

This research study will focus on links between housing accommodations and health among university undergraduate students at the University of Ontario Institute of Technology (UOIT). The most common living arrangements at UOIT are 1) commuter students who live at home with their family, 2) students who live in an on-campus residence building, and 3) students who live in an off-campus housing arrangement.

In particular, the research objectives of this study are as follows:

1) To assess the environmental and personal lifestyle exposures of UOIT undergraduate students, in relation to the three different types of housing accommodations.
2) To assess the general health of UOIT undergraduate students, with a focus on respiratory, gastrointestinal, and dermatological health.
3) To examine the environmental and personal lifestyle predictors of related health outcomes.

These research objectives have been selected in order to answer the primary research question: are students living in residence and student housing more likely to experience higher levels of exposure to environmental contaminants that negatively impact their health? It is hypothesized that students living in residence will report fair or poor health outcomes more frequently than students living at home with their families. Exploring this question will provide a comprehensive understanding towards the relationship between student housing accommodations and health.

The Population Health Framework (Evans and Stoddart, 1990) was used to guide this research and examine the links between environmental exposures and the health of undergraduate university students (Figure 1). This 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 boundaries of the health care system (Evans & Stoddart, 1990). Evans and Stoddart sought to construct an analytical framework within which such evidence can be fitted, and which will highlight the ways in which different factors and forces can interact to bear on different conceptualizations of health (Evans and Stoddart, 1990). The Population Health

Framework is divided into several components, including the physical environment, the social environment, genetic endowment, individual response, health care, disease, well-being, and prosperity, all of which impact health and disease. These factors are explored in relation to health in this research study.

SIGNIFICANCE OF THIS RESEARCH

Housing plays a significant role in the lives of Canadians (Rauh, V., Landrigan, P., & Claudio, L., 2008). Housing choices may be shaped by socioeconomic factors, which in turn impact social adversities, individual illness, and population health disparities. Although there is literature on the topics of physical environments, social environments, and personal behaviours influencing health, there remains a gap in the literature focusing on the multifaceted characteristics of health (Johnson, Cole, & Merrill, 2009; Roberts, Soge, Helgenson, & Meschke, 2011; Miko et al., 2008).

Research on the health of post-secondary undergraduate students, particularly in the Greater Durham area of Ontario has not been conducted to date. This may be due to UOIT being one of Canada's newest universities, thus making its students an understudied population (University of Ontario Institute of Technology, 2017). Research on the health of post-secondary undergraduate students has been conducted in longer-established universities, however there is minimal literature in Canada based on health in relation to housing. For example, York University, Wilfred Laurier University, and Queens University located in Toronto, Waterloo, and Kingston, Ontario respectively, participated in the National College Health Assessment (American College Health Association, 2007). This survey examined general health, disease and injury prevention, academic impacts, relationships and personal safety, substance use, sexual behaviour, nutrition and exercise, and mental health. It was concluded that all aforementioned

factors have an impact on health, and the data expands the understanding of the health needs and capacities of college students, however more research is needed. It is important to consider potential differences in a predominantly suburban area with varying housing accommodation styles, and students of varying experiences.

Research related to the post-secondary undergraduate student body, may be of concern for several groups of people. First and foremost, it may be of interest for the undergraduate student population who will be experiencing these changes. Generally, individuals will want to make choices that benefit them. If students understand the effects of substandard housing on health, this may prompt students to pursue housing accommodations that are recognized to be safe. For example, if a student sees a housing accommodation with signs of moisture, mould, or poor air circulation, they may seek another housing option. Secondly, this research may be of interest to parents, guardians, and families when influencing choices related to housing while attending post-secondary education. Living in an appropriate housing accommodation may provide a sense of reassurance to families. Lastly, this research may be important to society in general, specifically university communities and administrators, in aiding to understand the impact of housing accommodations on undergraduate student health.

OVERVIEW OF THESIS

This thesis is organized into six chapters, including this introduction. Chapter Two outlines the literature review, and includes background information, the search strategy, and conceptual framework chosen to guide this research. Chapter Three outlines the methodology used for the research study. This chapter discusses the development and use of the questionnaire, for the purpose of data collection. Furthermore, the collection and analysis of microbiological samples based on a sub-sample of participants are outlined. Lastly, univariate, bivariate, and

multivariate analysis methods that were used to generate results are documented. Chapter Four presents a manuscript focusing on results related to environmental exposure and respiratory health. Chapter Five presents a manuscript focusing on results related to environmental exposures and self-rated health, gastrointestinal health, and dermatological health. Finally, Chapter Six outlines the main conclusions of this research, as well as recommendations for positive health outcomes for this specific population.

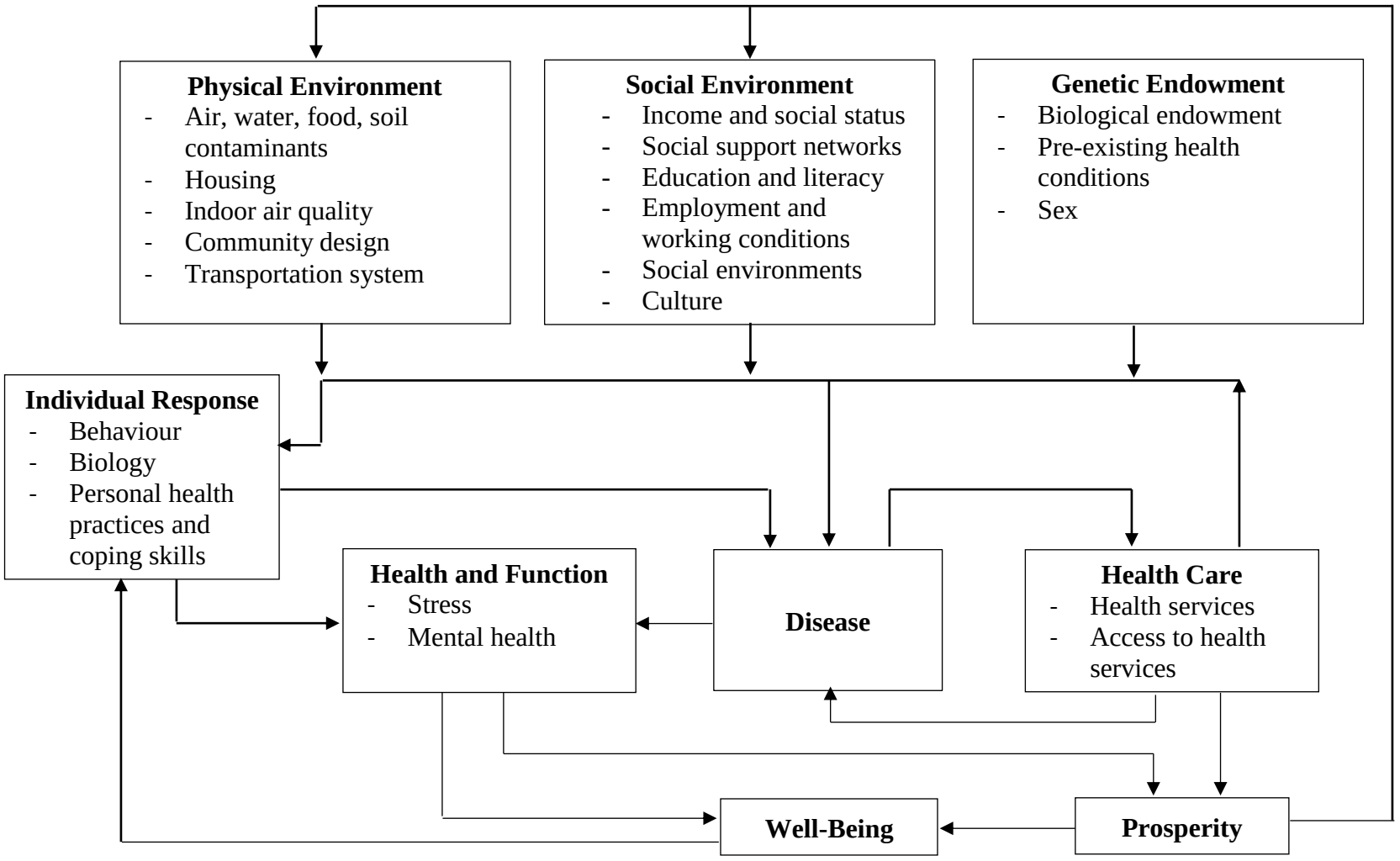

Figure 1: Key Determinants of the Population Health Framework- adapted from Evans and Stoddart

CHAPTER TWO- LITERATURE REVIEW

INTRODUCTION

This chapter reviews relevant literature examining the link between the environmental exposures and health outcomes experienced by the university undergraduate population. The chapter begins with details on each component of the Population Health Framework (PHF), as it applies to student housing accommodations. The section that follows outlines the search strategies employed to retrieve literature related to the general, respiratory, gastrointestinal, and dermatological health of university undergraduate students. In addition, the literature is presented based on the above mentioned health outcomes. The chapter concludes with a summary of key findings of this research study.

CONCEPTUAL MODEL APPLIED TO HOUSING ACCOMMODATIONS

Physical Environment

The physical environment arguably has the most significant impact on health. This encompasses safe water and clean air, healthy workplaces, safe housing, and communities and roads (World Health Organization, 2017). Housing is a component of the physical environment and is the focus of this research.

The literature surrounding the links between exposure to poor housing conditions and deteriorating physical health has long been documented (National Research Council and Institute of Medicine, 2013). Within the home, there are multiple health concerns that may arise. These include but are not limited to: the density of housing, dampness, heat, air pollution, and the presence of contaminants (Sexton, K., & Dyer, R., 1996). Literature finds consistent inverse relationships between these factors and health in Australia, Brazil, Canada, France, Italy, the Netherlands, South Korea, the United Kingdom, and the United States of America (Sexton, K., &

Dyer, R., 1996). For example, lead exposure in the home has been negatively linked to cognitive development in children (Bellinger, 2008). Another example is the physical condition of housing and indoor air quality, both impacting individual health outcomes such as changes in lung function, wheezing symptoms, asthma diagnoses, and school absences (Rauh, V., Landrigan, P., Claudio, L., 2008). Thus in many countries across the world, legislation has been introduced to reduce exposures of indoor and outdoor air pollutants (National Research Council and Institute of Medicine, 2013).

Social Environment

The social environment is largely impacted by social and economic factors, and have both positive and negative influences on health. Generally speaking, individuals who are living in underdeveloped areas, or in poverty, experience negative health consequences. Alternatively, individuals who are financially stable and live in developed regions typically experience better health outcomes (Public Health Agency of Canada, 2017). This social gradient is seen in numerous countries and illustrates the importance of societal resources such as income and social status, social support networks, education and literacy, employment and working conditions, social environments, and culture (World Health Organization, 2017).

Genetic Endowment

Genetic endowment provides an inherited predisposition to a wide range of individual responses that affect health status. This factor is beyond the control of the individual, and include aspects such as sex, height, and pre-existing health conditions (Durch, Bailey, & Stoto, 1997). Studies in biology confirm that genetics play a role on the health outcomes experienced throughout one's lifetime (Hernandez, 2006). Considering the impact of genetic endowment on

the university undergraduate population is necessary to explain any innate differences in observed health outcomes.

Individual Response

Individual responses such as behaviours, personal health practices and coping skills interplay with numerous determinants of health. These actions have the potential to prevent certain diseases and promote self-care, which can ultimately improve health. The influence of these actions may present as health conditions and alter much of an individual's lifestyle. There is a growing recognition of the influence of personal lifestyle choices, (eating habits, alcohol consumption, or physical activity), on an individual's life (Public Health Agency of Canada, 2017). Developing positive coping skills and making informed choices will enrich life and overall health. Research shows individuals with strong positive coping mechanisms are more likely to engage in healthy behaviours and lifestyles (Public Health Agency of Canada, 2017).

Health and Function

Health and function in terms of the PHF relates to the conditions of health for an individual (Public Health Agency of Canada, 2012). Furthermore, health and function refers to the physiological and psychological characteristics due to specific health outcomes. The PHF will be used to guide the research, in relation to stress levels and lung function (restrictive and obstructive). Stress and lung function are a direct representation of the health and function of an individual (Lagorio, S., Forastiere, F., Pistelli, R., Iavorone, I., Michelozzi, P., et al., 2006).

Access to Health Care

The Public Health Agency of Canada recognizes that access to health care is fundamental to health. Roughly 80% of Canadians have reported visiting their family physicians when needed (Public Health Agency of Canada, 2008). Canada, having a publicly funded health care system,

benefits from the numerous health promotion and disease prevention programs in place for communities across the country. Accessing these programs and services (for example: vaccinations, disease screening, and mental health counselling), has a positive impact on the health of individuals (Aday & Andersen, 1974). Although many Canadians access these services, there are some individuals who are unable to access health care services for a variety of reasons. These include but are not limited to: physical inaccessibility, cultural factors, geographical location, or the cost of non-insured health services (Public Health Agency of Canada, 2008). The challenges that these individuals face can lead to emotional distress, and feelings of isolation, which ultimately will affect overall health outcomes (Ensor & Cooper, 2004).

Well-being

Well-being is a mental state in which an individual realizes their own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community (Ryff, C., 1989). Moreover, well-being may be different from one person to another. Individuals perceive situations in diverse ways, which will also have an impact on well-being.

Prosperity

Prosperity, in health related terms, is defined as the ability to flourish physically, psychologically, and socially (Jackson and Senker, 2011). Within the context of prosperity, incomes appear to impact the physical and social environment, in addition to well-being (Evans and Stoddart, 1990). These factors affect the health by influencing individual responses, from a behavioural and biological standpoint (Denton, 2000). The way in which an individual handles these aspects may have a direct effect on prosperity.

Disease/ Health Outcomes

The PHF highlights health outcomes in order to understand the level of change that can be accredited to interventions (Evans & Stoddart, 1990). Health outcomes and determinants in the PHF are illustrated as having originated from interactions between social, economic, cultural, and physical environments (Evans & Stoddart, 2003). For example, health outcomes can be both positive and negative, and vary from the absence of disease to the presence of a communicable or non-communicable disease. Acknowledging the complexities of these interactions may aid in preventing the development of disease disparities (Centers for Disease Control and Prevention, 2013).

SEARCH STRATEGY TO GENERATE RESEARCH EVIDENCE

The 'PICO' Model, (Problem, Intervention or Exposure, Comparison, Outcome) was implemented to aid in the development of the literature search strategy (Schardt, Adams, Owens, Keitz & Fontelo, 2007). The 'PICO' Model guides the identification of the Patient or Problem for demographic purposes, an Exposure to understand what risk factors the patient or population is exposed to, a Comparison group to understand which alternatives prove to be better, and Outcomes to understand the effect of the intervention or exposure measured. When applying the 'PICO' model to this research study, the health of university undergraduate students is identified as the problem. The exposure and comparisons focuses on the diverse environmental exposures for an individual. The comparative framework examines the diverse types of housing accommodations. In the UOIT population, the most common living arrangements are students living with their family, on-campus residence, and off-campus housing. These situations will be the exposure and comparison focus of this study. Lastly, the outcome include the health

outcomes (fair or poor self-rated health, respiratory, gastrointestinal, and dermatological symptoms) experienced by this population.

The following databases were used to search for relevant research studies: Cumulative Index to Nursing and Allied Health Literature (CINAHL), ProQuest/ProQuest Nursing & Allied Health Source New Platform, PsycINFO, PubMed, and Google Scholar.

First, a literature review was conducted that specifically focused on respiratory health. Various combinations of keywords were used in each of the databases, and include: "respiratory health OR upper respiratory infection AND university OR college", "common cold OR flu", "student housing", and "asthma AND university students". In addition, the use of the medical subject headings "respiratory infection", "upper respiratory infection", and "respiratory illness" were used in order to control the vocabulary of the research articles to facilitate easier indexing of the subject being studied. This search strategy led to the identification of 14 research studies (Berry, T., & Fournier, A., 2014; Cohen, S., 1995; Engs, R., & Aldo-Benson, M., 1995; Goodall, E., Granados, A., Luinstra, K., Pullenayegum, E., Coleman, B., Loeb, M., & Smieja, M., 2014; Johnson, E., Cole E., & Merrill, R., 2009; Miko B., Cohen, B., Haxall, K., Conway, L., Kelly, N. et al., 2008; PausJenssen, E., & Cockcroft, D., 2003; Roberts, M., Soge, O., Helgenson, S., & Meschke, J., 2011; Smith, T.J., 2012; Sun, Y., Zhang, Y., Sundell, J., Fan, Z., & Bao, L., 2009; Tsuang, Bailar, & Englund., 2004; Vossen, D., McArel, H., Vossen, J., & Thompson, A., 2004; White, C., Kolble, R., Carlson, R., & Lipson, N., 2005; Yudhastuti, R., 2008).

Following the search for articles pertaining to respiratory health, a second search was conducted to retrieve literature on general, gastrointestinal, and dermatological health. Initially, a broad search was conducted with the keywords "gastrointestinal", "dermatological", "health" and "students". These terms presented literature that did not specifically discuss the influence

from residence or student housing. Boolean operators were implemented which changed keywords in the search to “health AND university OR college”, “health AND housing”, “gastrointestinal health AND students AND residence”, and “dermatological health AND students AND residence”. This search strategy led to the identification of 4 research articles (Scott, E., & Vanick, K., 2007; Martinez, E., Jimenez, Y., Vazquez, M., 2014; Surgeoner, Brae, Chapman, Benjamin, Powell, et al., 2009; Thumma, J., Aiello, A., Foxman, B., 2009).

SYNTHESIS OF FINDINGS IN RELATION TO HEALTH OUTCOMES

The scientific evidence to support the links between housing and health has grown significantly in recent years (World Health Organization, 2017). As such, the need for investing in housing to promote and improve health is evident (World Health Organization, 2017). Housing remains a factor that is seen to have a negative impact on health, even in a developed country such as Canada. Air pollution is known to impact health, and with at least 60 household air pollutants this presents as a concern (Apte & Salvi, 2016). These pollutants originate from many sources, and differ based on geographical location and cultural norms. They include indoor tobacco smoke, construction materials used in building houses, use of pesticides and chemicals used for cleaning at home, and use of artificial fragrances (Apte & Salvi, 2016). Literature indicates their respiratory health is affected the most, however the effects on other areas of the body must be considered as well.

The following section describes research designs, population characteristics, physical exposures, outcomes, and main findings in the areas of respiratory health, general health, gastrointestinal health, and dermatological health in relation to university undergraduate students.

Respiratory Health

Adverse respiratory health symptoms are the number one reason for students missing academic commitments (Smith, 2012). Regarding Canadian populations, respiratory conditions are one of the most common illnesses amongst society. Within the spectrum of respiratory illness, asthma and chronic obstructive pulmonary disease are the most prevalent (Cukic, Lovre, Dragisic & Ustamujic, 2012).

First, the physical environmental exposures will be discussed. These environments included various surfaces in university campus residence and student housing. In an article based in Indonesia, housing sanitation was investigated to examine associations between air quality in boarding houses and acute respiratory tract infections in students. This study was cross sectional, and measured population density, ventilation, temperature, and humidity using a systematic random sampling method. Significant associations between the population density, ventilation, humidity, and acute respiratory tract infection occurrence were found. Researchers concluded that student boarding houses should provide good air quality and sanitation to reduce the incidence of acute respiratory tract infection (Yudhastuti, R., 2008). Similarly, a cross sectional study based in Chicago used a survey on students living in college dormitory residence areas to understand the effect of residential environments on the transmission of the influenza virus (Tsuang, Bailar, & Englund, 2004). This study found no evidence to suggest influenza-like symptoms were affected by washroom, laundry, or dining settings. However, strong relations between influenza-like symptoms and the dorm room environment were found, compared to other settings. Additionally, the risk of influenza-like symptoms increased for roommates who shared sleeping quarters compared to those who slept in different rooms (Tsuang, Bailar, & Englund, 2004).

A cross-sectional study based at the Tianjin University Campus in China surveyed college students to assess the association between dampness with allergy and airway infections among the student population (Sun, Y., Zhang, Y., Sundell, J., Fan, Z., & Bao, L., 2009) Data analysis was conducted on wheezing, dry cough during the night, rhinitis, pneumonia, tuberculosis symptoms, and indoor moisture signs of mould/damp spots on walls, ceilings, and floors, water damage, and condensation. Dampness was found to negatively impact respiratory health, specifically, there was a significant positive association between condensation and dry cough. There was also indication of dampness problems in the dorms of Chinese students which was a risk factor in triggering allergic symptoms. The researchers suggest further studies be conducted on ventilation and microbiology in the dorm environment corresponding to dampness.

This literature review did not retrieve findings explicitly pertaining to the links between student housing, health outcomes, and the social environment. However, the 14 papers found in the literature search addressed individual response, behaviour, biology, personal health practices and coping skills. Evidence suggests that individual responses impact both the general health and respiratory health of students. Several research articles examined personal practices including hand hygiene, coughing and sneezing etiquette, alcohol consumption, and physical activity. One study based in Colorado studied the effectiveness of both a hand hygiene message campaign and the use of an alcohol hand sanitizer in decreasing the incidence of upper respiratory illness (White, C., Kolble, R., Carlson, R., Lipson, N., 2005). This particular study recruited 430 students from 4 residence halls during the fall semester at the University of Colorado. Dorms were paired into control and product groups. In the product groups, alcohol sanitizers were installed in every room, bathroom, and dining hall. The data collected was statistically analyzed for differences between the control and product groups for reported symptoms, illness rates, and

absenteeism. Negative statistically significant associations were found between hygiene behavior and symptoms, illness rates, and absenteeism. Researchers concluded that it is vital for students to be aware of the amount of bacteria on the hands and how easily disease can be transmitted through contact. The study also found that students who were exposed to this information, took advantage of regular hand washing and alcohol sanitation, and had decreased cold/flu illnesses, fewer missed classes/work commitments (White, Kolble et al. 2005). Another study conducted on undergraduate students in New York City used self-reported measures and microbial samples to assess the relationship between reported hygiene behaviours, environmental contamination and health status (Miko, B., Cohen, B., Haxall, K., Conway L., Kelly, N., et al., 2008). Bacterial contamination was evaluated using standard quantitative bacterial culture techniques. Reported hand hygiene practices varied among the population, and microbiologic growth varied from none to significant amounts. It was concluded that microbial infections from poor hand hygiene practices increases viral illness, upper respiratory tract infections, and gastroenteritis.

Evidence shows that those who are aware of specific personal practices, decrease their likelihood of contracting respiratory infections. Hand washing and sanitization are the most common personal practices, but there are other practices such as regular intake of supplements and vitamins that may also have an impact on health. Researchers from McMaster University, Hamilton, Ontario conducted a randomized control trial in which a questionnaire was administered and a self-collected mid-turbinate flocked nasal swab was provided to participants (Goodall, E., Granados, A., Luinstra, K., Pullenayegum, E., Coleman, B., et al., 2014). The study aimed to look at the use of vitamin D3 and gargling as a preventative measure against upper respiratory tract infections. Specifically, researchers assessed whether vitamin D or a placebo and gargling versus no gargling could prevent upper respiratory tract infections. Although no

statistically significant results were observed, vitamin D3 was reported to be a promising intervention in improving the immune system and preventing upper respiratory tract infections, as vitamin D3 significantly reduced the risk of laboratory confirmed URTI's and may reduce the risk of clinical infections. Moreover, a quantitative study based in New Jersey, used the Wisconsin Upper Respiratory Symptom Survey-21 to assess the effect of probiotics (Lactobacillus rhamnosus LGG® and Bifidobacterium animalis subspecies lactis BB-12®) on health related quality of life outcomes, such as duration and functional impairment during upper respiratory infections of college students (Smith, 2012). The severity and duration of upper respiratory infections and missed work/school days were documented. This study found certain probiotic strains modulate immune function and may positively impact health related quality of life outcomes during upper respiratory tract infections. Furthermore, it is possible the probiotic may aid in decrements of health related quality of life, and minimizing absenteeism during infection in college students. However, these findings cannot be generalized for all probiotics (Smith, 2012).

When considering alcohol consumption, researchers at Indiana University asked students to complete a self-reported survey on drinking habits and acute health problems (Engs, R., & Aldo-Benson, M., 1995). This cross-sectional study aimed to determine if alcohol could appreciably influence immunity and affect the incidence of acute health problems and upper respiratory infections. The research found no increase in acute health problems and upper respiratory infections in students who moderately consumed alcohol (21 drinks/week), but significantly more were observed in students who consumed excessive alcohol (≥28 drinks/week).

Lastly, a study based in Canada looked at the association between physical activity and the common cold in undergraduate university students (Vossen, D., McArel, H., Vossen, J., & Thompson, A., 2004). This study was conducted in Nova Scotia and aimed to determine if physical activity could be linked to the incidence and/or duration of the common cold. Researchers for this study used the Paffenbarger Physical Activity Questionnaire to estimate physical activity levels and a second questionnaire to record the number and length of upper respiratory tract infections. Using Pearson product-moment correlation coefficients to analyze the relationship between kilocalories per week and the incidence and duration of upper respiratory tract infections, researchers found that there was no relationship between kilocalories expended per week and the incidence of upper respiratory tract infections.

Few studies focused on genetic characteristics being a differentiating factor in the health of students (PausJenssen, E., & Cockcroft, D., 2003). However, one study conducted in Saskatchewan, Canada describes innate characteristics in order to assess prevalence of asthma, atopy and hyperresponsiveness in males and females, thus addressing the genetic component in the population health framework. Researchers used random sampling and the American Thoracic Society Questionnaire on respiratory disease with modifications to address rhinitis, conjunctivitis, and allergies. Allergy prick tests were also performed. This research found associations between being male and being diagnosed with asthma, atopy, and airway hyperresponsiveness. This is similar to the literature which reports male students have an increased likelihood of having airway hyperresponsiveness (PausJenssen, E., & Cockcroft, D., 2003).

An earlier systematic review examined several studies related to psychological stress and susceptibility to upper respiratory infections (Cohen, 1995). This review looked at studies

focused on smoking, poor diets, sleeping habits, family/life stressors and environmental exposures. The studies in this review suggest that psychological stress is a risk factor for upper respiratory infections with strongest evidence in prospective viral-challenge trials (Totman, R., J, Kiff, S.E. Reed, & Craig, J.W., 1980; Broadbent, D.E, Broadbent, R.J. Phillpotts, & Wallace, J., 1984; Greene, W.A., Betts, R.F., Ochitill, H.P. & Douglas, R.G., 1978; Locke, S., & Heisel, J., 1977; Jackson, G., Dowling, H., Anderson, L., Riff, M., & Turck, M., 1960). This review also suggests there is substantial evidence to support a psychosocial impact on infectious upper respiratory disease. Stress may influence immunity through direct innervation of the central nervous system and immune systems or through neuroendocrine-immune pathways (Cohen, 1995). Behavioural changes that occur as adaptations or coping mechanisms to life's stressors may also impact immunity.

General Health

Although much of the literature appears to be focused on respiratory health, general health of the student population has been addressed in the literature. At Brigham Young University in Utah, researchers used a questionnaire to ask about the adverse health effects due to the presence of mould, lead paints, insect and rodent contamination, smoke alarms, exhaust fans, gas leaks, and broken windows in off-campus student tenant-housing (Johnson, E., Cole, E., & Merrill, R., 2009). This study aimed to address the health and safety risks to the college student population in rental housing. The study found that there was indeed a correlation between increased environmental problems, such as visible mould, heating/cooling systems, indoor dampness/water damage, ants, electrical wiring, and mice and adverse self-rated health, as headaches, coughing, sneezing, nausea, and dizziness were reported. Researchers concluded it was important to inform college students about environmental health and safety problems in

leased housing, to promote responsibility of landlords to provide safe and healthful environments.

Some research that assessed the physical environmental exposures focused on bacterial growth of *Methicillin-resistant Staphylococcus aureus* (MRSA) and housing conditions in relation to general health. MRSA is seen in both hospital and community settings, and without proper precautions, can spread quite rapidly (Allen, 2006). This bacteria can cause bloodstream infections, pneumonia, and surgical site infections. A study based in Seattle, Washington isolated and characterized MRSA from frequently touched environments at a university, student homes, and community sites (Roberts, M., Soge, O., Helgenson, S., & Meschke, J., 2011). Twenty-four isolates from twenty-one surfaces were MRSA positive. These surfaces were identified in student homes and in the community. Although no students that were sampled had an MRSA infection, the risk of negative health consequences due to exposure with these bacteria are still possible.

Gastrointestinal Health

Gastrointestinal health of the student population may have been overlooked in this particular area of research, as literature appears to be limited. That being said, studies found that gastrointestinal health amongst the university undergraduate population was impacted mainly by personal behaviours, particularly, handwashing (Scott, Karabeth, & Vanick, 2007). A cross-sectional study conducted in Boston, Massachusetts aimed to determine the level of knowledge about hand washing practices and the impact of handwashing on gastrointestinal health (Scott, Karabeth, & Vanick, 2007). Researchers found that there is a need to create awareness of proper hand hygiene practices as they relate to everyday context of a college campus. Furthermore, there is a need for hand hygiene education targeted at students and it is recommended that

college authorities provide soap and means of hand drying in all residential bathrooms. Another cross-sectional study conducted in Guelph, Ontario observed student compliance with hand washing recommendations during a suspected norovirus outbreak (Surgeoner, Brae, Chapman, Benjamin, & Powell, 2009). Symptoms of gastrointestinal illness such as nausea, vomiting, abdominal cramps, and diarrhea were observed. It was concluded that hand washing, crisis communication, and a management plan must be in place to mitigate the spread of gastrointestinal illness, namely norovirus. At the University of Michigan, the association between handwashing practices and adverse gastrointestinal and respiratory symptoms was examined. Results showed females were more likely than males to report washing their hands before eating, after urinating, or after a bowel movement (Thumma, Aiello, Foxman, 2009). Identifying new strategies to increase handwashing may help prevent infectious disease transmission in residence hall environments.

Dermatological Health

Research suggests that dermatological health issues may be a primary indication of an upcoming respiratory illness (University of Maryland Medical Center, 2015). Specific literature on dermatological health of university undergraduate students in North America was not found. Dermatological health however, has been found to be affected by the physical environment (not specific to student housing). However, epidemiological findings suggest skin irritations may be associated with housing conditions such as odours, heating, ventilation, air conditioning systems, thermal discomfort, draught, or chemical emissions (Bonnefoy, X., 2007). Skin irritations were more prevalent in colder environments, specifically in the winter season (Hamadeh, 2014). This finding is applicable to a Canadian population, as winters can be very cold and dry.

SUMMARY AND RATIONALE

This chapter reviewed relevant literature that relates to health of the post-secondary population in relation to housing accommodations. It is evident that common areas of interest include the physical environment, social environment, and personal behaviours. This reinforces the validity of using the PHF as a guide, as it integrates the effects of these and numerous other determinants that impact this population.

This research study will attempt to add knowledge to the area surrounding North American post-secondary schools and the health of university undergraduate students living in various housing conditions. Respiratory and gastrointestinal health conditions are the primary reason for missed school days and academic commitments amongst university students (Smith, 2012). The factors that influence this specific population will be further investigated and described from numerous perspectives. This is important for several reasons. First, it is beneficial for students to understand the influences of their personal behaviours, as may directly impact their productivity and success as a student. Second, it is also significant from the university's perspective, as it provides information and insight about what the university can do to improve the health of students. Lastly, it may have a large impact on families whose children are planning to attend university. It is important for families and guardians to understand the relationships between housing accommodations and their children's health. The results of this research study adds to knowledge in health sciences regarding lifestyle situations and behaviours, and identify new areas to be studied.

Literature provides research on the overall health of university students, however there seems to be minimal information on specific areas such as respiratory and gastrointestinal health and skin conditions, which in combination affects general health (University of Maryland

Medical Center, 2015). Isolating respiratory and gastrointestinal health, and dermatological conditions based on living conditions is very difficult, however it is important to explore these living situations as well as the social and biological environments, which are commonly experienced by university students and has been documented to increase susceptibility to upper respiratory infections (Smith, 2012). It is important to assess these areas and the impact of housing accommodations, residence, and student housing to understand what can be done to improve the health of university undergraduate students.

The University of Ontario Institute of Technology (UOIT) is one of the newest universities in Ontario, established in 2002, hence there is little research to address the health of this student population. The proposed research will inter-collaboratively explore this area through the use of methods that involve self-reported data, physical quantitative data through spirometry, microbiological testing and visual data of the physical space to provide a thorough and comprehensive perspective on this topic. Evidence suggests undergraduate students are a unique population that needs to be further addressed.

CHAPTER THREE- METHODOLOGY

INTRODUCTION

This chapter discusses the research methodology that was employed to meet the objectives as outlined in Chapter One. The current chapter is divided into four sections. The first section outlines the research design and describes the application of the Population Health Framework (PHF). The following three sections relate to research design and consists of development of the data collection tools, participant recruitment, and the analytical methods used to meet the research objectives of the study.

RESEARCH DESIGN & APPLICATION OF THE POPULATION HEALTH FRAMEWORK

This research is a cross-sectional research design centered on the undergraduate student population at the University of Ontario Institute of Technology (UOIT). The Population Health Framework (PHF) developed by Evans and Stoddart (1990) was applied to examine determinants of health that impact general, respiratory, gastrointestinal, and dermatological health, in relation to the UOIT undergraduate student population. Determinants of health fall under the following categories: physical environment, social environment, genetic endowment, individual response, health and function, disease, and access to health care, prosperity, and well-being. (Figure 2).

In order to meet the research objectives of this study, a 70-item questionnaire, spirometry, microbiological testing and photographic data were used collectively to investigate self-rated health, respiratory, gastrointestinal, and dermatological risk factors, and health outcomes of UOIT undergraduate students. Combined, these methods provide a comprehensive understanding of the research question regarding whether students living in residence and student housing will have higher levels of exposure to environmental contaminants compared to students living with their families.

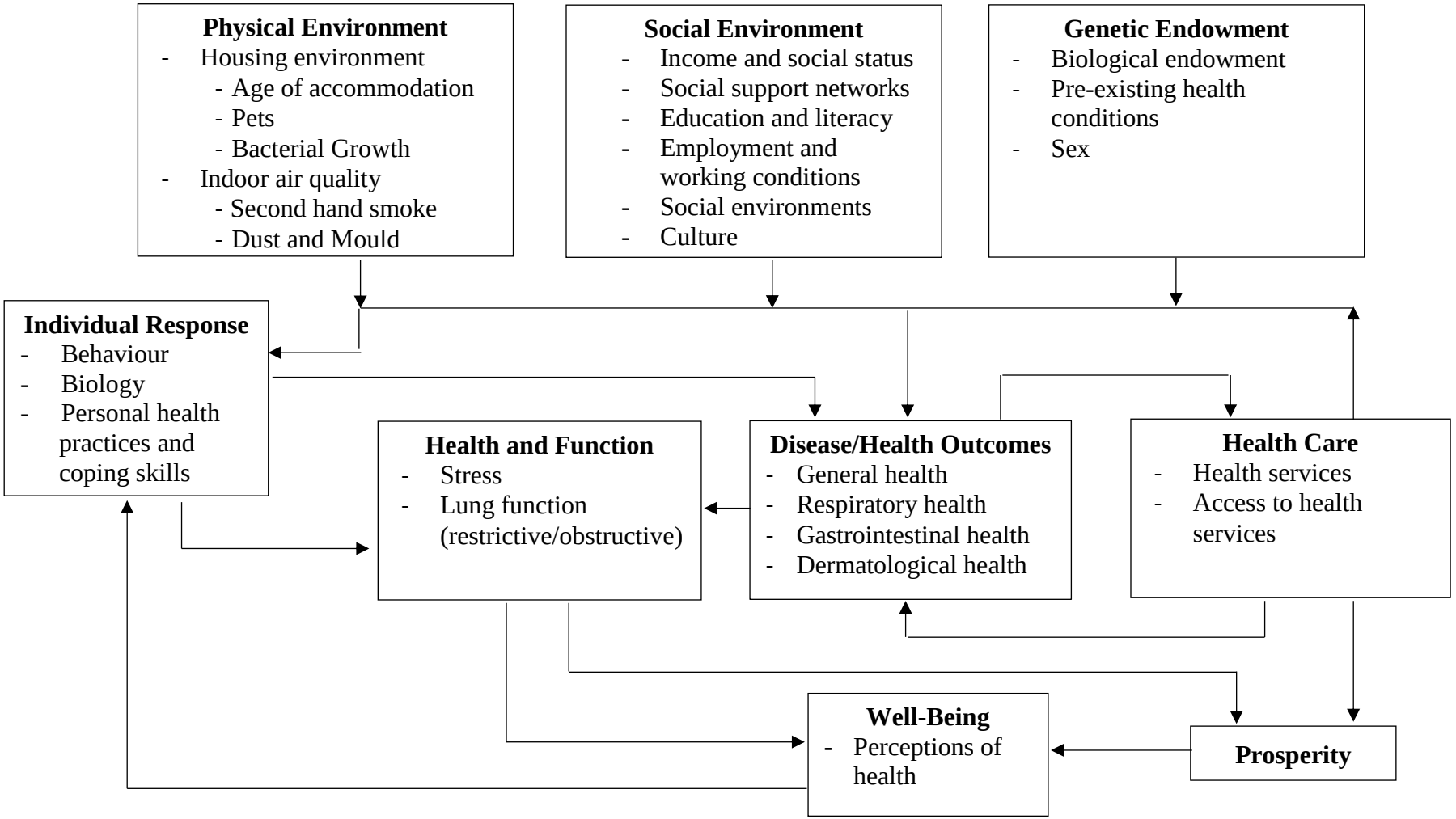

Figure 2: Applying the Population Health Framework to examine research on housing and health of university undergraduate student

QUESTIONNAIRE

Questionnaire Content

Items from validated questionnaires and Canadian certified guidelines were extracted and included in the 70-item questionnaire. Validated questionnaires were consulted for content in order to ensure all important aspects were addressed, in addition to unique questions developed by the researchers geared towards the university undergraduate population.

1) Physical Environment

In order to evaluate the physical environment that students are exposed to, the questionnaire inquired about the type of housing accommodation, environmental characteristics, and factors impacting the physical environment. Items were extracted from 'The Households and the Environment Survey (HES) (Statistics Canada, 2015). The following items were extracted from the HES:

> 'How often do you dust the common surfaces in your home with dry cleaning supplies?'; 'How often do you disinfect and sanitize the common surfaces in your home with wet cleaning supplies?'; 'How often do you disinfect your kitchen preparation surfaces?'; 'How often do you disinfect your bathroom surfaces?'; 'How often do you clean your bedroom?'; 'In the past 12 months, how often has the filter in your furnace been changed or cleaned?'; 'What measures do you/does your household take to improve the quality of the air in your home?' 'Do you have any pets that live with you?'; 'Is there currently any visible mould or mildew in your home?'; 'Are you exposed to second hand tobacco smoke in your home?'

In addition to these items, the following items were created to address the physical environment:

‘Which best describes your current housing accommodation?’; ‘How old is your housing accommodation?’; ‘How many people live in your home/student housing?’

2) Social Environment

In order to address the social environment of each student, the following items were created:

‘What is your current year of study?’; ‘What is your main source of income?’; ‘What is your combined family’s income?’; ‘Do you or your parents/guardians own or rent the property you currently reside in?’ ‘How much is the monthly rental cost (if applicable)?’ ‘What is the highest level of completed education of your mother?’; ‘What is the highest level of completed education of your father?’ ‘Are you currently employed?’; ‘How many hours a week do you work?’; ‘Which category best describes your type of employment?’

3) Genetic Endowment

Demographic and anthropometric items were included in the questionnaire and spirometry form to assess genetic endowment of each undergraduate student:

‘What is your age?’; ‘What is your sex?’; ‘What is your weight?’; ‘What is your ethnicity?’ ‘Do you have any pre-existing health conditions that affect your personal and/or academic commitments?’

4) Individual Response

The Canadian Society for Exercise Physiology’s (CSEP) Canadian Physical Activity Guidelines was consulted when creating the physical activity items. The following items were extracted from CSEP:

‘Please indicate your level of physical activity.’; ‘Do you perform either moderate or vigorous physical activity in bouts of 10 minutes?’; ‘What is the total length of your physical activities?’

In order to inquire about alcohol consumption, the Student Health and Lifestyle Questionnaire © was consulted. The following items were extracted from this questionnaire:

‘How often do you consume alcohol?’; ‘How many drinks on average do you usually drink at any one time?’

5) Health and Function

The following item was created to quantify the stress of each student:

‘How would you rate your level of stress on a scale from 0 to 5?’

Specific spirometry measures addressing restrictive and obstructive lung function will be discussed in the following section.

6) Disease/ Health Outcomes

To address self-rated health of students, the following items were created:

“In the last 30 days, have you been sick?”; ‘In the last 30 days, have you experienced any gastrointestinal symptoms?’; ‘How many times in the last 30 days have you suffered from nausea?’; ‘How many times in the last 30 days did you suffer from vomiting?’; ‘In the last 30 days, have you experienced any skin irritations?’; ‘How often does your health affect your academic commitments (if applicable)?’

To address respiratory health, the following items were extracted from the International Study of Asthma and Allergies in Childhood (ISAAC) © questionnaire:

"Was your illness respiratory related?'; 'Have you ever had wheezing or whistling in the chest at any time in the past?'; 'Have you had wheezing or whistling in the chest in the last 12 months?'; 'In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words between breaths?'; 'Have you ever had asthma?'; 'In the last 12 months, has your chest sounded wheezy during or after exercise?'; 'In the last 12 months, have you ever had a dry cough at night, apart from a cough associated with a cold or chest infection?'; 'In the last 30 days, have you had any difficulty breathing?'; 'How many attacks of wheezing have you had in the last 12 months?'; 'In the last 12 months, how often on average has your sleep been disturbed due to wheezing?'

7) Access to Health Care

The questionnaire explicitly targeted this area through the following questions:

'Do you have health care coverage through the Ontario Health Insurance Plan (OHIP)?'; 'How often do you use the health care system to see family physicians, specialists, hospitals, clinics, etc.?'; 'Have you had a general physical check up in the past 2 years?'; 'When was the approximate date of your last general physical checkup?'; 'Have you ever used the internet to self-diagnose any health conditions you have instead of seeing a health professional?'

8) Well-being

In order to capture the well-being of the UOIT undergraduate population, self-rated items based on the perceptions of health were included. The item regarding perceptions of health and mould was extracted from the Environmental Health Survey for Central and Western Minnesota ©.

Three items assessed the perceptions of the physical environment:

'In the past 30 days, how would you rate the quality of the air inside your accommodation?'; 'In the past 30 days, did you or anyone in your housing accommodation have health problems that may have been caused by the quality of the air in your home?'; 'On a scale from one to five, one being never and five being a lot, has mould affected a household member's health, including your own?'

'In general, would you say your health is:' 'How would you rate your level of stress?'; 'Do you know the main cause of your health, respiratory, gastrointestinal, or skin problem?'; 'What are the causes behind your health, respiratory, gastrointestinal, or skin problems?'

9) Prosperity

Prosperity in relation to health is the security of successful social status. This may impact all aspects of social determinants of health such as: housing, income, health services, and individual responses (Evans and Stoddart, 1990). Within the Durham context, prosperity is not considered as an explicit category but rather present in all categories of the PHF.

Administration of Questionnaire

The 70-item health questionnaire was developed by the principal investigator using the PHF (Figure 1). First, a draft questionnaire was produced and circulated amongst 15 students of similar characteristics to the study population (i.e. age, academic level, lifestyle). These individuals critiqued the survey by providing comments regarding the content, ease, clarity, and logistics. To improve the aforementioned areas, explanations to increase clarity were added to key terms, mandatory questions that may not be relevant to all students were altered, and skip

logic was implemented to certain questions. Thus, the health questionnaire was finalized for use in the research study (Appendix A).

Once participants expressed interest in partaking in the research study, additional information was provided to the student, which included informed consent, the provision of a unique study code and link to access the online, self-administered questionnaire on Google Forms. This website is a secure database, in which only UOIT students with university issued accounts would have access to. All information collected on this database was automatically transferred to a Microsoft Excel spreadsheet.

ADDITIONAL MEASURES

In addition to the questionnaire, time slots and pre-assessment instructions for the spirometry testing was included. At the end of the spirometry testing, a subsample of the first 40 students were asked to participate in the microbiology testing, and were provided with a collection kit to swab two areas within the home: kitchen preparation area, and bathroom light switch. The same subsample of students were asked to also provide a photograph of the kitchen and bathroom surfaces to provide a graphic representation of their environment.

Spirometry Testing

To assess the presence of restrictive or obstructive lung functions, Forced Vital Capacity (FVC), Forced Expiratory Volume after 1 second (FEV1), Peak Expiratory Flow (PEF), FEV1/FVC ratio numbers were collected. Restrictive lung diseases cause difficulties during lung expansion and obstructive lung diseases cause difficulties with expelling air from the lungs (The Lung Association of Saskatchewan, 2013). FVC is defined as the total amount of air that can be blown out with maximum effort. FEV1 is defined as the amount of air blown out in the first second of the forced expiration. PEF is defined as the maximum flow reached during exhalation.

Lastly, FEV1/FVC is defined as the ratio used to determine the presence of restrictive or obstructive lung disease (Canadian Thoracic Society, 2017). If the FEV1/FVC ratio is decreased, this indicates a restrictive or obstructive lung disease. The Lower Limit of the Normal (LLN) is a predicted value and is the mean value observed from many healthy persons of the same age, gender, height, and ethnic group. The LLN is the threshold below which a value is considered abnormal. Typically, this value is set so 95% of a normal population will have values above the LLN and 5% of a normal population will have values below the LLN. The LLN is roughly 80% of the predicted value for FEV1. These guidelines were used in conjunction with FEV1/FVC to determine the presence of restrictive or obstructive lung disease. These spirometric measures were documented from the spirometer (Vitalograph Micro, Vitalograph Medical) used during testing for each participant.

Students were provided time slots and pre-assessment instructions prior to meeting with the principal investigator in a private office for a spirometry appointment. Upon arrival, the principal investigator explained the purpose of the study, the study procedures, the benefits to participating in the study, potential risks and discomforts, confidentiality terms, and the procedure to withdraw from the study if necessary (Appendix B). Once consent was obtained, the principal investigator used a standard data collection tool from the Lung Association ™ to gather information on categories including: demographics- age, height, weight, gender, race, smoking history, medications, diagnoses, and present condition of student (Appendix C). These values were inputted into the spirometer to determine predictive spirometry values, comparative to the actual spirometry values of each participant. The participant was then asked to sit in a chair with their feet flat on the floor. A description of the test, along with the goals, test procedure, and a demonstration was provided before the participant engaged in the spirometry

testing to ensure comprehension and accurate results. Each manoeuvre was reviewed to determine if the results met the acceptability criteria outlined by the ATS and the ERS (American Thoracic Society, 2017). Once three (3) acceptable manoeuvres were established, the spirometry testing session was reviewed to identify two (2) repeatable results. If this criteria was met, spirometry testing concluded. According to the ATS and ERS, data was not collected if the participant has made 8 unacceptable attempts, the participant was in distress and could not continue, or if the participant's test became progressively worse. These scenarios did not occur during testing for any participants of this research study.

Microbiology Sampling

The microbiological sampling was conducted in order to discover the types of organisms that grow on common surfaces in student's housing accommodations (i.e. kitchen counter and bathroom light switch). Particularly, identifying and determining the prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Enterobacteriaceae was focused on as these strains are known to potentially pose health risks to humans (Roberts, Soge, No, Helgeson, & Meschke, 2011). The microbiological data was used as a proxy for housekeeping behaviours and validation for certain self-reported item responses. Additionally, this provided a possible crude linkage to the photographic data delivered by participants.

The first 40 participants were asked if they would be interested in swabbing their kitchen preparation surface and bathroom light switch, at the end of the spirometry testing. If a student agreed to participate, they were provided with a specimen collection kit, which included one swab for the kitchen counter and one swab for the bathroom light switch, along with specific instructions on collection procedures to maintain the specimen's integrity. Once the areas were swabbed, students were asked to seal the specimens, double bag and seal the kits, refrigerate the

samples overnight, and return the samples to the principal investigator the following day and/or within 24 hours of collection.

The microbiological specimens were analyzed by a fourth year Medical Laboratory Sciences student. This student completed the analysis in a Biohazardous Level 2 laboratory at UOIT, and was supervised by a Faculty of Health Sciences Medical Laboratory Sciences member.

Each swab from the specimen kit was inoculated onto MacConkey agar with crystal violet for the isolation of Enterobacteriaceae, and Denim Blue Chromogenic agar for the isolation of MRSA. Plates were divided in two sections, with the 'kitchen counter top' swab inoculated on one side and the 'bathroom light switch' swab on the other side. The swabs were rolled over the surface of the media, ensuring all sides of the swab came in contact with the plate to optimize isolation of organisms. Plates were placed in an incubator, away from light exposure and with oxygen, at 35 degrees Celsius for 18 to 24 hours. If plates could not be evaluated for the presence of growth immediately, they were refrigerated at two to eight degrees Celsius.

When MacConkey with crystal violet plates were removed from the incubator, growth was recorded as lactose fermenter or non-lactose fermenter, and quantified as light, moderate, heavy or very heavy growth. Each morphologically different organism was assigned an identification number. The identification number for organisms isolated from the kitchen surface began with the letter 'K' and were followed with the specimen identification number, and an organism number assigned during colonial morphology. Organisms isolated from the bathroom surface began with a 'B' and followed the same format as the kitchen specimens. Each organism was then run on the Vitek 2 Compact analyzer, using the Vitek Method, for identification. Colonies on the MacConkey plates that were difficult to isolate, were subcultured to a second,

full plate. The subculture was made by taking one colony with a loop, touching it to the subculture plate, and streaking for isolation. Subculture plates were then incubated for 18 to 24 hours at 35 degrees Celsius, and identified the following day. For each organism run on the Vitek 2 Compact, a purity plate was made on Typtone Soya agar with 5% sheep blood to ensure the culture was pure. The purity plate was also incubated for 18 – 24 hours at 35 degrees Celsius and growth was observed the following day.

Upon removal of the Denim Blue Chromogenic MRSA media from incubation, plates were examined for growth of dark blue colonies. If colonies appeared light blue or clear, specimens were considered negative for MRSA and recorded as "no significant growth". Growth of dark blue organisms were examined further. Identification was confirmed with the Tube Coagulase Method and PBP2a Method.

Photographic Data

The same subsample of students who completed the microbiological testing were also asked to provide photographs of the areas that were swabbed, to give a visual representation of common surfaces in student housing accommodations. These photographs were used for exploratory purposes to provide the principal investigator with a visual representation of the physical housing environment and were submitted via email (Appendix D).

PARTICIPANT RECRUITMENT

Eligibility Criteria

In order to participate in this study, students must have met the following inclusion criteria: be enrolled at UOIT as an undergraduate student (either part time or full time), and must be at least 17 years of age. Graduate students and students in the Faculty of Education were

excluded from the study, as these students typically were older and had different lifestyles compared to the vast majority of undergraduate students at UOIT.

Based on previous literature (Charan, J., & Biswas, T., 2013), the suggested sample size for this research is 400 students. Once the research received approval from the UOIT Research Ethics Board (REB), students were recruited through the use of two strategies:

Strategy 1

Initially, an email was sent to all UOIT undergraduate students by the UOIT Communications and Marketing Department on behalf of the principal investigator to university issued email accounts. This email informed students about the nature of the study, the type of information that would be collected and requirements for the study, along with contact information for the principal investigator and UOIT REB should there be any questions (Appendix E). A secondary snowball sampling method occurred subsequently, as it was anticipated that the initial email would result in referral of other students. In addition, convenience sampling was used, which involved contacting a randomly selected group of 10 professors across various faculties via email, to arrange a short announcement to inform students of the study. Professors were contacted in alphabetical order, by last name. In the event that a professor indicated non-interest or they were unable to assist, the next professor in alphabetical order was contacted. If students were interested in participating, they were instructed to provide their name and email address, and were contacted with further instructions to book an appointment. Lastly, recruitment posters were posted and visible around the school. These posters shared both research and contact information (Appendix G). If consent was provided, a research appointment would follow. The use of these techniques resulted in 70 students recruited for the study which prompted a second technique of recruitment.

Strategy 2

An amendment was made to the original REB application in order to recruit additional participants. These changes include the use of social media, as well as incentives for students to compensate participants for their time. Once approved, the Communications and Marketing Department was contacted and the recruitment message was shared on UOIT's MyCampus page (a web page only accessible to UOIT students), Facebook page, and Twitter accounts. Furthermore, a group of 58 randomly selected professors across various faculties were contacted via email, and were asked if the recruitment message could be shared on Blackboard with their students, along with the possibility of a bonus mark as an incentive. These strategies together increased the sample size to 213 participants.

DATA ANALYSIS

Data was collected from October 2015 to January 2016. Information submitted to Google Forms for the questionnaire was automatically converted into a Microsoft Excel Spreadsheet. This information was transferred electronically into SPSS (IBM SPSS Statistics 23 ©) for each student. All information collected from the spirometry forms were manually inputted by the principal investigator, along with an indication of light, moderate, heavy, or very heavy growth of bacterial cultures for those students who participated in the microbiology component of the research.

Data Cleaning

Once all data was inputted into the SPSS software, any duplications with study ID's were removed. In the case that there were variations in the data sets with the same study ID, the data set that was most complete was kept. Then, all variables were inspected to ensure values were in the correct format (nominal, ordinal). Appropriate labels were created for each variable, which

aided in the clarity of each variable during analysis. When cleaning data for each variable, similar categories were combined, which increased the n value, and allowed for better analysis. Missing data was identified for 180 data cells by the SPSS software, and were excluded in certain analyses in order to ensure accuracy. Furthermore, reference categories were identified and recorded, which was used in the discussion portion of the thesis.

Data Analysis

Variables were first assessed using univariate and bivariate analyses. Frequency analysis was completed on demographic data, type of housing accommodation, physical environmental exposures and health outcomes (e.g. respiratory illness, gastrointestinal symptoms) to indicate and represent the rate of occurrence.

The first research objective was to describe the environmental and personal lifestyle exposures of UOIT undergraduate students. Frequency analyses were performed to indicate the magnitude of each variable. The significance of each variable in relation to housing accommodation types (home with family, on-campus residence, off-campus housing) was completed using bivariate and multivariate analyses and informed the analyses for the third objective.

The second research objective was to describe the general health of UOIT undergraduate students, with a focus on respiratory health. Similar to the analysis completed to address the first research objective, respiratory health was analyzed by frequency analysis descriptive statistics. In order to compare the UOIT sample population with what is considered normal respiratory function, participant's predictive normal values were used. Factors that were considered in the predictive normal values include: gender, height, age, and the European 1993 Peak Expiratory Flow Adult and Child Normal Values.

The third research objective was describe predictors of related health outcomes. Variables were analyzed using bivariate and multivariable analyses to determine the relationships between variables and health outcomes. Variables that were deemed significant ($p \leq 0.05$) in the bivariate analyses, were entered as dependent variables in logistic regression modelling. Logistic regression was used as a predictive analysis to explain the relationship between independent and the dependent variables. The independent variables that were modelled for logistic regression include: fair or poor self-rated health, sick within 30 days, dry cough in the last 12 months, nausea or vomiting in the last 30 days, skin irritations in the last 30 days, and wheezing or whistling within 12 months. Values that were significant in the logistic regression were labelled as predictors of the chosen health outcomes. For respiratory health, the following were independent variables were modeled: wheezing/whistling within 12 months, dry cough at night within 12 months, and difficulties breathing within 12 months. A best fit model was created for all three both models based on the significant variables found in the logistic regression. The Hosmer-Lemeshow test was completed on each best fit model to test for goodness of fit and indicate how well the data fits each model. Lastly, the type of housing variable was forced into the best fit model to assess if it improves the goodness of fit. The same process was completed to create a model for self-rated health, gastrointestinal health, and dermatological health.

A p-value of <0.05 was considered significant. Odds ratios were used to measure the association between exposures and outcomes (Szumilas, M., 2010). This value determines how many times more likely the odds of finding an exposure in someone with disease is compared to finding the exposure in someone without the disease. Specifically, an odds ratio greater than 1 indicates an increased frequency of exposure among cases, an odds ratio of 1 indicates no change

in frequency of exposure among cases, and an odds ratio less than 1 indicates a decreased frequency of exposure among cases.

CHAPTER FOUR- MANUSCRIPT

Respiratory Health and Housing for University Undergraduate Students

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ABSTRACT

Background: The overall health of undergraduate students is impacted by diverse factors including physical and social environmental exposures, individual behaviours, and genetic predispositions. It is generally recognized that the most common illnesses experienced by this population is respiratory-related. Within the home, individuals are likely exposed to aspects that include but are not limited to indoor air pollutants, mould from water damage, and allergens. Although individuals are expected to engage in behaviours to reduce these exposures, they 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, and to explore predictors on these health outcomes, as well as the role of housing types. **Methods:** An online health questionnaire was developed 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. 40% of university undergraduate students reported being sick within the last 30 days, 36% of which reported this was respiratory related. Housing accommodations 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.

INTRODUCTION

Canadians spend approximately 87% of their time indoors (The National Human Activity Pattern Survey, 2001), 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 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 (Chauhan, Gupta, Suryawanshi, & Verma, 2016).

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 (Smith, 2012). However, interacting with socioeconomic status, individual behaviours, and genetic predispositions, these risks are greatly increased (World Health Organization, 2016). For example, the effects of exposure to particulate matter in the home on respiratory mortality and morbidity has been documented (Bhatnagar, Brook, Diez Roux, Rajagopalan, Pope, et al., 2010). Alternatively, positive personal behaviours such as engaging in sufficient physical activity has shown to improve respiratory function (Addy, Cheng, Macera, Sy, Wieland et al., 2003).

Adverse respiratory symptoms including wheezing and whistling, dry cough, and difficulties breathing have been identified as the most common cause of missed school days, and thus will be the primary focus of this research (Belongia, King, McLean, Meece, Peterson, 2016).

Literature has documented the risks of environmental exposures on respiratory health (Dales, R., Burnett, R., Zwanenburg, H., 1990). However, studies have not been conducted in relation to various housing accommodations in the university undergraduate population and geographic location to date. It is important to consider differences in types of housing accommodations of students and lifestyles, to gain an understanding of positive and/or negative interactions, if any. This research allows for multidimensional exploration of physical, social, and biological variables simultaneously, which can help in understanding health outcomes that university undergraduate students are exposed to. Specifically, this paper will study the University of Ontario Institute of Technology's undergraduate population and address three main objectives: 1) determining the prevalence of respiratory related symptoms, wheezing and whistling, dry cough, and difficulties breathing, 2) describing spirometric lung function and prevalence of restrictive and obstructive lung disease, and 3) exploring predictors of wheezing and whistling, dry cough, and difficulties breathing.

As discussed previously, there are several studies that focus 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 (Evans, 2005). Although there is literature in each of these areas, these specific research studies have been conducted in very different populations and geographical locations compared to the population currently being studied in Oshawa, Ontario.

This research is guided by the Population Health Framework (Evans and Stoddart, 1990). 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 (Evans & Stoddart, 1990). 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).

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 (Appendix A). 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) (Appendix C).

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) (Asher, Andersonsher, Beasley, Crane, Keil, et al., 1995), Environmental Health Survey for Central and Western Minnesota, (Danielson, Erickson, Nikle, Schwarzwalter, Rathge, 2007), Households and the Environment Survey (HES) (Statistics Canada, 2015), and Student Health and Lifestyle Questionnaire (Engs, 1991). The questionnaire also utilized guidelines from the Canadian Society for Exercise Physiology's (CSEP) Canadian Physical Guidelines (CSEP, 2017). 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 behaviours 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 modelled 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 was 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 for physical environmental exposures that were analyzed by housing accommodation (Table 2A), and health care analyzed by housing accommodation (Table 4A) 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 2B and Table 4B.

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.

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 (Table 1).

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 5). 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 6).

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 2B). There were no statistically significant variables within the individual response and health care categories in relation to housing accommodations (Tables 3 and 4). 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).

Associations of Dry Cough at Night Within 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. (Table 7A).

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.

Associations of Difficulties Breathing Within 12 Months

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 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 model, this did not improve the best-fit model. 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).

Spirometry

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.

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 (Smith, 2012). 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 are comparable to trends of respiratory infections presenting as a public health problems in Canada (26%) (Statistics Canada, 2014).

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 were 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 Shaikh et al 2006 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 (Shaikh, B., & Deschamps, J., 2006). 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 (Mahmoud, J., Staten, R., Hall, L., & Lennie, T., 2012). 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 (Dunn, R., 2010). 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 (Hynes, P., & Lopez, R., 1998). 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, mouldy, and have inadequate ventilation, which are all associated with asthma and other chronic respiratory symptoms (Higgins and Krieger, 2002). 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 (Qian, H., Zheng, X., Zhang, M., Weschler, L., & Sundell, J., 2016). 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 (Smith, J., 1999). 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 (American Lung Association, 2017). Furthermore, some products release harmful chemicals, including volatile organic compounds. These compounds and other chemicals released during

cleaning contribute to chronic respiratory illnesses (Becher, R., Hongslo, Jan., Jantunen, M., & Dybing, E., 1996).

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 (Garner, R., & Kohen, D., 2008) 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 (Banerjee, Das, Dey, Ghosal, Roy, et at., 2014).

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 conclude yearly general check-ups are important to identify risk factors that may lead to illnesses in the future (Gibson, P., Powell, H., Wilson, A., Abramson, M., Haywood, P., et al., 2002). 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 (Shekelle, P., Eccles, M., Grimshaw, J., & Woolf, S., 2001). 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 (The

College of Family Physicians of Canada, 2013). 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 (Esposito, S., Galeone, C., Lelii, M., Longhi, Benedetta, L., Ascolese, B., et al., 2014). 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.

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

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)
	11-20	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 2B: Physical Environmental Exposures by Housing Accommodation (n=213)

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)***	1-5 6+ I do not know/I do not wish to answer	18 (12.8) 113 (80.7) 9 (6.4)	2 (11.8) 6 (35.3) 9 (52.9)	21 (37.5) 20 (35.7) 15 (26.8)	41 (19.2) 139 (65.3) 33 (15.5)	.000
# of Individuals Residing in the Home***	1-2 3+	6 (4.2) 134 (95.7)	9 (52.9) 8 (47.1)	11 (19.6) 45 (80.4)	26 (12.2) 187 (97.8)	.000
Pets in the Home*	Yes	65 (46.4)	5 (29.4)	14 (25.0)	84 (39.4)	.014
Exposure to ETS in the Home**	Never Sometimes/Always	116 (82.8) 24 (17.1)	11 (64.7) 6 (35.3)	35 (62.5) 21 (37.5)	162 (76.1) 51 (23.9)	.005
Visible Mould in the Home	Yes	25 (17.8)	2 (11.8)	13 (23.2)	40 (18.8)	.510
Frequency of dusting common surfaces*	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/Daily	37 (26.4) 103 (73.6)	10 (58.8) 7 (41.2)	14 (25.0) 42 (75.0)	61 (28.6) 152 (71.4)	.016
Frequency of disinfecting surfaces***	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/ Daily	24 (17.1) 116 (82.3)	8 (47.1) 9 (52.9)	1 (1.8) 55 (98.2)	33 (15.5) 180 (84.5)	.000
Frequency of mopping/vacuuming*	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/ Daily	5 (3.6) 135 (96.4)	3 (17.6) 14 (82.4)	6 (10.7) 50 (89.3)	14 (6.6) 199 (93.4)	.030
Frequency of disinfecting kitchen surfaces	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/ Daily	14 (10.0) 126 (90.0)	5 (29.4) 12 (70.6)	6 (10.7) 50 (89.3)	25 (11.7) 188 (88.3)	.061
Frequency of disinfecting bathroom surfaces***	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/ Daily	10 (7.1) 130 (92.9)	6 (35.3) 11 (64.7)	5 (8.9) 51 (91.1)	21 (9.9) 192 (90.1)	.001
Frequency of cleaning bedroom	Never/Once every 4+ months/Once every 2-3 months Monthly/ Weekly/ Daily	25 (21.7) 115 (82.1)	5 (29.4) 12 (70.6)	4 (7.1) 52 (92.9)	34 (16.0) 179 (84.0)	.052
Filter cleaned within 12 months***	Once in the past year or more frequently Did not change filter/Not responsible for changing filter/ I do not know/ I do not wish to answer	72 (51.4) 68 (48.6)	4 (23.5) 13 (76.5)	10 (17.9) 46 (82.1)	86 (40.4) 127 (59.6)	.000
Perceptions of air quality in home within 30 days*	Excellent/Very good/Good Fair/Poor	130 (92.9) 10 (7.1)	12 (70.6) 5 (29.4)	48 (85.7) 8 (14.3)	190 (89.2) 23 (10.8)	.013
Opening windows	Yes	119 (85.0)	12 (70.6)	42 (75.0)	173 (81.2)	.136
Use of ceiling/floor fan	Yes	60 (42.9)	9 (52.9)	27 (48.2)	96 (45.1)	.629
Use of air conditioner	Yes	46 (32.9)	8 (47.1)	15 (26.8)	69 (32.4)	.288
Use of dehumidifier	Yes	28 (20.0)	1 (5.9)	8 (14.3)	37 (17.4)	.271
Use of humidifier	Yes	39 (27.9)	3 (17.6)	9 (16.1)	51 (23.9)	.178
Use of air cleaning system	Yes	8 (5.7)	2 (11.8)	4 (7.1)	14 (6.6)	.624
Use of higher quality filters**	Yes	37 (26.4)	0 (0.0)	5 (8.9)	42 (19.7)	.002
Use of furnace fan	Yes	25 (17.9)	2 (11.8)	13 (23.2)	40 (18.8)	.510
Use of air fresheners	Yes	86 (61.4)	7 (41.2)	36 (64.3)	129 (60.6)	.218

Table 3B: Individual Response and Personal Behaviours by Housing Accommodation

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 I engage in moderate PA/ I engage in vigorous PA	61 (43.6) 79 (56.4)	8 (47.1) 9 (52.9)	16 (28.6) 40 (71.4)	85 (39.9) 128 (60.1)	.464
Total length of PA/week	Less than 150 mins per week/ N/A 150+ per week	80 (57.2) 60 (42.9)	8 (47.1) 9 (52.9)	23 (41.0) 33 (58.9)	111 (52.1) 102(47.9)	.074
Moderate/Vigorous PA in bouts of 10 mins	Never Sometimes Always N/A	5 (3.6) 46 (32.9) 28 (20.0) 61 (43.6)	1 (5.9) 4 (23.5) 4 (23.5) 8 (47.1)	5 (8.9) 19 (33.9) 16 (28.6) 16 (28.6)	11 (5.2) 69 (32.4) 48 (22.5) 85 (39.9)	.369
Frequency of hands washed with soap (per day)	0-3 4-6 7-9 10+	20 (14.3) 46 (32.9) 35 (25.0) 39 (27.9)	5 (29.4) 7 (41.2) 4 (23.5) 1 (5.9)	11 (19.6) 21 (37.5) 13 (23.2) 11 (19.6)	36 (16.9) 74 (34.7) 52 (24.4) 51 (23.9)	.363
Use of alcohol based sanitizers	Yes	105 (75.0)	11 (64.7)	33 (58.9)	149(70.0)	.076
Frequency of vitamin/supplement consumption	Never Rarely Few times per week Daily	21 (15.0) 51 (36.4) 32 (22.9) 36 (25.7)	3 (17.6) 4 (23.5) 5 (29.4) 5 (29.4)	13 (23.2) 11 (19.6) 17 (30.4) 15 (26.8)	37 (17.4) 66 (31.0) 54 (25.4) 56 (26.3)	.358
Frequency of alcohol consumption	I do not consume alcohol/ Once a year or less/ >once a year but <once a month/ Once a month but <once a week Once a week but not every day	122 (87.1) 18 (12.9)	12 (70.5) 5 (29.4)	41 (73.3) 15 (26.8)	175 (82.1) 38 (17.8)	.429
Average drinks at any one time	<1/ N/A 1 or 2 3 or 4 5 or 6 6+	40 (28.6) 44 (31.4) 34 (24.3) 17 (12.1) 5 (3.6)	5 (29.4) 3 (17.6) 6 (35.3) 2 (11.8) 1 (5.9)	10 (17.9) 22 (39.3) 13 (23.2) 7 (12.5) 4 (7.1)	55 (25.8) 69 (32.4) 53 (24.9) 26 (12.2) 10 (4.7)	.785
Stress level (scale from 0-10)	0 1 2 3 4 5 6 7 8 9 10	0 (0.0) 4 (2.9) 5 (3.6) 13 (9.3) 12 (8.6) 18 (12.9) 23 (16.4) 30 (21.4) 20 (14.3) 8 (5.7) 7 (5.0)	1 (5.9) 0 (0.0) 0 (0.0) 3 (17.6) 1 (5.9) 3 (17.6) 4 (23.5) 2 (11.8) 3 (17.6) 0 (0.0) 0 (0.0)	1 (1.8) 0 (0.0) 8 (14.3) 5 (8.9) 7 (12.5) 11 (19.6) 8 (14.3) 7 (12.5) 6 (10.7) 2 (3.6) 1 (1.8)	2 (0.9) 4 (1.9) 13 (6.1) 21 (9.9) 20 (9.4) 32 (15.0) 35 (16.4) 39 (18.3) 29 (13.6) 10 (4.7) 8 (3.8)	.142
Hours of sleep per night	0-2/ 3-5 6-8/ 8+	22 (15.7) 118 (84.3)	1 (5.9) 16 (94.1)	5 (8.9) 51 (78.6)	28 (13.2) 185 (86.8)	.095
Difficulty sleeping in the last 30 days	Not at all/ No more than usual Rather more than usual/ Much more than usual	101 (72.2) 39 (27.8)	11 (41.2) 6 (23.5)	38 (67.9) 18 (32.1)	150 (70.3) 63 (29.6)	.434
Tobacco smoking	Yes	12 (8.6)	1 (5.9)	1 (1.8)	14 (6.6)	.222
Frequency of tobacco smoking (days)	1-5	4 (2.9)	0 (0.0)	0 (0.0)	4 (1.9)	.579

	6-10 11-15 16-20 21-25 26-30	4 (2.9) 2 (1.4) 1 (0.7) 1 (0.7) 0 (0.0)	0 (0.0) 0 (0.0) 0 (0.0) 1 (5.9) 0 (0.0)	0 (0.0) 0 (0.0) 1 (1.8) 0 (0.0) 0 (0.0)	4 (1.9) 2 (0.9) 2 (0.9) 2 (0.9) 0 (0.0)	
Non-tobacco smoking	Yes	17 (12.1)	2 (11.8)	6 (10.7)	25 (11.7)	.961
Frequency of non-tobacco smoking	1-5 6-10 11-15 16-20 21-25 26-30	11 (7.9) 5 (3.6) 1 (0.7) 0 (0.0) 0 (0.0) 0 (0.0)	1 (5.9) 1 (5.9) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0)	3 (5.4) 2 (3.6) 0 (0.0) 1 (1.8) 0 (0.0) 0 (0.0)	15 (7.0) 8 (3.8) 1 (0.5) 1 (0.5) 0 (0.0) 0 (0.0)	.145
E-cigarette smoking	Yes	0 (0.0)	0 (0.0)	2 (3.6)	2 (0.9)	.059

Table 4B: Health Care by Housing Accommodation (n=213)

Variable	Classification	Home with Family (n=140), n(%)	On-Campus Housing (n=17), n(%)	Off-Campus Housing (n=56), n(%)	Total n(%)	p-value
Frequency of use of health care system in the last 12 months	Never/Seldom Occasionally/Regularly	43 (37.7) 97 (62.3)	8 (47.1) 9 (52.9)	25 (44.6) 31 (55.4)	76 (35.7) 137 (64.3)	.110
General physical checkup in the past 2 years	Yes	84 (60.0)	7 (41.2)	28 (50.0)	119 (55.9)	.198
Approximate date of last physical check up	Within the last month+ Never had a physical check up	84 (60.0) 56 (40.0)	7 (41.2) 10 (58.8)	8 (14.3) 28 (50.0)	119 (46.5) 94 (44.1)	.198
Use of Internet for Self-Diagnosis*	Yes	93 (66.4)	6 (35.2)	33 (58.9)	132 (61.9)	.038

Table 5: Health Outcomes by Type of Housing Accommodation (n=213)

Variable	Classification	Home with Family (n=140), n (%)	On-Campus Residence (n=17), n (%)	Off-Campus Residence (n=56), n (%)	Total n (%)	p-value
General Health	Excellent/ Very Good/ Good Fair/Poor	127 (90.7) 13 (9.3)	12 (70.6) 5 (29.4)	51 (91.1) 5 (8.9)	190 (89.2) 23 (10.8)	.097
Health issues for anyone in the home	Yes	13 (9.2)	1 (5.8)	3 (5.3)	17 (7.9)	.024
Pre-existing health conditions	Yes	15 (10.7)	2 (11.7)	7 (12.5)	24 (11.3)	.974
Sick within 30 days	Yes	60 (42.8)	3 (17.6)	22 (39.2)	85 (39.9)	.133
Frequency of Health Affecting Academics**	Never Seldom Occasionally Regularly	125 (89.2) 6 (4.2) 9 (6.4) 0 (0.0)	15 (88.2) 0 (0.0) 0 (0.0) 2 (11.7)	50 (89.2) 3 (5.3) 2 (3.5) 1 (1.7)	190 (89.2) 9 (4.2) 11 (5.1) 3 (1.4)	.008
Respiratory Illnesses	Yes	53 (37.8)	2 (11.7)	21 (37.5)	76 (35.7)	.225
Ever had Wheezing or Whistling	Yes	54 (38.5)	6 (35.2)	15 (26.7)	75 (35.2)	.296
Wheezing or Whistling within 12 months	Yes	26 (18.5)	4 (23.5)	9 (16.0)	39 (18.3)	.777
Frequency of Wheezing attacks within 12 months (days)	None 1-3	2 (1.4) 18 (12.8)	2 (11.7) 1 (5.8)	1 (1.7) 6 (10.7)	5 (2.3) 25 (11.7)	.744

	4-12 More than 12 N/A	3 (2.1) 3 (2.1) 114 (81.4)	0 (0.0) 1 (5.8) 13 (76.4)	2 (3.5) 0 (0.0) 47 (83.9)	5 (2.3) 4 (1.8) 174 (81.6)	
Sleep disturbed by Wheezing or Whistling within 12 months	Never woken with wheezing Less than 1 night/week 1 or more nights/week N/A	16 (11.4) 9 (6.4) 1 (0.7) 114 (81.4)	3 (17.6) 1 (5.8) 0 (0.0) 13 (76.4)	5 (8.9) 1 (1.7) 3 (5.3) 47 (83.9)	24 (11.2) 11 (5.1) 4 (1.9) 174 (81.6)	.268
Speech limited by Wheezing or Whistling within 12 months	Yes	2 (1.4)	1 (5.8)	4 (9.1)	7 (3.3)	.176
Wheezing after exercise within 12 months	Yes	21 (15)	3 (17.6)	7 (12.5)	31 (14.6)	.846
Dry cough at night within 12 months	Yes	39 (27.8)	7 (41.1)	21 (37.5)	67 (31.5)	.282
Difficulty breathing within 30 days	Yes	23 (16.4)	2 (11.7)	7 (12.5)	32 (15.0)	.727
Student ever had asthma	Yes	34 (24.2)	5 (29.4)	9 (16.0)	48 (22.5)	.359

* p<0.05; **p<0.01; ***p<0.001

Table 6: Wellbeing by Type of Housing Accommodation (n=213)

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)	.539
Perceived adverse health due to cold/flu	Yes	6 (4.2)	1 (5.8)	3 (5.3)	10 (4.7)	.946
Perceived adverse health due to travel	Yes	2 (1.4)	0 (0.0)	0 (0.0)	2 (0.9)	.744
Perceived adverse health due to stress	Yes	11 (7.8)	1 (5.8)	7 (12.5)	19 (8.9)	.863
Perceived adverse health due to pregnancy	Yes	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)	.437
Perceived adverse health due to diet choices	Yes	8 (5.7)	0 (0.0)	5 (8.9)	13 (6.1)	.699
Perceived adverse health due to level of exercise	Yes	4 (2.8)	0 (0.0)	2 (3.5)	6 (2.8)	.897

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

	Variable (Reference)	Classification	Wheezing/Whistling Within 12 Months		Dry Cough at Night Within 12 Months		Difficulty Breathing 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* *-I do not know/ I do not wish to answer*			4.92 4.00	(1.91, 12.65) (.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 p-value			6.17 .63		7.32 .50		6.92 .55	

Table 7B: Role of Type of Housing by Best-fit Model for Respiratory Health Outcomes

	Variable (Reference)	Classification	Wheezing/Whistling Within 12 Months		Dry Cough at Night Within 12 Months		Difficulty Breathing Within 12 Months	
			OR	95% CI	OR	95% CI	OR	95% CI
Physical Environment	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* *-Home with Family*	**2.12** **1.95**	**(.22, 20.56)** **(.24, 15.84)**	**2.14** **1.76**	**(.24, 18.98)** **(.18, 16.86)**	**.94** **.85**	**(.26, 3.40)** **(.26, 2.79)**
	Current Property Owned/Rented (Own)	*-Rent* *-I do not know/I do not wish to answer*			4.49 4.08	(1.91, 12.65) (.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)			.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*					.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 p-value			4.14 .84		6.94 .54		2.19 .98	

Table 8: Respiratory Health Measures through Spirometry (n-180), Missing Data (n=33)

Lung Function Variable	Mean	SD	Min	Max
FVC	1.73, 7.64	1.00	.55	7.93
FEV1	.47, 4.20	16.59	.00	2.73
FEV%	.18, 100	9.17	.00	100
PEF	1.8, 754	139.11	1.31	735
Predicted	473.67	N/A	364	644

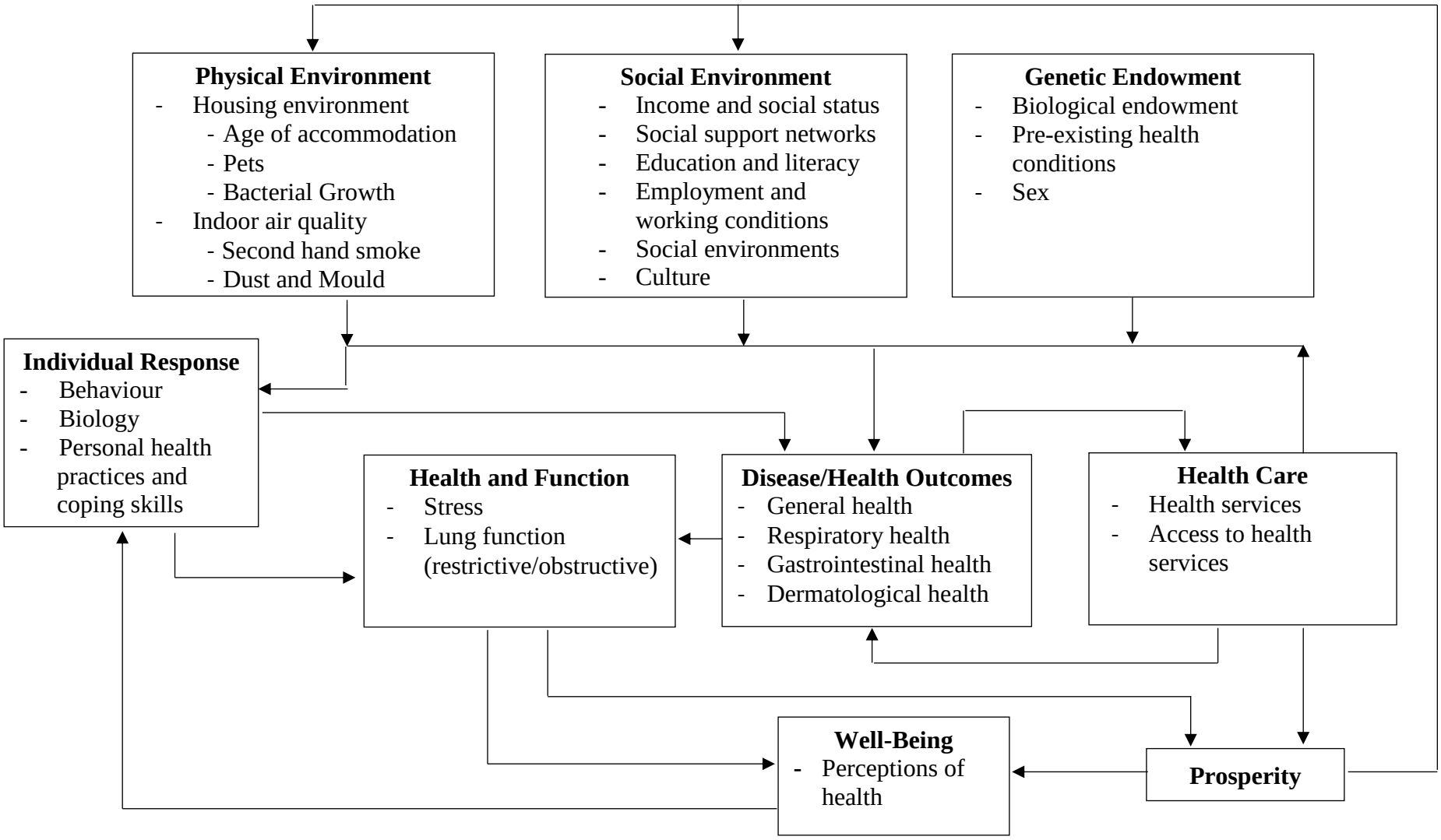

Figure 2: Applying the Population Health Framework to examine research on housing and health of university undergraduate students

CHAPTER FIVE- MANUSCRIPT

General Health Outcomes and Housing among University Undergraduate Students

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ABSTRACT

Background: Students have an increased susceptibility to illness from their fluctuating physical environmental exposures, stress levels, lack of sleep, and changes in diet and physical activity levels. These exposures separately can result in adverse health, gastrointestinal, and dermatological health symptoms. However, combined with socioeconomic status, individual behaviours, and genetic predispositions, these risks are greatly increased (World Health Organization, 2016). At certain levels of exposure, contaminants in the home such as air, water, and food can cause a variety of adverse health effects including overall health, gastrointestinal ailments, skin irritations (Nova Scotia Department of Health and Wellness, 2017). **Objectives:** To assess the prevalence of general, gastrointestinal, and dermatological health symptoms, in relation to environmental exposures from housing accommodations. Additionally, to explore predictors and the impact of housing accommodations on these health outcomes, and determining prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Enterobacteriaceae on common surfaces in student housing. **Methods:** An online health questionnaire was developed to collect data related to the sociodemographic and general, gastrointestinal, and dermatological health. Microbiological testing was conducted with a subsample of the population on kitchen food preparation and bathroom light switch surfaces, and analyzed for the prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Enterobacteriaceae. **Results:** A total sample of 213 participants completed the questionnaire, of

which 40 students completed microbiology. 9% of students reported having fair general health, and 3% reported having poor general health. Gastrointestinal symptoms in the last 30 days was reported in 38% of the total study population. Specifically, nausea and vomiting was reported to occur on more than 10 separate occasions within the last month for 1% of the study population. Dermatological symptoms (skin irritations) in the last 30 days was reported by 42% of students. With respect to specimens collected in the kitchen, 70% yielded identifiable growth. In the bathroom, 18% yielded growth. Both areas yielded Enterobacteriaceae, and neither yielded MRSA. **Conclusion:** This study suggests there are no significant differences in general, gastrointestinal, or dermatological health based on type of housing accommodation.

INTRODUCTION

Due to the demands of work and school commitments, the time spent outdoors by the average Canadian is limited (Youth Engagement with Nature and the Outdoors Survey, 2012). Therefore, most of the time individuals are in enclosed indoor environments, where environmental exposures including air pollutants and mould exist in significantly higher concentrations (Suryawanshi, Chauhan, Verma & Gupta, 2016).

University undergraduate students distinctively undergo changing environmental exposures, and drastically altered lifestyles. These aspects put the undergraduate population at a higher risk of illness. Alone, these exposures can result in adverse health, gastrointestinal, and dermatological health symptoms. When combined with social determinants of health these risks are significantly increased (World Health Organization, 2016).

At certain levels of exposure, air pollutants and contaminated water and food can cause serious conditions including cancer, respiratory illness, and gastrointestinal ailments (Nova Scotia Department of Health and Wellness, 2017). Additionally, poor housing accommodations,

water sewage systems, heating and kitchen facilities, as well as residential crowding has a direct impact on both gastrointestinal and dermatological infections (O'Neil, 2000).

The dangers of environmental exposures on health are clearly documented. Current literature does not appear to have been conducted in different types of housing accommodations with university undergraduate population and according to geographic location. Particularly, the university undergraduate population at UOIT in the predominantly suburban area of Oshawa, Ontario has not been studied. It is important to consider differences in residence styles, to gain an understanding of the positive and/or negative interaction these factors have on student experiences. This research allows for the exploration of physical, social, and biological variables simultaneously, which is vital to understand health outcomes that may be related to the multidimensional environments that university undergraduate students are exposed to. Specifically, this paper will address three main objectives: 1) determining the prevalence of general health, gastrointestinal, and dermatological related symptoms, 2) determining prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Enterobacteriaceae on common surfaces in student housing, and 3) exploring predictors of related health outcomes in the UOIT undergraduate population. This research will also offer awareness about gastrointestinal and dermatological conditions caused by environmental exposures, which have the potential to manifest into respiratory symptoms (University of Maryland Medical Center, 2017).

This research is guided by the Population Health Framework (Evans and Stoddart, 1990). 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 (Evans & Stoddart, 1990). The Population Health Framework is divided into the following components: 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).

METHODS

The data source, data collection tools, outcome variables, explanatory variables, and statistical analysis have been outlined in Chapter 4. Additional data collection tools related to microbiological testing is described below.

After conclusion of spirometry testing, the first 40 participants were asked if they would be interested in swabbing their kitchen preparation surface and bathroom light switch. If a student agreed to participate, they were provided with a specimen collection kit, which included one swab for the kitchen counter and one swab for the bathroom light switch, along with specific instructions on collection procedures to maintain the specimen's integrity. Once the areas were swabbed, students were asked to seal the specimens, double bag and seal the kits, refrigerate the samples overnight, and return the samples to the principal investigator the following day and/or within 24 hours of collection. The same subsample of students who completed the microbiological testing were also asked to provide photographs of the areas that were swabbed, to give a visual representation of common surfaces in student housing accommodations. These photographs were used to provide the principal investigator with a visual representation of the physical housing environment and were submitted via email.

RESULTS

Participant Characteristics

Sociodemographic characteristics for this study population are outlined in Chapter 4 of this thesis (Table 1). Results on physical environmental exposures are discussed in Chapter 4 (Table 2).

Nine percent of students reported having fair self-rated health, and 3% reported having poor self-rated health. Gastrointestinal symptoms in the last 30 days was reported amongst 38% of the total study population. Dermatological symptoms (skin irritations) in the last 30 days was reported by 42% of students (Table 2).

Multivariate regression modelling reveals that fair/poor health was predicted in 91% of cases. Gastrointestinal symptoms were predicted in 77% of cases, and dermatological symptoms were predicted in 66% of cases.

Associations to the Physical Environment

Logistic regression modelling was performed for fair or poor self-rated health, gastrointestinal symptoms, and dermatological symptoms. Pertaining to the physical environment, results suggest participants who believed having fair/poor air quality in the home in the last 30 days were 2.75 times (95% CI: .98, 7.71) more likely to experience gastrointestinal symptoms than those who believe the air quality in their home was excellent, very good, or good (Table 10A).

Associations to the Social Environment

Regarding the social environment, participants that lived in off-campus housing were 19.77 times (95% CI: 2.04, 191.80) more likely, and those living at home with their families were 26.56 times (95% CI: 2.31, 306.02) more likely to have overall general health concerns than those living in on-campus residences. Participants that have a monthly rental cost of less than $1000/month were 2.70 times (95% CI: .402, 18.05) more likely to have a general health concern than participants who did not pay a monthly rental cost. With respect to the highest level of education completed by a participant's father, those who reported their father's to have completed secondary school, community college, college or university, or post-graduate education were 2.89 times (95% CI: .92, 7.74) more likely to have gastrointestinal symptoms than those participants whose father did not attend school or only completed elementary school. Lastly, participants who were not employed in the food or accommodation industry were 2.72 times (95% CI: .96, 7.74) more likely to experience gastrointestinal symptoms than those who did work in that specific industry (Table 10A).

Associations to Individual Response

The frequency of participants dusting common surfaces predicted those who dusted monthly or less frequently were 1.93 times (95% CI: .96, 7.74) more likely to experience gastrointestinal symptoms than those who dusted weekly or daily. Participants who disinfected their bathroom monthly or less frequently were 14.71 times (95% CI: 1.88, 114.96) more likely to report fair or poor self-rated health than those who disinfected their bathroom weekly or daily. Participants who cleaned their bedroom weekly or daily were 2.29 times (95% CI: 1.20, 4.39) more likely to experience dermatological symptoms than those who cleaned their bedrooms monthly or less frequently. Participants who mopped or vacuumed on a weekly or daily basis

were 7.55 times (95% CI: 1.67, 34.25) more likely to report fair or poor self-rated health than those who engaged in these behaviours monthly or less frequently. Participants who washed their hands 0-3 times/day were 5.11 times (95% CI: 1.68, 15.58) more likely to experience gastrointestinal symptoms than those who washed their hands 10+ times/way. Similarly, those who washed their hands 4-6 times/day were 2.48 times (95% CI: .95, 6.47) more likely, and those who washed their hands 7-9 times/day were 2.56 times (95% CI: .94, 6.95) more likely to experience gastrointestinal symptoms. Participants who used their air conditioning were 2.33 times (95% CI: 1.14, 4.74) more likely to experience gastrointestinal symptoms than those who did not use air conditioning. The use of higher quality air filters among participants showed a 3.54 (95% CI: .494, 25.40) increased likelihood of reporting fair or poor self-rated health than those who did not use higher air quality filters (Table 3A).

Associations to Health and Function

Lastly, health and function showed impact on all three health outcomes. Participants who were sick in the last 30 days were 2.08 times (95% CI: 1.05, 4.11) more likely to experience gastrointestinal symptoms than those who were not. Participants who wheezed after exercise were 4.54 times (95% CI: .65, 31.60) more likely to report fair or poor self-rated health than those who did not have wheezing after exercise. Participants who did not have difficulties breathing were 2.17 times (95% CI: .87, 5.43) more likely to have dermatological symptoms than those who did have difficulties breathing. Participants who did not have a dry cough at night were 7.17 times (95% CI: 1.89, 31.44) more likely to report fair or poor self-rated health than those who did have a dry cough at night. Participants who had dermatological irritations were 2.67 times (95% CI: 1.37, 5.22) more likely to experience gastrointestinal symptoms than those who did not have irritations. Participants who attributed their adverse health to the cold or flu

were 8.37 times (95% CI: 1.42, 49.53) more likely to experience gastrointestinal symptoms than those who believed it was from another cause. Participants who did not have gastrointestinal symptoms were 2.62 times (95% CI: 1.38, 4.98) more likely to have dermatological symptoms than those who did have gastrointestinal symptoms (Table 3A).

The type of housing accommodation was found to be significant related to the self-rated health outcome model. When the type of housing accommodation was forced into the best-fit model, this did not initiate improvements, which indicates no substantial differences in the specific health outcomes studied based on housing accommodation. (Table 3B).

Microbiological testing of the kitchen and bathroom surfaces revealed light, moderate, heavy, and very heavy growth of numerous bacteria. MRSA was not identified on any surfaces, and *Enterobacteriacae* was seen in both kitchen preparation areas and on bathroom light switches. The results indicate there may be a relationship between certain housing accommodations and the presence of bacterial growth on surfaces in student homes. 93% of all specimens collected from off-campus housing yielded growth from one or more surface. There does not appear to be a relationship between the presence of growth on surfaces and students living at home with their family. Bacterial growth was present in 93% of homes that reported greater than five residents (Table 4).

DISCUSSION

The purpose of this study was to contribute to the understanding of the relative role of housing accommodations on general, gastrointestinal, and dermatological health of UOIT students. Univariate, bivariate, and multivariate analysis achieved many results that will be discussed below.

The physical environmental exposures based on housing accommodations showed those who perceived the air quality in the home to be fair/poor were 2.75 times more likely to experience gastrointestinal symptoms than those who believed the air quality in their home was excellent, very good, or good.

Many of the results found in this study were surprising, and may warrant further investigation. For example, related to the social environment, participants whose father's completed further education were more likely to experience gastrointestinal symptoms than those participants whose father's completed minimal education. Moreover, participants not employed in the food/ accommodation industry were also more likely to experience gastrointestinal symptoms than those who are employed in the food/ accommodation industry. It is possible both variables are linked to eating at restaurants. Perhaps, families where the father has a higher level of education, there is less time to prepare meals at home, resulting in eating food from restaurants more often (Kirkpatrick, S., & Tarasuk, V., 2003). This could have an effect on the digestive system, as it was found that the purchase of fruits and vegetables, and milk products was constrained in low income households. Lower nutritional values, can in turn cause gastrointestinal symptoms. Similarly, it is generally recognized that those who do not work in the food industry, may be more inclined to eat at a restaurant as opposed to those who do, as they are not regularly exposed to the environment. This could be a reason why this population is experiencing more gastrointestinal illnesses.

Results in the individual response category were also unexpected. Participants who cleaned their bedroom or mopped and vacuumed more frequently, were more likely to experience dermatological and overall general health symptoms compared to participants who cleaned less frequently. This could be due to exposures to cleaning supplies and chemicals which

have been documented to be harmful to health. Literature has documented the impact of cleaners on the skin, respiratory tract, the gastrointestinal system if ingested, as well as many other areas of the body (Gerster, Vernez, Wild, Hopf, 2014). These findings pose as a public health concern and should be taken into consideration when cleaning the home. However, the results also suggest that cleaning less frequently also increases the likelihood of gastrointestinal and fair or poor self-rated health. It is difficult to say whether the environmental exposures in the home are impacting health or if it is the personal behaviour itself that makes a difference, which may be an area for future research.

The frequency of handwashing proved to be an interesting finding in this study. Those who washed their hands less frequently were more likely to experience gastrointestinal illnesses than those who washed their hands more frequently. This is consistent with literature in the area. A particular study found that improvements in hand washing resulted in reductions of gastrointestinal illness as well as other general health symptoms (Aiello, Coulborn, Perez, Larson, 2008).

Another surprising finding within individual responses related to measures in improving the air quality in the home, specifically using air conditioners and higher quality filters. Although Health Canada recognize these promote good health, this study showed their use to increase the likelihood of gastrointestinal and fair or poor self-rated health. It is important to change air filters regularly to be effective. Failure to change air filters may provide no health benefits or may in fact pose as a health concern (Manuel, J., 1999). To understand the specific correlation between these variables, more research may be needed.

Lastly, there were a few findings that appear to be contradictory. Participants that reported *not* having difficulties breathing were *more* likely to experience dermatological

symptoms compared to those who did have difficulties breathing. Those who *did not* have a dry cough at night were *more* likely to report fair or poor self-rated health than those participants who did have a dry cough at night. Additionally, participants who *did not* have gastrointestinal symptoms were *more* likely to experience dermatological symptoms than those who did experience these symptoms. As mentioned previously, gastrointestinal and dermatological illnesses have the potential to manifest as symptoms in other areas of the body (Belongia, King, McLean, Meece, Peterson, 2016). Perhaps these findings suggest that certain exposures are manifesting at different times and in different systems physiologically. Further research may be needed to understand these unique findings.

Data collection on the university undergraduate student population is important in understanding the aspects that have a potential to cause adverse health effects. A health condition, whether general, gastrointestinal, dermatological or otherwise, will result in increased stress and decreased academic productivity. These conditions have the potential to further manifest into other health issues, such as respiratory conditions which is deemed the most common reason of missed academic commitments (Belongia, King, McLean, Meece, Peterson, 2016). This study shows that the aforementioned health conditions are prevalent in the UOIT undergraduate population and perhaps should be of focus in prevention strategies. Although this is true, there does not appear to be any significant differences in the health of students based on their housing accommodations.

This research highlights the importance of the social determinants of health, as components of the Population Health Framework, (physical environment, social environment, genetic endowment, individual response, health and function, disease, health care, well-being,

and prosperity) undoubtedly interplay with each other and affect both overall health, and specific health outcomes including gastrointestinal and dermatological symptoms.

Table 9: General Health Outcomes by Type of Housing Accommodation (n=213)

Variable	Classification	Home with Family (n=140), n (%)	On-Campus Residence (n=17), n (%)	Off-Campus Residence (n=56), n (%)	Total n (%)	p-value
General Health	Excellent/ Very Good/ Good Fair/Poor	127 (90.7) 13 (9.3)	12 (70.6) 5 (29.4)	51 (91.1) 5 (8.9)	190 (89.2) 23 (10.8)	.097
Health issues for anyone in the home	Yes	13 (9.2)	1 (5.8)	3 (5.3)	17 (7.9)	.024
Pre-existing health conditions	Yes	15 (10.7)	2 (11.7)	7 (12.5)	24 (11.3)	.974
Sick within 30 days	Yes	60 (42.8)	3 (17.6)	22 (39.2)	85 (39.9)	.133
Frequency of Health Affecting Academics	Never Seldom Occasionally Regularly	125 (89.2) 6 (4.2) 9 (6.4) 0 (0.0)	15 (88.2) 0 (0.0) 0 (0.0) 2 (11.7)	50 (89.2) 3 (5.3) 2 (3.5) 1 (1.7)	190 (89.2) 9 (4.2) 11 (5.1) 3 (1.4)	.008
Respiratory Illnesses	Yes	53 (37.8)	2 (11.7)	21 (37.5)	76 (35.7)	.225
Student ever had asthma	Yes	34 (24.2)	5 (29.4)	9 (16.0)	48 (22.5)	.359
Gastrointestinal Symptoms within 30 days	Yes	52 (37.1)	6 (35.2)	22 (39.2)	80 (37.6)	.942
Frequency of Nausea within 30 day	0-5 6+	133 (95.0) 7 (5.0)	17 (100.0) 0 (0.0)	55 (98.2) 1 (1.8)	205 (96.2) 8 (3.8)	.703
Frequency of Vomiting within 30 days	0-1 2-3	136 (97.1) 4 (2.8)	17 (100.0) 0 (0.0)	55 (98.2) 1 (1.7)	208 (97.6) 5 (2.3)	.725
Skin irritations within 30 days	Yes	56 (40.0)	8 (47.0)	26 (46.4)	90 (42.3)	.653

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table 10A: Best-Fit Model for General, Gastrointestinal, and Dermatological Health Outcomes

	Variable (Reference)	Classification	Fair or Poor Self-rated Health		Gastrointestinal Symptoms within 30 Days (Nausea and Vomiting)		Dermatological Symptoms within 30 Days (Skin Irritations)	
			OR	95% CI	OR	95% CI	OR	95% CI
Physical Environment	Perceived Air Quality in the Home within 30 Days (Excellent/ Very Good/ Good)	Fair/Poor			2.75	(.98, 7.71)		
Social Environment	Type of Housing Accommodation (On-campus Residence	Off-campus Housing Home with Family	19.77 26.56	(2.04, 191.80) (2.31, 306.02)				
	Monthly Rental Cost (N/A)	More than $1000/month Less than $1000/month	.099 2.70	(.016, .603) (.402, 18.05)	.99 8.56	(.47, 2.14) (2.26, 32.39)		
	Highest Level of Education Completed by Father (Did not attend school/ Elementary School)	Secondary school/Community College, College or University/ Post Graduate Education			2.89	(.92, 7.74)		
	Employed in Food/Accommodation Industry (Yes)	No			2.72	(.96, 7.74)		
Individual Response	Frequency of Dusting Common Surfaces (Weekly/Daily)	Monthly or Less Frequently			1.93	(.97, 3.84)		
	Frequency of Disinfecting Bathroom (Weekly/Daily)	Monthly or Less Frequently	14.71	(1.88, 114.96)				
	Frequency of Cleaning Bedroom (Monthly or Less Frequently)	Weekly/Daily					2.29	(1.20, 4.39)
	Frequency of Mopping and Vacuuming (Monthly or Less frequently)	Weekly/Daily	7.55	(1.67, 34.25)				
	Frequency of Handwashing (10+ times/day)	0-3 times/day 4-6 times/day 7-9 times/day			5.11 2.48 2.56	(1.68, 15.58) (.95, 6.47) (.94, 6.95)		
	Use of Air Conditioning (No)	Yes			2.33	(1.14, 4.74)		
	Use of Higher Quality Filters (No)	Yes	3.54	(.494, 25.40)				
Genetic Endowment	BMI		.812	(.72, .91)			1.08	(1.00, 1.15)
Health and Function	Sick in the Last 30 Days (No)	Yes			2.08	(1.05, 4.11)		
	Wheezing After Exercise in the Last 12 Months (No)	Yes	4.54	(.65, 31.60)				
	Difficulties Breathing (Yes)	No					2.17	(.87, 5.43)
	Dry Cough at Night in the Last 12 Months (Yes)	No	7.17	(1.89, 31.44)				
	Rating of Stress Level		.74	(.54, 1.01)				
	Dermatological Irritations in the Last 30 Days (No)	Yes			2.67	(1.37, 5.22)		
	Perceived Adverse Health From Cold/Flu (No)	Yes			8.37	(1.42, 49.53)		
	Gastrointestinal Symptoms (Yes)	No					2.62	(1.38, 4.98)
Specificity (%)/ Sensitivity (%)			40.0/97.5		88.7/56.3		49.3/79.0	
Hosmer and Lemeshow Test Chi-square p-value			8.28 .41		9.99 .27		3.04 .93	

Table 10B: Role of Housing by Best-Fit Model for General, Gastrointestinal, and Dermatological Health Outcomes

	Variable (Reference)	Classification	Fair or Poor Self-rated Health		Gastrointestinal Symptoms within 30 Days (Nausea and Vomiting)		Dermatological Symptoms within 30 Days (Skin Irritations)	
			OR	95% CI	OR	95% CI	OR	95% CI
Physical Environment	Perceived Air Quality in the Home within 30 Days (Excellent/ Very Good/ Good)	Fair/Poor			3.11	(1.05, 9.26)		
Social Environment	Type of Housing Accommodation (On-campus Residence	Off-campus Housing Home with Family	19.77 26.56	(2.04, 191.80) (2.31, 306.02)	1.93 1.87	(.48, 7.86) (.43, 8.03)	.72 1.01	(.19, 2.71) (.30, 3.44)
	Monthly Rental Cost (N/A)	More than $1000/month Less than $1000/month	.099 2.70	(.016, .603) (.402, 18.05)	8.44 1.04	(2.22, 32.14) (.31, 3.53)		
	Highest Level of Education Completed by Father (Did not attend school/ Elementary School)	Secondary school/Community College, College or University/ Post Graduate Education			3.06	(.96, 9.75)		
	Employed in Food/Accommodation Industry (Yes)	No			2.66	(.92, 7.67)		
Individual Response	Frequency of Dusting Common Surfaces (Weekly/Daily)	Monthly or Less Frequently			1.99	(.99, 3.99)		
	Frequency of Disinfecting Bathroom (Weekly/Daily)	Monthly or Less Frequently	14.71	(1.88, 114.96)				
	Frequency of Cleaning Bedroom (Monthly or Less Frequently)	Weekly/Daily					2.24	(1.17, 4.29)
	Frequency of Mopping and Vacuuming (Monthly or Less frequently)	Weekly/Daily	7.55	(1.67, 34.25)				
	Frequency of Handwashing (10+ times/day)	0-3 times/day 4-6 times/day 7-9 times/day			5.44 2.53 2.65	(1.76, 16.82) (.96, 6.66) (.97, 7.23)		
	Use of Air Conditioning (No)	Yes			2.41	(1.17, 4.95)		
	Use of Higher Quality Filters (No)	Yes	3.54	(.494, 25.40)				
Genetic Endowment	BMI		.812	(.72, .91)			1.08	(1.00, 1.16)
Health and Function	Sick in the Last 30 Days (No)	Yes			2.02	(1.02, 4.01)		
	Wheezing After Exercise in the Last 12 Months (No)	Yes	4.54	(.65, 31.60)				
	Difficulties Breathing (Yes)	No					2.18	(.87, 5.48)
	Dry Cough at Night in the Last 12 Months (Yes)	No	7.17	(1.89, 31.44)				
	Rating of Stress Level		.74	(.54, 1.01)				
	Dermatological Irritations in the Last 30 Days (No)	Yes			2.73	(1.39, 5.36)		
	Perceived Adverse Health From Cold/Flu (No)	Yes			8.23	(1.41, 49.09)		
	Gastrointestinal Symptoms (Yes)	No					2.62	(1.38, 4.98)
Specificity (%)/ Sensitivity (%)			40.0/97.5		88.7/55.0		48.0/80.0	
Hosmer and Lemeshow Test Chi-square p-value			8.28 .41		10.66 .22		6.87 .55	

Table 11: Prevalence of Microbiological Growth in Housing Accommodations (n=40)

Variable	Classification	Total n (%) (n=40)
Kitchen Preparation Surface	No growth	11 (27.5)
	Light	6 (15)
	Moderate	3 (7.5)
	Heavy	18 (45)
	Very Heavy	2 (5)
Bathroom Light switch	No growth	29 (72.5)
	Light	4 (10)
	Moderate	2 (5)
	Heavy	5 (12.5)
	Very Heavy	0 (0.0)

Table 12: Microbiological Growth in Housing Accommodations (n=40)

Level of Growth	Kitchen Food Preparation Surface	Bathroom Light Switch
Light	Acinetobacter baumannii Aeromonas salmonicida Enterobacter cloacae Klebsiella pneumoniae Leclercia adecarboxylata Pantoea agglomerans Pantoea spp Pseudomonas putida	Acinetobacter baumannii Acinetobacter radioresistens Aeromonas iwoffii Pseudomonas fluorescens
Moderate	Acinetobacter baumannii Acinetobacter junii Aeromonas iwoffii Enterobacter cloacae Escherichia coli Klebsiella pneumoniae Leclercia adecarboxylata Pantoea agglomerans Pantoea spp	Brevundimonas diminuta Pantoea agglomerans Pantoea spp Pseudomonas putida
Heavy	Aeromonas hydrophila Aeromonas iwoffii Aeromonas salmonicida Burkholderia cepacia Enterobacter amnigenus Enterobacter cloacae Klebsiella oxytoca Klebsiella pneumoniae Leclercia adecarboxylata Pantoea spp Pseudomonas aeruginosa Pseudomonas fluorescens Rahnella aquatilis Serratia marcescens Sphinogomonas paucimobilis	Pantoea spp
Very Heavy	Klebsiella oxytoca Serratia marcescens Stenotrophomonas maltophilia	

CHAPTER SIX: CONCLUSION

INTRODUCTION

This thesis examined the links between housing accommodations and health of 213 university undergraduate students at UOIT. Several issues shaped the focus of this research. First, the known impact of environmental exposures, specifically for students living in different types of housing accommodations is a concern for students, families, and public institutions. Second, mitigating potential health implications based on housing accommodations is also a concern. Examining these areas brings forth new knowledge and awareness to the University public and community.

Guided by the Population Health Framework, data was collected on demographics, physical environments, social environments, genetic endowment, individual responses, health and function, disease and health outcomes, health care, and well-being. In addition, lung function, microbiological specimens, and photographic data was collected. In doing so, the following objectives were addressed:

1) To assess the environmental and personal lifestyle exposures of UOIT undergraduate students, in relation to the three different types of housing accommodations.
2) To assess the general health of UOIT undergraduate students, with a focus on respiratory, gastrointestinal, and dermatological health.
3) To examine the environmental and personal lifestyle predictors of related health outcomes.

SUMMARY OF FINDINGS

Objective 1: Environmental and Personal Lifestyle Exposures

After collection of demographic information, participants were asked which type of housing accommodation they resided in. Results indicate 66% of participants live at home with their families, 8% of participants live in on-campus residence buildings, and 26% of participants live in off-campus housing. Participants were also asked about physical environmental exposures, in relation to the type of housing accommodation. Significant differences between home, on-campus residence and off-campus housing were observed for the age of housing, the number of individuals residing in the home, pets in the home, exposure to ETS, frequency of dusting common surfaces, frequency of disinfecting surfaces, frequency of mopping/vacuuming, frequency of disinfecting bathroom surfaces, filter cleaned within 12 months, air quality in the home in the last 30 days, and use of higher quality filters (Table 2B). In terms of personal lifestyle exposures, no significant differences were observed (Table 3).

Objective 2: Assessing General, Respiratory, Gastrointestinal, and Dermatological Health

The health questionnaire directly inquired about demographic information, physical environmental exposures, personal behaviours, and biological endowment. General, respiratory, gastrointestinal, and dermatological health outcomes were investigated based on each category. Results indicate 11% of participants experienced fair or poor self-rated health, 36% of participants experienced respiratory illness, 38% of participants experienced a gastrointestinal illness, and 42% of participants experienced skin irritations (Table 9). In addition, spirometry was conducted to assess lung function. FVC, FEV1, PEF, and FEV% measures showed no indication of restrictive or obstructive lung disease (Table 8). Testing revealed varying levels of bacterial growth in both kitchen preparation surfaces and bathroom light switches, which

correlates to adverse gastrointestinal symptoms. Microbiological testing did not reveal MRSA, but did reveal enterobacteriaceae in kitchen food preparation surfaces. (Table 11 & 12).

Objective 3: Examining Predictors of Each Health Outcome

In relation to respiratory health outcomes, symptoms of wheezing/whistling within the last 12 months, dry cough at night within the last 12 months, and difficulties breathing within the last 12 months were chosen for analysis. Within the physical environment, the age of housing accommodation, and air quality in the home within the last 30 days were identified as significant predictors of respiratory health outcomes. Similarly, within the social environment, the type of housing accommodation, whether the property was owned or rented, and employment income were significant predictors. Within the individual response category, the frequency of cleaning the bedroom, and the frequency of disinfecting common surfaces were significant predictors. Asthma, and BMI were significant genetic endowment predictors. General physical check-ups within the last 2 years identified as significant predictors for the respiratory health outcomes. Lastly, relative to health and function, difficulties breathing within the last 30 days, health affected by academic commitments, perceptions of general health, wheezing after exercise within 12 months, and wheezing/whistling within 12 months were identified as significant predictors of respiratory health outcomes (Table 7B).

In relation to general, gastrointestinal, and dermatological health, fair or poor self-rated health, nausea and vomiting, and skin irritations were the dependent variables chosen for analysis. In the physical environment category, perceived air quality in the home in the last 30 days was identified as a significant predictor for gastrointestinal health. For the social environment, the type of housing accommodation identified as a significant predictor for all health outcomes; monthly rental cost was a significant predictor of fair or poor self-rated health

and gastrointestinal health; and highest level of education completed by father and employed in the food/accommodation industry identified as significant predictors of gastrointestinal health. Within the individual response category, frequency of dusting common surfaces and frequency of disinfecting bathroom presented as significant predictors of gastrointestinal health, frequency of cleaning bedroom was a significant predictor or dermatological irritations, frequency of mopping and vacuuming and use of higher quality filters identified as a significant predictor of fair or poor self-rated health, frequency of handwashing and use of air conditioning was a significant predictor of gastrointestinal health. Regarding genetic endowment, BMI was the only significant predictor for both fair or poor self-rated health and dermatological symptoms. Lastly, in the health and function category, being sick in the last 30 days, perceived adverse health from cold and flu, and dermatological irritations were a significant predictor of gastrointestinal symptoms, wheezing after exercise in the last 12 months, dry cough at night in the last 12 months, and rating of stress level, were a significant predictor of fair or poor self-rated health, and difficulties breathing was a significant predictor of dermatological irritations. (Table 10B).

CONTRIBUTIONS OF THE RESEARCH

This research directly assessed the impact of the most common housing accommodations on the health of undergraduate students at a new and smaller Canadian University (UOIT)

An important methodological contribution is the application of the PHF that guides the exploration of the health implications of housing on health of UOIT students. The framework allows for the organization and consideration of the multidimensional nature of health determinants for this particular population. The framework proved to be an effective tool to investigate respiratory health outcomes (Chapter Four) and general, gastrointestinal, and dermatological health outcomes (Chapter Five). The development of the health questionnaire

itself is an important methodological contribution. This tool collects information on a wide range of variables by applying the conceptual model and validated questionnaires. Furthermore, the research exemplifies the usefulness of an electronic self-administered questionnaire to collect data. The electronic nature proved to be an effective method of data collection as it allowed for completion at a time that was most convenient for each participant. This alleviated issues that may arise from a student's class schedule prohibiting participation in the research.

Another methodological contribution was the use of spirometry, microbiology, and photographic data in addition to the questionnaire. The strength of this design provides objective evidence, and allows for a comprehensive understanding of health.

In terms of substantive contributions, there is a lack of previous literature on the health of Canadian undergraduate students based on housing accommodations. This information is unique and has the potential to promote new areas of study. The presence of respiratory symptoms, fair or poor self-rated health, gastrointestinal and dermatological symptoms suggests that although the population appears to be healthy overall, there are specific health outcomes that are prevalent. This information is particularly useful for the public health discipline. The health of students may have unique risks that may need specific attention.

RESEARCH LIMITATIONS

Despite the contributions of the research, this study was subject to limitations. When calculating sample size, the research aimed to recruit 400 participants. However, 213 students were recruited for the study. When categorizing the types of housing accommodations, 140 participants indicated living at home with family, 17 participants lived in an on campus residence, and 56 participants lived in an off campus residence. Smaller sample sizes in this research has reduced the statistical power, observed differences, and confidence intervals. In

turn, this did not allow for an appropriate assessment, and confidence intervals were large. Combining types of housing accommodations was not completed as each type of housing has very different characteristics. It may be beneficial to adopt further sampling and recruitment techniques to increase the total sample size.

Another limitation is the use of self-reported data from the health questionnaire. Participants may report what they believe the researcher wants or anticipates to observe, or may report what reflects positively on their own abilities, knowledge, beliefs, or opinions (Yu, 2016). It is also possible recall bias is present, which may have affected the reliability of self-reported data.

In terms of analysis, multicollinearity and the variance inflation factor was not accounted for.

Additionally, a cross-sectional study design provides data on a single point in time, which may differ if collected at another point in time (Mann, 2003). For example, data may be different depending on the season in which it was collected (flu season). Also, participants could have resided in numerous housing accommodations during the past 12 months, which is the framework for several items in the questionnaire. In the case that a participant recently moved, data would have been collected on the most recent housing accommodation which may not have has as much of an impact on health compared to a previous housing accommodation. Cross-sectional studies cannot be used to analyze health outcomes over a period of time, and does not help determine causal inference.

Pertaining to the microbiology portion of this research, although instructions were provided, it cannot be confirmed that all specimens were collected and stored correctly for analysis. It is possible that specimens were collected from the wrong surface and swabs may

have been switched which would compromise the results. Specifically, specimens that were collected numerous days before lab analysis, or specimens that were not stored at four degrees Celsius (perhaps during delivery), could present a false reading of increased growth. Microbiology was conducted on a sub-sample of the population. The sample size was much smaller, and there were not many specimens collected from each type of housing accommodation for comparative analysis. Lastly, the use of microbiology collection, specifically MRSA growth as a proxy for housekeeping behaviours may not be associated with viral symptoms reported from participants.

Overall, findings of this research are significant in stimulating further studies that concentrate on the links between environmental exposures, housing, and health. Guided by the PHF conceptual model, this research strengthens knowledge on the health outcomes experienced by this population.

FUTURE RESEARCH DIRECTIONS

Although this research enriches the understanding of the relationship between housing accommodations and health of university undergraduate students at UOIT, there is much remaining to be studied. As indicated in the research, a number of students are experiencing fair or poor general health, respiratory, gastrointestinal, and dermatological health symptoms. According to this research, the overall type of housing accommodations (at home with family, on-campus residence or off-campus housing) do not appear to have a significant impact on university undergraduates. It may be useful to further study health outcomes individually, to explore other reasons for experiencing these symptoms. The health questionnaire developed for the research is appropriate, however it may be useful to add items related to factors impacting mental health, the number of years the student resided in the housing accommodation, the

number of hours per day the student spent in their housing accommodation, noise levels and sleep, temperature, transportation networks, and bed bugs, and rework the content to be more specific to the health outcome in question.

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APPENDIX A- HEALTH QUESTIONNAIRE

Please enter your unique study ID code:*

Demographics:

Please enter your age:*

What is your current year of study?*

☐ 1

☐ 2

☐ 3

☐ 4

☐ Other:

Physical Exposures:

Which best describes your current housing accommodation?*

☐ Home with Family

☐ On-Campus Residence

☐ Off-Campus Housing

☐ Other (please specify)

☐ I do not know/I do not wish to answer

D**o you or your parents/guardians own or rent the property you currently reside in?***

☐ Own

☐ Rent

☐ I do not know/I do not wish to answer

If you rent your housing accommodation, how much is the monthly rental cost?*

☐ Less than $350/month

☐ $350-$500/month

☐ $501-$1000/month

☐ More than $1000/month

☐ I do not know/I do not wish to answer

How old is your housing accommodation?*

☐ 1-5 years

☐ 6-10 years

☐ 11-15 years

☐ 16+ years

☐ I do not know/I do not wish to answer

How many people live in your home/student housing?*

☐ 1-2

☐ 3-4

☐ 5+

☐ I do not know/I do not wish to answer

Do you have any pets that live with you?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

Are you exposed to second hand smoke in your home?*

☐ Never

☐ Sometimes

☐ Always

☐ I do not know/I do not wish to answer

How often do you dust the common surfaces in your home with <u>dry</u> cleaning supplies? For example: with a feather duster.*

☐ Never

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

How often do you disinfect and sanitize the common surfaces in your home with <u>wet</u> cleaning supplies? For example: with Lysol disinfectant wipes.*

☐ Never

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

How often do you mop* or vacuum* your home? (Mop is defined as with or without cleaning solution. *Vacuum is defined as with the use of a vacuum cleaner appliance)*

☐ Never

☐ Once every 4+ months

☐ Once every 2-3 months

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

How often do you disinfect your <u>kitchen</u> preparation surfaces? (Countertops, food preparation equipment). Disinfect is defined as the use of a cleaner that has the capability of destroying bacteria.*

☐ Never

☐ Once every 4+ months

☐ Once every 2-3 months

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

How often do you disinfect your <u>bathroom</u> surfaces? (Countertops, doorknobs, toilet)*

☐ Never

☐ Once every 4+ months

☐ Once every 2-3 months

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

How often do you clean your bedroom? (For example: dusting, mopping, disinfecting surfaces)*

☐ Never

☐ Once every 4+ months

☐ Once every 2-3 months

☐ Monthly

☐ Weekly

☐ Daily

☐ I do not know/I do not wish to answer

Is there currently any visible mould or mildew in your home? Refer to photo below for visual representation*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

In the past 12 months, how often has the filter in your furnace been changed or cleaned?*

☐ Once every three months or more frequently

☐ Once every six months

☐ Once in the past year

☐ Did not change or clean filter in the past year

☐ I live in a housing accommodation where I am not responsible for this (residence, student housing)

☐ I do not know/I do not wish to answer

In the past 30 days, how would you rate the quality of the air inside your housing accommodation:*

☐ Excellent

☐ Very good

☐ Good

☐ Fair

☐ Poor

☐ I do not know/ I do not wish to answer

In the past 30 days, did you or anyone in your housing accommodation have health problems that may have been caused by the quality of the air in your home?*

☐ Yes

☐ No

I do not know/I do not wish to answer

What measures do you/does your household take to improve the quality of the air in your home? Check all that apply.*

☐ Open windows more often to increase air circulation

☐ Turn on a floor or ceiling fan to increase air circulation

☐ Use air conditioner more frequently

☐ Use a dehumidifier

☐ Use a humidifier

☐ Use an air cleaning system (excluding ionizing systems)

☐ Use higher quality filters in the furnace

☐ Use the furnace fan or a heat recovery ventilation (HRV) system to increase air circulation

☐ Use air fresheners (potpourri, solid or spray air fresheners, essential oil dispensers or incense) to improve air quality

☐ Other-specify

☐ None of the above

☐ I do not know/I do not wish to answer

On a scale from one to five, one being never and five being a lot, has mould affected a household members health, including your own?

Personal Behaviours:

Please indicate your level of physical activity.*
The Canadian Society for Exercise Physiology recommends adults aged 18-64 should accumulate at least 150 minutes of moderate to vigorous intensity aerobic physical activity per week.

☐ I do not engage in physical activity

☐ I engage in light physical activity (by "light" physical activity, you are able to carry a conversation while exercising)

☐ I engage in moderate physical activity (by "moderate" physical activity, you are able to talk but unable to sing the words to a song while exercising)

☐ I engage in vigorous physical activity (by "vigorous" physical activity, you are unable to say more than a few words while exercising)

☐ I do not know/I do not wish to answer

Do you perform either moderate or vigorous physical activity in bouts of 10 minutes?*

☐ Never

☐ Sometimes

☐ Always

What is the total length of your physical activities?*

☐ Less than 150 minutes per week

☐ 150+ minutes per week

How often do you wash your hands with soap?*

☐ 0-3 times per day

☐ 4-6 times per day

☐ 7-9 times per day

☐ 10+ times per day

☐ I do not know/I do not wish to answer

Do you use alcohol based hand sanitizers?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

How often do you take vitamins and/or supplements?*

☐ Never

☐ Rarely

☐ Few times per week

☐ Daily

☐ I do not know/I do not wish to answer

How often do you consume alcohol?*

☐ I do not consumer alcohol

☐ Once a year or less

☐ More than once a year but less than once a month

☐ At least once a month but less than once a week

☐ At least once a week but not every day

☐ Every day

How many drinks on average do you usually drink at any one time?*

☐ 6+ drinks

☐ 5 or 6 drinks

☐ 3 or 4 drinks

☐ 1 or 2 drinks

☐ Less than 1 drink

How would you rate your level of stress (0 being not stressed at all and 10 being extremely stressed)?*

How many hours of sleep do you get per night?*

☐ 0-2

☐ 3-5

☐ 6-8

☐ 8+

☐ I do not know/I do not wish to answer

In the last 30 days, have you had difficulty staying asleep?*

☐ Not at all

☐ No more than usual

☐ Rather more than usual

☐ Much more than usual

☐ I do not know/I do not wish to answer

D**o you smoke tobacco products?***

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

In the past 30 days, how often have you smoked? Please indicate number of days.*

Do you smoke shisha, midwakh, or any other non-tobacco products?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

In the past 30 days, how often have you smoked? Please indicate number of days.*

Do you smoke e-cigarettes?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

What is your main source of income? Check all that apply.*

☐ Ontario Student Assistant Program (OSAP)

☐ Employment

☐ Scholarships/Bursaries

☐ Assistance from family members

☐ Other:

☐ I do not know/I do not wish to answer

What is your combined family's annual income?*

☐ Less than $20,000

☐ $20,000-$40,000

☐ $40,000-$60,000

☐ $60,000-$80,000

☐ $80,000-$100,000

☐ More than $100,000

☐ I do not know/I do not wish to answer

What is the highest level of completed education of your mother?*

☐ Did not attend school

☐ Elementary school

☐ Secondary school

☐ Community college, technical school, apprenticeship

☐ College or university

☐ Post graduate education

☐ I do not know/I do not wish to answer

What is the highest level of completed education of your father?*

☐ Did not attend school

☐ Elementary school

☐ Secondary school

☐ Community college, technical school, apprenticeship

☐ College or university

☐ Post graduate education

☐ I do not know/I do not wish to answer

Are you currently employed?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

If yes, how many hours a week do you work?*

☐ 0-10

☐ 11-20

☐ 21-30

☐ 31-40

☐ I do not know/I do not wish to answer

Which category best describes your type of employment? Check all that apply.*

☐ Agriculture

☐ Business/Office Setting

☐ Contractor/Trades

☐ Educational Services

☐ Food Industry and Accommodation

☐ Health Care

☐ Retail

☐ Other:

Do you have health care coverage through the Ontario Health Insurance Plan?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

How often do you use the health care system to see family physicians, specialists, hospitals, clinics etc?*

☐ Never

☐ Seldom

☐ Occasionally

☐ Regularly

☐ I do not know/I do not wish to answer

Have you had a general physical check up in the past 2 years?*

☐ Yes

☐ No

When was the approximate date of your last general physical check up?*

☐ Within the last 4+ months

☐ Within the last 2-3 months

☐ Within the last month

☐ Within the last week

Have you ever used the internet to self-diagnose any health conditions you have instead of seeing a health professional?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

Biological Endowment:

In general, would you say your health is:*

☐ Excellent

☐ Very Good

☐ Good

☐ Fair

☐ Poor

Do you have any pre-exisiting health conditions that affect your personal and/or academic commitments?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

If yes, how often does your health affect your school commitments?*

☐ Never

☐ Seldom

☐ Occasionally

☐ Regularly

☐ I do not know/I do not wish to answer

In the last 30 days, have you been sick?*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

Was your illness respiratory related? (Ex: Cough, flu, cold, sore throat, runny nose)*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

Have you ever had wheezing or whistling in the chest at any time in the past?*

☐ Yes

☐ No

Have you ever had wheezing or whistling in the chest in the last 12 months?*

☐ Yes

☐ No

How many attacks of wheezing have you had in the last 12 months?*

☐ None

☐ 1 to 3

☐ 4 to 12

☐ More than 12

In the last 12 months, how often on average has your sleep been disturbed due to wheezing?*

☐ Never woken with wheezing

☐ Less than one night per week

☐ One or more nights per week

☐ More than 12

In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words between breaths?*

☐ Yes

☐ No

Have you ever had asthma?*

☐ Yes

☐ No

In the last 12 months, has your chest sounded wheezy during or after exercise?*

☐ Yes

☐ No

In the last 12 months, has you ever had a dry cough at night, apart from a cough associated with a chest infection?*

☐ Yes

☐ No

In the last 30 days, have you had any difficulty breathing?

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

In the last 30 days, have you experienced any gastrointestinal symptoms? (For example: diarrhea, constipation, gastrointestinal bleeding)*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

How many times in the last 30 days have you suffered from nausea (felt like vomiting but did not actually vomit)?*

How many times in the last 30 days did you suffer from vomiting?*

In the last 30 days, have you experienced any skin irritations? (Ex: Itchiness, rash)*

☐ Yes

☐ No

☐ I do not know/I do not wish to answer

Do you know the main cause of your health, respiratory, gastrointestinal or skin problem?*

☐ Yes

☐ No

What are the causes behind your health, respiratory, gastrointestinal, or skin problems? Check all that apply.*

☐ Pre-existing health condition (For example: asthma, Crohn's disease, psoriasis)

☐ Smoking

☐ Cold/flu seasons

☐ Travel

☐ Stress

☐ Pregnancy

☐ Contaminated food and/or water

☐ Diet choices

☐ Level of exercise

☐ Other:

Thank you for your participation in the study!

APPENDIX B- STATEMENT OF CONSENT TO PARTICIPATE IN HEALTH SCIENCES RESEARCH STUDY

You are being asked to participate in a research study entitled: "Exploring the health of university undergraduate students in relation to housing accommodations" carried out by Shantel Mangroo, a Master of Health Sciences Candidate from the University of Ontario Institute of Technology and supervised by Dr. Caroline Barakat-Haddad, Assistant Professor in the Faculty of Health Sciences, University of Ontario Institute of Technology. Please take your time to review the consent form and ask for clarification on any areas you do not clearly understand.

Purpose of the Study
This research is being conducted to examine the relationship between environmental exposures and general health, with a specific focus on respiratory health of university undergraduate students living in various housing situations. The information collected from the study will increase our knowledge of the exposures experienced by university undergraduate students, and make informed conclusions about how these exposures impact their health.

Study Procedures
Participants selected for this study must be enrolled at the University of Ontario Institute of Technology as an undergraduate student and, be at least 17 years of age.

If you choose to participate in this study, you will have previously booked an appointment to come to the school with instructions for the day of the test. Upon arrival, you will complete a self-administered online questionnaire that will ask you questions related to your exposures and general health. You will also complete spirometry testing in order to assess your lung function where you will be coached in forced exhalation with the use of a spirometer. Lastly, students will be asked to provide photographs of their kitchen and bathroom areas, in order to provide a more comprehensive representation of the cleanliness of the home.

A portion of the students that have agreed to participate will be asked to participate in a related component of this research that focuses on microbiological testing. If you are selected to participate in this component of the research, you will be instructed on how to use a specimen collection kit to swab the kitchen preparation and bathroom doorknob in your home. There is no obligation to complete this component.

Benefits
If you choose to participate in this study, you will receive a free assessment on your lung function. If you are concerned about any of the results of your lung function test, you are encouraged to speak to your physician. You will also be directed to information and resources that focus on the health effects of personal behaviours and residential exposures, and that provide instructions on how to reduce these exposures.

Risks and Discomforts
It is not anticipated that you will experience any risks if you choose to participate in this research study. During the spirometry testing portion of the study, you will be coached in forced exhalation. You may be asked to perform the test up to a maximum of 8 times as suggested by

the American Thoracic Society/European Respiratory Society. If at any time you feel distressed and do not wish to continue, you may stop with the testing. If the tester observes any distress and believes that you should not continue, or observes a declining trend in readings, testing will not continue. Participants that are asked to collect a microbiological sample may be exposed to certain contamination, however this would be a level of bacteria that you have been regularly exposed to in the home previously.

Costs
All procedures to be performed as part of this study, are provided at no cost to you. You will not receive any payment for taking part in this study.

Confidentiality
The information collected for this study may be published or presented to the public, however your name or other identifying information will not be used or revealed. Any information submitted through the questionnaire portion of the study will be managed on a secure network and data collected through the spirometry portion of the study will be stored in a locked area.

Voluntary Participation and Withdrawal from the Study
Your participation in this research study is voluntary. You may refuse to participate or withdraw from the study at any time.

Statement of Consent
By signing this form, I agree that:

- The study has been explained to me and all questions were answered to my satisfaction.
- The possible discomforts of the study have been explained to me.
- I understand my information will be kept confidential.
- I understand that I have the right to voluntarily withdraw from the study at any time, with no consequence to me.

_____ _____

Participant Signature Date

_____

Participant Printed Name

APPENDIX C- SPIROMETRY REPORT FORM

Age:	**Appointment Date:**
Gender:	**Appointment Time:**
Height:	**Room Temperature:**
Weight:	**Humidity:**
Race:	

Adherence to Instructions:

☐ Did not smoke within the last hour
☐ Did not consume alcohol within the last 4 hours
☐ Did not perform vigorous exercise within the last 30 minutes
☐ Wearing clothing that does not substantially restrict full chest and abdominal expansion
☐ Did not eat a large meal within the last 2 hours

Smoking History:

☐ Current Smoker ☐ Former Smoker ☐ Never Smoked

Relative Contraindications:

☐ Recent Surgery (within 4 weeks)
☐ Pregnant (near term)
☐ Uncontrolled Hypertension
☐ Unstable Cardiac Status
☐ Cross Infection Concerns
☐ Aneurysm (cerebral, thoracic, abdominal)
☐ Hemoptysis
☐ Pneumothorax
☐ Myocardial Infarction
☐ Other _____

Medical History & Medications:

Pre-existing Health Conditions _____

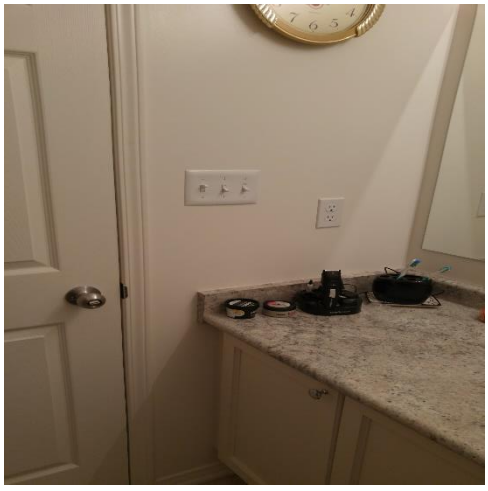
Respiratory Medications _____

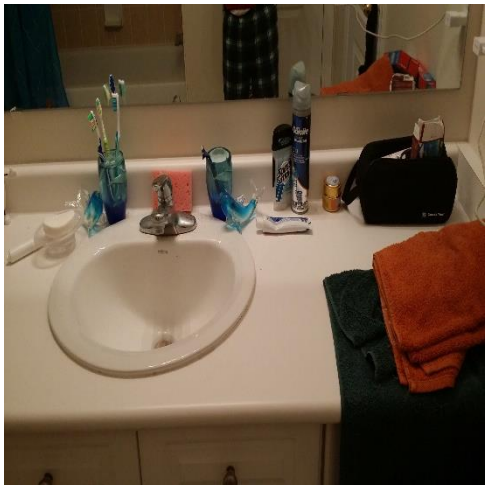
Inhaler used ☐ Yes ☐No

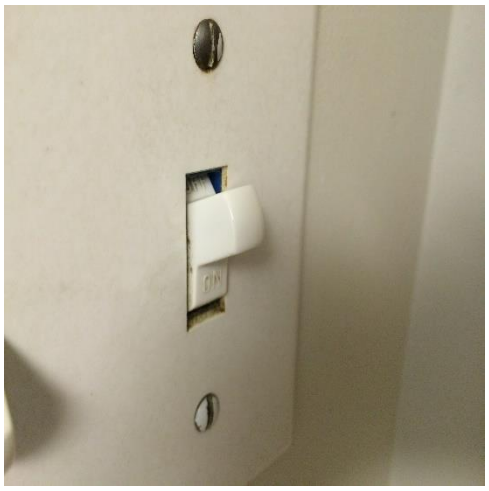
Spirometry Readings:

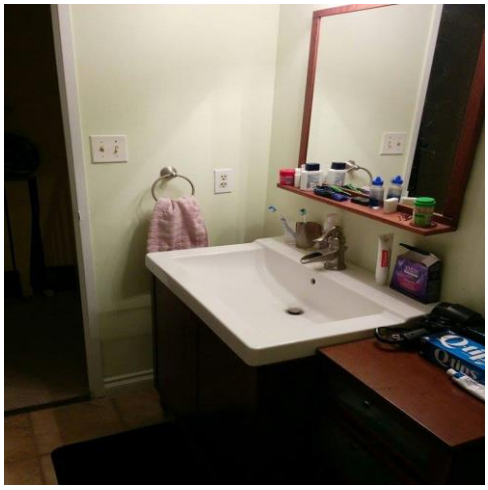
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**Trial 6**	**Trial 7**	**Trial 8**
FVC								
FEV1								
PEF								
FEV1 %								

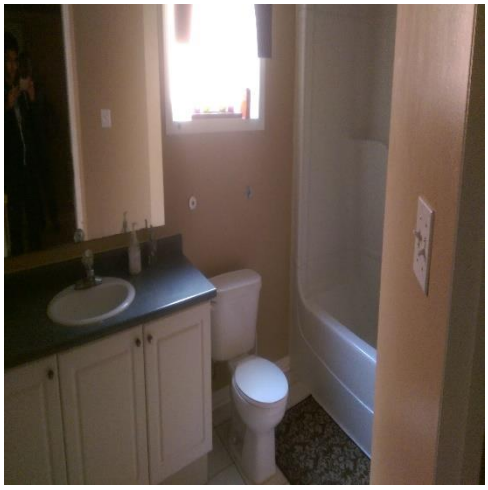
APPENDIX D- PHOTOGRAPHIC DATA

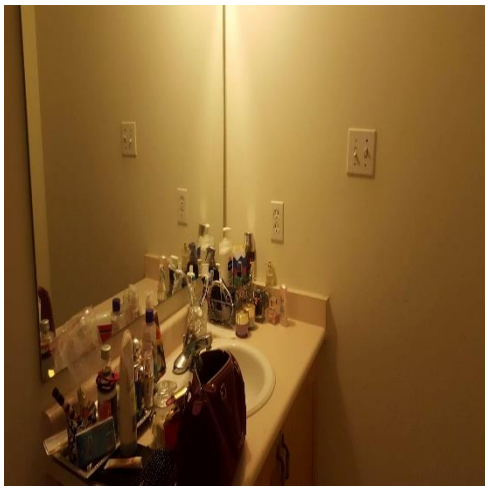


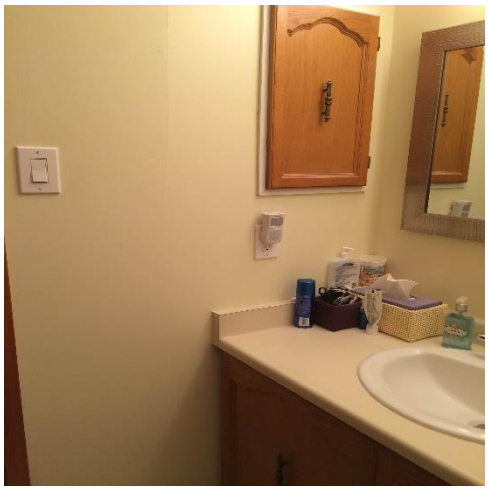


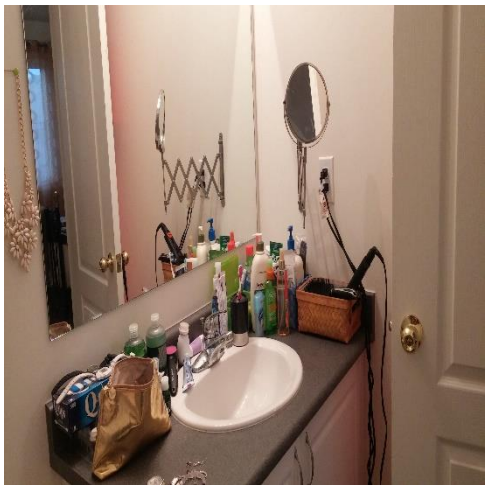


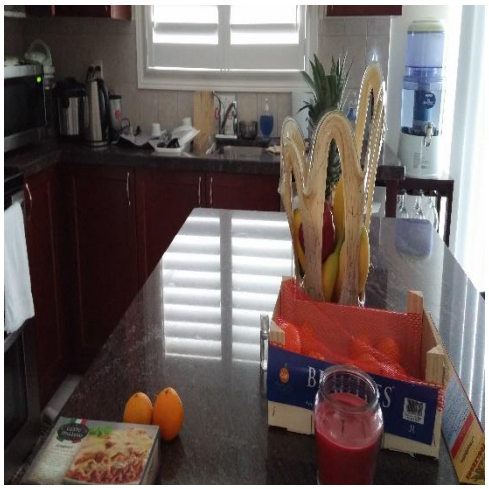






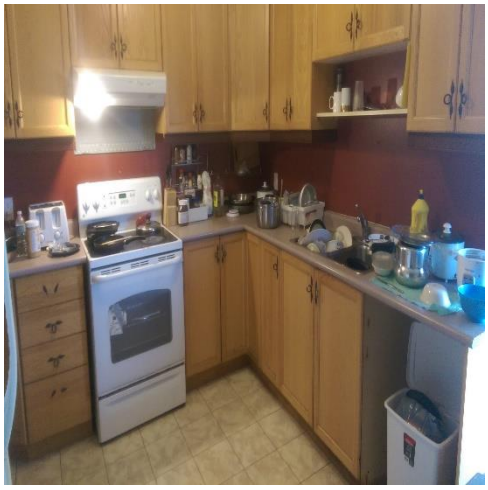


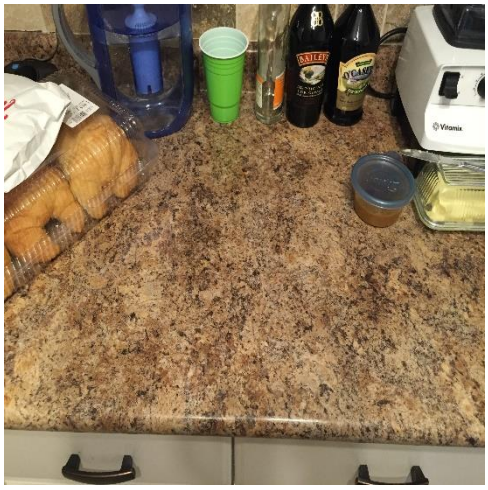




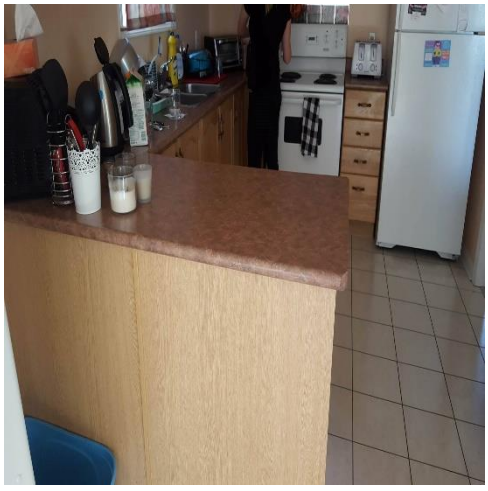

Danby

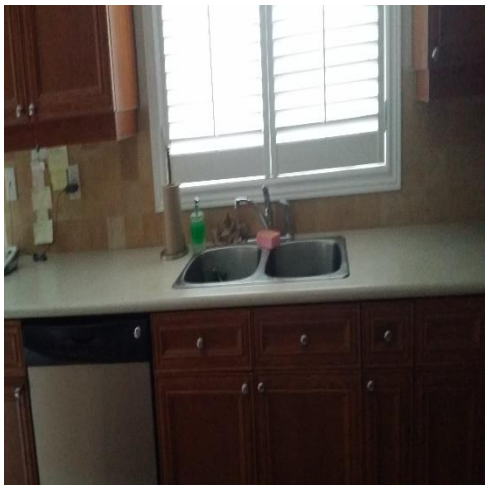

Friends

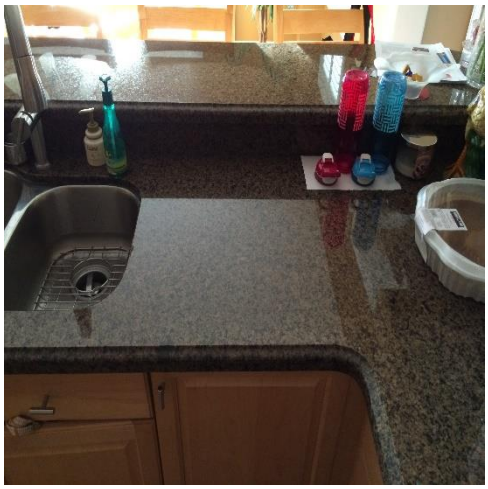


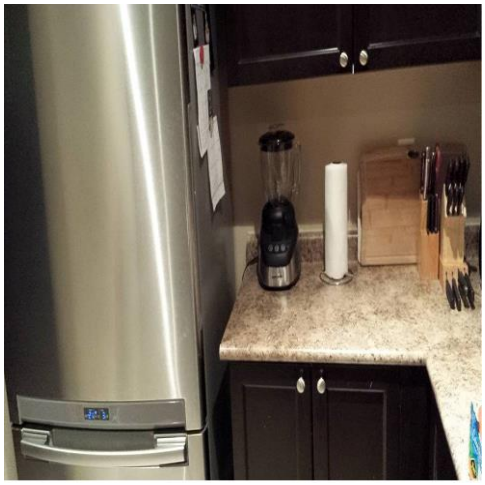



Cuisinart









APPENDIX E- LETTER OF INVITATION

You are being invited to participate in a Health Sciences research study entitled: "Exploring the health of university undergraduate students in relation to housing accommodations".

We are looking for participants to complete a self-administered online questionnaire, a lung function assessment coached by a graduate student in the Faculty of Health Sciences, and you MAY be asked to participate in a related component of this research that involves swabbing areas in your home.

If you choose to participate, you will be provided with information on the health effects of personal behaviours and residential exposures, as well as instructions on how to reduce those exposures.

For more information and to sign-up to participate in this research, please e-mail shantel.mangroo@uoit.ca.

Thank you for your time.

Ethics #15-020

APPENDIX F- EXPANDED ANALYSIS TABLES

Table 2A: Physical Environmental Exposures by Housing Accommodation (n=213)

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)	1-5	18 (12.8)	2 (11.8)	21 (37.5)	41 (19.2)	.000
	6-10	21 (15.0)	4 (23.5)	9 (16.1)	34 (15.9)	
	11-15	22 (15.7)	1 (5.9)	5 (8.9)	28 (13.1)	
	16+	70 (50.0)	1 (5.9)	6 (10.7)	77 (36.1)	
	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	1-2	6 (4.2)	9 (52.9)	11 (19.6)	26 (12.2)	.000
	3-4	80 (6.4)	4 (23.5)	18 (32.1)	102 (47.9)	
	5+	54 (7.8)	4 (23.5)	27 (48.2)	85 (39.9)	
Pets in the Home	Yes	65 (46.4)	5 (29.4)	14 (25.0)	84 (39.4)	.014
Exposure to ETS in the Home	Never	116 (82.8)	11 (64.7)	35 (62.5)	162 (76.1)	.009
	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)	.510
Frequency of dusting common surfaces	Never	9 (6.4)	5 (29.4)	6 (10.7)	20 (9.4)	.041
	Once every 4+ months	12 (8.5)	4 (23.5)	2 (3.6)	18 (8.5)	
	Once every 2-3 months	16 (11.4)	1 (5.9)	6 (10.7)	23 (10.8)	
	Monthly	43 (30.7)	2 (11.8)	15 (26.8)	60 (28.2)	
	Weekly	52 (37.1)	5 (29.4)	24 (42.9)	81 (38.0)	
	Daily	8 (5.7)	0 (0.0)	3 (5.4)	11 (5.2)	
Frequency of disinfecting surfaces	Never	4 (2.8)	3 (17.6)	0 (0.0)	7 (3.3)	.000
	Once every 4+ months	9 (6.4)	1 (5.9)	0 (0.0)	10 (4.7)	
	Once every 2-3 months	11 (7.8)	4 (23.5)	1 (1.8)	16 (7.5)	
	Monthly	31 (22.1)	3 (17.6)	23 (41.1)	57 (26.8)	
	Weekly	66 (47.1)	6 (35.3)	29 (51.8)	101 (47.4)	
	Daily	19 (13.5)	0 (0.0)	3 (5.4)	22 (10.3)	
Frequency of mopping/vacuuming	Never	0 (0.0)	2 (11.8)	0 (0.0)	2 (0.9)	.000
	Once every 4+ months	3 (2.1)	0 (0.0)	1 (1.8)	4 (1.9)	
	Once every 2-3 months	2 (1.4)	1 (5.9)	5 (8.9)	8 (3.8)	
	Monthly	26 (18.5)	8 (47.1)	21 (37.5)	55 (25.8)	
	Weekly	91 (65.0)	6 (35.3)	27 (48.2)	124 (58.2)	
	Daily	18 (12.8)	0 (0.0)	2 (3.6)	20 (9.4)	
Frequency of disinfecting kitchen surfaces	Never	1 (0.7)	3 (17.6)	1 (1.8)	5 (2.3)	.000
	Once every 4+ months	9 (6.4)	2 (11.8)	1 (1.8)	12 (5.6)	

	Once every 2-3 months Monthly Weekly Daily	4 (2.8) 9 (6.4) 44 (31.4) 73 (52.1)	0 (0.0) 4 (23.5) 5 (29.4) 3 (17.6)	4 (7.1) 11 (19.6) 29 (51.8) 10 (17.9)	8 (3.8) 24 (11.3) 78 (36.6) 86 (40.4)	
Frequency of disinfecting bathroom surfaces	Never Once every 4+ months Once every 2-3 months Monthly Weekly Daily	1 (0.7) 4 (2.8) 5 (3.5) 23 (16.4) 93 (66.4) 14 (10.0)	2 (11.8) 3 (17.6) 1 (5.9) 4 (23.5) 7 (41.2) 0 (0.0)	0 (0.0) 2 (3.6) 3 (5.4) 20 (35.7) 28 (50.0) 3 (5.4)	3 (1.4) 9 (4.2) 9 (4.2) 47 (22.1) 128 (60.1) 17 (7.9)	.000
Frequency of cleaning bedroom	Never Once every 4+ months Once every 2-3 months Monthly Weekly Daily	0 (0.0) 11 (7.8) 14 (10.0) 41 (29.2) 66 (47.1) 8 (5.7)	1 (5.9) 3 (17.6) 1 (5.9) 3 (17.6) 9 (52.9) 0 (.)	1 (1.8) 0 (0.0) 3 (5.4) 23 (41.1) 27 (48.2) 2 (3.6)	2 (0.9) 14 (6.6) 18 (8.5) 67 (31.4) 102 (47.9) 10 (4.7)	.043
Filter cleaned within 12 months	Once every 3 months/more frequently Once every 6 months Once in the past year Did not change in the last year I am not responsible for this I do not know/ I do not wish to answer	24 (17.1) 23 (16.4) 25 (17.9) 6 (4.3) 6 (4.3) 56 (40.0)	0 (0.0) 2 (11.8) 2 (11.8) 0 (0.0) 7 (41.2) 6 (35.3)	3 (5.4) 4 (7.1) 3 (5.4) 1 (1.8) 29 (51.8) 16 (28.6)	27 (12.7) 29 (13.6) 30 (14.1) 7 (3.3) 42 (19.7) 78 (36.6)	.000
Air quality in home within 30 days	Excellent Very good Good Fair Poor	24 (17.1) 60 (42.9) 46 (32.9) 7 (5.0) 3 (2.1)	5 (29.4) 5 29.4) 2 (11.8) 3 (17.6) 2 (11.8)	9 (16.1) 19 (33.9) 20 (35.7) 4 (7.1) 4 (7.1)	38 (17.8) 84 (39.4) 68 (31.9) 14 (6.6) 9 (4.2)	.089
Opening windows	Yes	119 (85.0)	12 (70.6)	42 (75.0)	173 (81.2)	.136
Use of ceiling/floor fan	Yes	60 (42.9)	9 (52.9)	27 (48.2)	96 (45.1)	.629
Use of air conditioner	Yes	46 (32.9)	8 (47.1)	15 (26.8)	69 (32.4)	.288
Use of dehumidifier	Yes	28 (20.0)	1 (5.9)	8 (14.3)	37 (17.4)	.271
Use of humidifier	Yes	39 (27.9)	3 (17.6)	9 (16.1)	51 (23.9)	.178
Use of air cleaning system	Yes	8 (5.7)	2 (11.8)	4 (7.1)	14 (6.6)	.624
Use of higher quality filters	Yes	37 (26.4)	0 (0.0)	5 (8.9)	42 (19.7)	.002
Use of furnace fan	Yes	25 (17.9)	2 (11.8)	13 (23.2)	40 (18.8)	.510
Use of air fresheners	Yes	86 (61.4)	7 (41.2)	36 (64.3)	129 (60.6)	.218

Table 3A: Individual Response and Personal Behaviours by Housing Accommodation

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	5 (3.6)	1 (5.9)	3 (5.4)	9 (4.2)	.464
	I engage in light PA	56 (40.0)	7 (41.2)	13 (23.2)	76 (35.7)	
	I engage in moderate PA	43 (30.7)	5 (29.4)	20 (35.7)	68 (31.9)	
	I engage in vigorous PA	36 (25.7)	4 (23.5)	20 (35.7)	60 (28.2)	
Total length of PA/week	Less than 150 mins per week	75 (53.6)	7 (41.2)	18 (32.1)	100(46.9)	.074
	150+ per week	60 (42.9)	9 (52.9)	33 (58.9)	102(47.9)	
	N/A	5 (3.6)	1 (5.9)	5 (8.9)	11 (5.2)	
Moderate/Vigorous PA in bouts of 10 mins	Never	5 (3.6)	1 (5.9)	5 (8.9)	11 (5.2)	.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)	.363
	4-6	46 (32.9)	7 (41.2)	21 (37.5)	74 (34.7)	
	7-9	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)	.076
Frequency of vitamin/supplement consumption	Never	21 (15.0)	3 (17.6)	13 (23.2)	37 (17.4)	.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	28 (20.0)	4 (23.5)	8 (14.3)	40 (18.8)	.429
	Once a year or less	10 (7.1)	1 (5.9)	3 (5.4)	14 (6.6)	
	>once a year but <once a month	42 (30.0)	4 (23.5)	15 (26.8)	61 (28.6)	
	Once a month but <once a week	42 (30.0)	3 (17.6)	15 (26.8)	60 (28.1)	
	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	12 (8.6)	1 (5.9)	2 (3.6)	15 (7.0)	.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)	
	N/A	28 (20.0)	4 (23.5)	8 (14.3)	40 (18.8)	
Stress level (scale from 0-10)	0	0 (0.0)	1 (5.9)	1 (1.8)	2 (0.9)	.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	0 (0.0)	0 (0.0)	1 (1.8)	1 (0.5)	.095
	3-5	22 (15.7)	1 (5.9)	4 (7.1)	27 (12.7)	

	6-8 8+	111 (79.3) 7 (5.0)	13 (76.5) 3 (17.6)	44 (78.6) 7 (12.5)	168(78.9) 17 (7.9)	
Difficulty sleeping in the last 30 days	Not at all No more than usual Rather more than usual Much more than usual	34 (24.3) 67 (47.9) 24 (17.1) 15 (10.7)	7 (41.2) 4 (23.5) 5 (29.4) 1 (5.9)	15 (26.8) 23 (41.1) 13 (23.2) 5 (8.9)	56 (26.2) 94 (44.1) 42 (19.7) 21 (9.9)	.434
Tobacco smoking	Yes	12 (8.6)	1 (5.9)	1 (1.8)	14 (6.6)	.222
Frequency of tobacco smoking (days)	1-5 6-10 11-15 16-20 21-25 26-30	4 (2.9) 4 (2.9) 2 (1.4) 1 (0.7) 1 (0.7) 0 (0.0)	0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 1 (5.9) 0 (0.0)	0 (0.0) 0 (0.0) 0 (0.0) 1 (1.8) 0 (0.0) 0 (0.0)	4 (1.9) 4 (1.9) 2 (0.9) 2 (0.9) 2 (0.9) 0 (0.0)	.579
Non-tobacco smoking	Yes	17 (12.1)	2 (11.8)	6 (10.7)	25 (11.7)	.961
Frequency of non-tobacco smoking	1-5 6-10 11-15 16-20 21-25 26-30	11 (7.9) 5 (3.6) 1 (0.7) 0 (0.0) 0 (0.0) 0 (0.0)	1 (5.9) 1 (5.9) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0)	3 (5.4) 2 (3.6) 0 (0.0) 1 (1.8) 0 (0.0) 0 (0.0)	15 (7.0) 8 (3.8) 1 (0.5) 1 (0.5) 0 (0.0) 0 (0.0)	.145
E-cigarette smoking	Yes	0 (0.0)	0 (0.0)	2 (3.6)	2 (0.9)	.059

Table 4A: Health Care by Housing Accommodation

Variable	Classification	Home with Family (n=140), n(%)	On-Campus Housing (n=17), n(%)	Off-Campus Housing (n=56), n(%)	Total n(%)	p-value
Frequency of use of health care system in the last 12 months	Never Seldom Occasionally Regularly	1 (0.7) 42 (30.0) 76 (54.3) 21 (15.0)	1 (5.9) 7 (41.2) 5 (29.4) 4 (23.5)	3 (5.4) 22 (39.3) 23 (41.1) 8 (14.3)	5 (2.3) 71 (33.3) 104 (48.8) 33 (15.4)	.139
General physical checkup in the past 2 years	Yes	84 (60.0)	7 (41.2)	28 (50.0)	119 (55.9)	.198
Approximate date of last physical check up	Within the last 4+ months Within the last 2-3 months Within the last month Within the last week Never had a physical check up	70 (50.0) 9 (6.5) 3 (2.1) 2 (1.4) 56 (40.0)	6 (35.3) 1 (5.9) 0 (0.0) 0 (0.0) 10 (58.8)	22 (39.2) 3 (5.4) 3 (5.4) 0 (0.0) 28 (50.0)	98 (46.0) 13 (6.1) 8 (3.8) 2 (0.9) 94 (44.1)	.605
Use of Internet for Self-Diagnosis*	Yes	93 (66.4)	6 (35.2)	33 (58.9)	132 (61.9)	.038

APPENDIX G- RESEARCH POSTER

RESEARCH PARTICIPANTS WANTED!

We are seeking individuals' participation in a research study investigating the health of university undergraduate students in relation to their housing accommodations. The results of this study will be important in understanding ways to maximize student productivity in both academic and personal lives.

Eligibility to Participate:

✓ At least 17 years of age

✓ Enrolled as UOIT undergraduate student in FHS, FS, FBIT, FEAS, FESNS, or FSSH

Do you…

- Live in residence?
- Stay off-campus?
- Live at home?

Contact Information:

If you are interested in participating please contact:

Shantel Mangroo, BHSc
Principal Investigator
shantel.mangroo@uoit.ca

This study is being conducted by Shantel Mangroo (Principal Investigator) and Dr. Caroline Barakat-Haddad (Research Supervisor) at University of Ontario Institute of Technology (UOIT), and has been approved by the UOIT Research Ethics Board (REB # 15-020).

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APPENDIX H- RESEARCH ETHICS BOARD APPROVAL

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

RESEARCH ETHICS BOARD
OFFICE OF RESEARCH SERVICES

Date:	*September 19, 2015*
To:	*Shantel* Mangroo and Dr. Caroline Barakat-Haddad
From:	*Shirley Van Nuland, Chair, Research Ethics Board*
REB File #:	*15-020*
Decision:	*Approved*
Current Expiry:	*September 19, 2016*

Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario Institute of Technology Research Ethics Board (REB) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2014 and the UOIT Research Ethics Policy and Procedures.

You are required to adhere to the protocol as last reviewed and approved by the REB. Always quote your REB file number on all future correspondence.

Continuing Review Requirements:

- **Renewal Request Form:** All approved projects are subject to an **annual** renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). **Projects not renewed within 30 days of the expiry date will be automatically suspended by the REB; projects not renewed within 60 days of the expiry date will be automatically closed by the REB.** Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form:** any changes or modifications (e.g. adding a Co-PI or change in method) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form:** events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** must be completed when the research study has completed.

Forms can be found at http://research.uoit.ca/faculty/policies-procedures-forms.php.
We wish you success with your study.

Chair, Research Ethics Board

Dr. Shirley Van Nuland

shirley.vannuland@uoit.ca

Ethics and Compliance Officer

compliance@uoit.ca

APPENDIX I- TIPS TO STAYING HEALTHY AT UNIVERSITY

Physical Health

Seasonal Influenza (Flu)

Influenza (or flu) is a common respiratory illness affecting millions of Canadians each year. In Canada, flu season usually runs from November to April.

The most effective way to protect yourself from the flu is to be vaccinated each year in the fall, and practicing regular hand washing to reduce your chance of becoming infected.

Healthy Living Environment

Kitchen

-Plastic cutting boards are best because they are easier to sanitize.

-To sanitize kitchen materials (dishes, cutting boards and utensils), put them in the dishwasher, or wash them with hot water and detergent.

-Bacteria can thrive in dish cloths, so change them daily. Keep them clean by washing with detergent as part of your regular laundry load, or by handwashing then soaking them in diluted bleach.

Bathroom

-Wash your hands after using the bathroom

-Clean and sanitize your bathroom once a week

-Close the lid on your toilet when flushing to reduce spread of bacteria

-Change your towels once a week

Resources at the University of Ontario Institute of Technology (UOIT)

UOIT offers many services to ensure their students are healthy in all aspects of their life:

-Campus Health Centre

-Campus Recreation and Wellness Centre (CRWC)

-Mental Health Services