FREQUENCY AND PREDICTORS OF TONSIL SURGERY

By

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Abstract

This thesis assesses the frequency of tonsil surgery and examines its predictors. Tonsil surgery is a common procedure which carries both advantages and disadvantages. The study begins with a systematic literature review of published articles which address the frequency and predictors of tonsil surgery worldwide. Using the data collected from a survey conducted on 6,363 high school students in the United Arab Emirates (UAE), the prevalence and predictors of tonsil surgery in this population are then examined.

In relation to the systematic review, a search strategy and inclusion and exclusion criteria lead to 11 relevant papers that were appraised by two reviewers. Findings suggest that age, geographical region, and race are predictors of tonsil surgery. However, there is conflicting, insufficient, or limited evidence for the association between tonsil surgery and each of sex, household income, parental educational levels, number of siblings, environmental tobacco smoke, asthma, allergies, serum Immunoglobulin E level, high body mass index, middle ear infections, upper respiratory tract infections, Down syndrome, and prematurity.

Using data from the UAE, our case study suggests that tonsil surgery is associated with nationality, maternal educational level, pesticide/insecticide, indoor humidity, and hay fever symptoms. However, after adjusting for potential confounders, findings related to multivariate analysis (binary logistic regression) suggest that nationality is the only predictor of tonsil surgery and that nationals of other Gulf Cooperation Council countries are more likely to undergo tonsil surgery. Additionally, adding interaction terms to the regression model reveals that seafood consumption and pesticide/insecticide exposure have interactions with nationality.

To conclude, this present work proposes age, geographical region of residence, and nationality (race) as predictors of tonsil surgery. However, further studies are needed to reassess other potential predictors with insufficient evidence. Furthermore, since each type of tonsil surgery may have a unique set of predictors, it is important to separately identify the predictors of each type of tonsil surgery. Additionally, there is a need for studies that separately assess and identify the predictors of each indication (a disease treated by the surgery) for tonsil surgery. Comparing the predictors of tonsil surgery with the predictors of indications for tonsil surgery may help to determine the reasons for the disparities in the frequency of tonsil surgery among different populations.

Keywords: Frequency, Prevalence, Incidence, Predictors, Risk factors, Tonsil surgery, Tonsillectomy, Adenoidectomy, Adenotonsillectomy, Adolescents, Students, The UAE

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Chapter 1

Introduction

The tonsils are located at the opening of the respiratory and digestive passage, and function as members of the human immune system. The tonsils (from the Latin *tonsa* which means *paddle*) include the mass of lymphoid tissue located at the back of the throat (Feldmann, 1997). There are three types of tonsils: palatine, lingual, and pharyngeal. The palatine tonsils (generally just referred to as tonsils) are a pair of oval-shaped structures approximately the size of almonds with one on each side of the back of the throat. The lingual tonsils are below the palatine tonsils at the base of the tongue. The pharyngeal tonsils, or adenoids, are on the upper rear wall of the mouth cavity behind the nose (Appendix A). According to Feldmann (1997), these lymphoid organs are the initial defence mechanism of the body (especially in children), and fight against pathogenic agents such as bacteria and viruses, by participating in immunoglobulin (antibody) production (Appendix B). This immunological activity may cause tonsillar enlargement by increasing tonsillar cells (Harley, 2002). As a result, tonsillectomy is more likely to be performed on children, since they are more prone to tonsillar enlargement. Children do not develop resistance to infection until 7 to 8 years old, after which the protective role of the tonsils decreases (Ying, 1988). Therefore, tonsil surgery does not have a significant impact on a child's immunity beyond the age of 8.

Since the first tonsil surgery, known to have been performed more than 3,000 years ago, the global rates of surgery have changed many times (Hultcrantz & Ericsson, 2013). In spite of some sharp shifts, either upward or downward, in the epidemiologic trends of tonsil surgery, the overall rates of this surgery have been rising. As a result, on a

global level, tonsil surgery is currently one of the most common types of surgery (Hultcrantz & Ericsson, 2013). Improvement in anesthetic techniques has reduced the consequences of both anesthesia and surgery, making tonsil procedures increasingly more acceptable for both patients and doctors. Additionally, the identification of sleep apnea (pauses in breathing or instances of shallow breathing during sleep) as a major health problem, and the recognition of tonsil surgery as an effective treatment method, has resulted in an increase in the rates of tonsil surgery. On the contrary, emerging new antibiotics such as oral penicillin have reduced the need for tonsil surgery by decreasing tonsillar infections (Hultcrantz & Ericsson, 2013). On a global basis, the annual incidence of tonsil surgery in the general population is approximately 89-160 per 100,000 (Al-Hussaini, Owens, & Tomkinson, 2013; Choi, Hah, Jung, Kim, & Sung, 2014). In Ontario, Canada, the annual incidence of tonsil surgery is approximately 560 per 100,000 among individuals younger than 18 years, while in the USA the annual incidences of the surgery is 1,085 and 284 per 100,000, for the under 15 age group and the general population, respectively (Cullen, Hall, & Golosinskiy, 2009; Gooden & Husein, 2013).

Tonsils occasionally need to be removed in order to treat some diseases. This includes those diseases which involve the tonsils such as chronic tonsillitis or those that involve other organs. Examples of the latter are failure to thrive and sinusitis (David and Siemens, 2009). In medicine, the diseases that are treated by this surgery are referred to as “indications for tonsil surgery”. Tonsil surgery is a general term, referring to any type of surgery performed on the tonsils, from a simple tonsillar incision to evacuate pus from an abscess to the complete removal of the tonsils. In order to refer to a specific type of tonsil, different terms has been developed in medical literature, including: tonsillectomy

for the complete removal of the palatine tonsils; adenoidectomy for surgery on the pharyngeal tonsils; or adeno-tonsillectomy for the removal of both the palatine and pharyngeal tonsils. Additionally, under special circumstances, surgeons may decide to perform a partial tonsillectomy, which involves removing a part of the tonsil (Feldmann, 1997).

Although there are several conditions that can lead to tonsil surgery, tonsillar enlargement causing airway obstruction and infections of the tonsils are the most common indications for this surgery (Flint et al., 2010). Airway obstruction may be presented as snoring, upper airway resistance syndrome, or obstructive sleep apnea (hypopnea) syndrome. All of these conditions are classified under the category of sleep disordered breathing (Garcha, Aboussouan, & Minai, 2013). Infections of the tonsils include recurrent tonsillitis (infection of the tonsils), chronic tonsillitis, and tonsillar abscesses (Shah & Meyers, 2017). It should be noted that not all patients with the above health issues need to undergo tonsil surgery; rather, there are specific criteria that should be met for each of the above diseases to be considered as an indication for tonsil surgery. For example, the American Academy of Otolaryngology-Head and Neck surgery recommends that surgeons may perform tonsillectomy on patients who have recurrent throat infections with a frequency of at least seven episodes in the previous year, or at least five episodes per year for two years or three episodes per year for three years (Baugh et al., 2011). The role of tonsil removal in improving the quality of life has been well documented by some investigators (Mohsen, Susan, Shahin, & Soheila, 2014). Furthermore, Korean investigators indicated that sleep quality is improved after adenotonsillectomy in patients with sleep apnea (Lee, Kang, Weng, Lee, & Hsu, 2015).

This surgery can also potentially reduce the rates of complications of sleep apnea including failure to thrive, craniofacial growth abnormalities, cardiovascular diseases, or even enuresis (Flint et al., 2010). Additionally, by eliminating recurrent tonsillitis, a tonsillectomy can largely prevent the complications of tonsillitis such as scarlet fever, reduce the rates of tonsillitis-related absences from school or work, and improve quality of life by resolving the disease symptoms (Windfuhr, Toepfner, Steffen, Waldfahrer, & Berner, 2016).

However, alongside the advantages, tonsil removal includes several disadvantages such as potentially serious complications and significant direct and indirect costs (Ikoma et al., 2014; Meier et al., 2014). Respiratory compromise and postoperative bleeding, which occur in 9.4% and 11.6% of tonsil surgeries, respectively, are the most common short-term complications of the surgery (De Luca Canto et al., 2015; Meier et al., 2014). Moreover, a significant amount of money is annually allocated for tonsil surgeries by individuals, governments, and insurance companies. For example, according to Sun et al. (2013), in 2009 in the USA, the average cost of a tonsil surgery was $7,525 per patient (95% confidence interval, $6,453-$8,59) while, in the case of complications, the costs increased to $30,081 per patient (95% confidence interval, $18,199-$41,964). Considering that approximately 700,000 tonsil surgeries are performed annually in the USA, the total costs of these surgeries amount to more than five billion dollars per year (Bhattacharyya & Lin, 2010; Boss, Marsteller, & Simon, 2012). Tonsil surgery also has several indirect or hidden costs, such as the time that the patients or caregivers take off from work or study and the potential decrease in work quality during a relatively long recovery period that can last from two to three weeks. Furthermore, some experts are

concerned about the increase in unnecessary tonsil surgery (Ferriman, 2013). In a systematic review of randomised controlled trials assessing the effectiveness and safety of tonsil surgery in children aged 2 to 16 years with sleep apnea, the authors claim that the benefits of tonsil surgery in the treatment of sleep apnea in the under 5 age group could not be documented, and that non-surgical management may be as effective as tonsil surgery in many cases of sleep apnea (Venekamp et al., 2015). Additionally, a study by Kim and Han (2015) reveals that allergic rhinitis (hay fever) may deteriorate long-term quality of life after tonsil surgery, and concludes that tonsil surgery should be cautiously performed in patients with allergies. Conclusively, tonsil surgery is a procedure with questionable effectiveness and probable safety issues. Therefore, it is desirable to reduce the frequency of unnecessary tonsil surgery by controlling the modifiable factors that impact its incidence while receiving the benefits of the surgery.

According to the literature, some considerations, such as demographic, socio-economic, and environmental factors, may predict the incidence of tonsil surgery. As an example, in the USA, African Americans are more prone to tonsillectomy than other ethnicities. Furthermore, parental smoking elevates the risk of tonsillitis and the incidence of tonsillectomy in children (Cote, Ruiz, Perkins, Sillau, & Friedman, 2015). However, these factors are still obscure and debatable, despite several studies having been administered to identify the predictors of tonsil surgery. An example of this is that different studies report conflicting results regarding an association between parents' socio-economic status and the incidence of tonsil surgery. A study by Doganer et al. (2015) suggests that tonsil surgery is associated with a higher paternal educational level among Turkish high school students while another study from the same country

concludes that tonsil surgery is more prevalent among children with less educated parents (Ozkırış, Kapusuz, & Saydam, 2013). Conclusively, there is a need for more studies not only to enhance our knowledge of predictors but also to determine new potential predictors of tonsil surgery. In preparation for this research, no formal systematic reviews that comprehensively assess research on the predictors of tonsil surgery had been identified. Therefore, there is a need for systematic reviews to gather and examine all studies that have assessed predictors of tonsil surgery.

The United Arab Emirates (UAE), which consists of seven emirates (or states), is a small Arab country located in the Middle East in the south of the Persian Gulf. The largest and most populated emirate, Abu Dhabi, is the capital of the country, of which the other emirates are Dubai, Sharjah, Ajman, Umm al-Quwain, Ras al-Khaimah, and Fujairah (Appendix C). Since independence in 1971, the UAE has used oil wealth to develop the infrastructure of the country in different fields, such as industry, tourism, and health (Issa, 2009). As a result of the fast growing economy and low population, the UAE is obliged to accept a large number of immigrants who mostly come from other Asian regions. Currently, the immigrant population of the UAE accounts for 88% of the country's population, which is more than nine million. The UAE expatriates are mostly from South East Asia and other countries of the region (Snoj, 2015). The large number of immigrants, combined with a hot climate, rapid industrialization, and fast growing cities, can potentially threaten the health of residents through increasingly harmful factors such as infectious agents, air pollution, and stress.

Adolescents consist approximately 13% of the UAE's population. Socio-economic factors differ among the adolescents residing in the UAE, especially between

nationals and non-nationals. The rate of unemployment is higher among the fathers of Emirati adolescents compared the fathers of expatriate adolescents (23% and 7%, respectively), In spite of that, Emirati nationals have a higher monthly household income than expatriates. Additionally, the frequency of unemployment is quite high among the mothers of adolescents (86% among nationals and 75% among non-nationals). Regarding educational levels of adolescents' fathers, 35% of nationals and 80% of non-nationals completed high school while the frequencies of mothers who graduated from high school are 27% for nationals and 69% for non-nationals (Barakat-Haddad & Siddiqua, 2015).

Health care services are mainly affected by health care spending, which is not uniformly distributed among Emirati residents. The UAE government provides 75% of health costs while the remaining 25% is provided by private sources (WHO, 2014). Using a considerable health budget, the UAE government provides all nationals with free health care while non-nationals have to pay for their health insurance. However, many foreign workers are not covered by health insurance (WHO, 2014). Therefore, non-nationals, who include most of the low income individuals, have to pay more for their healthcare services compared to UAE nationals. Additionally, due to different policies, it is possible that government and private hospitals do not deliver the same health care services. Approximately one third of UAE hospitals are government owned hospitals, where UAE citizens receive free health care services, while non-citizens receive only emergency services. The remaining two thirds of hospitals are private (Berthier, 2013). Therefore, currently, the UAE experiences an inequality in health care service utilization between nationals and non-nationals. Additionally, it is expected that the distribution of health outcomes is not uniform among the residents of the UAE. Overall, 23% of Emirati

adolescents do not regularly use health care services. The existing evidence reveals that a personal busy schedule, dislike or fear of doctors, long patient waiting times, and the costs of health care services are the four main reasons for not obtaining health care. However, only 10% of adolescents have no easy access to health care services (Barakat-Haddad & Siddiqua, 2015).

In addition to disparities in health care access, the ethnic, cultural, and economic diversity which exists in the UAE makes it an ideal location to assess the roles of various factors regarding common diseases such as tonsillitis or asthma. Furthermore, tonsil surgery is the most common inpatient operation among Emirati adolescents (Barakat-Haddad & Siddiqua, 2015).

Given such a context, this study begins with a systematic review of the literature on the frequency and predictors of tonsil surgery worldwide. Additionally, using the data collected from a survey conducted on 6,363 high school students between 2005 and 2007 in the UAE, the prevalence and predictors of tonsil surgery (such as demographic factors or socio-economic status) are assessed in this population. Since some diseases are potentially associated with tonsillectomy, the associations between hearing loss, asthma, or hay fever (allergic rhinitis) and tonsil surgery are also examined.

Scoping Literature Review

This section reviews recent research studies that focus on contributory factors such as age, sex, geographical region of residence, air pollution, and household income.

Age. The distribution of tonsil surgery is not uniform among different populations. This surgery is one of the most common surgeries in children while less

frequently performed in adults. Therefore, age can be a predictor of tonsil surgery. Most studies indicate that rates of tonsil surgery are higher in the 5-8 age group followed by the 15-19 age group (Erickson, Larson, Sauver, Meverden, & Orvidas, 2009). Thus, the rates of tonsil surgery show a bimodal age distribution with the first peak between ages 5 to 8 and the second peak (which is lower than the first one) between ages 15 to 19. Furthermore, the literature reveals that the reasons for surgery especially in recent decades are interestingly varied among different age groups. While most of the children under 5 are operated on for obstructive problems such as sleep apnea, in the older age group (above 5) the main causes of surgery are infections such as recurrent tonsillitis or tonsillar abscess (Patel, Straight, Lehman, Tanner, & Carr, 2014).

Sex. Sex can also be a predictor of tonsil surgery. Studies show conflicting results with regards to which sex is more prone to tonsil surgery. Some studies suggest that tonsil surgery is more common among females (Al-Hussaini et al., 2013; Boss et al., 2012; Vestergaard et al., 2007) while others suggest that males are more likely to undergo this surgery (Choi, Hah, Jung, Kim, & Sung, 2014; Cote et al., 2015; Fedeli et al., 2009). However, several studies, which examine the effects of sex on the frequency of tonsil surgery in different age groups, report that sex is associated with the age-specific incidence of the surgery (Vestergaard et al., 2007). In younger children (0-8 years), males are more prone to tonsil surgery, whereas in older children (above 8 years), tonsil removal is more common in female than males (Erickson et al., 2009). The literature also shows that there is a correlation between sex and the different types of tonsil surgery. Tonsillectomy is more common in females while adenoidectomy (with or without tonsillectomy) is more frequent in males (Materia et al., 2004).

Geographical region and race. Studies reveal inconsistencies in surgery frequency among different geographical regions. The frequency of surgery differs not only among different countries (Al-Hussaini et al., 2013; Fedeli et al., 2009) but also among different parts of a country (Boss et al., 2012). For instance, in spite of similar population sizes, Italy had much higher rates of tonsil surgery than England during the early years of the 21st century: 100,000 per year versus 28,000 per year, respectively (Koshy, Bottle, Murray, Sharland, & Saxena, 2014; Materia et al., 2004). In comparison, the USA with a population 5 times greater than both Italy and England, had 583,000 (95% CI, 370 000-796 0000) cases of tonsillectomy in 2006, with higher rates in the south compared to the west of the country (Boss et al., 2012).

The differences that exist in the incidence of tonsil surgery in different geographical regions may partially originate from the effects of genetics on tonsil diseases. Weinstock et al. (2014) conclude that genetic factors may affect the incidence of tonsil surgery, by showing that African Americans are more prone to severe forms of obstructive sleep apnea and tonsil surgery than other Americans. In addition, a study by Kalampouka et al. (2016) conducted on children recruited from an emergency room and a pulmonology clinic, reveals an association between a family history of tonsil surgery and tonsillar enlargement in children.

Socio-economic status. Socio-economic status is another factor that appears to impact the rate of tonsil surgery. According to a 2015 study by Doganer et al., higher rates of tonsillectomy among children with highly educated fathers can be related to their awareness of tonsil diseases and probable easier access to health care services. In contrast, a study, which assessed socio-economic status and the rate of tonsil surgery in

primary school students in Turkey, suggests that tonsil surgery is reversely related to paternal educational level and household income (Ozkırış et al., 2013). Therefore, the role of socio-economic status on the rate of tonsil surgery still remains controversial and needs to be examined by studies that control confounding factors in order to establish the actual relationship between socio-economic status and tonsil surgery.

In addition to the above factors, living in crowded homes is a risk factor for developing respiratory infections which, in turn, can increase the frequency of tonsil surgery (Krieger & Higgins, 2002). However, the present study has not identified any research that examined the association between tonsil surgery and living in crowded homes.

Lifestyle. Harmful behaviors such as unhealthy diet and physical inactivity may also potentially alter the rate of tonsil removal in children. Among children aged 4-6, an unhealthy diet, such as sugary products, soft drinks, and edible fats, was reported to be more common in those with tonsillar enlargement, which is one of the causes of snoring, sleep apnea, and tonsil surgery (Gkouskou et al., 2010). Although obesity is known as one of the risk factors of obstructive sleep apnea, which is treated by tonsillectomy especially in those under 5 years old , the present work has not identified any study that has assessed the direct association between tonsil surgery and each factor of obesity and physical inactivity, (Kohler, 2009).

Air pollution. Air pollution is also a potential predictor of tonsil surgery. However, outside of environmental tobacco smoke (ETS), the role of other types of air pollution has not been well documented. Straight et al. (2015) compared the exposure contacts in two groups of children who underwent a tonsillectomy or hernia repair. In this

case-control study, the association between environmental tobacco smoke and tonsil surgery was examined among children under the age of 15. The authors concluded that exposure to tobacco smoke raises the rate of tonsillectomies performed for recurrent infections of the tonsils (Straight, Patel, Lehman, & Carr, 2015). Hinton et al. (1993) also demonstrated how parental smoking elevates the risk of tonsillitis and the rate of tonsillectomy in children by altering oropharyngeal flora, impairing mucociliary function, increasing cross infection or a combination of these factors. Furthermore, living in neighbourhoods with air pollution may increase the incidence of habitual snoring (loud snoring more than two nights per week), which is one of the indications for tonsillectomy in students aged 6 to 12 (Kheirandish-Gozal, Ghalebandi, Salehi, Salarifar, & Gozal, 2014). Additionally, in Peru, investigators claim that an improvement in traditional wood-burning stoves decreases the symptoms of sleep apnea in children (Castañeda, Kheirandish-Gozal, Gozal, & Accinelli, 2013). However, no studies have thoroughly examined the contribution of indoor or outdoor air pollution on the frequency of tonsil surgery.

Indoor humidity. Several epidemiologic studies suggest that the incidence of respiratory infections increases among people working or living in environments with high relative humidity. Both mite and fungal populations are maximized when the relative humidity exceed 60% (Arundel, Sterling, Biggin, & Sterling, 1986). These agents can trigger allergic reactions such as allergic rhinitis or asthma (Arlian & Platts-Mills, 2001; Corey, Kaiseruddin, & Gungor, 1997). High relative humidity also increases the concentration of several chemicals present in indoor building materials (Arundel et al., 1986). An example of such a chemical is formaldehyde, which is a common cause of

allergy (De Groot, Flyvholm, Lensen, Menné, & Coenraads, 2009). It is suggested that allergic rhinitis is an influential factor in increasing the incidence of adenoidectomy, tonsillectomy, and adenotonsillectomy (Huang & Giannoni, 2001; Sadeghi-Shabestari, Jabbari Moghaddam, & Ghaharri, 2011). As a result, individuals who live in places with higher levels of humidity are prone to tonsil surgery.

Hearing loss. Some health problems are believed to directly or indirectly affect or be affected by tonsillar enlargement or tonsil surgery. Tonsils are not only anatomically located close to the ears, but also potentially associated with some types of hearing loss. Otitis media with effusion (glue ear) is one of the main causes of hearing loss in children (Dhooge, 2003; Hunter, Margolis, & G. Giebink, 1994). Several authors establish a correlation of adenoid enlargement and infection with glue ear (Maw, 1985). It is common current practice to remove the adenoids as one of the stages of otitis media with effusion treatment to promote the effects of other modalities of treatment and reduce the rates of recurrence (van den Aardweg, Schilder, Herkert, Boonacker, & Rovers, 2010). However, recent studies debate the beneficial effects of tonsil surgery on middle ear status and hearing loss. As a result, the latest clinical guideline for otitis media with effusion from the American Academy of Otolaryngology-Head and Neck Surgery does not recommend tonsil surgery for the treatment of otitis media with effusion in children under the age of 4 (Rosenfeld et al., 2016). Since there is conflicting evidence for an association between tonsil surgery and ear involvement, the present study aims to assess the relationship between tonsil surgery and hearing loss.

Allergies and asthma. According to several studies, different types of allergies such as hay fever (allergic rhinitis), atopic dermatitis (skin allergy), and asthma as well as

a family history of allergy affect the frequency and age distribution of tonsil surgery by increasing the rates of early onset enlargement of either or both the adenoids and palatine tonsils (Olusesi, Undie, & Amodu, 2013). Additionally, poorly-controlled asthma has been revealed to be associated with more severe sleep apnea, which is the main cause of tonsil surgery (Ramagopal et al., 2009). However, by measuring serum Immunoglobulin E (IgE) levels, some researchers have stated that allergies to airborne allergens do not contribute to tonsillar enlargement in children with sleep apnea (Carr, Obholzer, & Caulfield, 2007). In turn, adenotonsillectomy can efficiently improve asthma control by reducing chitinase activity, which is responsible for airway inflammation (Levin et al., 2014), although the effects of surgery on asthma are not long lasting (van Hattum et al., 2006). Therefore, it is possible that allergies and asthma are associated with tonsil surgery.

The variation in the distribution of tonsil surgery among children with different demographic characteristics, lifestyles, and health issues suggests that these factors are potential predictors of tonsil surgery. Although several studies have assessed the relationship between various factors and the frequency of tonsil removal, to my knowledge a comprehensive review does not exist that simultaneously evaluates all predictors. In order to assess the significant predictors of tonsil surgery, there is a need for research on tonsillectomy that examines various potential predictors such as ethnicity, lifestyle, socio-economic status, and residential location, as well as potential interactions between these factors.

Research Problem

Tonsil surgery improves quality of life in many patients by reducing upper airway obstructive problems and tonsillar infections (Mohsen et al., 2014; Nokso-Koivisto, Blomgren, Roine, Sintonen, & Pitkäranta, 2014). However, this surgery, as any major surgery, includes some potential health and life threatening complications, such as postoperative bleeding and pulmonary problems (Chang, Buchanan, Geremakis, Sheikh, & Mitchell, 2014). Additionally, direct and indirect costs of the surgery, together with post-operative care, are a significant financial burden on society. Therefore, in order to avoid the consequences of the surgery, it would be advantageous to decrease the frequency of tonsillectomy by avoiding unnecessary surgery through identifying and controlling the modifiable predictors of this procedure. Furthermore, understanding the predictors of tonsil surgery will provide information on the causes of population-level disparities in the frequency of tonsil surgery. Several studies indicate the frequency of surgery or assess the association between potential predictors and the incidence of surgery. However, lack of sufficient evidence for an association between some of these predictors and tonsil surgery, as well as conflicting findings, has resulted in unreliable conclusions. Furthermore, no comprehensive study has simultaneously evaluated the predictors of tonsillectomy (Carr et al., 2007; Olusesi et al., 2013). The literature also reveals limited evidence for the frequency and predictors of tonsil surgery in the UAE or other countries of that region. The present study aims to fill these gaps in knowledge by addressing the following research questions:

1) What evidence exists regarding the frequency of tonsil surgery?

2) What evidence exists regarding the predictors of tonsil surgery?

3) What is the frequency of tonsil surgery among adolescents who reside in the UAE?

4) What are the predictors of tonsil surgery among adolescents who reside in the UAE?

5) How do the frequency and predictors of tonsil surgery in the UAE compare to the existing evidence?

Research Objectives

The primary research objectives of this study are to:

1. Identify all studies that examine the frequency and predictors of tonsil surgery.
2. Assess the frequency of tonsil surgery among adolescents who reside in the UAE.
3. Determine the predictors of tonsil surgery among adolescents who reside in the UAE.
4. Compare the frequency and predictors of tonsil surgery in the UAE with the existing evidence.

Furthermore, the secondary objectives of this study are to:

1. Identify all studies that assess the association between tonsil surgery and other health issues.
2. Examine the association between tonsil surgery and each of hearing loss, hay fever, and asthma among adolescents who reside in the UAE.

3. Compare the comorbidities associated with tonsil surgery in the UAE with the existing evidence.

Conceptual Framework

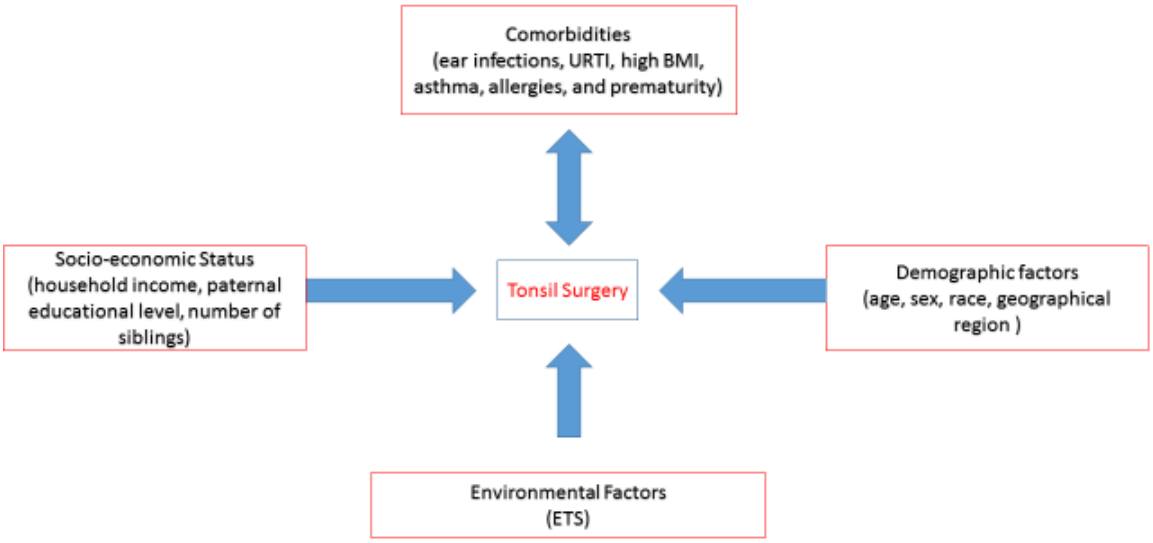
According to Aday and Andersen “An individual's access to and use of health services is considered to be a function of three characteristics: predisposing factors, enabling factors, and need factors”. Predisposing factors, which exist before a health issue, include demographic (such as age and sex) and socio-cultural factors (such as education and occupation). Enabling factors, which provide the possibility for obtaining a service, are related to available health facilities, income, and health insurance. Finally, the most important characteristic is linked with need factors or cause of a health service use (Aday and Andersen, 1974). While the above-mentioned model is useful as a general framework for studies that examine the effects of different factors on health outcomes, this study uses a self-developed framework based on findings of the scoping review that relates specific factors to tonsillitis.

The evidence provided in the literature reveals that several demographic, socio-economic, and environmental factors, as well as lifestyle and some comorbidities, may be associated with tonsil surgery. These factors can elevate the frequency of tonsil surgery by increasing the need for this type of surgery. One such factor is the correlation between race and tonsil surgery. As an example, African Americans are more prone to sleep apnea, thus are more likely to undergo tonsil surgery than other Americans (Weinstock et al., 2014). Therefore, race indirectly impact the frequency of tonsil surgery by changing the frequency of sleep apnea, which is one of the reasons for this type of surgery. However, some factors can directly affect the frequency of tonsil surgery. To exemplify,

individuals from lower socio-economic groups, who are in dire need of tonsil surgery, may not have easy access to health care services (Doganer et al., 2015). Consequently, socio-economic status may be an actual predictor of tonsil surgery. This study focuses on the factors that directly affect tonsil surgery. Based on the findings of the literature review, two conceptual frameworks have been separately created for the systematic review and cross-sectional phases.

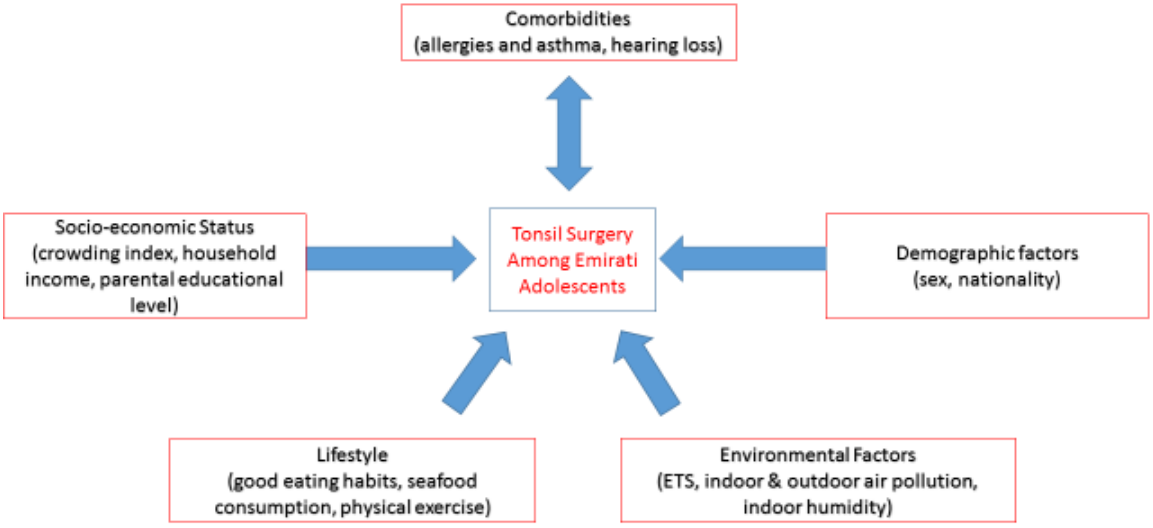
The predictors that are assessed in the systematic review include 17 factors classified into four groups: demographic, socio-economic, and environmental factors, and comorbidities. The individual factors are: age, sex, race, geographical region of residence, household income, paternal educational level, maternal educational level, number of siblings, ETS, asthma, allergies, serum IgE level, upper respiratory tract infections (URTI), high body mass index (BMI), ear infections, Down syndrome, and prematurity.

Systematic Review Framework



For the cross-sectional phase of this study, 21 predictors are classified into five groups: demographic, socio-economic, and environmental factors, together with lifestyle and comorbidities. These predictors are: sex; nationality, household income, parental educational levels, crowding index, good eating habits, access to good foods, seafood consumption, physical exercise, ETS, outdoor air pollution, exposure to pesticide/insecticide, exposure to chemicals used in arts and crafts, indoor humidity, peeling paint, hearing loss, asthma (symptoms and diagnosis), and allergies (symptoms and diagnosis). These predictors were chosen based on the data provided by the UAE survey and the information extracted from other studies. The two phases of this study do not examine the same variables because the UAE survey did not include data related to several variables assessed by the systematic review and the articles of the review did not examine all potential predictors of tonsil surgery.

Case Study Framework



Chapter 2

Systematic Review of Articles

Abstract

Background. Tonsil surgery is a common procedure, especially in children. According to the literature, it may be associated with factors such as age and household income. However, a comprehensive list of the predictors of tonsil surgery is not well established.

Objective. To conduct a systematic review of the literature in order to determine the evidence on the frequency and predictors of tonsil surgery for all age groups.

Data Sources. The data sources are PubMed, Web of Science, and Ovid Cochrane (2006-2016). The search keywords used for PubMed and Web of Science include: predictors, frequency, and tonsil surgery as well as their synonyms, alternatives, and closely related text-words. In order to identify related systematic reviews, only tonsil surgery and its synonyms were adopted for use with the Cochrane Database.

Study Selection. All types of study design are included.

Study Appraisal. A modified Downs and Black checklist was used on 11 articles that were independently appraised by two reviewers.

Results. The search strategy culminated in 1653 articles, of which 1625 were excluded. A full review of 28 full text articles led to the final identification of 11 relevant articles. Results reveal that the incidence of tonsil surgery is between 88.9 and 159.2 per 100,000 annually among the general population, and between 304.6 and 1,440 per

100,000 annually in the under 15 age group. This review suggests that tonsil surgery is associated with each of age, geographical region, and race. However, there is limited evidence for an associations between tonsil surgery and each of paternal educational level, high BMI, middle ear infections, Down syndrome, and prematurity. Results are conflicting regarding an association between tonsil surgery and each of sex, household income, environmental tobacco smoke, asthma, and allergies. Additionally, the review finds no evidence of an association between tonsil surgery and maternal educational level, number of siblings, and serum IgE level.

Conclusions. This review suggests age, geographical regions, and race as predictors of tonsil surgery. However, there is insufficient evidence for an association between tonsil surgery and other assessed factors.

Introduction

Tonsil surgery, which is typically performed on children, is one of the most common types of surgery around the world (Vestergaard et al., 2007). In Ontario, Canada, more than 14,000 tonsil surgeries are performed annually in individuals aged 18 years and younger. In the UK the annual frequency of such surgeries is more than 58,000 and more than 80,000 in South Korea (Al-Hussaini et al., 2013; Choi et al., 2014; Gooden & Husein, 2013). Depending on the patient's age and geographical region, and the cause of surgery, tonsil surgery may be performed either as an inpatient or outpatient (ambulatory) procedure. In 1996 in the United States, the incidence of outpatient tonsillectomy was 456 per 100,000 among the under 15 age group while the incidence of inpatient tonsillectomy was approximately 300 per 100,000 among the under-18 population (Bernstein, 2004).

The role of tonsil removal in improving quality of life has been well documented (Mohsen et al., 2014; Thong, Davies, Murphy, & Keogh, 2016). Adenotonsillectomy can significantly improve sleep quality in patients with sleep apnea and also reduce the rate of complications of sleep apnea, such as failure to thrive, craniofacial growth abnormalities, cardiovascular diseases, and enuresis (Lee et al., 2012). Additionally, this surgery can effectively eliminate the airway obstruction caused by tonsillar enlargement, and treat chronic or recurrent tonsillar infections (Flint et al., 2010).

However, tonsil surgery also involves several disadvantages, such as complications and costs of the surgery (Ikoma et al., 2014; Meier et al., 2014). Respiratory compromise and postoperative bleeding, which occur in 9.4% and 11.6% of tonsil surgeries, respectively, are the most common complications of the surgery (De Luca Canto et al., 2015; Ikoma et al., 2014). Additionally, a significant amount of money is allocated each year for tonsil surgeries by individuals, governments, and insurance companies. For example, in the USA, the average cost of a tonsil surgery is approximately $7,525 (Sun et al., 2013).

Furthermore, some experts are concerned about the increase in unnecessary tonsil surgeries (Ferriman, 2013). In other words, they have doubts about the actual benefits of some tonsil surgeries, when safety issues are taken into account. Venekamp et al. (2015) conducted a systematic review of randomised controlled trials in order to assess the effectiveness and safety of tonsil surgery in children aged 2 to 16 years with sleep apnea. These investigators could not find sufficient evidence for the benefits of tonsil surgery as a treatment of sleep apnea in the under 5 age group. Additionally, they proposed that non-surgical management might be as effective as tonsil surgery in many cases of sleep apnea

(Venekamp et al., 2015). A study by Kim & Han (2015) claims that allergic rhinitis (hay fever) may deteriorate long-term quality of life after tonsil surgery and concludes that allergic patients should be cautiously selected for tonsil surgery.

The frequency of tonsil surgery may be affected by factors such as sex, age, and ETS (Doganer et al., 2015). Many authors have assessed the association between tonsil surgery and demographic factors, socio-economic status, and life style (Choi et al., 2014; Straight, Patel, Lehman, & Carr, 2015). However, the present study identifies no formal systematic reviews that comprehensively assess research on the predictors of tonsil surgery.

In order to determine the frequency and predictors of tonsil surgery, the present study reviews all randomised and non-randomised studies that assessed the frequency of tonsil surgery, together with the factors that are associated with this surgery in any age group and any geographical region. The criteria used for this review, with regard to participants, interventions, comparisons, outcomes, and study design (PICOS), are as follows:

- Participants: Any individual who underwent any type of tonsil surgery is included.
- Interventions: Any exposure is included.
- Comparators: When applicable, any type of comparator is included in order to provide the widest possible overview of outcomes.

- Outcomes: The study dependent (outcome) variable is the frequency of tonsil surgery. Therefore, all studies that evaluate the effects of different factors on the prevalence and/or incidence of any type of tonsil surgery are included.
- Study design: Any type of study design is included.

Methods

In order to gain insight into all types of studies relating to the factors that influence the frequency of tonsil surgery, a systematic review was chosen. In order to select a comprehensive set of relevant studies, all papers that examine cases of tonsil surgeries at any age, and of any sex or nationality, are included. Tonsil surgery is defined as adenoidectomy (removal of the pharyngeal tonsils), tonsillectomy (removal of the palatine tonsils), or adenotonsillectomy (removal of both the pharyngeal and palatine tonsils). Research studies that specifically evaluate surgical or anesthetic methods, surgical complications, the advantages and disadvantages of tonsil surgery, and tonsil surgeries performed for malignancies are excluded from this study. Additionally, in order to identify the predictors of tonsil surgery rather than predictors of the conditions treated by tonsil surgery (indications for tonsil surgery), studies in which participants were candidates for tonsil surgery, but did not undergo the surgery, were also excluded.

A search of PubMed, Web of Science, and Ovid Cochrane databases was conducted for English language articles from 2006 to 2016. Since there are some sharp shifts, either upward or downward, in the epidemiologic trends of tonsil surgery, in order to gather the most recent data, the present study focuses on articles published within last

10 years, and use the following strategy to search PubMed and Web of Science databases (Appendix D):

1. Identify key concepts in the research questions. Three key concepts of frequency, predictors, and tonsil surgery are identified based on the research questions:

    a. What is the frequency of tonsil surgery?
    b. What are the predictors of tonsil surgery?

    These key concepts are used to create search keywords.

2. Select the keywords for each concept. In order to create a comprehensive literature search, in addition to Medical Subject Heading (MeSH) terms, all synonyms, alternatives, and closely related text-words, such as *rate*, *risk factors*, or *adenoidectomy*, are added to the list of keywords for each concept.

3. Use special search techniques. In order to find the singular and plural forms of keywords, truncation is used for keywords such as *influence* or *predictor*.

4. Combine keywords. In order to make the search more sensitive as well as more specific, keywords are combined using Boolean operators (AND, OR). The keywords of each concept are first combined using OR, and each combination is then combined using AND.

However, in order to search Ovid Cochrane, *tonsil surgery* and closely related words were adopted as keywords, due to the expected limited number of search results (Appendix D).

After applying the above search strategies and discarding any duplicated articles, the remaining studies were screened in two steps. In the first step, all the articles retrieved from the initial search were assessed by using titles and/or abstracts to exclude those studies that focus on the methods of tonsillectomy and anesthesia, surgical complications, the advantages and disadvantages of tonsil surgery, tonsil surgeries performed on malignancies, and other irrelevant subjects. In the second step, the full texts were examined to include those articles which examine the frequency and predictors of tonsil surgery and exclude those studies that assess the predictors of the indications for tonsil surgery.

To assess the risk of bias and methodological quality of the included articles, a modified Downs and Black checklist is used (Downs & Black, 1998). This checklist includes four sections: external validity, bias, exposure measurement, and confounding. The highest possible score that an article can achieve is 20: 2 for external validity; 8 for bias; 6 for exposure measurement; and 4 for confounding (Appendix E). According to the selected parameters of this study, those articles which have a score of less than 11 were considered to be low quality and thus excluded. All included studies were independently appraised by two reviewers who then discussed any differences of opinion in order to determine the best fit quality score for each study. Furthermore, the remaining disagreements were evaluated by a third reviewer as a referee.

In order to collect information from each included study, a data extraction sheet was developed using Microsoft Excel. The data extracted from all studies include: (1) objectives; (2) design; (3) sample size; (4) subjects (participants); (5) exposures (independent variables) including age, sex, socio-economic status, lifestyle,

environmental factors and co-morbidities; and (4) results (such as the frequency of tonsil surgery).

Results

The search of the PubMed, Web of Science and Ovid Cochrane databases provided a total of 3,123 citations. After adjusting for duplicates, 1,653 articles remained. Of these, 1,625 studies were discarded since, after review of the titles and/or abstracts, it appeared that these papers are not relevant for the purposes of this study. The articles that are linked to the following subjects were excluded from the review at this step: methods of tonsil surgery and anesthesia (810 articles); surgical complications (482 articles); the advantages and disadvantages of tonsil surgery (162 articles); tonsil surgeries performed on malignancies (10 articles), and other irrelevant subjects (161 articles). The full text of the remaining 28 citations were completely examined, of which 17 studies that examined the frequency and predictors of the indications for tonsil surgery were discarded. The remaining 11 studies are included in the systematic review (Appendix F). According to two independently completed appraisal checklists, all included articles are moderate to high quality and none of them are highly biased. (The articles' scores are between 12 and 20 using the modified Downs and Black's checklist.)

Study design. All 11 included studies are observational, consisting of one case-control study and ten cross-sectional studies (Table 1).

Table 1

Summary of the Articles Included in the Systematic Review: Study Setting, Design, Participants, and Sample Size

	Article	Study Setting	Study Design	Participants	Sample Size
1	Suvilehto et al., 2007	Finland	Cross-sectional	Aged 2-17 (tonsillitis)	100
2	Vestergaard et al., 2007	Denmark	Cross-sectional	All ages (all Danish residents)	6,300,117
3	Carr et al., 2007	England	Cross-sectional	Aged <16 y. (OSA)	117
4	Fedeli et al., 2009	Italy	Cross-sectional	Aged 2–9 y.	15,096
5	Suleman et al., 2010	England	Cross-sectional	Aged <15 y.	Not mentioned
6	Boss et al., 2012	USA	Cross-sectional	Aged <18 y. (outpatient surgeries)	294
7	Al-Hussaini et al., 2013	UK	Cross-sectional	All ages	699,898
8	Choi et al., 2014	South Korea	Cross-sectional	All ages	403,924
9	Straight et al., 2015	USA	Case-control study	Aged <15 y. (recurrent tonsillitis)	256
10	Doganer et al., 2015	Turkey	Cross-sectional	Aged 6-12 y.	1,900
11	Cote et al., 2015	USA	Cross-sectional	Aged <24 m. (OSA or SDB)	215

Participants. The sample size of the studies varies from 100 to 6,300,117 participants (Suvilehto et al., 2007; Vestergaard et al., 2007). Considering that tonsil surgery is more common among children than adults, eight studies limit their participants to younger age groups (under the age of 18). However, each study defined different

criteria for the specific age of their participants. As an example, one study includes all children under the age of 15 while another considers children between the ages of 6 to 16 (Table 1).

Frequency of Tonsil Surgery. Although seven out of the 11 included studies explore the frequency of tonsil surgery, only one study states the prevalence of this intervention, which was 7.3% among Turkish students aged 6 to 12 (Doganer et al., 2015). According to other studies that assess the incidence of tonsil surgery, when all age groups of the population are taken into consideration, the annual incidence of all types of tonsil surgery is between 88.9 and 159.2 per 100,000 (Al-Hussaini, Owens, & Tomkinson, 2013; Choi et al., 2014; Vestergaard et al., 2007). From 1980 to 2011, the annual incidence of tonsil surgery was 88.9, 100.6, 105.5, 143.2, and 159.2 per 100,000, in Scotland, England, Wales, Denmark, and South Korea, respectively (Al-Hussaini et al., 2013; Choi et al., 2014; Vestergaard et al., 2007). However, when measurements are limited to the lower age groups (under the age of 18), which includes most of the tonsil surgeries, the annual incidence increased to 304.6-1,440 per 100,000. Specifically, Suleman et al. (2010) state that the annual incidence of tonsillectomy is 304.6 per 100,000 among English children under the age of 15, while the incidence of this procedure in the Veneto region of Italy is approximately 400% higher at 1,440 per 100,000 person-years in children aged 2 to 9 (Fedeli et al., 2009). Moreover, Boss et al. (2012) identified that, out of 100,000 children under the age of 18, approximately 791 undergo outpatient tonsillectomy each year in the United States (Table 2).

Table 2

Literature Findings related to the Incidence of Tonsil Surgery

	Article	Incidence (cumulative) (per 100,000/year)	Incidence rate (density) (per 100,000 person-years)
1	Vestergaard et al., 2007		143.2 (Denmark)
2	Fedeli et al., 2009		1,440 (Italy)
3	Suleman et al., 2010	304.6 (England)	
4	Boss et al., 2012	791 * (USA)	
5	Al-Hussaini et al., 2013	100.6 ± 8.0 (England) 88.9 ± 14.9 (Scotland) 105.5 ± 28.1 (Wales)	
6	Choi et al., 2014	159.2 (Korea)	

* Only ambulatory (outpatient) surgeries

Exposures. Each of the 11 articles evaluates one or more predictors of tonsil surgery. These predictors include demographic characteristics, lifestyle, socio-economic status, environmental factors, and co-morbidities (Table 3).

Table 3

Literature Findings related to Predictors of Tonsil Surgery

Predictors \ Articles	Suvilehto, 2007	Vestengaard, 2007	Carr, 2007	Fedelini, 2009	Suleman, 2010	Boss, 2012	Al-Husseaini, 2013	Choi, 2014	Straight, 2015	Doganer, 2015	Cote, 2015
Age[1]		**4 , 16-17**				**0-6, 7-12**	**0-14**	**5-9**			
Sex[2]		**F**		**M**		**F**	**F**	**M**		**F = M**	**M**
Race											**A[3]**
Geographical Region				**A**	**A**	**A (R>U[4])**					
Household Income								**A[5]**		**N**	
Paternal Education										**A**	
Maternal Education										**N**	
Number of Siblings										**N**	
ETS	**N**								**A**		**N**
Asthma	**A**									**N**	
Allergies	**A**		**N**							**N**	
Serum IgE	**N**		**N**								
URTI	**N**									**A**	
High BMI										**A**	
Otitis Media	**A[6]**									**A[7]**	
Down Syndrome											**A**
Prematurity											**A**

Empty areas = Not assessed, **A** = Associated, **N** = Not-associated

ETS= Environmental Tobacco Smoke

URTI= Upper Respiratory Tract Infections

(1) = Age group for the highest rate of tonsil surgery in years

(2) = The sex that had more frequent tonsil surgeries

(3) = African-Americans

(4) = Rural > Urban

(5) = Reversely associated

(6) = Otitis Media with Effusion

(7) = Acute Otitis Media

Demographic factors. In order to identify the national incidence figures in Denmark, Vestergaard et al. (2007) determined the age-specific incidence of tonsillectomy. According to this study, the incidence of tonsillectomy has two peaks: at the age of 4 (for both sexes) and then at the age of 16 for females and 17 for males. Additionally, Choi et al. (2014) show that the incidence of tonsil surgery is highest in the 5-9 year age group in Korea (460 per 100,000 annually). Al-Hussaini et al. (2013) reveal that the age group of 0-14 has the highest rates of tonsil surgery in the UK. Furthermore, Boss et al. (2012) state that children aged 0-6 and 7-12 are more prone to undergo tonsil surgery (1029 and 913 per 100,000 annually, respectively). However, this study does not include all age groups, limiting its participants to the under 18 group (Tables 2&3).

Seven articles assess the relationship between sex and tonsil surgery. The results of three of these articles reveal that tonsil surgery is more common in females than males, while another three claim that more males undergo tonsil surgery than females. The final article reported almost the same frequency of tonsillectomy for males and females (Table 3).

The only study that assesses the effects of race on the frequency of tonsil surgery is from the United States. This research reveals that the incidence of tonsil surgery is the highest among African-Americans ($p = 0.0008$, Z-test), and that Hispanics are least prone to tonsil surgery ($p = 0.01$, Z-test). Additionally, the multivariate analysis establishes that the odds ratio of severe sleep-disordered breathing in Caucasians (SDB) is 0.08 (C.I. 0.01–0.71, $p = 0.021$) compared to African-Americans (Cote et al., 2015).

As Table 3 illustrates, the rates of tonsil surgery are significantly different among geographical regions in England, Italy, and the United States (Boss, Marsteller, & Simon,

2012; Fedeli et al., 2009; Suleman, Clark, Goldacre, & Burton, 2010). Suleman et al. (2010) revealed that that there is a significant variation (7-fold) in tonsil surgery rates among children under the age of 15 in different regions of England. Furthermore, Fedeli et al. (2009) illustrate similar results in Veneto, Italy. Boss et al. (2012) also determine that tonsillectomy is more prevalent in the Southern United States compared to other regions of the country ($p < 0.01$). Additionally, the study suggests that the Americans who live in rural areas have a higher risk for tonsil surgery than those who live in urban areas (1,180 per 100,000 versus 420 per 100,000; $p < 0.05$).

Socioeconomic status. In order to assess the association between household income and tonsil surgery, Choi et al. (2014) categorized all South Korean people into two groups of high income and low income, based on their type of insurance plan. They suggest that tonsil surgery is more common in the low income group. However, Doganer et al. (2015) claim that household income is not associated with frequency of tonsil surgery, after dividing patients into three categories of low income (less than 1000 Turkish Lira per month), medium income (between 1000 and 2000 Turkish Lira per month), and high income (more than 2000 Turkish Lira per month) ($X^2 = 4.69$, $p = 0.096$).

A study conducted by Doganer et al. (2015) on school-aged children in Turkey reveals that participants with a higher paternal educational level have a greater rate of tonsil surgery than those with low and medium levels ($X^2 = 13.24$, $p= 0.001$). A high educational level is defined by the authors as ‘finishing college’ or above. However, the same study establishes that maternal educational level is not associated with frequency of

tonsil surgery (Table 3). Through a cross-sectional study, Doganer et al. (2015) found that the number of siblings does not affect the frequency of tonsil surgery (Table 3).

Environmental factors. In order to determine the association between ETS and the incidence of tonsillectomy, Straight et al. (2014) conducted a case-control study on children undergoing tonsillectomy for recurrent tonsillitis (case group) and those undergoing hernia repair (control group). The authors suggest an association between ETS and the incidence of tonsillectomy in chronic tonsillitis by demonstrating that exposure to contacts who smoke was more common in the case group than the control group (OR = 2.49, $p < 0.001$). In contrast, a cross-sectional study conducted by Cote et al. (2015) postulates that ETS exposure does not increase the incidence of tonsil surgery performed for sleep related breathing disorders in children aged under 2 ($p = 0.001$, Z-test). Additionally, Suvilehto et al. (2007) show no association between history of adenoidectomy and ETS exposure in individuals with tonsillitis who were candidates for tonsillectomy ($p = 0.1743$, Chi-square test).

Comorbidities. The current study identifies two investigations which examined the association between asthma and tonsil surgery. The first study, which assessed the prevalence of asthma among candidates for tonsillectomy, claims that asthma is more common among children under the age of 7 with a history of adenoidectomy than those with no history ($p = 0.015$, Chi-square test) (Suvilehto et al., 2007). However, according to the second study, there is no correlation between asthma and tonsil surgery ($p = 0.772$, Chi-square test) (Doganer et al., 2015).

Suvilehto et al. (2007) suggest that allergies are more common among candidates for tonsillectomy who have previously undergone adenoidectomy than those who did not

($p = 0.007$, Chi-square test). However, using immunological tests, Carr et al. (2007) find no evidence that allergies can affect the frequency of tonsil surgery performed for sleep apnea. Additionally, Doganer et al. (2015) determined that allergic diseases do not increase the frequency of tonsil surgery ($p = 0.102$, Chi-square test). Finally, no study suggests an association between tonsil surgery and serum IgE level, which indicates the presence of allergies (Carr, Obholzer, & Caulfield, 2007; Suvilehto et al., 2007).

Three studies assessed the effects of other health issues on the frequency of tonsil surgery (Table 3). Cote et al. (2007) propose that prematurity ($p = 0.0001$, Z-test) and Downs syndrome (0.0001, Z-test) are associated with tonsil surgery. Furthermore, Suvilehto et al. (2007) conclude that ear infections (otitis media with effusion) constitute a tonsil surgery comorbidity ($p < 0.00013$, Chi-square test). In their 2015 study, Doganer et al. consistently suggest that acute ear infections are more common among children who have undergone tonsil surgery ($p < 0.001$, Chi-square test). The results that are linked to an association between tonsil surgery and upper respiratory tract infections (URTI) are conflicting. While Doganer et al. (2015) propose that the prevalence of URTI is associated with tonsil surgery ($p = 0.001$, Chi-square test), Suvilehto et al. (2007) argue that having a history of adenoidectomy cannot change the frequency of URTI among candidates for tonsillectomy ($p = 0.0683$, Chi-square test). Finally, Doganer et al. suggest that a high BMI is a predictor of tonsil surgery (OR = 2.32, $p = 0.003$) (Table 3).

Discussion

All the included articles are observational studies; one has a case-control design, and 10 have cross-sectional designs. Almost no predictor (exposure) could be fully

controlled by investigators. As a result, the authors only use observational designs rather than trials, which should enable full control of independent variables (exposures).

Frequency of Tonsil Surgery. According to the results of this review, the studies that consider all age groups reveal that the annual incidence is from 88.9 to 159.2 per 100,000. However, studies which focus on lower age groups (under the age of 18) identify higher but also more variable incidence numbers. The variable rates of tonsillectomy may be linked to different perspectives regarding the indications and usefulness of tonsil surgery, among different physicians with different specialities and different geographical locations (Capper & Canter, 2001). Through a cross-sectional study conducted in the UK, Capper and Canter (2001) illustrate significant variations between physicians with different specialities in the definition of tonsillar diseases, the indications for tonsillectomy, and the expected benefits following tonsillectomy. This disagreement not only leads to differences in referring patients for tonsil surgery between general practitioners and pediatricians, but also affects the decision-making process of Ear, Nose, and Throat surgeons in performing tonsillectomy. Therefore, it can be concluded that doctors' attitudes towards tonsillar diseases and tonsillectomy influence the rate of the surgery in their areas of practice (Capper & Canter, 2001).

Demographic characteristics. The studies that focus on assessing the rates of tonsil surgery in various age groups reveal different results for age distribution. However, most of them suggested that tonsil surgery is more common in the under 20 age group than in other age groups. This finding is consistent with existing medical knowledge revealing that children have immunologically more active and larger tonsils compared to

adults. Consequently, the present review proposes age as a predictor of tonsil surgery (Table 4).

The results of seven related studies show less agreement regarding an association with sex. Nonetheless, those studies that limit their participants to lower age groups postulate that males have a higher risk for tonsil surgery than females. Therefore, in spite of the conflicting results, sex can be said to be an age-specific predictor of tonsil surgery (Table 4).

A higher risk of African Americans having tonsil surgery, which is revealed by Cote et al. (2015) and mentioned in the result of this review, has been also suggested by other studies. Lumeng et al. (2008) reveal that sleep disordered breathing, which is one of the main reasons for tonsil surgery (Lee et al., 2012), is more common among African Americans. Additionally, a study performed on American children with sleep apnea illustrates that African American ethnicity is associated with a 20% increase in the number of apnea attacks (Weinstock et al., 2014). An increase in the number of apnea attacks during sleep can elevate the risk of undergoing tonsil surgery (Baugh et al., 2011). However, the protective effects of Hispanic ethnicity against tonsil surgery have not been confirmed by other studies (Goodwin et al., 2003; Redline et al., 1999). Goodwin et al. (2003) mention that Hispanic children are more likely to have symptoms of sleep-disordered breathing compared to White children. Although assessed in only one study, it is proposed that race can be a predictor of tonsil surgery, since there is other evidence that suggests an association between race and tonsil surgery (Table 4).

According to three studies conducted in the USA, Italy, and England, the rates of tonsil surgery significantly vary among different geographical regions. Socio-economic

status may be responsible for some of this variability (Suleman et al., 2010). Environmental factors, such as temperature or uncertainty about the indications for surgery are other potential causes of the heterogeneity of tonsillectomy rates among geographical regions (Capper & Canter, 2001; Fedeli et al., 2009). Moreover, Boss et al. (2012) suggest that the physician-to-population ratio for otolaryngologists may also account for the non-homogeneity in tonsillectomy rates among different locations in a country. The authors further propose that people living in less populated areas are more prone to be candidates for tonsil surgery than residents of crowded cities. However, they do not provide reasons for the lower tonsil surgery rate in populated cities. Since all the articles that examine the geographical region of residence suggest an association between geographical region and tonsil surgery, it can be concluded that geographical variation can be a predictor of tonsil surgery (Table 4).

Socio-economic Status. Among socio-economic factors, family (household) income is the most controversial factor. Choi et al. (2014) reveal that children from low-income families face a higher risk for undergoing tonsillectomy surgeries compared to high-income families, but results of the study conducted by Doganer et al. (2015) do not confirm any association between family economic status and tonsil surgery. Additionally, two other studies illustrate conflicting results regarding the impact of family income on tonsillectomy frequencies. Cahit and Kaan (2010) suggest that students who belong to high-income families are more likely to undergo tonsil surgery, whereas Ozkırış et al. (2013) state that tonsil surgery rates are higher in children from low-income families. To assess the actual effects of family income on tonsil surgery rates, other factors such as health insurance coverage should be taken into account. For instance, in countries where

the general population does not have appropriate health insurance coverage, it is expected that low-income families are not in a position to afford the expenses of tonsillectomy procedures. Therefore, the frequency of tonsil surgery is bound to decline in this group. However, in countries with well-established social security and public health plans, children from low-income families more frequently undergo tonsil surgery (Boss et al., 2012). The 2015 study by Doganer et al. demonstrates that the father's educational level correlates with the rates of tonsil surgery, and attribute this correlation to increased paternal awareness and knowledge of health issues and health care systems. In contrast, some authors believe that parental educational level negatively correlates with the rates of tonsil surgery (Ozkırış et al., 2013) because the poor living conditions and lower quality of health care in families with minimum wages may increase the rates of tonsillar infections, which in turn increase the need for tonsil surgery. In this present review, tonsil surgery is not associated with the mother's educational level or the number of siblings.

Environmental factors. The damaging effect of smoking tobacco has been well-documented in the literature, as smoking is the cause of many health issues such as cancer or heart disease (Cb, 1991; Sturm, 2002). Tobacco smoke may be harmful, not only to smokers but also to bystanders, such as children, who are exposed to the smoke (Cook & Strachan, 1999). In a 1993 study, Hinton et al. (1993) suggest that parental smoking elevates the risk of tonsillitis and the incidence of tonsil surgeries in children by altering oropharyngeal flora, impairing mucociliary function, increasing cross infection or a combination of these. Straight et al. (2015) also propose that second-hand smoking elevates the frequency of tonsil surgery by increasing the rates of recurrent tonsillitis. It

should be noted that, after assessing the effects of ETS on children who underwent tonsil surgery for sleep apnea, Cote et al. (2015) claim that the surgery is not more common among the children of smokers compared to children of non-smokers. Therefore, according to the current review, the evidence for the association between the rate of tonsil surgery and ETS is conflicting

Co-morbidities. Individuals who undergo tonsil surgery may have other health issues. Cote et al. (2015) suggest that children with Down syndrome or prematurity have a higher risk for tonsil surgery. In addition, Doganer et al. (2015) propose that acute middle ear infections, upper respiratory tract infections, and high BMI are more common in children who have undergone tonsil surgery. Furthermore, Suvilehto et al. (2007) propose that diagnosed asthma and allergies are more common among children with previous adenoidectomy. However, it is not clear if individuals who have asthma and allergies are more prone to adenoidectomy or if adenoidectomy increases the rates of allergies and asthma. Moreover, Doganer et al. (2015) and Carr et al. (2007) were unable to find any association between tonsil surgery and each of asthma and allergies. Although some reviewed articles propose several co-morbidities, there is insufficient evidence to suggest that any of these health issues are associated with tonsil surgery (Table 4).

Table 4

Synthesis of the Systematic Review: Suggested and Assessed Predictors of Tonsil Surgery

Predictors	Articles suggested the association / assessed the association	Interpretation of the results
Age	**4** / 4	Associated
Geographical Regions	**3** / 3	Associated
Race	**1** / 1	Associated
Sex	**6** / 7	Conflicting results
Household Income	**1** / 2	Conflicting results
ETS	**1** / 3	Conflicting results
URTI	**1** / 2	Conflicting results
Allergies	**1** / 3	Conflicting results
Asthma	**1** / 2	Conflicting results
Paternal Education	**1** / 1	Limited evidence
High BMI	**1** / 1	Limited evidence
Down Syndrome	**1** / 1	Limited evidence
Middle Ear Infections	**2** / 2	Limited evidence
Prematurity	**1** / 1	Limited evidence
Maternal Education	**0** / 1	Not associated
Number of Siblings	**0** / 1	Not associated
IgE	**0** / 2	Not associated

Conclusions

This review proposes that tonsillectomy is a common surgical procedure. The global incidence of tonsil surgery in the general population is 88.9-159.2 per 100,000 annually. Children and young adults under the age of 20 have a higher risk for tonsillectomy than other age groups. This review suggests that the factors that affect the frequency of tonsil surgery are age, ethnicity, and geographical region of residence. However, there is limited evidence for an association between tonsil surgery and paternal educational level, prematurity, Down syndrome, otitis media, or high BMI. Furthermore, the evidence for an association between tonsil surgery and each of sex, household income, ETS, allergies, asthma, and URTI is conflicting. Additionally, this review finds no evidence that supports an association between tonsil surgery and each of maternal educational level, number of siblings, or serum IgE level. Therefore, the existing evidence is insufficient to support or disprove an association between tonsil surgery and most of the predictors that are assessed in this review. Further studies to evaluate the factors that can change the frequency of tonsil surgery will provide more information about these factors, and the frequency of tonsil surgery, as well as the disparities in incidence of the surgery among different population groups. Identifying actual predictors of tonsil surgery will help to eventually implement strategies to reduce the incidence of unnecessary tonsil surgery and the existing disparities, especially by controlling the modifiable predictors.

Chapter 3

Frequency and Predictors of Tonsil Surgery among Emirati Adolescents

Abstract

Tonsil surgery is a common procedure that improves quality of life but at the same time includes potential consequences and burdens society with significantly large costs. In the literature, some factors are suggested as predictors of tonsil surgery. By using the data collected from a survey conducted on 6,363 high school students in the UAE, the current study seeks to assess the frequency and predictors of tonsil surgery among Emirati students aged 13-20. Furthermore, since some diseases are potentially associated with tonsillectomy, the correlations between hearing loss, asthma, or hay fever and tonsil surgery are individually examined. The current study has found that tonsil surgery is associated with nationality, maternal educational level, pesticide/insecticide, indoor humidity, and hay fever symptoms (p value < 0.05 in chi-square test). However, after adjusting for potential confounders, multivariate analysis suggests that nationality is the only predictor of tonsil surgery and that nationals of Gulf Cooperation Council (GCC) countries other than the UAE are more likely to undergo tonsillectomy (p value < 0.05 in binary logistic regression test). Additionally, adding interaction terms to the regression model reveals that seafood consumption can decrease the rate of tonsil surgery in other GCC nationals and that pesticide/insecticide exposure increases the incidence of the surgery in the group of “other nationalities.”

Introduction

Tonsil surgery, which is one of the most common types of surgeries performed on children around the world, improves quality of life, mainly by treating obstructing tonsillar enlargement and infections of the tonsils. However, along with the advantages, tonsil removal includes several disadvantages. Serious surgical complications (such as postoperative bleeding and respiratory problems) and significant direct and indirect costs are the main disadvantages of tonsil surgery.

According to the literature, some considerations, such as demographic, socio-economic, and environmental factors, may predict the incidence of tonsil surgery. As examples , African Americans (a demographic factor) are more prone to tonsillectomy than other races in the USA and parental smoking (an environmental factor) elevates the risk of tonsillitis and frequency of tonsillectomy in children (Cote et al., 2015). However, since the evidence for the association between tonsil surgery and several predictors is limited and/or conflicting, these factors are still debatable. For instance, different studies provide conflicting results for the association between parental socio-economic status and the incidence of tonsil surgery. Doganer et al. (2015) suggest that tonsil surgery is associated with higher paternal educational levels among Turkish high school students while another study from the same country concludes that tonsil surgery is more prevalent among children with less educated parents (Ozkırış et al., 2013). Conclusively, further studies are needed not only to enhance current knowledge of predictors (which have already been introduced by other investigators) but also to determine new potential predictors of tonsil surgery.

The UAE, which consists of seven emirates (or states), is a small Arab country located in the Middle East in the south of the Persian Gulf (Appendix A). Since independence in 1971, the UAE has used oil wealth to develop the infrastructure of the country in different fields, such as industry, tourism, and health (Issa, 2009). As a result of the fast growing economy and low population, and to compensate for a work force shortage, the UAE has accepted a large number of immigrants who mostly come from other Asian regions. The immigrant population of the UAE is currently 88% (more than 9 million people). This large number of immigrants, together with a hot climate, rapid industrialization, and fast growing cities can potentially threaten the health of residents, through increasingly harmful factors such as infectious agents, air pollution, and stress. The ethnic, cultural, and economic diversity that exists in the UAE makes it an ideal location to assess the roles of the various factors that impact common diseases such as tonsillitis or asthma (Barakat-Haddad, 2013; Snoj, 2015).

Background study. The current study uses data collected by a comprehensive survey conducted in 2007 in the UAE. The original survey, which aimed to evaluate the health status of the UAE adolescents, includes valuable information that links with demographic factors, environment, life style, socioeconomic status, and health issues.

Population and sampling. A cohort of 6,363 high school students, aged 13-20, were randomly selected by use of a stratified sampling strategy. Based on school enrolment data from the Ministry of Education, 147 public and private secondary schools were randomly selected from 10 educational zones located in the seven emirates of the UAE. For selected schools that had more than one class per grade, one class from each grade was randomly selected. For the purpose of administering the developed surveys,

social workers employed by the UAE Ministry of Education attended training workshops and then collected completed surveys via two-component self-reporting questionnaires (Barakat-Haddad, Zhang, Siddiqua, & Dghaim, 2015).

Measurement tools. The survey created a modified version of the International Study of Asthma and Allergies in Childhood questionnaire which was originally produced in 1991 to examine asthma, allergic rhinitis, and eczema in children (Solé, Vanna, Yamada, Rizzo, & Naspitz, 1998). This two-component self-reporting questionnaire was previously modified, validated, and used in several studies (Barakat-Haddad, 2013; Barakat-Haddad & Siddiqua, 2014; Barakat-Haddad et al., 2015). The first component of the survey (Appendix G), which is linked to information on smoking behaviours, physical activity, diseases, symptoms in relation to respiratory health, and demographic and socio-economic data, was answered by the adolescent participants during a one-hour free period in a classroom setting. The second component of the survey (Appendix H), which was completed with parental assistance at home, collected data related to the number of previous residences and locations, as well as residential and neighborhood characteristics (Barakat-Haddad et al., 2015). Since the questionnaire includes some information related to participants' health issues such as surgery history and previous diseases, it has been used for purposes other than asthma and allergic diseases including cardiovascular and blood disorders (Barakat-Haddad, 2013; Barakat-Haddad & Siddiqua, 2014).

Research Design

This study uses a quantitative approach and a cross-sectional design to assess the frequency and predictors of tonsil surgery among adolescents who reside in the UAE.

The study is based on data from the National Study of Population Health in the UAE (2007–2009); a research programme that was developed in collaboration with the UAE Ministry of Education to examine the health status of the UAE adolescents.

Methods

Preparation of the dataset. The dataset was checked and analyzed using IBM SPSS version 23. After cleaning errors, inconsistencies, and outliers, a dependent variable was created by using the written information provided by the study participants. Regarding history of surgeries, all adolescents who mentioned any words that referred to tonsil surgery such as Lahmieh (meaning adenoids in Arabic) and Louz (meanings tonsils in Arabic) were considered to have history of tonsil surgery. Then, the data linked to several variables were recoded. Some variables such as sex could be directly used with no changes; however, others needed modifications. For instance, the variable linked with monthly family income, which is an ordinal variable with several categories, was recoded to a variable with two categories to draw more meaningful conclusions. The variables used in this study are described below.

Dependent variable. In the questionnaire (Part 1 - Question 40), participants were asked if they had had a surgical operation and, if so, to provide the reason for the surgery. A history of tonsil surgery is the outcome variable of this study. This variable is a two-level nominal (categorical) variable that includes all types of tonsil surgery: tonsillectomy, adenoidectomy, or adenotonsillectomy.

Independent variables. The following variables are the 21 potential predictors of tonsil surgery:

1. *Sex.* One question in the survey is: What is your sex? (Part 1 - Question 68). This predictor has two levels: male and female. Although the results are conflicting, the systematic review suggests that sex is associated with tonsil surgery.
2. *Nationality.* The participants claimed their nationalities in response to: What is your nationality? (Part 1 - Question 74). The categories of this 5-level categorical variable are:

    1) UAE
    2) Other Gulf Corporation Council (GCC) countries (Kuwait, Kingdom of Saudi Arabia, Oman, Qatar, Bahrain, and Yemen)
    3) Other Middle East Arab countries (Lebanon, Syria, Jordan, Palestine, and Iraq)
    4) South East Asia (India, Pakistan, Bangladesh, Sri Lanka, Philippines, and Indonesia)
    5) Other countries (including North Africa [Egypt, Tunisia, Morocco, Algeria, Libya, Sudan, Somalia, and Mauritania], Iran and Western countries)

    The literature reveals that race and geographical region of residence are predictors of tonsil surgery. Nationality is associated with both race and geographical region.

3. *Healthy diet and eating habits.* Three questions relate to healthy diet and good eating habits:

    1. On average, how many days do you eat fish or seafood per month? (Part 1 - Question 12)

2. Do you eat good food? (Part 2 - Question 17)

3. Do you have good eating and drinking habits? (Part 2 - Question 17).

The first example is a continuous variable that indicates the number of seafood servings per month. The other two variables are binary with categories of 'Yes' and 'No.' None of the predictors that were assessed in the review are linked to a healthy diet. However, existing data suggest that tonsillar enlargement is more prevalent among children who consume unhealthy foods (Gkouskou et al., 2010). Additionally, according to the review, high BMI, which can be caused by an unhealthy diet, is associated with tonsil surgery.

4. *Physical exercise.* A nominal variable was created using the question: Do you do physical exercise? (Part 1 - Question 17). This has two categories, based on participating or not in physical exercise. A high BMI, which was suggested by the review as a predictor of tonsil surgery, can be caused by physical inactivity. Therefore, physical inactivity may be associated with tonsil surgery.
5. *Father's educational level* and *mother's educational level.* Two questions separately focus on the highest level of education of participants' parents (Part 2 - Questions 28 and 29). Both of these independent variables were originally 10-level categorical variables that were recoded to a binary variable with categories of: 'completed high school' and 'not completed high school.' The review found limited evidence for the association between paternal educational level and tonsil surgery, and no evidence for an association between maternal educational level and the surgery. However, considering that only one study examined each of these

predictors, the association between parental educational level and tonsil surgery needs to be assessed in further studies.

6. *Household income.* The survey collected data on household income through the question: Could you please tell me how much income all members of your household receive every month? (Part 2 - Question 32). Family income is considered as a 2-level categorical variable with those who report a monthly family income at or below AED15,000 in one category versus those who report a family income greater than AED15,000. This classification was chosen based on a UAE Ministry of Economy report which reveals that the average monthly income for non-Emirati households is approximately AED15,000 (Bundhun, 2009). The review reveals that the results of an association between household income and tonsil surgery are conflicting and need to be re-evaluated by further studies.
7. *Residential crowding.* Two questions from the survey provide information about participants' residential crowding:
    a. How many people live in your household including yourself, relatives, and staff? (Part 2 - Question 4).
    b. How many bedrooms do you have in your home? (Part 1 - Question 77).

    The index of residential crowding, which is a ratio (numerical) variable, was calculated using the ratio for the number of individuals who reside in the household over the number of bedrooms in the house. In addition to parental educational levels and household income, the present study includes the index of crowding as an indicator of socio-economic status although, as far as can be

ascertained, the relationship between this index and tonsil surgery has not yet been assessed by any other study.

8. *Environmental tobacco smoke (ETS).* By asking how often the participants are exposed to tobacco smoke at home or with friends, the survey tried to indicate the existence and frequency of exposure to ETS, which is also referred to as second-hand smoke (Part 1 - Question 7). This ordinal variable, which is associated with passive smoking, was recoded to a binary variable with the categories of Exposed and Not exposed. According to the review, the results that relate to an association between ETS and tonsil surgery, are conflicting and should be reassessed in further studies.
9. *Outdoor air pollution.* This nominal (dichotomous) variable indicates an exposure to outdoor air pollution when the study participants live near an industrial plant, gas station, dump site, or major construction area (Part 2 - Question 22). The categories are Yes and No. Although the review identified no studies that assess the direct relationship between outdoor air pollution and tonsil surgery, it is suggested that living in neighbourhoods with air pollution may increase the incidence of habitual snoring (loud snoring more than two nights per week), which is one of the indications for tonsillectomy in students aged 6 to 12 (Kheirandish-Gozal et al., 2014).
10. *Indoor air pollution.* Two questions link with indoor air pollution:
    a. Are pesticides or insecticides ever used in your home, garden, or on your pet/s? (Part 2 - Question 19)

b. Do you or anyone in your household do arts, crafts, ceramics, stained glass work or similar hobbies on a regular basis? (Part 2 - Questions 20).

These variables are also binary variables with two categories of Yes and No. Although it is proposed that indoor air pollution may increase the symptoms of sleep apnea in children (Castañeda et al., 2013), no studies thoroughly examine the contribution of indoor air pollution to the frequency of tonsil surgery.

11. *Humidity.* Two binary variables, which indicate the level of humidity in participants' homes, were created based on these questions:
    a. Do you feel that your home is too humid? (Part 2 - Question 18)
    b. Are there any rooms in your home where you can see paint that is peeling, flaking or chipping off the walls, ceilings, doors or windows? (Part 2 - Question 16).

    Both variables have two categories: Yes and No. Several epidemiologic studies suggest that the rates of respiratory infections and allergies, which may be associated with tonsil surgery, increase among people working or living in environments with high relative humidity (Arlian & Platts-Mills, 2001; Arundel et al., 1986; Corey et al., 1997).
12. *Hearing loss.* The questionnaire includes questions regarding participants' ability to hear without a hearing aid in two situations: in a group conversation with at least three other people and in a conversation with one other person in a quiet room (Part 1 – Questions 22 and 23). Depending on the type of hearing loss, individuals may initially have difficulty in understanding speech in either the

presence of background noise (group conversation) or in a quiet room. When hearing loss worsens, they are bound to have hearing difficulty in both situations. Therefore, hearing was considered to be: normal, if participants could hear in both situations; mild to moderately impaired, if they could easily hear only in quiet or with background noise; and moderate to severely impaired, if they were not able to properly hear in both situations (with and without background noise). This variable is a three-level ordinal variable with categories of: No Hearing Loss; Mild to Moderate Hearing Loss; and Moderate to Severe Hearing Loss. The effects of adenoid enlargement and infection on otitis media with effusion (glue ear), which is one of the main causes of hearing loss in children, is proposed by several studies (Maw, 1985). However, recent studies debate the beneficial effects of tonsil surgery on middle ear status and hearing loss (Baugh et al., 2011). Therefore, the current study includes hearing loss to assess any association between this comorbidity and tonsil surgery.

13. *Hay fever (allergic rhinitis).* The survey asked participants if they were ever told by a health care professional that they have hay fever or other types of allergy (Part 1 - Question 31), and also if they had ever had a problem with sneezing, or a runny or blocked nose when they did not have a cold or the flu (Part 1 - Question 50). Two independent binary variables were created for these questions. The first indicates that hay fever is a diagnosis and the second refers to the symptoms of hay fever. Both variables have two categories: Yes and No. This study assesses the relationship between allergies and tonsil surgery since the systematic review reveals conflicting results for such an association.

14. Asthma. The participants are considered to have either a diagnosis of asthma or symptoms of asthma if they replied affirmatively to either of these questions:

a. Have you ever had asthma? (Part 1 - Question 47)
b. Have you ever had wheezing or whistling in the chest at any time in the past? (Part 1 - Question 42).

These variables are also binary variables. According to the review, one study suggests asthma to be associated with tonsil surgery while another study claims there is no association between allergies and the surgery. This co-morbidity, therefore, needs to be examined in further studies.

Missing Data. Missing data, which can potentially have significant effects on the results of data analysis as well as on the conclusions drawn from the data, are a common occurrence, especially when data are collected by self-report questionnaires. Therefore, in order to prevent any distortion of inference regarding the study population, it was decided to address the missing data of this study. The distribution of missing values was not uniform among different variables; many revealed no significant amount of missing values, while proportions of missing data in some variables were significant.

Data Analysis. In this phase, the information on study variables, which was extracted from different aspects of the questionnaire, such as lifestyle, health, and residence, was first analyzed by univariate statistical methods to create descriptive information such as the prevalence of each of the variables. Using bivariate and multivariate data analysis, any associations between tonsil surgery and independent variables were then assessed.

Univariate analysis (descriptive analysis). To individually explore the data in order to highlight the important aspects of each variable, univariate analysis was conducted for all variables. The categorical variables, both nominal and ordinal, were located in frequency tables to indicate the prevalence of the values of each variable in the study population. Seafood consumption and index of residential crowding, which are the continuous variables of the study, were examined by descriptive analysis to reveal characteristics such as mean and standard deviation. In order to achieve one of the primary objectives of the research, the present study is especially focused on identifying the prevalence of tonsillectomy in the sample population.

Bivariate analysis. The chi-square test is the main statistical test that was used to compare observed frequencies with expected frequencies in order to individually examine the association between the independent categorical variables such as sex and nationality, and tonsil surgery. An independent t-test was conducted to compare continuous variables such as sea food consumption in participants who had undergone tonsillectomy with those who had not. Significant association is defined as an association with p-value of less than 0.05 in the chi-square or independent t-test.

Multivariate analysis. Considering that the dependent variable is a binary variable, a logistic regression test was conducted to identify predictors of tonsil surgery. All variables with p-value of less than 0.1 in the chi-square or independent t-test were included in binary logistic regression models to control for confounding factors and, ultimately, identify the predictors of tonsil surgery. The binary logistic regression test was conducted by three methods: enter; forward stepwise (conditional); and backward stepwise (conditional). Additionally, in order to assess how a predictor can change the

effects of other predictors, interaction terms were added to the original logistic regression models. Therefore, there are six models for the logistic regression test, three with interactions and three without interactions. In order to ascertain how well the data fits the models, a Hosmer-Lemeshow test (a statistical test for goodness of fit) was then conducted. Furthermore, to determine how much variation in the study outcome was explained by each model, this study uses a McFadden's pseudo-R^2 test (likelihood ratio index). One of the logistic regression models (backward stepwise with interactions) was ultimately selected as the best model. All variables with significant p-value (less than 0.05) were examined in a new logistic regression test (enter method). Those variables and interactions with p-value of less than 0.05 are considered to be significant.

Missing Data Analysis. To manage the missing data, several steps were taken. First of all, missing data analysis was conducted to determine how many missing values existed in each variable and which of them could be significant. In addition, variables with a significant amount of missing data were identified, assuming a cut-off point of 15% for significance of missing data. Variables with significant amounts of missing data were then recoded to new binary variables with two categories: missing value and non-missing value. Furthermore, the frequency of sex, nationality, household income, parents' educational level, and tonsil surgery were assessed and compared between the missing values and non-missing values of each related variable. Finally, the results of the missing data analysis were interpreted to select the best fit missing data handling method.

Ethical Considerations. The original survey obtained ethical approval from the UAE Ministries of Education and Health. All participants' parents were informed by letter of the research objectives and methods a few days prior to the start of the survey

and asked for participation consent. Additionally, although not absolutely necessary to acquire research ethics clearance for working on secondary datasets, this study also obtained approval from the University of Ontario Institute of Technology Research Ethics Board.

Results

The current study included 6,363 students who completed the questionnaire with their parents. The results of descriptive analysis include frequency and proportion for categorical variables and mean and standard deviation for continuous variables (Table 5).

Table 5

Analysis of Results for Variables from the UAE Case Study

Variable	Valid Number	Values	Percent	Mean/SD
Tonsil surgery	6363			
		Negative	96.8	
		Positive	3.2	
Sex	6257			
		Male	44.7	
		Female	55.3	
Nationality	6223			
		UAE	49.3	
		Other GCC	5.7	
		Other Middle East	15.7	
		South East Asia	16.7	
		Other Nationalities	12.5	
Household Income	3882			
		Low	74.3	
		High	25.7	
Crowding Index	5065			2.39/1.38
Paternal Education	5098			
		Not completed HS	42.2	
		Completed HS	57.8	
Maternal Education	5130			
		Not completed HS	51	
		Completed HS	49	

Seafood Consumption	5532			7.58/7.20
Good Eating Habits	6192			
		No	27.4	
		Yes	72.6	
Eating Good Food	6213			
		No	62.4	
		Yes	37.6	
Physical Exercise	6220			
		No	43.2	
		Yes	56.8	
ETS	5443			
		No	60.5	
		Yes	39.5	
Outdoor Air Pollution	5247			
		No	84.4	
		Yes	25.6	
Pesticide/Insecticide	5114			
		No	27.8	
		Yes	72.2	
Art/Craft	5190			
		No	80.7	
		Yes	19.3	
Indoor Humidity	4849			
		No	81.7	
		Yes	18.3	
Peeling Paint	5097			
		No	59.9	
		Yes	40.1	
Hearing Loss	5643			
		No HL	88.2	
		Mild to Moderate HL	8.2	
		Moderate to severe HL	3.6	
Hay Fever Diagnosis	6214			
		No	94.7	
		Yes	5.3	
Hay Fever Symptoms	6140			
		No	65.6	
		Yes	34.4	
Asthma Diagnosis	6121			
		No	87.5	
		Yes	12.5	
Asthma Symptoms	6121			
		No	84.4	
		Yes	15.6	

Overall, 3.2% of the students had undergone at least one type of tonsil surgery: adenoidectomy, tonsillectomy, or adenotonsillectomy. 2,794 (44.7%) participants were male and 3,463 (55.3%) were female. 3,067 (49.3%) students were from the UAE and 3,156 (50.7%) were from other countries. Expatriates include nationalities of other GCC countries (5.7% of participants), other Middle East Arab countries (15.7% of participants), South East Asia (16.7% of participants), and other countries (12.6% of participants).

Regarding health behaviours, the results show that on average, participants consumed seafood 7.58 days per month (SD = 7.20). Additionally, 4,509 (72.6%) students ate good food to maintain their health and 2,328 (37.6%) participants believed that their eating and drinking habits were good. The analysis also shows that 3,531 (56.8%) students participated in physical exercise to promote their health.

According to the descriptive analysis of the socio-economic status of participants, 2,150 (42.2%) students' fathers and 2,614 (51%) students' mothers did not complete high school. Furthermore, 2,885 (74.3%) participants were from low-income families (household income at ADH 1,500 or below). The descriptive analysis also reveals that the crowding index, which is the ratio of the number of household residents over the number of household rooms, is 2.39 with standard deviation (SD) of 1.38.

The univariate analysis of the variables related to the environment shows that exposure to second hand smoke, pesticides or insecticides, and chemicals used in arts and crafts were mentioned by 2,150 (39.5%), 3,694 (72.2%), and1,003 (19.3%) students, respectively. Additionally, 819 (15.6%) participants were living in air-polluted areas, 887

(18.3%) participants agreed that humidity was high in their homes, and 2044 (40.1%) individuals could see peeling or flaking paint in their residences.

According to the analysis of the health-related variables, 665 (11.8%) students claimed that they had hearing problems, 8.2% had mild to moderate hearing loss and 3.6% had moderate to severe hearing loss. Furthermore, although 2,121 (34.4%) participants had symptoms of hay fever, only 331 (5.3%) participants were diagnosed by a doctor as having hay fever or other allergies. Finally, 763 (12.5%) students had a diagnosis of asthma, while 953 (15.6%) stated that they had experienced symptoms of asthma.

A Pearson chi-square test and an independent t-test were used to assess the associations between each study independent variable and tonsil surgery (study dependent variable). The results of bivariate analyses are expressed by X^2 and p-value for the chi-square test used for categorical independent variables, and t and p-value for the t-test used for independent continuous variables (Table 6).

Table 6

Bivariate Analysis of Results from the UAE Sample in Relation to Tonsil Surgery (n=6,363)

Variables	Valid Number	t	t-Test p-value	X^2	Chi-Square p-value
Sex	6257			0.111	0.739
Nationality	6223			**34.554**	**P<0.001**
Household Income	3882				0.631
Crowding Index	5065	0.481	0.631		
Father's Educational Level	5098			0.850	0.357
Mother's Educational Level	5130			**5.449**	**0.020**
Seafood Consumption	5532	1.872	0.063		
Good Eating Habits	6192			0.054	0.816
Eating Good Food	6213			1.398	0.237
Physical Exercise	6220			0.054	0.816
ETS	5443			1.470	0.225
Outdoor Air Pollution	5247			0.498	0.480
Pesticide/Insecticide	5114			**4.589**	**0.032**
Art/Craft	5190			0.254	0.614
Indoor Humidity	4849			**5.348**	**0.021**
Peeling Paint	5097			2.027	0.155
Hearing loss	5643			0.444	0.801
Hay Fever Diagnosis	6214			0.536	0.464
Hay Fever Symptoms	6140			**10.687**	**0.001**
Asthma Diagnosis	6121			3.546	0.060
Asthma Symptoms	6121			1.776	0.183

In the Pearson chi-square test, no association was found between sex and a history of tonsil surgery ($X^2 \geq 0.111$, $p = 0.739$). Regarding participants' nationality, including two variables of nationals of the UAE and expatriates, the Pearson chi-square test indicates no association between having UAE nationality and history of tonsil surgery ($X^2 \geq 0.432$, $p = 0.511$). However, when participants were categorized into five groups of nationalities (the UAE, other GCC, other Middle East Arab, South East Asia, other nationalities), the Pearson chi-square revealed an association between a participant's nationality and history of tonsil surgery ($X^2 \geq 46.861$, $p < 0.001$).

Considering that seafood consumption is a continuous variable, an independent t-test was used to compare the frequency of seafood consumption by participants who had undergone tonsil surgery with those who had not. Additionally, the present study uses Levene's test to indicate whether the variances are equal across the two groups. Assuming that the variances are not equal across the groups (p-value of Levene's test = 0.002), the independent t-test was unable to illustrate any association between the frequency of seafood intake and incidence of tonsil surgery ($t = 1.872$, $p = 0.063$, respectively). However, given that the p-value of the independent t-test is less than 0.1, which is the required score for entering the multivariate analysis, this variable was included in the logistic regression test. The results of the bivariate analysis of other variables linked with health behaviours shows that tonsil surgery is not associated with eating good food ($X^2 \geq 1.398$, $p = 0.237$), eating habits ($X^2 \geq 0.54$, $p = 0.816$), and physical exercise ($X^2 \geq 0.54$, $p = 0.816$).

According to the bivariate analysis of the socio-economic variables, the Pearson chi-square test suggests an association between maternal educational level and tonsil surgery ($X^2 \geq 5.449$, $p = 0.020$). However, this test does not suggest any associations between tonsil surgery and each of paternal educational level ($X^2 \geq 0.850$, $p = 0.357$) and household income ($X^2 \geq 0.029$, $p = 0.864$). The independent t-test (equal variances in Levene's test, p=0.169) reveals that the crowding index shows no significant difference between participants who had undergone tonsil surgery and those who had not ($t = 0.481$, $p = 0.631$).

According to the Pearson chi-square test performed for environment related variables, there is no association between tonsil surgery and each of ETS ($X^2 \geq 1.470$, $p =$

0.225), outdoor air pollution ($X^2 \geq 0.498$, $p = 0.480$), and chemicals used in arts or crafts ($X^2 \geq 0.254$, $p = 0.614$). However, the Pearson chi-square test suggests that there is an association between exposure to pesticides or insecticides and tonsil surgery ($X^2 \geq 4.589$, $p = 0.032$). Regarding the variables related to humidity, indoor humidity can increase the rates of tonsil surgery ($X^2 \geq 5.348$, $p = 0.021$), while the chi-square test does not reveal an association between seeing peeling or flaking paint at home and tonsil surgery ($X^2 \geq 2.027$, $p = 0.155$).

The results of the Pearson chi-square test for health related variables reveals that tonsil surgery is not associated with each of hearing loss ($X^2 \geq 0.444$, $p = 0.801$) and hay fever diagnosis ($X^2 \geq 0.536$, $p = 0.464$). However, the test suggests an association between symptoms of hay fever and tonsil surgery ($X^2 \geq 10.687$, $p = 0.001$). Based on the results of the bivariate analysis, tonsil surgery is not associated with either asthma symptoms ($X^2 \geq 1.776$, $p = 0.183$) or diagnosis ($X^2 \geq 3.546$, $p = 0.060$). However, since all variables with p-value of less than 0.1 in the chi-square test are qualified to participate in the logistic regression test, this study includes the variable related to asthma diagnosis in the multivariate analysis.

All variables that reveal significant results in the bivariate analysis are included in the six models of a multivariate analysis (binary logistic regression test). The included categorical variables are nationality, maternal educational level, indoor humidity, pesticide/insecticide, symptoms of allergy, and diagnosis of asthma, all of which have p-values of less than 0.1 in the chi-square test. The only included continuous variable is seafood consumption, which has a p-value of less than 0.1 in the t-test. According to the

Hosmer-Lemeshow test results, the p-values were greater than 0.05 for all models (Table 7).

Table 7

Goodness of Fit Results for the Logistic Regression Models of the UAE Case Study

Model	Hosmer & Lemeshow (p-value)	McFadden's-R^2
Enter (No interactions)	0.543	0.041
Forward (No interactions)	0.828	0.037
Backward (No interactions)	0.828	0.037
Enter (With interactions)	0.816	0.078
Forward (With interactions)	0.593	0.036
Backward (With interactions)	0.480	0.063
New Enter (With interactions)	0.826	0.057

Hence, it can be concluded that each of these logistic regression models is a good fit for the study data (Schoonjans, 2017). Additionally, the results of McFadden's pseudo-R^2 test illustrate no significant differences in explaining the outcome variation among the models, although the enter model performed slightly better than the others on the McFadden test (Table 7). Considering the results of the Hosmer-Lemeshow and McFadden tests, and based on the number of significant variables for each model, backward stepwise with interactions was selected as the best model (Table 8). All significant variables and interactions, in addition to the variables that participate in these interactions, were then included in a binary logistic regression (enter method).

Table 8

Best Fit Model of Predictors of Tonsil Surgery in the UAE Case Study

Variables	Reference Category	Categorization	OR	95% CI
Nationality	UAE			
		Other GCC	**8.224***	**2.127 - 31.802**
		Other Middle East	0.782	0.291 - 2.100
		South East Asia	0.502	0.122 - 2.062
		Other Nationalities	0.665	0.199 - 2.223
Nationality by Pesticide/Insecticide	UAE/ No			
		Other GCC/Yes	0.413	0.106 - 1.618
		Other Middle East/ Yes	1.692	0.690 - 4.148
		South East Asia/ Yes	1.221	0.263 - 5.666
		Other Nationalities/ Yes	**3.386***	**1.117 - 10.264**
Seafood by Nationality	Increasing/ UAE			
		Increasing/ Other GCC	**0.803***	**0.653 - 0.989**
		Increasing/ Other Middle East	1.016	0.948 - 1.088
		Increasing/ South East Asia	0.882	0.755 - 1.031
		Increasing/ Other Nationalities	0.980	0.894 - 1.074
Maternal Education by Hay Fever (Symptoms)	Not completed high school/ No	Completed high school/ Yes	1.507	0.965 - 2.354
Seafood by Maternal Education	Increasing/ Not completed high school	Increasing/ Completed high school	**1.061***	**1.017 - 1.108**
Indoor Humidity by Pesticide/Insecticide	Low/ No	High/ Yes	**2.142***	**1.372 - 3.344**
Seafood by Pesticide Insecticide	Increasing/ No	Increasing/ Yes	**0.946***	**0.908 - 0.987**

* $P < 0.05$

The results of this final logistic regression test (Table 9) reveal that tonsil surgery is more common in nationals of other GCC countries (OR = 8.616, 95% CI 1.889-39.298, p = 0.005). Furthermore, exposure to pesticides or insecticide increases the incidence of tonsil surgery among "other nationalities" category (OR = 3.840, 95% CI 1.042-14.155, p = 0.043). However, seafood consumption reduces the incidence of tonsil surgery among nationals of other GCC countries (OR = 0.780, 95% CI 0.629-0.967, p = 0.024).

Table 9

Final Logistic Regression Model for Predictors of Tonsil Surgery for the UAE Case study

Variables	Reference Category	Categorization	OR	95% CI
Nationality	UAE			
		Other GCC	**8.616***	**1.889-39.298**
		Other Middle East	0.741	0.231-2.375
		Southeast Asia	0.441	0.090-2.158
		Other Nationalities	0.612	0.159-2.353
Maternal education	Not completed HS	Completed HS	1.419	0.776-2.593
Indoor Humidity	Low	High	1.202	0.468-3.089
Pesticide/Insecticide	No	Yes	0.895	0.341-2.351
Seafood	Continuous	Increasing	1.023	0.957-1.094
Nationality by Pesticide/Insecticide	UAE / No			
		Other GCC/ Yes	0.452	0094-2.164
		Other Middle East/ Yes	1.857	0.616-5.601
		Southeast Asia/ Yes	1.369	0.247-7.592
		Other Nationalities/ Yes	**3.840***	**1.042-14.155**
Seafood by Nationality	Increasing / UAE			
Seafood by Other GCC		Increasing/ Other GCC	**0.780***	**0.629-0.967**
Seafood by Other Middle East		Increasing/ Other Middle East	1.015	0.943-1.093
Seafood by Southeast Asia		Increasing/ Southeast Asia	0.885	0.753-1.040

Seafood by Other Nationalities		Increasing/ Other nationalities	0.975	0.888-1.072
Seafood by Maternal education		Increasing/ Completed HS	1.025	0.963-1.091
Indoor Humidity by Pesticide/Insecticide		High/ Yes	1.770	0.623-5.030
Seafood by Pesticide/Insecticide		Increasing/ Yes	0.958	0.899-1.021

* $p < 0.05$

Missing data analysis reveals that the independent variables with significant amounts of missing data are crowding Index, household income, outdoor air pollution, pesticide/insecticide, art/craft, paint peeling, indoor humidity, father's education, and mother's education (Table 10).

Table 10

Frequency and Proportion of Missing Data for the Independent Variables of the UAE Case Study

	Variables	Frequency of Not Missing Data	Missing Data	
			Frequency	Proportion
1	Sex	6257	106	1.7
2	Nationality	6223	140	2.2
3	Household Income	3882	2481	**39.0**
4	Crowding Index	5224	1139	**17.9**
5	Father's Education	5098	1265	**19.9**
6	Mother's Education	5130	1233	**19.4**
7	Seafood (Quantitative)	5719	644	10.1
8	Good Eating Habits	6192	171	2.7
9	Eating Good Food	6213	150	2.4
10	Physical Exercise	6220	143	2.2
11	ETS	5443	920	14.5
12	Outdoor Air Pollution	5247	1116	**17.5**
13	Pesticide/Insecticide	5114	1249	**19.6**
14	Art/Craft	5190	1173	**18.4**
15	Indoor Humidity	4849	1514	**23.8**
16	Paint Peeling	5097	1266	**19.9**
17	Hearing Loss	5643	720	11.3

18	Hay Fever (Diagnosis)	6214	149	2.3
19	Hay Fever (Symptoms)	6140	223	3.5
20	Asthma (Diagnosis)	6121	242	3.8
21	Asthma (Symptoms)	6121	242	3.8

According to the results of the missing data analysis, there are associations between nationality and missing values of all variables. Participants who were from the UAE, and to a much lesser extent those who belong to the 'other nationalities' group, reveal higher rates of missing values than other participants. In most variables, having a less educated parent/s increases the rate of missing data. However, missing values of outdoor air pollution, pesticide/insecticide, and mother's educational level are independent of parents' education. Being male is associated with higher rates of missing data in art/craft and mother's educational level, but not with other variables. Finally, peeling paint is the only variable where missing values are associated with tonsil surgery, the study outcome variable (Table11).

Table 11

Results of the Bivariate Analysis (Chi-square Test) of the Characteristics of the Missing Data (Assessment the Association between the Missing Data and Five Study Variables)

	Attributes / Missing Data	Tonsil Surgery	Sex	Nationality	Father's Education	Mother's Education	Income
1	Crowding Index	0.154	0.899	**<0.001**	**0.002**	**0.004**	0.219
2	Household Income	0.251	0.070	**<0.001**	**<0.001**	**<0.001**	N/A
3	Outdoor Air Pollution	0.115	0.178	**0.002**	0.336	0.286	0.809
4	Pesticide/Insecticide	0.355	0.152	**<0.001**	0.177	0.198	**0.018**
5	Art/Craft	0.635	**0.012**	**<0.001**	**<0.001**	**<0.001**	0.556
6	Paint Peeling	**0.038**	0.274	**<0.001**	0.138	**<0.001**	0.453
7	Household Humidity	0.340	0.380	**<0.001**	**<0.001**	**<0.001**	**0.019**
8	Father's Education	0.407	0.065	**<0.001**	N/A	**<0.001**	0.058
9	Mother's Education	0.509	**0.001**	**<0.001**	0.089	N/A	0.052

Discussion

This cross-sectional study reveals that 3.2% of adolescents who reside in the UAE had undergone adenoidectomy, tonsillectomy, and adenotonsillectomy, a proportion that appears to be relatively lower than other countries. Various frequencies of tonsil surgery have been reported worldwide. For example, in 2012, the prevalence of tonsil surgery was 7.9% among Turkish children aged 6-13 (Ozkırış et al., 2013) while a survey conducted in Finland in 1998 illustrated that the prevalence of the surgery was approximately 32% among people aged 10-27 (Mattila et al., 2001). The lower rates of tonsil surgery in the UAE can be due to by several factors. Firstly, the majority of the UAE population are expatriates who mostly have a lower socio-economic status compared to UAE nationals and, in spite of that, have to pay for their healthcare costs and health insurance by themselves (Berthier, 2013). Therefore, it is possible that many parents of the children who need a tonsillectomy are not able to afford the surgery costs. Additionally, the need for tonsil surgery may decline in the warm weather of the UAE due to a reduction in the rates of tonsillar infections (Materia et al., 2004). In Turkey, the prevalence of tonsillectomy is higher in the eastern part, where the weather is cold, than the western part, where the weather is moderate (Polat & Demirören, 2010; Topal, Kara, Bozkurt, & Saatci, 2013). Furthermore, doctors' attitudes to tonsillar diseases and tonsillectomy may influence the rate of the surgery (Capper & Canter, 2001). Capper and Canter (2001) illustrate significant variations between physicians with different specialities in the definition of tonsillar diseases, the indications for tonsillectomy, and the expected benefits following tonsillectomy. This disagreement not only causes differences in referring patients for tonsil surgery between general practitioners and

pediatricians but also affects the decision-making processes of ENT surgeons for performing tonsillectomy. Finally, other factors, such as physician-to-population ratios for otolaryngologists and the prevalence of underlying diseases, can influence the incidence of the surgery (Boss et al., 2012).

The current study was unable to find any associations between sex and tonsil surgery. However, according to studies that assess the age-specific rates of the surgery and those that separately estimate the rates for adenoidectomy, tonsillectomy, and adenotonsillectomy, sex influences the frequency of the surgery (Bluestone, 2003). In children under the age of 9, tonsil surgery is more common among boys than girls (Bluestone, 2003; Cote et al., 2015; Fedeli et al., 2009). Furthermore, adenoidectomy is more commonly performed in males than females whereas the frequency of tonsillectomy is higher in females compared to males (Bluestone, 2003). Studies that take into account all age groups and all types of tonsil surgery report conflicting results regarding the association between sex and tonsil surgery (Al-Hussaini et al., 2013; Choi et al., 2014; Vestergaard et al., 2007). These conflicting results mostly relate to the individual perspectives of practitioners regarding the benefits of and indications for tonsil surgery (Capper & Canter, 2001).

The study illustrates that about half of the study participants (49.3%) are from the UAE while according to estimates nationals comprise about 11% of the UAE population as a whole (Snoj, 2015). While education is free for citizens, non-citizens have to pay fees in order to attend school. Therefore, it is expected that expatriates with a lower socio-economic status are not able to afford their children's school costs (Bennett, 2013). Additionally, more than half of expatriates are not allowed to bring their families to the

UAE due to limitations applied by the Emirati government (De Bel-Air, 2015). These factors have increased the proportion of domestic students in UAE schools compared to the nondomestic students. When all groups of nationalities are considered, the Pearson chi-square test suggests an association between nationality and tonsil surgery. This means that frequencies of tonsil surgery are different among different nationality groups.

Gkouskou et al. (2010) illustrate that an unhealthy diet such as sugary products, soft drinks, and edible fats is more common among children with tonsillar enlargement than those with normal tonsils. However, no studies assesse the direct effects of an unhealthy life style on the rate of tonsillectomy. The results of this present study do not suggest an association between seafood consumption, good food, good eating habits, or physical exercise and the incidence of tonsil surgery. However, there is a need for further studies to examine a possible association between lifestyle and tonsil surgery.

By combining different predictors such as parental educational level, family income, and number of siblings, several authors have tried to create socio-economic status models and illustrate that the socio-economic characteristics of family are influential factors on the frequency of the surgery (Doganer et al., 2015; Ozkırış et al., 2013). To assess the effects of each socio-economic factor on the frequency of tonsil surgery, instead of using a combination of socio-economic factors as a model, this study includes four socio-economic factors: paternal education, maternal education, household income, and residential crowding. Doganer et al. (2015) were unable to establish any association between household income and rates of tonsil surgery. However, Ozkiris et al. (2013) report that students from low-income families and with parents with an educational level lower than a university degree are at risk of having adenoidectomy,

tonsillectomy, or adenotonsillectomy. Choi et al. (2014) also reveal that Korean children from low-income families face a higher risk for undergoing tonsil surgeries compared to high-income families. On the contrary, Cahit and Kaan (2010) mention that incidence of tonsil surgery is higher among children with more educated and wealthier parents. In the present study, household income and paternal educational level are not associated with the rate of tonsil surgery. However, participants whose mothers completed high school were more likely to undergo a type of tonsil surgery. This may be attributed to increased maternal awareness and knowledge of health issues (Cahit & Kaan, 2010). In addition to the above socio-economic variables, this study includes the crowding index to assess the effects of crowded homes on the incidence of tonsillectomy among Emirati students. According to the results of the independent t-test, this factor does not impact the frequency of the surgeries among study participants.

The damaging effect of tobacco smoke has been well-documented in the literature, as smoking is the cause of many health issues such as cancer or heart disease (Cb, 1991; Sturm, 2002). Tobacco smoke may be harmful not only to smokers but also to bystanders, such as children, who are exposed to the smoke (Cook & Strachan, 1999). Hinton et al. (1993) demonstrate that parental smoking elevates the risk of tonsillitis and the incidence of tonsil surgeries in children by altering oropharyngeal flora, impairing mucociliary function, increasing cross infection or a combination of these. Straight et al. (2015) consistently suggest that second-hand smoking elevates the rates of tonsil surgery by increasing the rates of recurrent tonsillitis. Contrary to these findings, assessing the effects of ETS on children who had undergone tonsil surgery for sleep apnea, Cote et al. (2015) demonstrate that the surgery is no more common among children of smokers than

of non-smokers. The results of bivariate analysis of the current study do not reveal any association between ETS and the rate of tonsil surgery. Therefore, the relationship between ETS and tonsil surgery needs to be further examined in subsequent studies.

Several studies examine the contribution of outdoor and indoor air pollution to the frequency of adenoidectomy and tonsillectomy. By assessing the effects of outdoor air pollution on Iranian students aged 6 to 12, a study by Kheirandish-Gozal et al. (2014) suggests that living in neighbourhoods with air pollution may increase the incidence of habitual snoring (loud snoring more than two nights per week), which is one of the reasons for tonsillectomy. Additionally, in order to evaluate the effects of indoor air pollution on tonsillar diseases in Peru, investigators claim that an improvement in traditional wood-burning stoves decreases the symptoms of sleep apnea in children (Castañeda et al., 2013). However, no studies directly assess the role of air pollution in increasing the frequency of tonsil surgery. According to the results of the present study, neither outdoor air pollution nor chemicals used in arts and crafts, which are included in this study as indicators of indoor air pollution, impact the rate of the surgery. However, bivariate analysis reveals that participants who had undergone tonsil surgery are more likely to have a history of exposure to pesticide or insecticides. In conclusion, there is limited evidence for an association between air pollution and tonsil surgery.

Several epidemiologic studies suggest that the incidence of respiratory infections increases among people working or living in environments with high relative humidity levels. Both mite and fungal populations are maximized when the relative humidity exceeds 60% (Arundel et al., 1986). These agents can trigger allergic reactions such as allergic rhinitis or asthma (Arlian & Platts-Mills, 2001; Corey et al., 1997). High relative

humidity also increases the concentration levels of several chemicals present in indoor building materials (Arundel et al., 1986). One such example is formaldehyde, which is a common cause of allergy (De Groot et al., 2009). It has been suggested that allergic rhinitis is an influential factor in increasing the incidence of adenoidectomy, tonsillectomy, and adenotonsillectomy (Huang & Giannoni, 2001; Sadeghi-Shabestari et al., 2011). Therefore, individuals who live in places with higher humidity are prone to tonsil surgery. The results of the current study reveal that living in homes with high humidity elevates the rate of tonsil surgery. However, peeling and flaking paint, which is the second independent variable related to indoor humidity, is not associated with the surgery. Although the evidence for an association between indoor humidity and tonsil surgery is still insufficient, some indications suggest such an association.

Otitis media with effusion (glue ear) is one of the main causes of hearing loss in children (Dhooge, 2003; Hunter, Margolis, & G. Giebink, 1994). Furthermore, several articles suggest that adenoidectomy is useful for children with otitis media with effusion (Boonacker et al., 2014; Higgins, 2017; Maw, 1985; Takahashi, Fujita, & Honjo, 1989; van den Aardweg, Schilder, Herkert, Boonacker, & Rovers, 2010). Additionally, the clinical practice guidelines of the American Academy of Otolaryngology-Head and Neck Surgery recommend adenoidectomy for otitis media with effusion in children over the age of 4 (Rosenfeld et al., 2016). However, some studies claim that tonsil surgery has no significant effects on otitis media with effusion (Hibbert & Stell, 1982). The results of the present study consistently demonstrate that there are no differences in the rates of tonsil surgery among children with normal hearing, those with mild to moderate hearing loss, and those with moderate to severe hearing loss.

Associations between different types of allergies and enlargement of the adenoids and palatine tonsils are suggested in several studies. Modrzynski and Zawisza (2007) propose that the rate of adenoid enlargement is greater in children with allergic rhinitis than non-allergic children. Additionally, after comparing two groups of children with and without adenotonsillar enlargement, Sadeghi-Shabestari et al. (2011) conclude that allergy control may reduce rates of adenotonsillectomy in allergic children. Furthermore, Olusesi et al. (2013) suggest that, in addition to allergic rhinitis, other types of allergy, such as atopic dermatitis (skin allergy), affect the frequency and age distribution of tonsil surgery by increasing the rates of early onset enlargement of the adenoids, palatine tonsils, or both. On the contrary, some studies state that allergy is not associated with tonsillectomy. For instance, using a cohort study design, van Hattum et al. (2006) found no association between the rates of adeno-tonsillar surgery and hay fever. The results of the present study illustrate that the incidence of tonsil surgery is not greater in students with a diagnosis of hay fever. However, the participants with symptoms of hay fever were more prone to tonsil surgery than those without. Therefore, the role of allergy in increasing the frequency of tonsil surgery is still debatable.

Asthma, which is inflammation of the lower airways due to allergic reactions, is a predictor of severe sleep apnea (Ramagopal et al., 2009). Therefore, children with asthma are more likely to have tonsil surgery. Additionally, adenotonsillar surgery can improve asthma (Bhattacharjee, Choi, Gozal, & Mokhlesi, 2014; Busino, Quraishi, Aguila, Montalvo, & Connelly, 2010; Levin et al., 2014). Considering that asthma increases the incidence of tonsil surgery and that the surgery reduces the symptoms of asthma, it is expected that a cross-sectional study is not able to illustrate an association between

asthma and tonsil surgery. According to the results of this study, neither diagnosis nor symptoms of asthma are associated with tonsil surgery.

According to the results of the binary logistic regression, nationality is the only predictor of tonsil surgery and nationals of other GCC countries are more likely to undergo tonsil surgery than other participants. The reason for this association is unknown and should be assessed in further studies.

Contrary to the results of the bivariate analysis, the multivariate analysis demonstrates no significant association between tonsil surgery and each of maternal educational level, pesticide/insecticide exposure, indoor humidity, and hay fever symptoms. However, when interaction terms are taken into account, the logistic regression demonstrates that seafood consumption can decrease the rate of the surgery in other GCC nationals. It is suggested that seafood consumption can prevent those diseases, such as sleep apnea, that increase the rate of tonsil surgery (Lam, Mak, & Ip, 2012). However, it is not clear why seafood consumption was not beneficial for other participants in this study. Additionally, due to unrecognized reasons, exposure to pesticides/insecticides increased the risk of tonsil surgery among the group of “other nationalities.”

Missing data. According to the results of binary logistic regression, three variables can directly or indirectly affect the rate of tonsil surgery: nationality, seafood consumption, and pesticide/insecticide exposure. Missing values of nationality and seafood consumption are not significant. However, pesticide/insecticide exposure includes a significant number of missing values, therefore, the results that are related to this variable should be interpreted with caution. Considering that all missing data

handling methods have some disadvantages, conclusions drawn from these methods are not completely reliable (Joseph, Bélisle, Tamim, & Sampalis, 2004). Therefore, to deal with the missing data, the present study uses pairwise deletion for bivariate analysis and listwise deletion for multivariate analysis while mentioning the frequencies of the missing data and associations between the data and other variables.

Conclusions

The current cross-sectional study assesses the frequency and predictors of tonsil surgery among Emirati high school students. According to descriptive analysis, the prevalence of tonsil surgery is 3.2% among adolescents in the UAE. The bivariate analysis proposes that five independent variables (out of 21 included variables) are associated with tonsil surgery ($p < 0.05$ in the chi-square test): nationality, maternal educational level, pesticide/insecticide exposure, indoor humidity, and hay fever symptoms. However, the chi-square test fails to reveal any association between tonsil surgery and the other 16 independent variables: sex, household income, crowding index, paternal educational level, seafood consumption, eating good food, good eating habits, physical exercise, ETS, outdoor air pollution, arts/crafts; peeling paint, hearing loss, hay fever diagnosis, and asthma symptoms.

However, after adjusting for potential confounders, multivariate analysis suggests that nationality is the only predictor of tonsil surgery and that nationals of other GCC countries are more likely to undergo tonsillectomy. Additionally, after interaction terms are considered, it is proposed that seafood consumption can decrease the rate of tonsil surgery in other GCC countries and that pesticide/insecticide exposure increases the incidence of the surgery in the group of “other nationalities”.

Chapter 4

General Discussion and Conclusions

Drawing Parallels between the Systematic Review and the Case Study

The present study, which assesses the frequency and predictors of tonsil surgery, was conducted in two phases: a systematic review and a case study from the UAE. The systematic review examines the existing evidence for the frequency and predictors of tonsil surgery in any age group and any geographical location. However, the case study assesses the frequency and predictors of the surgery among high school students in the UAE. The predictors that are assessed in the current study can be categorized into three groups. The first group includes predictors, such as prematurity and Dawn syndrome, which are only included in the systematic review. The predictors of the second group are those that are examined only in the case study, such as indoor humidity and seafood consumption. The predictors that are shared in both phases, such as ETS and sex, form the final group. Comparing the results of the systematic review and case study phases for the predictors that belong to the final group delivers an improved understanding of the predictors of tonsil surgery.

Variables Assessed only in the Systematic Review

Eight independent variables are assessed only by systematic review. This review has identified some evidence for an association between tonsil surgery and each of age, geographical location, ear infections, URTI, high BMI, Down syndrome, and prematurity. However, the review has found no evidence for an association between tonsil surgery and the number of siblings.

The studies that consider age as an independent variable reveal different results for age-specific frequencies of tonsil surgery. This is mainly because the investigations include participants with different age ranges and use different age groups for age categorization. However, three studies, which examine all age groups, suggest that tonsil surgery is more common in the under 20 age groups than in other age groups.

The systematic review included in this present investigation suggests that geographical region of residence is a predictor of tonsil surgery based on the fact that all three studies that examine geographical region of residence identify such an association. However, the association between tonsil surgery and each of high BMI, Down syndrome, and prematurity are assessed and suggested by only one study. Middle ear infection was found to be a predictor of tonsil surgery in two studies. However, these studies examined two different types of middle ear infections (acute and chronic), meaning that each type of middle infection is only examined and proposed by one investigation. Furthermore, the results for URTI, which are included in two studies, are conflicting. Therefore, there is not sufficient evidence for considering high BMI, Down syndrome, prematurity, middle ear infections, and URTI as predictors of tonsil surgery.

Variables Assessed only in the UAE Case Study

Eleven (out of 21) independent variables are assessed only in the case study. According to the bivariate analysis of this study, indoor humidity and pesticide/insecticide exposure are associated with tonsil surgery. However, the other nine variables (crowding index, seafood consumption, eating good food, good eating habits, physical exercise, outdoor air pollution, arts/crafts, peeling paint, and hearing loss) are not found to be associated with the surgery.

Several epidemiologic studies suggest that the incidence of respiratory infections increases among people working or living in environments with high relative humidity. Both mite and fungal population are maximized when the relative humidity level exceeds 60% (Arundel et al., 1986). These agents can trigger allergic reactions such as hay fever or asthma (Arlian & Platts-Mills, 2001; Corey et al., 1997). High relative humidity also increases the concentration levels of several chemicals, including formaldehyde, which are used in indoor building materials (Arundel et al., 1986) and are a common cause of allergy (De Groot et al., 2009). It is suggested that allergic rhinitis is an influential factor in increasing the incidence of adenoidectomy, tonsillectomy, and adenotonsillectomy (Huang & Giannoni, 2001; Sadeghi-Shabestari et al., 2011). Therefore, individuals who live in places with higher humidity are prone to tonsil surgery. The results of the current study consistently reveal that living in homes with high humidity elevates the rate of tonsil surgery.

Few studies examine the contribution of indoor air pollution to the frequency of adenoidectomy and tonsillectomy. In a study to evaluate the effects of indoor air pollution on tonsillar diseases in Peru, investigators claim that an improvement in traditional wood-burning stoves reduced the symptoms of sleep apnea in children (Castañeda et al., 2013). However, no studies directly assess the role of indoor air pollution in increasing the frequency of tonsil surgery. According to the bivariate analysis, participants who had undergone tonsil surgery were more likely to have a history of exposure to pesticide or insecticides. It is consistently demonstrated that insects are more prevalent in environments with high humidity (Crampton, 2017); as a result, more chemicals need to be applied to eliminates these insects.

Variables Assessed in both the Systematic Review and the Case Study

The final group includes variables that are shared between the systematic review and the case study. These variables are sex, nationality (race), household income, parental educational levels, ETS, asthma, and allergies.

Although the studies included in the review suggest an association, the results of these studies are conflicting regarding the effects of sex on tonsil surgery. Three studies propose that males are more prone to tonsil surgery compared to females while another three suggest that females are more likely to undergo tonsil surgery than males. Similar to one of the articles covered in the review, the case study phase of the current study is unable to establish an association between sex and tonsil surgery. The type of tonsil surgery and the age of participants are two factors that can affect the relationship between sex and the frequency of tonsil surgery. The studies that assess the age-specific rates of the surgery and those that separately estimate the rates for each of adenoidectomy, tonsillectomy, and adeno-tonsillectomy propose that sex has a predictable effect on the frequency of tonsil surgery (Bluestone, 2003). In children under the age of 9, tonsil surgery is more common among boys than girls (Bluestone, 2003; Cote et al., 2015; Fedeli et al., 2009). Furthermore, adenoidectomy and adeno-tonsillectomy are more commonly performed in males than females whereas the rate of tonsillectomy is higher in females compared to males (Bluestone, 2003). Studies that do not consider factors of age and type of tonsil surgery report conflicting results regarding the association between sex and tonsil surgery (Al-Hussaini et al., 2013; Choi et al., 2014; Vestergaard et al., 2007). These conflicting results are mostly related to the individual perspectives of practitioners, who have different specialities and different geographical locations, on the benefits and

indications for tonsil surgery (Capper & Canter, 2001). Since the current study does not consider the type of tonsil surgery and the age of participants, an association between sex and tonsil surgery was not anticipated.

Race and nationality, which are examined in the systematic review and case study phases, respectively, are two predictors that are closely inter-related. Consistent with the studies that reveal the association between race and sleep apnea (one of the main reasons for tonsil surgery), the systematic review phase also suggests that race is linked to tonsil surgery. Both the bivariate and multivariate analyses of the case study phase propose that nationality is a predictor of tonsil surgery. It is observed that, according to the logistic regression test, nationality is the only predictor of tonsil surgery.

According to the systematic review, except for maternal educational level, which is not associated with the surgery, the results of the other variables of this group are conflicting. The case study phase also reveals that household income, paternal educational level, ETS, and asthma are not associated with the surgery. Although the bivariate analysis suggests that maternal educational level and symptoms of allergies are associated with tonsil surgery, these associations are not confirmed after controlling the confounding factors in the multivariate analysis. As a consequence, this study cannot conclusively propose household income, parental educational levels, and ETS as predictors of tonsil surgery or suggest that the surgery is associated with asthma and allergies.

Conclusions

The frequency of tonsil surgery can be impacted by demographics, lifestyle, environmental factors, and co-morbidities. To establish evidence for the frequency and predictors of this surgery, which include the first objective of this thesis, the current study has conducted a systematic review of relevant studies. In addition, a case study was implemented to specifically assess the frequency and predictors of the surgery in the UAE, which are the second and third objectives of this thesis. The studies that are included in the systematic review in Chapter 2 assess the individual associations between 17 factors (potential predictors) and tonsil surgery. These studies are unable to determine any association between three factors (maternal educational level, number of siblings, and serum IgE level) and tonsil surgery. For a further six factors (sex, household income, ETS, asthma, allergy, and URTI), the results are conflicting. Additionally, there is limited evidence for an association between tonsil surgery and each of paternal educational, high BMI, middle ear infections, Down syndrome, and prematurity. Finally, three predictors are suggested for tonsil surgery, namely age, geographical region, and race.

The case study assesses individual associations between tonsil surgery and 21 factors including demographics, lifestyle, environmental factors, and co-morbidities. According to the results of a bivariate analysis, tonsil surgery is associated with five factors: nationality, maternal educational level, pesticide/insecticide exposure, indoor humidity, and hay fever symptoms ($p < 0.05$ in chi-square test). Consistent with the systematic review results, nationality (race) is suggested as a predictor of tonsil surgery by multivariate analysis of the case study. However, there is disagreement regarding the impact of maternal educational level between two phases of this study. This factor is

significantly associated with tonsil surgery in the case study while the systematic review is unable to determine any association between maternal educational level and tonsil surgery. While indoor humidity is not included in the systematic review, paternal educational level, which is a predictor of tonsil surgery in the systematic review, is not significantly associated with the surgery in the case study.

However, after adjusting for potential confounders, multivariate analysis confirms that nationality is the only predictor of tonsil surgery and that nationals of GCC countries other than the UAE are more likely to undergo tonsillectomy. Additionally, seafood consumption can decrease the rate of tonsil surgery in other GCC nationals while pesticide/insecticide exposure increases the incidence of the surgery in other nationalities.

Future Steps

The current study reveals the existence of a knowledge gap regarding the predictors of tonsil surgery. According to the systematic review, the evidence for an association between tonsil surgery and several predictors is limited and conflicting. Therefore, further observational studies to examine the factors that are associated with tonsil surgery are recommended.

Additionally, there is a need for studies that separately assess and identify the predictors of each indication (e.g. sleep apnea, chronic tonsillitis) for tonsil surgery. Comparing the predictors of tonsil surgery with the predictors of the diseases treated by the surgery may help to determine the reasons for the disparities in the frequency of tonsil surgery among different populations. For example, it is suggested that African Americans are more prone to severe forms of obstructive sleep apnea, which is one of the main

indications for tonsil surgery. Therefore, it is expected that tonsil surgery be more frequent among African Americans than other races. However, if it were determined that air pollution can increase the rate of sleep apnea (one of the indications for tonsil surgery) but does not change the rate of tonsil surgery, the result could be that some children, who are exposed to air pollution and in need of tonsil surgery, are either not offered or reject such surgery.

Finally, since each type of surgery may have a unique set of predictors, it is necessary to separately identify the predictors of each type of tonsil surgery. Furthermore, this may help explain some of the differences in the incidence of tonsil surgery among different populations. For instance, females are more prone to tonsillectomy (without adenoidectomy) while males are more likely to undergo adenoidectomy. Thus, when both types of surgery are assessed at the same time and under one variable name, studies may suggest conflicting results for the association between tonsil surgery and sex.

Study Limitations

Similar to any cross-sectional study, the current study, in spite of having many benefits, has encountered some inevitable limitations. Confounding variables can cause false results by interfering with the relationship between the study dependent and independent variables. In this study, there were two groups of confounding variables that could affect the results. The first group includes the study independent variables that have associations with both the dependent variable and another study independent variable and which therefore could negatively impact the results of the bivariate analysis. For instance, in the UAE, people originating from some countries are likely to have a lower socio-economic status compared to other nationalities. Therefore, during assessment of the

correlation between nationality and tonsil surgery in a bivariate analysis, household income could be a confounding factor. Similarly, household income, as a confounding variable, could intervene in the association between parental educational level and tonsil surgery since most individuals with a high level of education have higher family income than those with a lower level of educational. The variables of the second group of confounders are variables that are not included in the survey but which may be associated with the study variables and therefore affect the results. For example, in the UAE, the rates of tonsil surgery may be different between private and government hospitals, as a result of different health care policies. Therefore, given that families with different nationalities, household income, or educational levels may use different types of hospitals, health care policy can be considered a confounding variable in association between tonsil surgery and each of participants' nationality, household income, and parental educational level.

Considering that all independent variables could potentially be confounding factors, in order to control these variables, a binary logistic regression method was selected for two reasons. Firstly, considering that this present study uses a secondary set of data and has no control on sampling and questionnaire design, the confounding factors could not be addressed by methods such as matching and restriction that are applied at the design stage. Additionally, it should be noted that a stratified randomized sampling that was used by the background survey is a method to control confounding variables at the design stage (Pourhoseingholi, Baghestani, & Vahedi, 2012). Secondly, given that there are multiple potential confounding variables, the study could not use a stratification method, which is a method applied at the analysis stage and has a practical limit on the

number of confounders that can be included (McNamee, 2005). As a result, this study uses a logistic regression model which, similar to stratification, is a method for controlling confounding factors.

In addition to the confounding factors, other limitations may affect the results of the research. Most of these limitations are because of self-reported data, which are subject to low response and recall bias. Having access to the participants' medical records could invaluably help to indicate many uncertain points. The most important point for which there is no information is the main reason for tonsil surgery. Knowing the precise reason helps distinguish among predictors of tonsil surgery with different underlying diseases. For example, the predictors of tonsillectomy may not be the same when it is performed for sleep apnea versus recurrent tonsillitis. Furthermore, many participants did not know or mention their exact type of surgery (tonsillectomy, adenoidectomy, or adenotonsillectomy) which, in order to distinguish the predictors of different types of tonsil surgery, is a necessary piece of information. Generally, some patients misunderstand or do not know the correct and exact diagnosis of their diseases, so entirely relying on their claims may impact the results of the study. Moreover, some of the study variables do not have exact definition. For example, the present study has no information about the actual distances of participants' residences from industrial plants, gas stations, dumpsites, construction sites, and overhead power lines, which could modify the relationship between exposure to air pollution and tonsil surgery. In order to reduce the adverse effects of inaccurate information in the findings, the current study omits obviously inconsistent and unreliable data.

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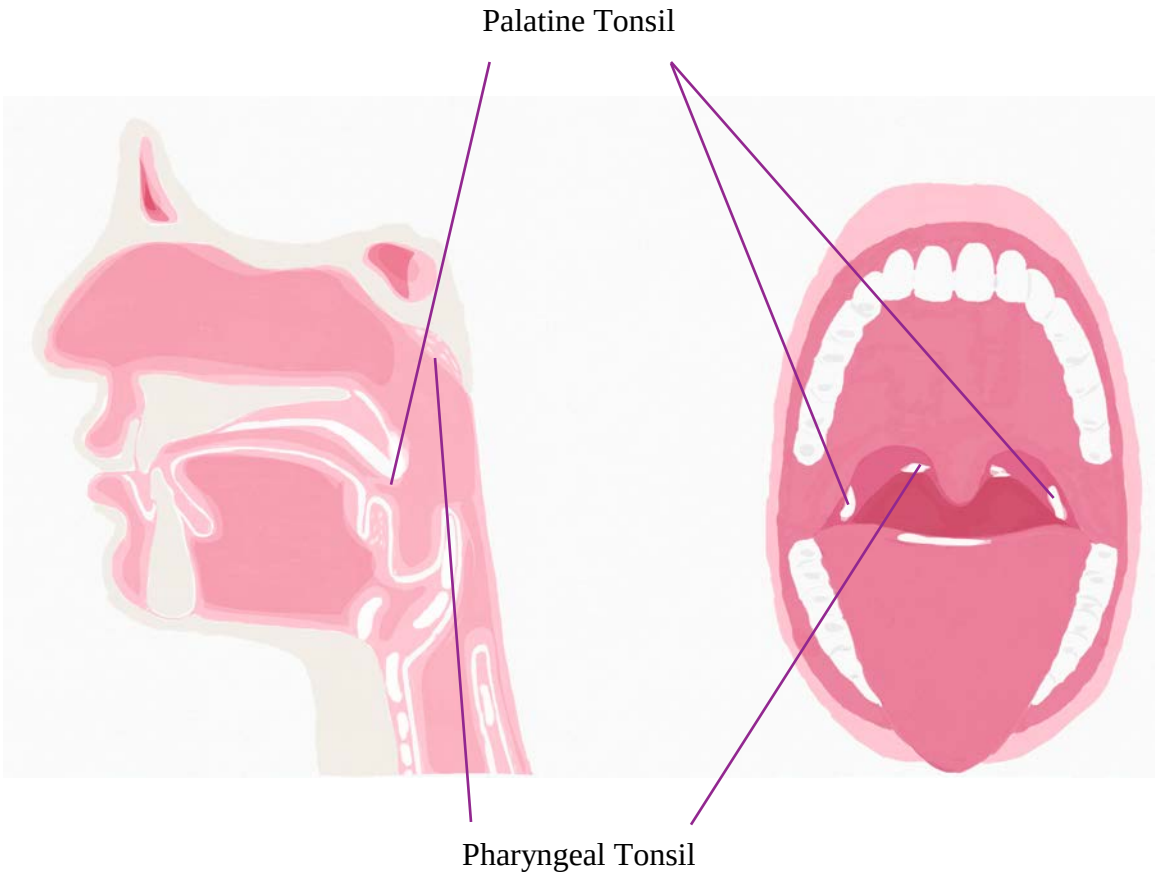
Appendices

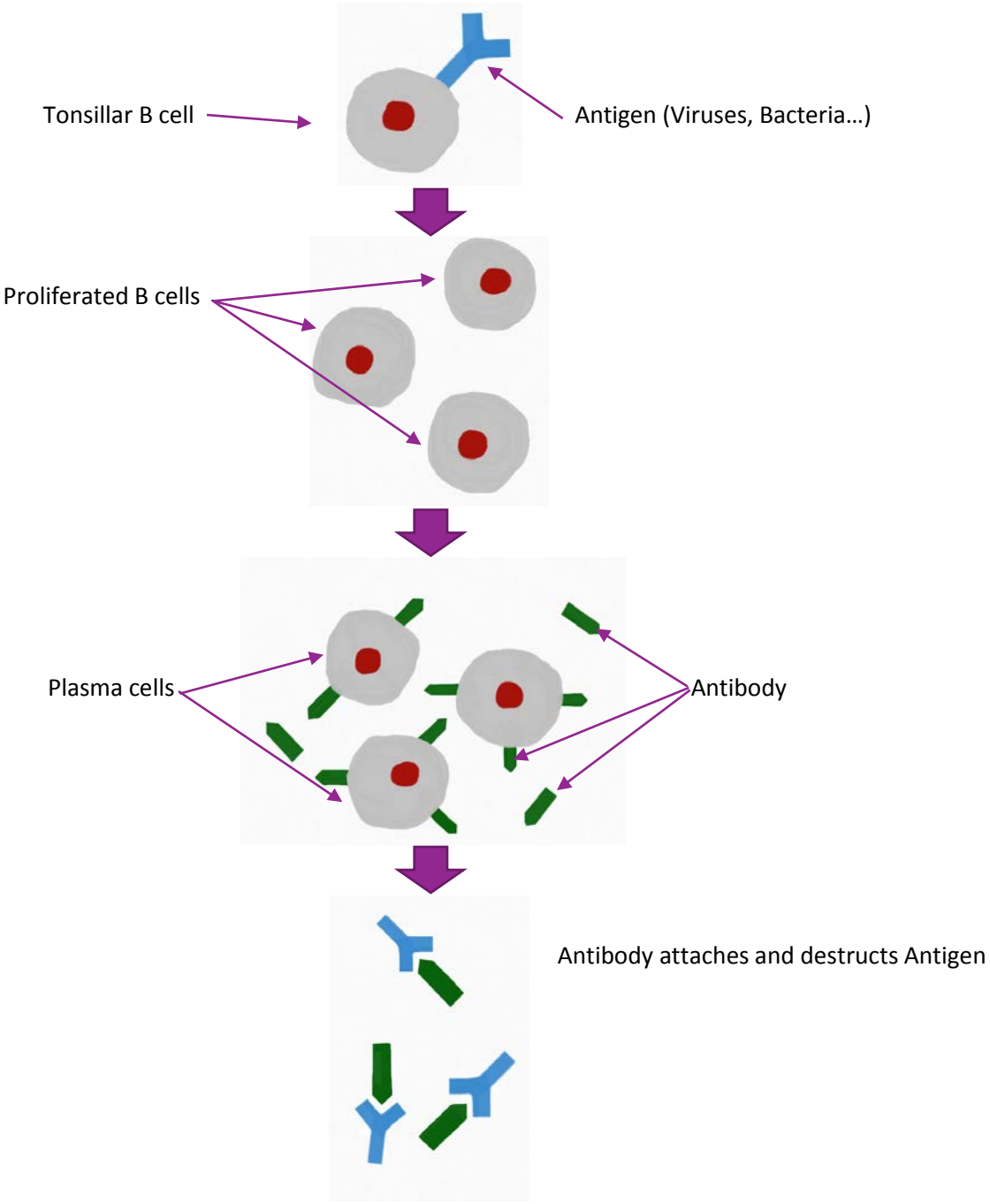
Appendix A

Anatomy (Locations) of Tonsils



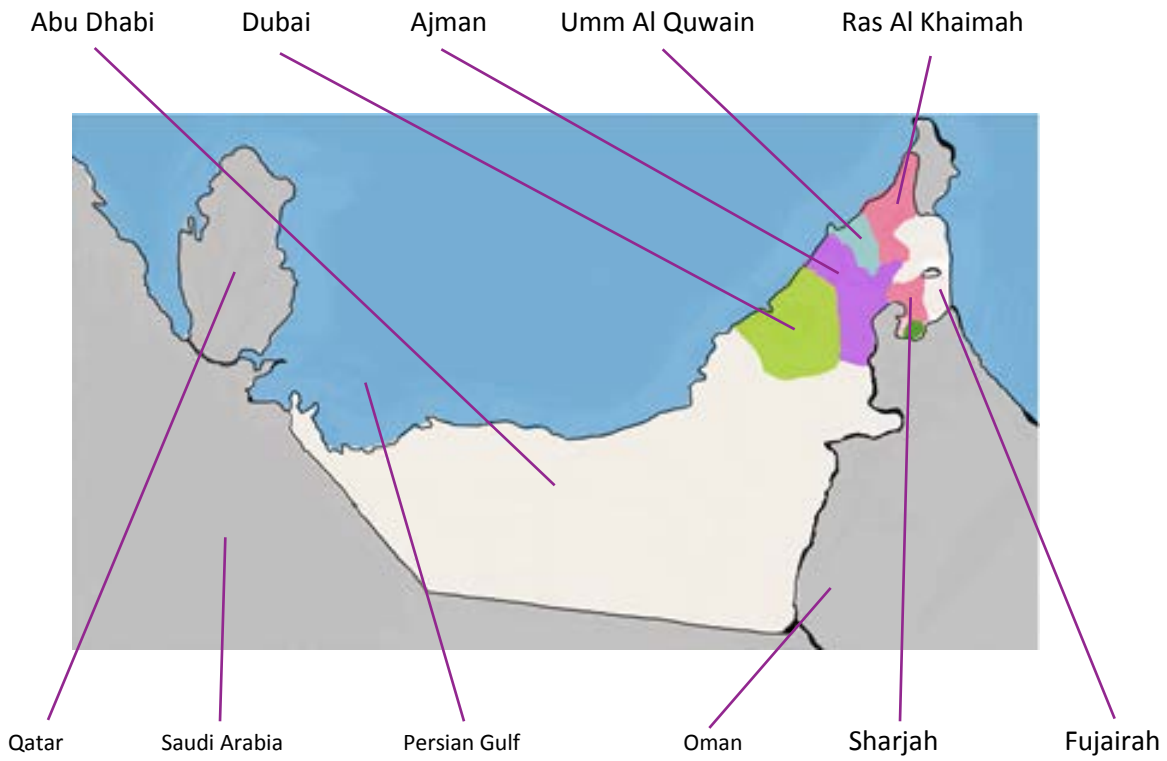
Appendix B

Physiology of Tonsils (Antibody Production)



Appendix C

Map of the UAE and its Emirates



Appendix D

Systematic Review Search Strategy

The research question is 'What are the frequency and predictors of tonsil surgery?' To gather all relevant articles, the following steps were taken:

PubMed [1]

Identifying the Key concepts in the research question. *Frequency, predictors, and tonsil surgery* are the main concepts which are used to create search keywords.

1. Selecting the *keywords* for each concept. To have a comprehensive literature search, in addition to MeSH terms, all synonyms, alternatives, and closely related text-words were added to the list of the keywords for each concept.
   The keywords of concept 1 (Prevalence) are: *prevalence, incidence, rates, and frequency* (all fields).
   The keywords of concept 2 (Predictors) are: *predictors, risk factors, association, associated, correlation, correlated, relation, related, influence, contribution, effect, impact, prevalence, incidence, rates, and frequency* (all fields).
   The keywords of concept 3 (Tonsil surgery) are: *tonsil surgery, tonsillectomy,* *adenoidectomy,* and *adenotonsillectomy.* (These keywords were used to search article titles**).**
2. Merging the first two concepts because the keywords of the first concept (prevalence) are included in the keywords of the second (predictors).
3. Using search techniques. To find both singular and plural forms of keywords, truncation was used for keywords such as influence or predictor.
4. Combining keywords. To make the search more sensitive as well as more specific, the key words were combined using Boolean operators (AND and OR). The keywords of each concept were first combined using OR, then each combination was combined using AND.
5. Applying limits. The search was limited to sources published in English within the last 10 years.

Web of Science [2]

In addition to the above steps, Medline results were excluded.

Ovid Cochrane

1. Identifying keywords. The keywords are *tonsil surgery, tonsillectomy, adenotonsillectomy,* and *adenoidectomy.*
2. Using search techniques. To include both singular and plural forms of keywords, the truncation symbol of * was used at the end of all keywords instead of the letter "y".
3. Combining keywords. The keywords were combined by Boolean operator OR.

4. Applying limits. The search was limited to the last 10 years.

1 PubMed: Search ((predictor* OR "risk factor*" OR association OR associated OR correlation OR correlated OR link OR relation OR related OR influence* OR contribution* OR effect* OR impact* OR incidence OR prevalence OR frequency OR rates)) AND ("tonsil surgery"[Title] OR tonsillectomy [Title] OR adenoidectomy [Title] OR adenotonsillectomy [Title]) Filters: published in the last 10 years; English

2 Web of Science Search: **TITLE:** ("tonsil surger*") *OR* TITLE: (tonsillectom*) *OR* TITLE: (adenoidectom*) *OR* TITLE: (adenotonsillectom*); *TOPIC: (predictor$) OR TOPIC: ("risk factor$") OR TOPIC: (associat*) OR TOPIC: (correlat*) OR TOPIC: (link) OR TOPIC: (relat*) OR TOPIC: (influence$) OR TOPIC: (contribution$) OR TOPIC: (effect$) OR TOPIC: (impact$) OR TOPIC: (incidence) OR TOPIC: (prevalence) OR TOPIC: (frequency) OR TOPIC: (rates); Refined by: LANGUAGES: (ENGLISH) AND [excluding]: Databases: (MEDLINE)*

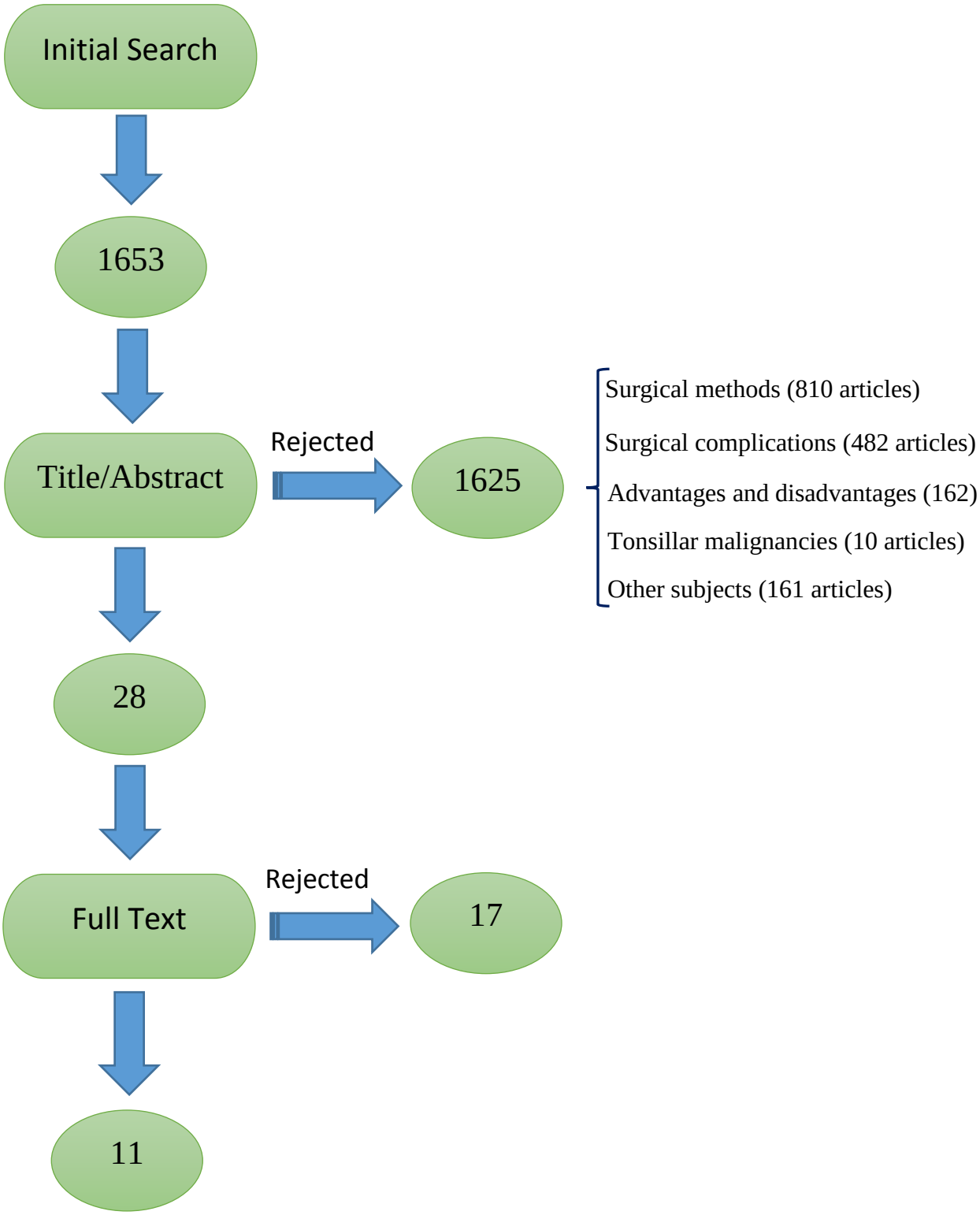
Appendix E

Modified Downs and Black's Appraisal Checklist

	Modified Downs and Black's appraisal checklist	Score
Item	Criteria	
	External Validity	
1	Were the subjects asked to participate in the study representative of the entire population from which they were recruited? Cases and controls were representative of the source population of interest (population- or cohort-based cases and controls), the source population was identified, and subject selection described.	1
2	Were those subjects who were prepared to participate representative of the entire population from which they were recruited? Participation rate for cases and controls of at least 70%.	1
	Subtotal	2
	Internal validity – Bias	
3	Was an attempt made to blind those measuring the main outcomes of the intervention? Exposure ascertainment was based on interviews blinded to health outcome status, mailed questionnaire, or other pre-existing or documented exposure information.	1
4	If any of the results of the study were based on "data dredging", was this made clear? The study was designed to examine the reported association.	1
5	In case-control studies, is the time period between the intervention and outcome the same for cases and controls? Cases and controls were age matched and the exposure period examined was well-defined.	1
6	Were the statistical tests used to assess the main outcomes appropriate? The statistical techniques used were appropriate for the study design and sample size.	1
7	Was compliance with the interventions reliable? The effect of exposure misclassification was likely to bias the reported association towards the null. For example, exposure status based on pre-existing or documented information exposure information (not retrospective case interviews).	1
8	Were the main outcome measures used accurate (valid and reliable)? Outcome measurement was clearly described and was virtually certain (histologically confirmed cancer cases).	1
	Subtotal	6
	Internal Validity – Exposure Measurement	
9	Were measures of exposure robust? Exposure status was either documented or determined via biomarker (2); used small area ecological measures, job titles, or was self-reported (1); was based on large area ecological measures (0).	2
10	Was there a sufficient exposure gradient? The degree of variability between categories of exposure frequency, duration, or intensity was high (2), medium (1), low/unknown (0).	2
11	Were measures of exposure specific? Exposure measures were specific (2); based on broader, chemically-related groups (1); based on broad groupings of diverse chemical and toxicological properties (0).	2
12	Were all critical exposure time windows measured and reported? Exposure time windows were all (2); partially (1); or not at all defined, measured, and reported (0).	2
	Subtotal	8
	Internal Validity – Confounding	
13	Were the cases and controls recruited from the same population? Information on the source of study participants provided; controls representative of the study base from which cases are drawn.	1
14	Were the cases and controls recruited over the same period of time? The calendar period over which cases and controls were recruited was defined and similar.	1
15	Was there adequate adjustment for confounding in the analyses from which the main findings were drawn? The study collected data on all major (2), some (including basic demographic only) (1), or no (0) potential confounders and assessed their effect in analysis.	2
	Subtotal	4
	Total	20

Appendix F

Search Flow Chart of the Systematic Review



Appendix G

Questionnaire (First Component)

In this section, we would like to ask you a few questions about your lifestyle activities. Please put a check mark beside the response that most accurately reflects your answer to each question and fill in the blanks when applicable.

1. Did you ever smoke cigarettes or any form of tobacco such as shisha or midwakh?
   - ☐ Yes
   - ☐ No; **IF 'NO', GOT TO QUESTION 5.**
   - ☐ Do not know

2. During the past 30 days, how often did you smoke cigarettes?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

3. During the past 30 days, on how many days did you use midwakh?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all

5. During the past 30 days, on how many days did you use any form of tobacco products (other than cigarettes, shisha or midwakh), for example: cigars, pipe, little cigars, chewing tobacco, snuff, dip?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

6. How old were you when you first used any form of tobacco?
   _____age in years

7. How often are you exposed to tobacco smoke at home or with friends?
   - ☐Daily
   - ☐Occasionally
   - ☐Not at all; **PLEASE GO TO QUESTION 9.**
   - ☐Do not know; **PLEASE GO TO QUESTION 9.**

8. How old were you when you first started being regularly (at least twice a week, every week of the year) exposed to tobacco smoke at home or with friends?
   _____age in years

☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

4. During the past 30 days, on how many days did you use shisha?
   - ☐ Daily
   - ☐ Occasionally; **CIRCLE NUMBER OF DAYS BELOW**
   - ☐ Not at all
   - ☐ Do not know

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	

9. During your life, have you ever used illegal drugs such as marijuana (hashish) or cocaine?
   - ☐Yes
   - ☐No
   - ☐Do not know

10. During your life, have you ever purposely smelled gasoline fumes, glue, correctors, car exhaust, or burning black ants?
    - ☐Yes
    - ☐No
    - ☐Do not know

Next, we would like to ask you a few questions about your day to day activities. Please put a check mark beside the response that most accurately reflects your answer to each question and fill in the blanks when applicable.

11. During the past 30 days, how often did you wash your hands with soap before eating?
- ☐ **Always**
- ☐ **Most of the time**
- ☐ **Sometimes**
- ☐ **Rarely**
- ☐ **Never**

12. On average, how many days do you eat fish or seafood per month? Please circle the number of days.

16. How often do you use any of the following when you spend time outdoors?

Sunscreen	☐	Always
	☐	Sometimes
	☐	Rarely
	☐	Never
Sunglasses	☐	Always
	☐	Sometimes
	☐	Rarely
	☐	Never
Shade or umbrella	☐	Always
	☐	Sometimes
	☐	Rarely
	☐	Never
Hat	☐	Always
	☐	Sometimes
	☐	Rarely
	☐	Never

17. Which of the following practices do you do in order to maintain your health? You

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29

13. Do you eat a specific type of fish on a regular basis?

☐**Yes; Specify TYPE OF FISH _____**
☐**No**
☐**Do not know**

14. In the past 12 months, have you experienced painful sunburn on any part of your body?

☐**Yes**
☐**No**
☐**Do not know**

15. If you use sunscreen products, is the SPF value greater or equal to 15?

☐**Yes**
☐**No**
☐**Do not know**

can select more than one from the list below.

☐ I eat good food
☐ I do physical exercise
☐ I care for my personal hygiene
☐ I sleep sufficiently
☐ I take iron tablets
☐ I take care of my psychological health
☐ I avoid smoking
☐ I take vitamins
☐ I avoid drugs
☐ I use medicine
☐ I consult a doctor
☐ I avoid alcohol
☐ I have good eating and drinking habits
☐ Other (specify)
_____
☐ I do nothing

18. Please fill the table below by moving across each row:

i) Do you have any of the following?			**ii) In a typical or usual day, how many hours do you use it?**		
a. Mobile phone	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more
b. Cordless phone	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more
c. Wireless local area networks	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more
d. Bluetooth	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more
e. Television	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more
f. Computer(s) / Video display games	☐ YES	☐ NO	☐ Less than 1	☐ 1 to 4	☐ 5 or more

19. Which of the following physical activities have you practiced **in the past year** during your leisure time?

Type of activity	On average, how many hours per week did you practice this activity?	For how many weeks did this program run?	Was the activity held indoors or outdoors?
☐ walking for exercise	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ swimming	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ bicycling	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ popular or social dance	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ home exercises	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ skating or rollerblading	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ jogging or running	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ golfing	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ exercise class or aerobics	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ bowling	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ tennis	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ weight-training	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ fishing	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ volleyball	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ basketball	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ soccer	_____ hours / week	_____	☐ Indoors ☐ Outdoors
☐ Other, please specify	_____ hours / week	_____	☐ Indoors ☐ Outdoors

The following section asks you some general questions about your health. Please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

19. Do you take any over-the-counter medication on a regular basis (such as Panadol, Tylenol, Advil etc..)?
    - ☐ Yes; **SPECIFY MEDICATION USED**
      _____
    - ☐ No
    - ☐ Do not know

21. Are you usually able to hear what is said in a group conversation with at least three other people without a hearing aid?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

20. Are you usually able to see well enough or read your books without glasses or contact lenses?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

22. Are you usually able to hear what is said in a conversation with one other person in a quiet room without a hearing aid?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

23. Are you usually able to hear what is said in a conversation with one other person in a quiet room without a hearing aid?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

24. During the past year, on how many occasions did you have severe stomach pain that could have resulted from an upset stomach or food poisoning? Please circle the appropriate answer.

0	1	2	3	4	5	6	7	8	9	10	> 10

25. During the past 30 days, how many days did you miss classes or school **due to a particular health problem?**

0	1	2	3	4	5	6	7	8	9	10	> 10

26. During the past 30 days, how many days did you miss classes or school **due to injury**?

0	1	2	3	4	5	6	7	8	9	10	> 10

27. How many school days did you miss in the previous academic year?
    - ☐ 0 days
    - ☐ 1 or 2 days
    - ☐ 3 to 5 days
    - ☐ 6 to 9 days
    - ☐ 10 or more days

28. How would you rate your ability to handle the day-to-day demands in your life, like work or school or family responsibilities?
    - ☐ Excellent
    - ☐ Very good

- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ Do not know

29. How would you rate your ability to handle unexpected or difficult problems, like a family or personal crisis?
    - ☐ Excellent
    - ☐ Very good
    - ☐ Good
    - ☐ Fair
    - ☐ Poor
    - ☐ Do not know
30. Please indicate by circling the appropriate box, the feelings you have now taking into account what has happened in the last 5 years and what you expect in the near future.

a) How do you feel about your school results?

I feel:

7	6	5	4	3	2	1
Delighted	Pleased	Mostly Satisfied	Mixed (About equally Satisfied and Dissatisfied)		Mostly dissatisfied	Unhappy	Terrible

b) How do you feel about your life in general?

I feel:

7	6	5	4	3	2	1
Delighted	Pleased	Mostly Satisfied	Mixed (About equally Satisfied and Dissatisfied)		Mostly dissatisfied	Unhappy	Terrible

31. Were you ever told by a doctor or health professional that you have any of the following conditions? **PLEASE CHECK ALL THAT APPLY.**
    - ☐ Chronic Bronchitis
    - ☐ Emphysema
    - ☐ Asthma
    - ☐ Other chest conditions**;**
      SPECIFY_____
    - ☐ Any long-term skin conditions
      SPECIFY_____

- ☐ Hay fever / other allergies
  SPECIFY_____
- ☐ Arthritis / rheumatism
- ☐ Any respiratory problems
  SPECIFY_____
- ☐ High blood pressure / hypertension
- ☐ Heart disease
  SPECIFY_____
- ☐ Thalassemia;
  SPECIFY_____
- ☐ Sickle Cell Anemia
- ☐ Any type of Anemia
  SPECIFY_____
- ☐ Diabetes**;**
  SPECIFY_____
- ☐ Kidney Problem;
  SPECIFY_____
- ☐ Ulcer**; SPECIFY**_____
- ☐ Any type of cancer**;**
  SPECIFY_____
- ☐ Migraine Headache
- ☐ Thyroid condition**;**
  SPECIFY_____
- ☐ Any food allergies**; SPECIFY**_____
- ☐ Other major health diagnosis**;**

SPECIFY_____

32. If you select any condition from above, please specify any type of medication prescribed:
    _____

33. Do you or any direct family member (parent or sibling) suffer from any of the following conditions?
    - ☐ Headaches
    - ☐ Fatigue
    - ☐ Unexplained pain
    - ☐ Blurring vision
    - ☐ Dizziness
    - ☐ Memory loss
    - ☐ Learning and/or reading disability

34. In the past 12 months, have you seen or talked on the phone about your health with any of the following**? PLEASE CHECK ALL THAT APPLY.**
    - ☐ Family doctor or general practitioner (GP)
    - ☐ Eye specialist (ophthalmologist or optometrist)
    - ☐ Other medical doctors (surgeon, allergist, psychiatric)
    - ☐ A nurse for care or advise / Pharmacist
    - ☐ Dentist or orthodontist
    - ☐ Chiropractor / physiotherapist
    - ☐ Social worker / counsellor / psychologist
    - ☐ Nutritionist

35. Where do you often go when you need health care?
    - ☐ Private clinic / hospital
    - ☐ Public clinic / hospital
    - ☐ School clinic
    - ☐ Telephone consultation only
    - ☐ Internet
    - ☐ Other; **PLEASE SPECIFY** _____

36. During the past 12 months, was there ever time when you felt that you needed health care but did not receive it?
    - ☐ Yes
    - ☐ No; **IF 'NO', PLEASE GOT TO QUESTION 38.**

Do not know

37. Thinking of the most recent time, why didn't you get care?
    - ☐ None available in the area
    - ☐ Not available at the time required
    - ☐ Waiting time too long
    - ☐ Cost
    - ☐ Too busy
    - ☐ Didn't know where to go
    - ☐ Transportation problem
    - ☐ Language problems
    - ☐ Dislike/afraid of Doctors
    - ☐ Other; **PLEASE SPECIFY** _____

38. In the past two years, have you had a routine physical checkup without having a specific problem?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

39. Have you ever traveled for medication to other countries?
    - ☐ Yes; **if 'yes' please fill in the table below**
    - ☐ No

Country	Medical Condition

40. Have you ever had an in-patient surgical operation?
    - ☐ Yes; **if 'yes' please fill in the table below**
    - ☐ No

Country	Hospital	Medical Condition

The following section contains questions about your respiratory health. <u>All questions are about problems that occur when you *DO NOT* have a cold or the flu.</u>

41. Have you recently spent any nights as an in-patient in a hospital for asthma or any respiratory health illness?
    - ☐ Yes
    - ☐ No
    - ☐ Do not know

Have you <u>ever</u> had wheezing or whistling in the chest at any time in the past?

- ☐ Yes
- ☐ No; **IF 'NO' SKIP TO QUESTION 47.**

43. Have you had wheezing or whistling in the chest <u>in the last 12 months?</u>
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 47.**

44. How many attacks of wheezing have you had <u>in the last 12 months?</u>
    - ☐ 1 to 3
    - ☐ 4 to 12
    - ☐ More than 12

45. 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

46. In the last 12 months, has wheezing ever been severe enough to limit your speech to only one or two words at a time between breaths?
    - ☐ Yes
    - ☐ No

47. Have you ever had asthma?
    - ☐ Yes
    - ☐ No

48. In the last 12 months, has your chest sounded wheezy during or after exercise?
    - ☐ Yes
    - ☐ No

49. In the last 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection?
    - ☐ Yes
    - ☐ No

50. Have you ever had a problem with sneezing, or a runny, or blocked nose when you DID NOT have a cold or the flu?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 55.**

51. In the past 12 months, have you had a problem with sneezing, or a runny, or blocked nose when you DID NOT have a cold or the flu?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 55.**

52. In the past 12 months, has this nose problem been accompanied by itchy-watery eyes?
    - ☐ Yes
    - ☐ No

53. In which of the past 12 months did this nose problem occur? (Please tick any which apply).

January	☐	May	☐	September	☐
February	☐	June	☐	October	☐
March	☐	July	☐	November	☐
April	☐	August	☐	December	☐

54. In the past 12 months, how much did this nose problem interfere with your daily activities?
    - ☐ Not at all
    - ☐ A little
    - ☐ A moderate amount
    - ☐ A lot

55. Have you ever had an itchy rash which was coming and going for at least six month?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 60.**

56. Have you had this itchy rash at any time in the last 12 months?
    - ☐ Yes
    - ☐ No; **IF 'NO' SKIP TO QUESTION 60.**

57. Has this itchy rash at any time affected any of the following places: the folds of the elbow, behind the knees, in front the ankles, under the buttocks, or around the neck, ears, or eyes?
    - ☐ Yes
    - ☐ No

58. Has this rash cleared completely at any time during the last 12 months?
    - ☐ Yes
    - ☐ No

59. In the last 12 months, how often, on average, have you been kept awake at night by this itchy rash?
    - ☐ Never in the last 12 months
    - ☐ Less than one night per week
    - ☐ One or more nights per week

Now some questions about injuries which occurred in the past 12 months, and were serious enough to limit your normal activities. For examples: multiple injuries, broken or fractured bones, burn, dislocation, sprain or strain, cut or scrape, bruise or abrasion, concussion, poisoning, or internal injury.

60. In the past 12 months, did you have any injuries that were serious enough to limit your normal activities?
    - ☐ Yes; **PLEASE SPECIFY TYPE _____**
    - ☐ No; **PLEASE GO TO QUESTION 63.**
    - ☐ Do not know

61. Where did your most recent injury happen?
    - ☐ In a home or surrounding area
    - ☐ Recreation or sport place
    - ☐ Street or highway
    - ☐ Building used by general public (hotel, mall, restaurant)
    - ☐ School
    - ☐ Other; **PLEASE SPECIFY _____**

62. What were the main causes of injuries occurred to you during the past 12 months? **PLEASE SELECT ALL THAT APPLY.**
    - ☐ Motor Vehicle accident
    - ☐ Accidental fall
    - ☐ Fire, flame and resulting fumes
    - ☐ Accidentally struck by an object or person
    - ☐ Accidental injury caused by natural or environmental factors (weather conditions, animal bites, stings)
    - ☐ Accidental suffocation
    - ☐ Accidental near drowning
    - ☐ Caused by machinery
    - ☐ Caused by cutting or piercing instruments (knife, stapler etc.)
    - ☐ Accidental poisoning
    - ☐ Other; **PLEASE SPECIFY _____**

63. In the past 12 months, have you been a passenger with a driver who had an accident?
    - ☐ Yes **If 'Yes', were you wearing a seatbelt?** ☐ Yes ☐ No
    - ☐ No
    - ☐ Do not know

64. In the past 12 months, have you had an accident while driving a motor vehicle?
    - ☐ Yes **If 'Yes', were you wearing a seatbelt?** ☐ Yes ☐ No
    - ☐ No

Do not know

65. As a driver or passenger, how often does the vehicle you are in exceed the posted speed limit?
    - ☐ Always
    - ☐ Most of the time
    - ☐ Sometimes
    - ☐ Rarely or never

66. As a driver or passenger, how often do you ensure that all passengers in the car have their seatbelts fastened and that young children are in car seats?
    - ☐ Always
    - ☐ Most of the time
    - ☐ Sometimes
    - ☐ Rarely or never

Next, we would like to ask a few questions about you.

67. In what year where you born? _____

68. What is your sex:
    - ☐ Male
    - ☐ Female

69. How tall are you without shoes on?
_____ m □ / cm □ / ft □ / in □

70. How much do you weigh? _____kg □ / lb □

71. What is your parents' marital status?
- ☐ Married
- ☐ Widowed
- ☐ Separated / Divorced
- ☐ Other

72. Does your family have at least one housekeeper (maid or servant)?
- ☐ Yes **IF YES, HOW MANY? _____**
- ☐ No
- ☐ Do not know

73. From the list below, select the duties that your housekeeper(s) is / are responsible for. **PLEASE SELECT ALL THAT APPLY**
- ☐ Cleaning
- ☐ Cooking
- ☐ Washing dishes
- ☐ Laundry
- ☐ Preparing meals
- ☐ Grocery shopping
- ☐ House shopping
- ☐ Helps with school homework

Other; **PLEASE LIST _____**

74. What is your nationality?
- ☐ UAE
- ☐ Other GCC countries (Kuwait, KSA, Oman, Qatar, Bahrain, and Yemen)
- ☐ Lebanon, Syria, Jordan, Palestine, and Iraq
- ☐ North Africa (Egypt, Tunisia, Morocco, Algeria, Libya, and Mauritania
- ☐ South East Asia (India, Pakistan, Bangladesh, Srilanka, Philippines, and Indonesia
- ☐ Europe, USA, and Australia
- ☐ Other country; **PLEASE SPECIFY** _____

75. What is the primary language spoken in your home?
- ☐ Arabic
- ☐ English
- ☐ Indian
- ☐ Persian

☐ Other; **PLEASE SPECIFY _____**

76. Were you born in the UAE?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

77. How many of each do you have in your home?

PLEASE CIRCLE THE APPROPRIATE ANSWER.

Bedrooms	0 1 2 3 4 5 6 7 8 9 10+
Washrooms	0 1 2 3 4 5 6 7 8 9 10+
Cars	0 1 2 3 4 5 6 7 8 9 10+
Televisions	0 1 2 3 4 5 6 7 8 9 10+
Computers	0 1 2 3 4 5 6 7 8 9 10+
Bicycles	0 1 2 3 4 5 6 7 8 9 10+

The following section is optional. We will be requesting contact information for yourself. This information may be used in the future for follow-up studies. Choosing to provide your contact information does not necessarily include you in follow-up studies. You will have the option to refuse or accept participation at that point.

Please enter any or all of the information below.

Mobile number: _____

House number: _____

E-mail address: _____

Thank You for Taking the Time to Complete this Survey!

ID Number _____

Appendix H

Questionnaire (Second Component)

First, we would like to ask you a few questions about the neighborhood and the residence that you live in.

For each question, please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

1. How long have you lived at your current address?
   Number of years_____

2. Please enter your current address: Emirate _____
   Area _____

3. Does your family own □ or rent □ this property

4. How many people live in your household including yourself, relatives, and staff? _____

5. What is the approximate age of this property:
   _____ years

6. Please fill in the table below by moving across each row:

Do you have any of the following?	**How often do you use it?**
6a) Air conditioner ❑ Yes ❑ No	☐ always in hot weather ☐ almost always ☐ sometimes ☐ never
6b) Air filter / purifier / cleaner ❑ Yes ❑ No	☐ always ☐ almost always ☐ sometimes ☐ never

7. Which best describes the type of air conditioning in this property?
   ☐ Separate units

22. Which best describes your family's most frequently used cooking method? Please check all that apply.
   ☐ Electricity
   ☐ Gas
   ☐ Microwave
   ☐ Other; **PLEASE SPECIFY**_____
   ☐ Do not know

23. Which best describes the source of tap water where you live? Please check all that apply.
   ☐ Tanker-truck, vendor
   ☐ Piped into your house by the municipality (DEWA, ADWEA etc.)
   ☐ Water well
   ☐ Other; **PLEASE SPECIFY**_____
   ☐ Do not know

24. Which best describes the source of drinking water where you live?
   ☐ Bottled water; **PLEASE SPECIFY THE BRAND CONSUMED**_____
   ☐ Tap water
   ☐ Boiled tap water
   ☐ Other; **PLEASE SPECIFY**_____
   ☐ Do not know

25. Do you currently have any pets living in your home?
   ☐ Yes**; PLEASE SPECIFY**_____
   ☐ No

☐ central
☐ other; **PLEASE SPECIFY** _____

8. If applicable, how often is your home maintained in terms of cooling equipment, air filtration and/ or air duct cleaning?
☐ Yearly
☐ As needed
☐ Rarely
☐ Do not Know

9. What types of flooring are in the main living areas (TV room, living room, bedrooms) of your house/apartment?

☐ Wall-to-wall carpet; **ENTER AGE:_____years**
☐ Ceramic tiles
☐ Wooden floors
☐ Heavy rugs
☐ Other; **PLEASE SPECIFY_____**

17. Do you feel that the temperature in your home is comfortable?
☐ Yes always
☐ Most of the time
☐ No; **SPECIFY if temperature is: Too Hot ☐ OR Too Cold ☐**
☐ Do not know

18. Do you feel that your home is too humid? **Answer 'Yes' if you see moisture on windows, walls or ceilings.**
☐ Yes
☐ No
☐ Do not know

19. Are pesticides or insecticides ever used in your home, garden, or on your pet (s)?
☐ Yes
☐ Sometimes
☐ No
☐ Do not know

20. Do you or anyone in your household do arts, crafts, ceramics, stained glass work or similar hobbies on a regular basis?
☐Yes
☐No
☐Do not know

26. Do you live in a house that was recently (in the last 12 months) renovated or repaired?
☐ Yes
☐ No
☐ Do not know

27. During the last 12 months, were any areas inside your home painted, such as wall, trims or ceiling?
☐ Yes
☐ No
☐ Do not know

28. Are there any rooms in your home where you can see paint that is peeling, flaking or chipping off the walls, ceilings, doors or windows?
☐ Yes
☐ No
☐ Do not know

22. Do you currently live near an industrial plant, gas station, dump site, or major construction area?
☐ Yes
☐ No
☐ Do not know

23. Do you currently live close to overhead power lines and /or plants (hydroelectric power plant, radio stations, etc.)?
☐ Yes
☐ No; **IF 'NO', GO TO QUESTION 25.**
☐ Do not know

24. Which of the following is the best estimate of the walking distance to the overhead power lines or plants?

21. Does your home have any pests (e.g. cockroaches, rodents)?
    - ☐Yes
    - ☐Sometimes
    - ☐No
    - ☐Do not know

- ☐ Less than 5 minutes
- ☐ Between 5 and 15 minutes
- ☐ More than 15 minutes

25. How concerned are you about air pollution in your neighborhood?
    - ☐ Extremely concerned
    - ☐ Moderately concerned
    - ☐ Slightly concerned
    - ☐ Not at all concerned

26. Do you have a previous place of residence?
    - ☐ Yes
    - ☐ No**; IF 'NO', SKIP TO QUESTION 28.**

27. Please describe your previous places of residence. Residence A represents the most recent residence before your current residence.

	Residence A	Residence B	Residence C	Residence D
a) Duration of residence From	_____ Enter Year	_____ Enter Year	_____ Enter Year	_____ Enter Year
To	_____ Enter Year	_____ Enter Year	_____ Enter Year	_____ Enter Year
b) Location City	_____	_____	_____	_____
Country	_____	_____	_____	_____

c) How many people lived in this household including yourself?	_____	_____	_____	_____
d) How many bedrooms did this property have?	_____	_____	_____	_____
e) What was the approximate age of the property at the time of residence?	_____years	_____years	_____years	_____years

28. What is your father's highest level of education?
    - ☐ Did not attend school
    - ☐ Completed primary school
    - ☐ Some intermediate school
    - ☐ Completed intermediate school
    - ☐ Some secondary school
    - ☐ Completed secondary school
    - ☐ Some community college, technical school, or university
    - ☐ Completed college or university
    - ☐ Completed post graduate training
    - ☐ Do not know

29. What is your mother's highest level of education?
    - ☐ Did not attend school
    - ☐ Completed primary school
    - ☐ Some intermediate school
    - ☐ Completed intermediate school
    - ☐ Some secondary school
    - ☐ Completed secondary school
    - ☐ Some community college, technical school, or university
    - ☐ Completed college or university
    - ☐ Completed post graduate training
    - ☐ Do not know

30. Which best describes your father's employment?
    - ☐ Government employee
    - ☐ Private employee
    - ☐ Self-employed
    - ☐ Not employed

31. Which best describes your mother's employment?
    - ☐ Government employee
    - ☐ Private employee
    - ☐ Self-employed
    - ☐ Not employed

32. Could you please tell me how much income all members of your household receive <u>every month</u>? Be sure to include FROM ALL SOURCES such as savings, pensions, rent, and unemployment insurance as well as wages.
    - ☐ Less than 2000
    - ☐ Between 2000- 5000 DHS
    - ☐ More than 5000 - 8000 DHS
    - ☐ More than 8000 and 10,000 DHS
    - ☐ More than 10,000 and 12,000 DHS
    - ☐ More than 12,000 and 15,000 DHS
    - ☐ More tan 15,000 and 20,000 DHS
    - ☐ more than 20,000 DHS

Do not know

<u>Finally</u>, in the next three pages, we will ask you questions about the health of your biological parents and siblings. For each question, please put a check mark beside the response that most accurately reflects your answer and fill in the blanks when applicable.

33. Please provide information on **ALL** your family members.

Family member	Age	Sex	Status	Reason
Father		Male	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Mother		Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 1		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 2		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 3		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 4		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 5		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 6		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 7		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 8		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 9		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.**	

			☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	
Sibling 10		☐ Male ☐ Female	☐ Lives at your residence; **please go to next row.** ☐ Lives elsewhere in the UAE; **please go to next row.** ☐ Lives abroad; **please go to next row.** ☐ No longer alive; **please enter reason in column on the right**	

34. Were either of your natural parents or siblings ever been told by a doctor / health professional that they had the following conditions? (DNK = Do not know)

Medical Condition	Mother	Father	Sibling 1	Sibling 2	Sibling 3	Sibling 4	Sibling 5
i)Chronic Bronchitis?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
ii) Emphysema?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
iii) Asthma?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
iv) Lung cancer?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
v) Other chest	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
vi) Any long-term skin conditions?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
vii) Arthritis/Rheumat.	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
viii) Any respiratory	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
ix) High blood	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
x) Heart disease?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xi) Thalassemia?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
Medical Condition	Mother	Father	Sibling A	Sibling B	Sibling C	Sibling D	Sibling E
xii) Sickle cell Anemia?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xiii) Diabetes?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xiv) Any type of Anemi	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK

xv) Any type of cancer	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xvi)Thyroid condition	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xvii) Any food allergies	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xviii) Kidney problem?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xix) Ulcer?	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xx) Autism	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xxi) Developmental Delay	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xxii) Any hearing problem	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK	☐ Yes ☐ No ☐ DNK
xxiii) Other major health diagnosis? **If yes, SPECIFY**	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____	☐ No ☐ Yes _____

The following section is optional. We will be requesting contact information for yourself. This information may be used in the future for follow-up studies. Choosing to provide your contact information does not necessarily include you in follow-up studies. You will have the option to refuse or accept participation at that point.

Please enter any or all of the information below.

Mobile number: _____

House number: _____

E-mail address: _____

Parental contact name: _____

Relationship to student: _____

Thank You for Taking the Time to Complete this Survey!

Glossary

Abscess: a localized collection of pus surrounded by inflamed tissue

Acute Otitis Media (AOM): the first 3 weeks of a process in which the middle ear shows the signs and symptoms of acute inflammation. It is a painful type of ear infection.

Acute Rheumatic Fever: an acute often recurrent disease that occurs chiefly in children and young adults following Group A streptococcal infection of the upper respiratory tract (as in strep throat) and is characterized by fever, inflammation, pain, and swelling in and around the joints, inflammatory involvement of the pericardium and valves of the heart, and often the formation of small nodules chiefly in the subcutaneous tissues and the heart.

Adenoids: pharyngeal tonsil

Adenoidectomy: surgical removal of the adenoids (pharyngeal tonsils)

Adenotonsillectomy: surgical removal of the tonsils and adenoids at the same time

Aerodigestive tract: The mixed airway/gastrointestinal tract that includes the oral cavity, pharynx, paranasal sinuses, sinonasal tract, larynx, pyriform sinus, pharynx, and upper esophagus.

Allergic rhinitis: hay fever

Asthma: a chronic lung disorder that is marked by recurring episodes of airway obstruction (as from bronchospasm) manifested by labored breathing accompanied especially by wheezing and coughing and by a sense of constriction in the chest,

triggered by hyper-reactivity to various stimuli (as allergens or rapid change in air temperature).

Craniofacial: a medical term that relates to the bones of the skull and face

Craniofacial (growth) abnormalities: irregularities that exist in physicochemical process of craniofacial enlargement.

Cross infection: infection transmitted between patients infected with different pathogenic microorganisms.

Environmental Tobacco Smoke (ETS): smoke that comes from the burning of a tobacco product and smoke that is exhaled by smokers. Inhaling environmental tobacco smoke is called involuntary or passive smoking. Also called ETS and second-hand smoke.

Mucocilliary: pertaining to mucus and to the cilia of the epithelial cells in the airways

Obstructive Sleep Apnea (Hypopnea) Syndrome: is characterized by recurrent episodes of partial or complete airway obstruction during sleep due to repetitive obstruction of the upper airway, necessitating recurrent awakenings or arousals to re-establish airway patency, often with oxygen desaturation.

Oropharyngeal Flora: The population of microorganisms inhabiting the mucosa of the mouth and throat of healthy humans

Otitis Media with Effusion (OME): is characterized by a non-purulent effusion of the middle ear.

Otolaryngologist: ear, nose, and throat surgeon

Palatine tonsil: either of a pair of prominent masses of lymphoid tissue that lie one on each side of the throat and that are composed of lymph follicles grouped around one or more deep crypts and, except for the exposed surface which is covered only by the epithelium, are surrounded by diffuse lymphoid tissue in a fibrous capsule.

Passive smoking: Inhaling second-hand smoke.

Pharyngeal tonsil: a mass of lymphoid tissue at the back of the pharynx between the Eustachian tubes that is usually best developed in young children, is commonly atrophied in the adult, and is markedly subject to hypertrophy in children.

Recurrent tonsillitis: when inflammation of the tonsils happens repeatedly.

Second-hand smoke: Environmental tobacco smoke

Sleep Disordered Breathing (SDB): is a general term for breathing difficulties occurring during sleep.

Sleep apnea: brief periods of recurrent cessation of breathing during sleep that is caused especially by obstruction of the airway or a disturbance in the brain's respiratory centre and is associated especially with excessive daytime sleepiness.

Snoring: breathing during sleep with hoarse or harsh sounds as caused by the vibrating of the soft palate.

Syndrome: a group of symptoms that consistently occur together or a condition characterized by a set of associated symptoms.

Tonsil: palatine tonsil.

Tonsillectomy: Surgical removal of tonsils or a tonsil.

Tonsillitis: inflammation of the tonsils and especially the palatine tonsils, typically due to viral or bacterial infection, and marked by red enlarged tonsils usually with sore throat, fever, difficulty in swallowing, hoarseness or loss of voice, and tender or swollen lymph nodes.