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# Spatial Analysis and Correlates of Waterpipe Tobacco Smoking among College Students in the United States

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# SPATIAL ANALYSIS AND CORRELATES OF WATERPIPE TOBACCO SMOKING AMONG COLLEGE STUDENTS IN THE UNITED STATES

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## DEDICATION

I dedicate this dissertation to my family, especially my wife Auman for her patience and understanding and my parents for instilling the importance of hard work and higher education.

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## ABSTRACT

**Introduction:** In the United States, young adults have the highest prevalence of waterpipe tobacco smoking (WTS) according to National Adult Tobacco Surveys (NATS) published by the Center for Disease Control (CDC). Experimentation of different tobacco products is highest among 18-24 year olds. Most recently, WTS has surged in popularity among this demographic group. The rapid diffusion of WTS among this population has been accelerated by marketing efforts on the Internet. There are misperceptions that WTS is less harmful than smoking cigarettes and there is a proliferation of WTS establishments due to tobacco retail exemptions. Presently, WTS establishments are almost completely unregulated and limited information exists about the actual number and locations of these businesses in the U.S.

**Objectives**: To survey WTS establishments in the U.S. and assess their proximity to this vulnerable population as well as evaluate socio-demographic variables and specific characteristics related to young adult tobacco users.

**Methods:** Information about WTS establishments was captured from phone directories, business, and commercial databases. Business addresses were geocoded in ArcGIS 10.2. Geographic spatial analyses were run to assess density and proximity of WTS businesses in relation to colleges. Next, bivariate analyses and logistic regressions were run on the NATS data to understand the usage characteristic for different tobacco products and combination of products within the 18-24 year old population.

**Results:** The first study found 1,690 WTS establishments, which is significantly higher than any other published study. Of the 1,454 colleges analyzed, 38.1% were within 3 miles of a WTS establishment. Proximity of WTS establishments to colleges was associated with full-time student enrollment and higher among private colleges and those without a smoke-free campus policy. The second study found 18-21 year olds, the level of education, and the region where the respondents live were associated with different use patterns for waterpipe and different tobacco products.

**Conclusions:** These studies could influence health policy initiatives that are aimed at reducing tobacco retail exemptions, which make it possible for many of these WTS establishments to open. Different intervention strategies are needed for specific characteristics and patterns within the 18-24 year old population for varying waterpipe and dual tobacco product usage.

# PREFACE

American Psychological Association, 6th edition was used in the dissertation.

# TABLE OF CONTENTS

DEDICATION ..... iii

ACKNOWLEDGEMENTS ..... iv

ABSTRACT ..... v

PREFACE ..... vii

LIST OF TABLES ..... x

LIST OF FIGURES ..... xi

LIST OF SYMBOLS ..... xii

LIST OF ABBREVIATIONS ..... xiii

CHAPTER 1: SPATIAL ANALYSIS AND CORRELATES OF WATERPIPE TOBACCO SMOKING AMONG COLLEGE STUDENTS IN THE UNITED STATES ..... 1

CHAPTER 2 LITERATURE REVIEW ..... 8

2.1 DESCRIPTION OF WATERPIPE TOBACCO COMPONENTS ..... 8

2.2 PROCESS AND HISTORY OF WATERPIPE TOBACCO SMOKING ..... 11

2.3 GLOBAL AND UNITED STATES TREND OF WATERPIPE TOBACCO SMOKING ..... 12

2.4 TOXICANTS AND HEALTH EFFECTS OF WATERPIPE TOBACCO SMOKING ..... 14

2.5 PERCEPTIONS AND UPTAKE OF WATERPIPE TOBACCO SMOKING ..... 19

2.6 TOBACCO CONTROL POLICIES ..... 20

2.7 WATERPIPE TOBACCO SMOKING PRODUCTS AND WARNING LABELS ..... 21

2.8 WATERPIPE TOBACCO SMOKING LOCATIONS ..... 23

2.9 Theoretical Frameworks .....24

2.10 Research Objectives and Corresponding Hypotheses .....27

Chapter 3 Methods .....28

3.1 First Study .....28

3.2 Second Study .....37

Chapter 4 First Study .....43

4.1 Geographical Proximity of Waterpipe Tobacco Smoking Establishments to College and Universities in the United States .....43

Chapter 5 Second Study .....59

5.1 Determinants and Distribution of Young Adult Waterpipe Tobacco Users in the U.S.: Findings from the National Adult Tobacco Survey .....59

Chapter 6 Conclusion .....73

References .....79

Appendix A – First Study Supplemental Information .....105

Appendix B – Second Study Supplemental Information .....109

# LIST OF TABLES

Table 2.1 EPA Air Quality Index .....16

Table 2.2 Predicted Steady-State Blood Carboxyhemoglobin (COHb) Levels.....17

Table 3.1 Exclusion Summary by Database .....29

Table 3.2 Distance from Colleges to the Nearest WTS Establishment .....31

Table 3.3 Distance from the WTS Establishments to Nearest College .....32

Table 3.4 Walking Distance from College to the Nearest WTS Establishment .....33

Table 3.5 Multiple Ring Buffer Analysis .....34

Table 4.1 Distance from Colleges to the Nearest WTS Establishment, by FTE .....52

Table 4.2 Multinomial Logistic Model: Colleges to the Nearest WTS Establishment .....54

Table 5.1 Nationally Weighted Characteristics for 18-24 Year Old Waterpipe Only.....67

Table 5.2 Survey Weighted Logistic Regression Results for Current Waterpipe .....69

Table B.1 Non-weighted Characteristics of 18-24 Year Old Waterpipe Only Users.....112

# LIST OF FIGURES

Figure 1.1 Frieden's Health Impact Pyramid....2

Figure 2.1 Waterpipe Components....9

Figure 2.2 A Graphical Representation of Porter's Five Forces Model....25

Figure 3.1 WTS Establishment Final Database....30

Figure 3.2 Overlay Analysis Results....32

Figure 3.3 Application of Porter's 5-Forces Model....42

Figure 4.1 Commercial Waterpipe Tobacco Smoking Establishments in the U.S. ....51

Figure 4.2 Distance from Colleges/Universities to the Nearest WTS Establishment, by Full-time Enrollment: (a) All; (b) Enrollment 2,500-4,999; (c) Enrollment ≥ 20,000 ....53

Figure A.1 Proximity Analysis Dorm Capacity Greater Than 250 ....105

Figure A.2 Proximity Analysis Dorm Capacity Greater Than 500 ....106

Figure A.3 Proximity Analysis Dorm Capacity Greater Than 1000 ....106

Figure A.4 Proximity Analysis Dorm Capacity Greater Than 2000 ....107

Figure A.5 Proximity Analysis Dorm Capacity Greater Than 4000 ....107

Figure A.6 Proximity Analysis Dorm Capacity Greater Than 8000 ....108

## List of Symbols

| | |
|---|---|
| $PM_{2.5}$ | Particle Matter: size is below 2.5 μm |
| $PM_{10}$ | Particle Matter: is below 10 μm |
| μm | One millionth of a meter. |
| $\chi^2$ | Chi-square |

## List of Abbreviations

CDC ..... Centers for Disease Control and Prevention

CI ..... Confidence Interval

EMSS ..... Exhaled Main-Stream Smoke

EPA ..... Environmental Protection Agency

ETS ..... Environmental Tobacco Smoke

FTE ..... Full-time Enrollment

GED ..... Graduate Education Development Certification

GIS ..... Geographic Information System

MSS ..... Main-Stream Smoke

NATS ..... National Adult Tobacco Survey

OR ..... Odds Ratio

PAH ..... Polycyclic Aromatic Hydrocarbons

SHS ..... Second Hand Smoke

SSS ..... Side-Stream Smoke

UFP ..... Ultra-Fine Particles

WHO ..... World Health Organization

WTS ..... Waterpipe Tobacco Smoking

# CHAPTER 1

## INTRODUCTION

In the past decade, waterpipe tobacco smoking has become a popular social activity for young adults. The use of tobacco is particularly common among college and university students (Clarkin, Tisch, & Glicksman, 2008; Sutfin et al., 2012). With the new social context of college life come changes in smoking behaviors with an increase of weekend smoking among 18-19 year old freshman (Colder et al., 2006). This is referred to as "social smoking" (Berg et al., 2010). The transition from high school to college is a period of initiation associated with increased substance use such as alcohol, drugs and tobacco products (Arnett, 2005; Schane, Glantz, & Ling, 2009).

The emerging WTS trend in the United States runs in stark contrast to attitudes about cigarette smoking. Since the 1964 Surgeon General's report *Smoking and Health,* cigarette smoking rates have been cut in half over the past five decades (CDC, 2007a) and yet other forms of tobacco smoking, like WTS, are increasing. Today in the United States and in the world, tobacco remains the greatest preventable cause of death, nearly half the people that use tobacco will die from a tobacco-related illness. This year nearly five million people worldwide will die from tobacco use (WHO, 2008). An example of an actual number of deaths in the United States directly related to tobacco is 435,000 deaths or 18.1% of the population in 2000. These are preventable deaths caused by behaviors and unnecessary exposures both of which need continuous high priority interventions in the public health and health care systems (Mokdad, Marks, Stroup, & Gerberding, 2004).

To be effective these interventions need to have the maximum impact on the socio-economics determinates of health and less on individuals efforts. Frieden's health impact pyramid illustrates that for inventions to have the greatest impact, the focus needs to be on socioeconomic factors and making health decisions the default behavior. See figure 1.1 Frieden's Health Impact Pyramid below.

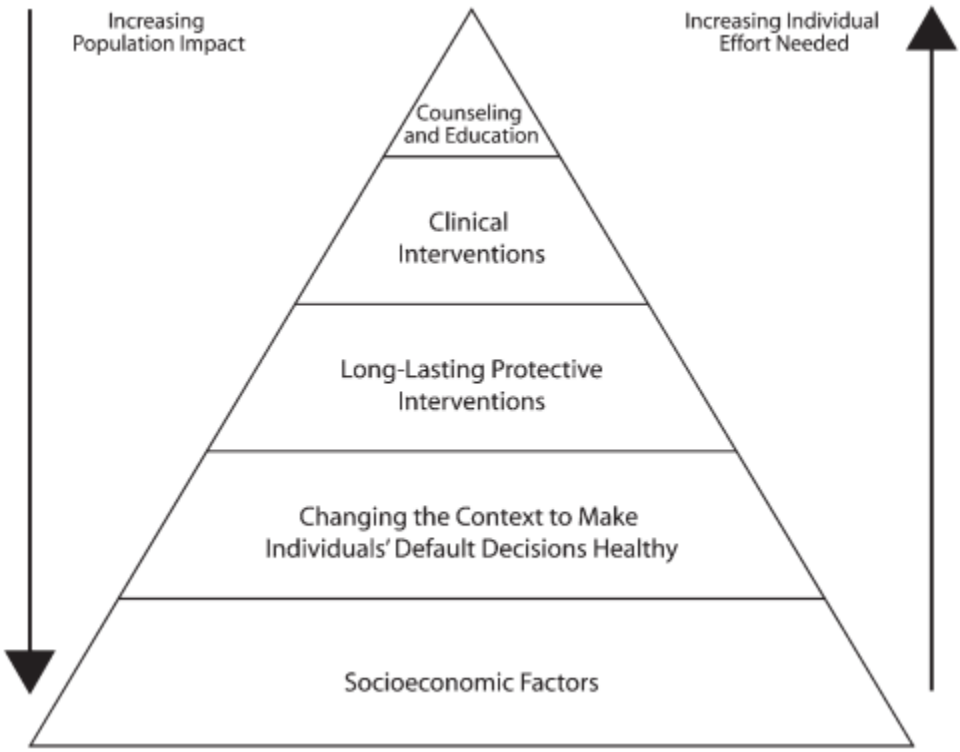


Figure 1.1 Frieden's Health Impact Pyramid (Frieden, 2010)

The "default choice" needs to be the healthy option. Examples include fluoridated water automatically in the public water supply which improves health by reducing tooth decay or the elimination of lead or asbestos exposures by regulating the sale of products containing these toxicants thus improving the overall health of the population (Frieden, 2010). This same theoretical construct can be applied to waterpipe tobacco smoking. Regulations that restrict hours of operation or zoning restrictions not allowing businesses providing WTS to locate near schools and

campuses can change behaviors. To illustrate, if college students routine behavior is to smoke waterpipe tobacco at WTS establishments after drinking at bars near the campus and regulations are put into place restricting WTS establishment hours of operation or locating near a campus then the default behavior begins to change. These context-changing interventions which reduce the cues to use tobacco can have some of the greatest potential public health benefits. The mortality estimates are staggering. By the year 2030, tobacco will kill more than eight million people per year and by the end of this century, a billion people will have died from tobacco use. The project estimate for 2015 is that globally tobacco will be responsible for 10% of all deaths (Mathers & Loncar, 2006).

Even though tobacco control efforts in the United States have been successful in changing the perception of cigarette smoking from an acceptable pastime to a serious threat to public health (DHHS, 2014), somehow WTS has not been affected by the same negative social stigmas (Eissenberg, Ward, Smith-Simone, & Maziak, 2008; Smith-Simone, Curbow, & Stillman, 2008). Experimentation of waterpipe tobacco smoking starts at a young age. Prevalence has been identified within middle and high school students (Barnett, Curbow, Weitz, Johnson, & Smith-Simone, 2009; Martinasek, McDermott, & Martini, 2011; Primack et al., 2013; Smith-Simone, Maziak, Ward, & Eissenberg, 2008). The smoking of waterpipe tobacco by adolescents may continue as these students enter college. The prevalence of WTS is particularly high among college and university students and is expected to increase (Cobb, Khader, Nasim, & Eissenberg, 2012; Grekin & Ayna, 2012; Noonan, Kulbok, & Yan, 2011; Primack et al., 2013; Sutfin et al., 2011).

Waterpipe smoking, like cigarettes, delivers nicotine, 82 different toxicants from the tar, and potentially lethal levels of toxic carbon monoxide because the waterpipe uses

charcoal to heat the tobacco (Cavus, Rehber, Ozeke, & Ilkay, 2010; Clarke et al., 2012; Monzer, Sepetdjian, Saliba, & Shihadeh, 2008; Shihadeh & Saleh, 2005; Ward, 2015). Epidemiologic studies have identified associations between waterpipe smoking and increased risks of cancer and other chronic diseases (Akl et al., 2010; Hakim et al., 2011; Jacob et al., 2013; Maziak et al., 2014; Raad et al., 2011; Shihadeh & Eissenberg, 2011).

Because smoke is filtered through water, many college students believe waterpipe smoking is less harmful, less addictive, and delivers less nicotine than cigarettes (Eissenberg et al., 2008; Maziak, 2011; Primack et al., 2013; Smith-Simone, Maziak, et al., 2008). The large selection of flavors, the social aspect and the excitement of waterpipe smoking in a bar-like atmosphere at a WTS establishment are also contributing to the popularity of WTS among young adults.

The first study attempts describes the landscape of the waterpipe establishment industry and examines the extent to which businesses are locating near college and universities. Therefore, applying an economist's view of market outcomes that take into consideration variables such as supply, demand, location and the nature of competition might be an appropriate approach. The research suggests that WTS establishments are multiplying in the United States at an alarming rate (Grekin & Ayna, 2008; Lyon, 2008; Salloum, Osman, Maziak, & Thrasher, 2014; Smith, Edland, et al., 2011). The demand for WTS is being driven by young adults (Amrock, Gordon, Zelikoff, & Weitzman, 2014; Heinz et al., 2013). As these young adults create a demand for a social environment to smoke waterpipe tobacco market forces suggest businesses will open to meet this demand. Location continues to be fundamental to competition, but business today is far more dynamic (Porter & Porter, 1998). Some of the unique market forces affecting this

industry are retail tobacco exemptions and the FDA's oversight of not including waterpipe tobacco included in the statutory definition for tobacco products. This has created an environment with little or no regulations for WTS establishments and waterpipe tobacco. This ease of entry makes it easier and less expensive for entrepreneurs to open a WTS establishments near colleges and universities. Some of WTS establishment owners are opening multiple locations and in some cases, franchising the business structure. There are scale economics that come into play for multiple locations. For example, buying product in bulk and the benefits of large scale marketing reduces costs which can be passed on to the consumer in the form of lower per unit costs These economies of scale are being promoted by businesses trying to sell waterpipe franchises. For example, *40 Thieves,* a large waterpipe franchiser, promotes the benefits of buying in bulk directly from the waterpipe manufacturers to reduce product cost and because of their size offers more marketing avenues (Thieves, 2012). In general the rule of scale economics in providing supra-normal profits is generally short-term and diminishes as the number of businesses in an industry increases (Nahata & Olson, 1989). The theoretical concept of "entry barriers" will be expanded upon further in the first study. The economic concept of entry barriers may help to explain the growth of WTS establishments as well as provide health policymakers ways to stem this growth.

The second study addresses the young adults 18-24 who are patronizing these WTS establishments. This age group also has the highest prevalence of tobacco use in the United States. (Jarrett, Blosnich, Tworek, & Horn, 2012; Ling, Neilands, & Glantz, 2009; Salloum, Thrasher, Kates, & Maziak, 2015). The prevalence of WTS among 18-24 years olds is out pacing all other forms of tobacco consumption. The 2009-2010 National

Adult Tobacco Survey (NATS) showed current WTS use was 7.8%. The most recent unreleased to the general public 2012-2013 NATS shows current WTS use at 18.2% in preliminary reports from the CDC (Agaku et al., 2014; King, Dube, & Tynan, 2012).

The second study will break down the demographic characteristics of 18-24 year olds in greater detail for different tobacco products from a weighted national survey. This type of detailed information is needed by policymakers, health care providers, and regulators because different intervention strategies are needed for different tobacco products and different individuals within the 18-24 year old population. For example, successful anti-marketing campaigns used for cigarettes focusing on brands and large tobacco companies may not be as effective for controlling waterpipe usage. In a WTS establishment, the patron usually does not see the label on the tobacco container. All the patron knows is they ordered a strawberry and lime hookah which is then brought out to the table ready to smoke.

More information is needed about this age group because these young adults are in a critical time in their lives as they are transitioning out of the high school environment into new social environments with different roles and responsibilities (Newcomb & Bentler, 1987). This transitional period is associated with greater freedom and less social control resulting in more experimentation of different substances (Arnett, 2005). This finding was not limited to college and university students. Young adults not going to college transitioning to living arrangements with friends and roommate also had an increase in substance use (Bachman, Wadsworth, O'Malley, Johnston, & Schulenberg, 2013; Bingham, Shope, & Tang, 2005). The second study goes beyond typical college and university studies and looks at the demographic characteristics of both college and

non-college young adults. The theoretical concept that best describes the transition period for young adults is called the Emerging Adulthood Theory. This theory is defined as the stage of life from 18-25 years old that begins following high school and ends with the adoption of adult roles such as marriage, parenthood or the start of a career (Arnett, 2000).

The manuscript style option has been chosen for this dissertation, which will include two agreed-upon manuscripts. The first three chapters will follow the traditional dissertation monograph. Chapter one provides an introduction explaining the importance of the subject matter being examined. Chapter two is a literature review pertinent to the topic with the stated hypotheses at the end of the chapter. Chapter three outlines the methods, study design, and data sources. This chapter will explain in detail all methods, and all data used in carrying out the studies. The results, discussions, and conclusions will be addressed in the manuscript chapters. Chapter four will include the first manuscript with related tables and figures. Since the final decision on journal submission has not been decided, optional tables and figures will be included. Chapter five will include the second manuscript with related tables and figures. Once a decision is made on which journal to submit to, tables and figures will be reduced to meet the journal's requirements. Chapter six is a conclusion which synthesizes the findings and implications of the two studies.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 DESCRIPTION OF WATERPIPE TOBACCO COMPONENTS

The waterpipe, colloquially referred to as a hookah in the US, is the centerpiece of waterpipe tobacco smoke (WTS). The waterpipe is made up of four fundamental components; the bowl, the base, the body and the hose (Maziak, et al., 2004). The bowl, also referred to as the head, is where the tobacco is loaded. The bowl is generally made of clay, marble or glass. The body is usually made of metal and has a tube running through the middle connecting the bowl to the base. The body also has a hose socket to connect the hose, a coal tray to catch ashes, and a release value to remove stale smoke. The base or smoke chamber is usually made of colorful glass and is partially filled with water. The hose, not seen in the figure below, is usually brightly covered and fitted with a pipe hose socket on one end and a mouthpiece on the other end.

Other accoutrements include charcoal, tongs, grommets, screens or aluminum foil, wind covers, disposable mouth pieces, steam stones, herbal shisha, and actual waterpipe tobacco. Charcoal specifically designed for waterpipe smoking is made to burn cleaner with less smell and taste. The grommets or plastic seals are used to ensure a better seal at various connection points on the waterpipe. Metal screens or perforated aluminum is placed on top of the tobacco between the charcoals to protect the tobacco from burning. Not shown on in the figure, wind covers are sometimes added around the.

bowl to prevent the wind from accelerating the burn rate of the charcoal and to prevent ash and embers from being blown on smokers (Figure 2.1).

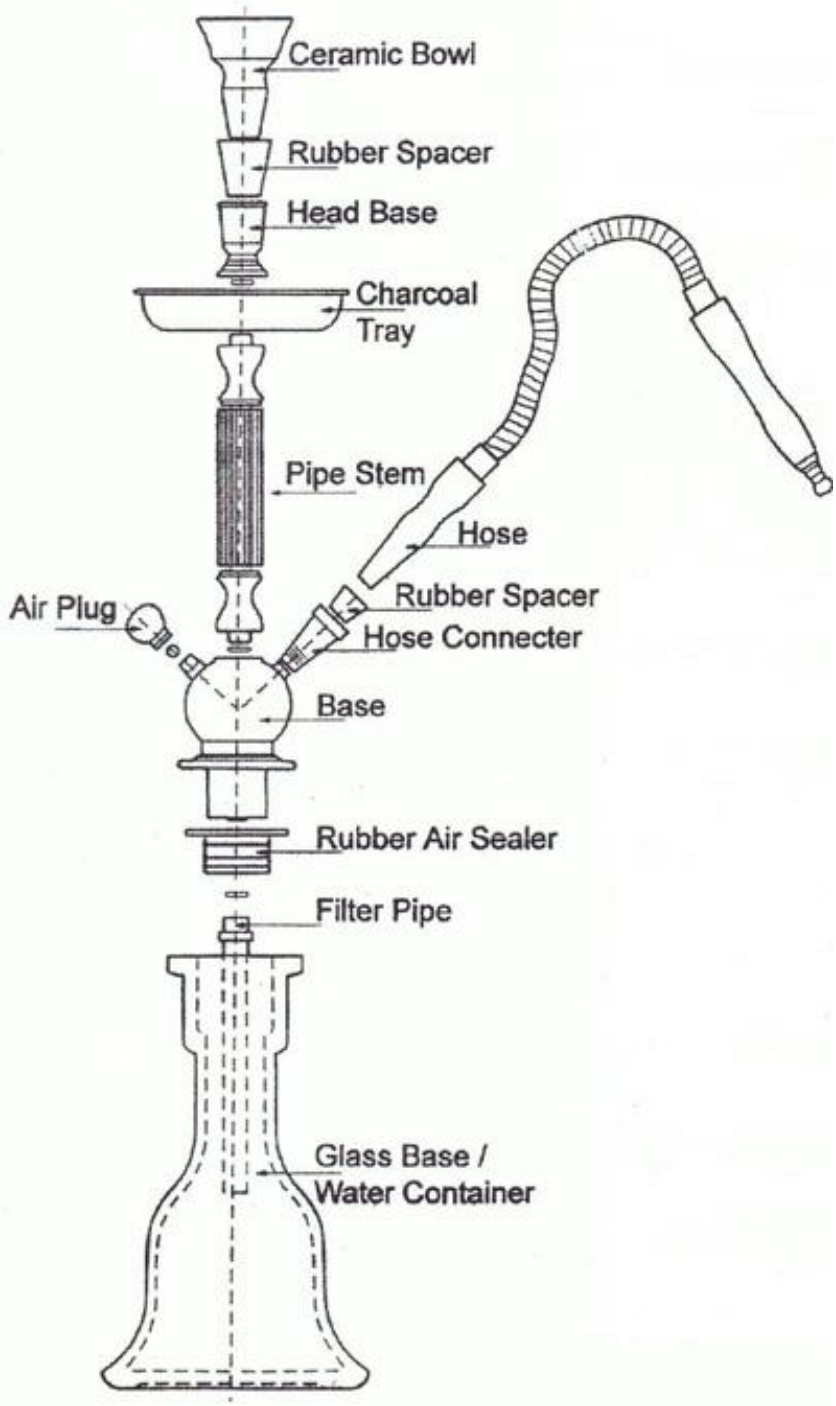


Figure 2.1 Waterpipe Components (FGT, 2015)

A variety of products can be smoked in a waterpipe ranging from some of the new products entering the WTS market to traditional tobacco. Steam stones are a new product that absorb liquids and release them in the form of steam when heat is applied. Herbal shisha is a tobacco-free alternative without the nicotine. It still has substantial quantities of toxicants associated with waterpipe smoking (Shihadeh et al., 2012). Waterpipe tobacco comes in wide variety of modern flavors and mixtures. Introduced in the 1990s by Egyptians, waterpipe tobacco includes a mixture of fruit flavors along with a sweet aroma when smoked. Many believe it contributed to the spread of WTS globally (Maziak, et al., 2004; Rastam, Ward, Eissenberg, & Maziak, 2004). This favored tobacco is usually packaged in 50 grams (1.76 ounces) and 250g (8.82 ounces) cardboard boxes and in the U.S., jars and tin canisters are popular. Some of the more traditional favors are "Maassel" which is a mixture of tobacco and molasses and "Ajami," the traditional form of unflavored tobacco (Nakkash & Khalil, 2010). The mixture of tobacco and a sweetener is generally called "shisha" in the United States. The U.S. market is flooded with a variety of flavors such as apple, cherry, chocolate, coconut, grape, kiwi, mango, orange, peach, pineapple strawberry, vanilla, and watermelon to name just a few. The larger manufactures of shisha in the Middle East are Al Fakher, Al Waha, Fumari, and Nakhla all of which import to the U.S. Some of the manufacturers including Sahara Smoke and Hookak-Hookah (ALA, 2007). Flavors and the names of flavors are such an important component of the shisha market in the U.S. that companies are going to court to protect their interest. A U.S. company receiving attention for recent law suits regarding branding and trademark infringements is Starbuzz. The Starbuzz company is involved in a lawsuit against Hershey Chocolate over the citrus mist e-cigarette flavor trademark (Keshishian,

2014) and Fusion Tobacco for using the names “Blue Mist”, “White Peach”, and “Sweet Melon” (Phillips, 2010).

### 2.2 Process and History of Waterpipe Tobacco Smoking

The waterpipe uses water filtration and indirect heat during the smoking process. The tobacco is placed in the bowl at the top of the waterpipe which is connected to a pipe which leads to the water filled base. The bowl is then covered by a screen or perforated aluminum foil. Burning charcoal is placed on top of the metal cover. During the inhalation process, smoke from the charcoal is pulled through the tobacco into the water-filled base. The smoke-filled air is pulled into the water and bubbles in the base of the waterpipe. Then, the smoke which has been cooled by the water, is drawn through the hose and inhaled(Gatrad, Gatrad, & Sheikh, 2007). The inhalation from the smoker at the end of the hose produces a vacuum which creates bubbles and a rhythmic sound commonly referred to as “hubble bubble” among waterpipe smokers (Maziak, et al., 2004). Different cultures use various names to describe a waterpipe. The colloquial term most often used in the United States is hookah (Salloum et al., 2014) In eastern countries, the terminology used often depends on a particular region. For example, the term “shisha” is associated with Egypt and Saudi Arabia. The spelling of it can vary. Examples include “narghile,” “nargile,” or “arghile” which are used in Israel, Jordan, Lebanon and Syria to describe waterpipe smoking. Africa and India users tend to use the terms “hookah,” or “hubble bubble”(Maziak, et al., 2004). Early literature from the 1600s suggests the Persians probably invented the waterpipe and the Muslims were responsible for spreading the tradition to the east African coast and Asia (Goodman, 2005).

## 2.3 Global and United States Trend of Waterpipe Tobacco Smoking

### The History and Prevalence in Eastern Countries

Waterpipe tobacco smoking is an ancient traditional method of smoking tobacco products dating back over four centuries and globally there are an estimated 100 million daily waterpipe tobacco smokers (Wolfram, Chehne, Oguogho, & Sinzinger, 2003). The tradition is particularly prevalent in the Middle East, Northern Africa and Southeast Asia.(Shihadeh, Azar, Antonios, & Haddad, 2004). In many parts of the world such as Turkey, India, Bangladesh, Pakistan, and area of China waterpipe smoking is more prevalent than cigarette smoking (Koul et al., 2011) In 1980s the Middle East actually saw a decline in WTS, but in the 1990s a resurgence of popularity happened globally (Rastam et al., 2004). This is also the time that the U.S. experienced a growth in popularity which experts believe came with the introduction of "Maassel" is a mixture of tobacco and molasses which appealed to younger users (Maziak, Ward, et al., 2004). The minimal information exists about how and when WTS arrived in the U.S. Experts do agree that in the last two decades the use of waterpipe tobacco has steadily increased in the U.S. (Jordan & Delnevo, 2010; E. Nuzzo et al., 2013; Palamar, Zhou, Sherman, & Weitzman, 2014; Primack et al., 2008; Smith, Edland, et al., 2011).

### The History of WTS in the United States

Waterpipes or hookahs first started making a presence in the United States in 1960s at a time when the country was going through tremendous social and cultural changes. Some historians refer to this as the counter-culture (Bindas & Heineman, 1994; Sherkat, 1998). Examples can be observed in the media in both television and in movies. Television was moving away from the 1950s established concept of the American family portrayed in shows like *Leave it to Beaver* or *Father Knows Best* where the family was as

depicted as a heterosexual, patriarchal, and churchgoing entity. America's thinking and family depictions were changing rapidly in 1960s (Merritt, 2013). In 1964 ABC introduced a television series *The Addams Family*. This show challenged the culture norms of the 1950s and is a satirical inversion of the American family. The show had a waterpipe prominently displayed in the living room and also subtly hinted of drug use (Morowitz, 2007). Another prominently displayed hookah can be seen in Lewis Carroll's 1865 book *Alice's Adventure in Wonderland*. The Walt Disney Company made a movie from the book in 1951 which included the hookah scene. In the movie scene, Alice comes upon a large mushroom with a blue caterpillar sitting on it smoking a hookah. The caterpillar tells Alice that one side of the mushroom will make her taller and the other side will make her shorter. Alice breaks off and eats two pieces of the mushroom. One side makes her shrink smaller than ever, and the other causes her neck to grow high into the trees. Many media historians have made reference to this scene as depicting the drug culture; the hookah for smoking illegal drugs such as marijuana and the mushroom as a psilocybin mushroom (Bonner & Jacobs, 2011; Hibler, 2011; Imholz & Imholz, 2008). Psilocybin mushrooms which grow naturally in fields and cow pastures in the U.S. and induce hallucinations when ingested (Schwartz & Smith, 1988). From 1960s to early 1990s, it seems the waterpipe was associated more often with marijuana and hashish than with tobacco. Today, tobacco is used in waterpipes with greater frequency than marijuana or hashish (Braun, Glassman, Wohlwend, Whewell, & Reindl, 2012; Sterling & Mermelstein, 2011). Waterpipe smoking of tobacco in the U.S. started to increase in the 1990s and into the 2000s with the introduction of flavored tobacco which appeals to adolescents and young adults (Maziak et al., 2014). Although the United States does not

have a long history of WTS, the same toxicants exist as with cigarettes. In addition, WTS is associated with greater carbon monoxide (CO) and increased smoke exposure (Eissenberg & Shihadeh, 2009).

### 2.4 Toxicants and Health Effects of Waterpipe tobacco Smoking

Understanding the toxicant exposure of tobacco waterpipe smoking is not only important for educating the waterpipe tobacco smoker, but also the non-smoker who is exposed to their second-hand smoke. Although there are not a significant number of large-scale epidemiological studies on waterpipe tobacco smoking, there is significant evidence suggesting waterpipe tobacco smoking is associated with many of the same tobacco caused diseases as cigarette smoking. Commonly cited associations include; chronic lung disease, lung cancer, cardiovascular illness, esophageal cancer, bladder cancer, low birth weight, periodontal disease, diabetes, stroke, and nicotine dependence (Akl et al., 2010; Chaouachi, 2009; Eissenberg & Shihadeh, 2009; Hammond, Fong, Mcneill, Borland, & Cummings, 2006; Knishkowy & Amitai, 2005).

The CDC in conjunction with other prevention organization have included other disorders that include abdominal aortic aneurysm, acute myeloid leukemia, cataract, cervical cancer, kidney cancer, pancreatic cancer, pneumonia, and stomach cancer (HHS & others, 2004). Reiterating another study, WTS, like cigarettes exposes the user to ultrafine particles absorbed in the lungs such as; carcinogenic polyaromatic hydrocarbons (PAH), volatile aldehydes, and carbon monoxide (CO) which are associated with a variety of cancers, and heart and pulmonary diseases (Bentur et al., 2014).

## Charcoal Toxicants and Secondhand Waterpipe Smoke

What differentiates waterpipe tobacco smoking from other types of tobacco products is the use of charcoal in the smoking process. Charcoal is used to heat the moist tobacco during a waterpipe smoking process. The charcoal introduces new toxicants as well as higher levels of toxicants that are normally associated with tobacco consumption (Eissenberg & Shihadeh, 2009).

The CO emitted from the charcoal creates secondhand waterpipe smoke that can be a risk for both employees and patrons of WTS establishments(Kumar, Davies, Weitzman, & Sherman, 2014). WTS establishments are usually stand-alone locations that have a tobacco exemption or restaurants with an open air patio where patrons can smoke from a waterpipe. Relatively few studies have been conducted on secondhand waterpipe smoke in these type of venues. The measurement criteria used in air quality studies of waterpipe tobacco smoking establishments typically includes fine particle matter (PM2.5) and carbon monoxide (CO). Other more comprehensive studies evaluate black carbon (BC), element carbon (EC), organic carbon (OC), and airborne nicotine (Fiala, Morris, & Pawlak, 2012; Hammond, 2011; Zhou et al., 2014)

The United States Environmental Protection Agency (EPA) sets the standard for acceptable levels of fine particle matter $PM_{25}$. In 2012, the EPA revised the guidelines for $PM_{2.5}$ concentrations lowering the upper end of good to 12.0μg/m3 and retaining the 24-hour fine particle standard of 35 μg/m3 noting exposure to particle pollution can cause premature death and cardiovascular health risks (EPA, 2012) The EPA has established an air quality index with categories based on $PM_{2.5}$ levels with cautionary and health effect statements (Table 2.1).

Table 2.1 EPA Air Quality Index

**EPA's Air Quality Index (AQI) for 24-hour Fine Particle Pollution ($PM_{2.5}$)**

| 24-hr $PM_{2.5}$ ($\mu g/m^3$) | AQI Categories | AQI Values | AQI Cautionary Statements | AQI Health Effects Statements |
|---|---|---|---|---|
| 0 – 12.0 | Good | 0 - 50 | None | None |
| 12.1 – 35.4 | Moderate | 51 - 100 | Unusually sensitive people should consider reducing prolonged or heavy exertion. | Respiratory symptoms possible in unusually sensitive individuals, possible aggravation of heart or lung disease in people with cardiopulmonary disease and older adults. |
| 35.5 – 55.4 | Unhealthy for Sensitive Groups | 101 - 150 | People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion. | Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults. |
| 55.5 – 150.4 | Unhealthy | 151 - 200 | People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion; everyone else should reduce prolonged or heavy exertion. | Increased aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; increased respiratory effects in general population. |
| 150.5 – 250.4 | Very Unhealthy | 201 - 300 | People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion. | Significant aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; significant increase in respiratory effects in general population. |
| Greater than 250.5 | Hazardous | Over 300 | Everyone should avoid all physical activity outdoors; people with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. | Serious aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease and older adults; serious risk of respiratory effects in general population. |

(EPA, 2014)

The studies that collected air samples from waterpipe establishments all found WTS establishments that exceeded the EPA's "hazardous" range for fine particulate matter PM2.5 (Fiala et al., 2012; Torrey et al., 2014; Zhou et al., 2014).

One study in Virginia found PM2.5 concentrations at one particular waterpipe establishment reaching levels approximately seven times higher than the US EPA-defined "hazardous" level (>250 μg/m3 daily exposure) which not only exposes the smoker to extreme PM2.5 risks, but also the employees and nonsmoking patrons (Cobb et al., 2013)

The next toxicant that is routinely monitored during an air quality study is carbon monoxide (CO). The regulation for CO falls under the United States Department of Labor in the Occupational Safety and Health Administration (OSHA). Exposure to carbon monoxide decreases the ability of blood to carry needed oxygen to tissues in the body. The OSHA standard for carbon monoxide is 50 ppm during an eight hour shift and NIOSH the recommended exposure limit is 35 ppm (CDC, 1978).

When measuring air quality, the measurement is parts per million but when measuring a smoker in a clinical experiment, the standard measurement is carboxyhemoglobin (COHb). Carboxyhemoglobin (COHb) is hemoglobin combined with carbon monoxide. A normal COHb level for non-smokers is <1.5%. For smokers the range for COHb levels between 3-15% (Pearce & Jones, 1984). The median COHb for someone who smokes a pack of cigarettes a day is approximately 5.9%. This concentration is significant enough to cause health cardiovascular issues(Goldsmith & Landaw, 1968). Carbon monoxide is responsible for a large percentage of the accidental poisonings each year with many complications. Frequently after a CO poisoning, individuals may experience immediate death from myocardial impairment, hypotension, arrhythmias and pulmonary edema (Raub, Mathieu-Nolf, Hampson, & Thom, 2000) Two of the studies identified WTS establishments with CO readings in the upper 40s for PPM to over 50 PPM (Torrey et al., 2014; Zhou et al., 2014). Both these readings would put the COHb well over 6.1 exposing the waterpipe tobacco smokers, employees, or any nonsmoking patron to high health risks (Table 2.2).

Table 2.2 Predicted Steady-State Blood Carboxyhemoglobin (COHb) Levels

| Carbon monoxide exposure concentration (ppm) | Steady-state blood COHb (percent) |
|---|---|
| 0.1 | 0.25 |
| 0.5 | 0.32 |
| 1 | 0.39 |
| 2 | 0.50 |
| 5 | 1.0 |
| 10 | 1.8 |
| 15 | 2.5 |
| 20 | 3.2 |
| 40 | 6.1 |
| 60 | 8.7 |
| 80 | 11 |
| 100 | 14 |
| 200 | 24 |
| 400 | 38 |
| 600 | 48 |
| 800 | 56 |
| 1,000 | 61 |

[a]Blood COHb levels are predicted from the Coburn-Forster-Kane (CFK) model (see Section 3.4.5 for a discussion of model and parameter values).

(CDC, 2007b)

Workers at commercial WTS establishments are beginning to experience the imminent health hazard that carbon monoxide can present. For example, a worker at a commercial WTS establishments got severe carbon monoxide poisoning from lighting coals for customer's waterpipes. The patient arrived at hospital unconscious and had electrocardiogram (ECG) consistent with a cardiac ischemia. His COHb level was 33.8%, is a level that can cause death (Misek & Patte, 2014).

Besides air quality studies, researchers have started doing clinical experimental studies to investigate biomarkers of nicotine intake and carcinogenic exposure from a waterpipe tobacco smoking. The term biomarker refers to a medical signs that are objective indications of the medical state of the observed patient which can be measured accurately and are reproducible (Strimbu & Tavel, 2010). The World Health Organization in a joint venture with the international program on chemical safety and the United Nations environmental program which has defined and established criteria for biomarkers. The WHO notes biomarkers may be used to assess the exposure, the absorption amount and effects of chemicals on smokers. Furthermore, biomarkers may be used to interpret cause- effect relationships in health risk assessments and for monitoring purposes(WHO, 1993). In another report, the WHO defined the validity of biomarkers in environmental risk assessments.

Biomarkers are measured in blood, saliva, or urine. The most specific and sensitive biomarker to quantify exposure to environmental tobacco smoke appears to be cotinine, the major proximate metabolite of nicotine (Benowitz, 1999). Cotinine is specific to tobacco whereas carbon monoxide is nonspecific. Though present in tobacco smoke, it can originate from other sources. he validity of using continine has been

questioned because the ratio of nicotine to other ETS components can vary in different spaces due to surfaces, ventilation, sample duration and their distribution patterns (Idle, 1990). The different space variations may have contributed to the high PM2.5 concentrations as in the Virginia air quality WTS establishment study (Cobb et al., 2013) or the high CO concentrations in the other two studies (Torrey et al., 2014; Zhou et al., 2014). Because cotinine is so specific in tobacco that even with possible elevated results from space variation and not from direct individual intake, the biomarker will still capture nicotine absorption. For this reason, some researchers prefer measuring cotinine concentrations because they correlate better to the biologic effects of smoking than self-reporting (Kandel et al., 2006; Perezstable, Benowitz, & Marin, 1995).

Besides evaluating cotinine, the major proximate metabolite of nicotine, the clinical studies analyzed exposure to benzene, low and high molecular weight polycyclic aromatic hydrocarbon (PAH), tobacco-specific nitrosamines, 1,3-butadiene, acrolein, acrylonitrile, propylene oxide, ethylene oxide, and mercapturic acid metabolites of volatile organic compounds (VOC). Review of the first two studies showed substantial nicotine concentrations and absorption of significant carcinogens (Helen et al., 2014; Jacob et al., 2011). The other two studies found similar results along with an uptake of benzene (Jacob et al., 2013; Kassem et al., 2014). Volatile organic compounds (VOC) such as Benzene from tobacco smoke are associated with cancer such as leukemia and cardiovascular, and respiratory illnesses (North et al., 2014; St.Helen et al., 2014).

### 2.5 Perceptions and Uptake of Waterpipe Tobacco Smoking

There is a misconception among college students who are current waterpipe tobacco smokers that WTS is less harmful and addictive than cigarettes (Aljarrah,

Ababneh, & Al-Delaimy, 2009; Smith-Simone, Maziak, et al., 2008). The perception that since the smoke is filter through water it is less harmful. The misconception dates back to the 16th century during the reign of Emperor Akbar in India. Akbar allowed tobacco smoking, but one of high ranking physicians Abul Fath at that time was not in agreement. The physician's solution was to have the smoke pass through water claiming it would minimize the risks (Chattopadhyay, 1999). However studies have found that the air passing through the water does not change the contents so the same carcinogens and other particles in the tobacco smoke pass through the water into the users' lungs (Kiter, Uçan, Ceylan, & Kilinç, 2000).

The volume of smoke inhaled by waterpipe tobacco smokers is significantly higher than cigarettes some studies suggesting up to 10 times higher (Maziak et al., 2009; Shihadeh, 2003; Shihadeh & Saleh, 2005). The level of nicotine which is the addictive component of tobacco is still as high as cigarettes even when the smoke is filtered through water (Eissenberg & Shihadeh, 2009; Neergaard, Singh, Job, & Montgomery, 2007). The influence of nicotine on young adults is a concern because waterpipe tobacco smokers are more likely to become regular cigarette smokers (Martinasek et al., 2011). Another study that a 6-month follow-up of waterpipe tobacco smokers found an increase in the number of cigarettes smoked (Doran, Godfrey, & Myers, 2015).

## 2.6 Tobacco Control Policies

To protect their constituents, city and state legislators are moving forward on the war on tobacco where one tobacco method is banned and another method takes its place. States such as California, Connecticut, and New York have introduced bills that would ban or limit hookah bars. Boston and Maine have already ended exemptions in their indoor-

smoking laws.(Quenqua, 2011) Ending or changing the retail tobacco exemptions can be an effective way to discourage the proliferation of WTS establishments. For example, the Oregon Health Authority now has greater authority to regulate WTS establishments due to a change to the definition of a "smoke shop" in their indoor Clean-air Act. The legislation cuts into the profits of businesses that were not entirely a stand-alone WTS establishment. The Oregon Indoor Clean Air Act now reads that "smoke shops" or businesses where customers can sample tobacco can no longer serve food, drink, or sell lottery tickets. Also, no one under the age of 18 can enter and the seating capacity is limited to four patrons(Waldroupe, 2011). This type of information, about best practices to slow the stem of WTS establishments located near colleges and universities needs to be shared with legislators, health advocates, and college administrators in other cities and states.

### 2.7 Waterpipe Tobacco Smoking Products and Warning Labels

For 50 years, the Surgeon General Office has been warning the US public about the consequences of smoking but there is still a gap in smokers' understanding. One study found less than three-quarters of smokers were aware smoking can cause strokes(Hammond, Fong, McDonald, Cameron, & Brown, 2003), In another study, the majority of the participants were unaware smoking could cause impotence.(O'Hegarty, Pederson, Nelson, Wortley, & Yenokyan, 2007) Warnings are the most common way of communicating the health risks of smoking to the users and others exposed to their smoke.(Hammond et al., 2006; O'Hegarty et al., 2006) During a typical WTS smoking session, the exposure to secondhand smoke compared to a cigarette can amount to ambient toxicants and carcinogens several times higher.(Eissenberg & Shihadeh, 2009) Some countries follow the World Health Organization's recommendations present in

Article 11 and 12 which address warning labels, communication, and education about the hazards of smoking tobacco. In short, Article 11 recommends large pictorial health warnings and encourages more effective forms of disseminating product ingredients and emissions.(WHO, 2008) Article 12 provides guidelines to identify key measures needed to successfully educate, communicate and train people on the health, social, economic, and environmental consequences of tobacco consumption and exposure to tobacco smoke (WHO, 2010).

In fact, many of the countries that implemented the Article 11 recommendation for pictorial warnings on cigarette packages have noticed a greater frequency of smokers reading the warnings as well as an increased motivation to quit (Hammond, 2011). Another benefit of using graphical images is it can be used to convey the consequence of smoking, which is an effective educational strategy for population segments that are either illiterate or unlikely to comprehend the text-based warnings (Thrasher et al., 2007).

The WTS market is expanding rapidly and the Internet is ideal channel to sell this novel product. Amazon was rated number nine in 2014 year for the highest retail sales and was the only e-retailer in the top 10 US retailers (Schulz, 2014). Amazon shows a significant presence in the WTS market. A search current search as of April 11, 2015 using the term *hookah* in all the departments shows a strong involvement in the WTS market with 13,719 products meeting that criteria (Amazon, 2015). With Amazon having such a large market, do they have an obligation to warn their customers about the potential hazards of smoking tobacco? In fairness to Amazon, they do not sell any tobacco products but they do sell products that are used to consume tobacco products such as thousands of water-pipes. But some of their retailers might be pushing the

envelope on the legitimacy of their products. For example, a product called Ice Drops which is a hookah smoking gel sold by Beamer Hookah Products requires a legal disclaimer. For this particular product, Amazon requires a legal disclaimer to be placed in the description; "must be 18 years and over to purchase in USA" (Amazon, 2015). A review of Beamer's website show, Beamer Ice Drops are small pieces of gel that have been injected with glycerin and other flavor fluids that when heated with hookah charcoal, produce steam instead of smoke (Beamer, 2015). Glycerin is one of the ingredients in e-cigarettes and is causing concerns about its consumption and should contain a warning label so consumers have a better idea what they are smoking. This same about concern about knowing what consumers is also being discuss in term of actual waterpipe tobacco or shisha. Waterpipe tobacco and other accessories such as the charcoal is presently not regulated by the US Food and Drug Administration so the content and packaging are not standardization. In most cases patrons of WTS establishments never see the packaging and if they did there is no regulations in place to require warning labels (Bower, 2011; Dugas, Tremblay, Low, Cournoyer, & O'Loughlin, 2010; Nakkash & Khalil, 2010).

### SMOKING 2.8 WATERPIPE TOBACCO ESTABLISHMENTS

The terminology often used to describe a business dedicated to providing waterpipe tobacco smoking is hookah bar, hookah lounge, or hookah café. Limited information exists about the actual number and the density of these businesses in U.S. The estimate often cited from the American Lung Association in 2007, reported there was an estimated 200 to 300 WTS establishments across the U.S. tabulated from Hoovers, Better Business Bureau, and three WTS community websites (ALA, 2007). Another

study which in 2010 also merged large WTS community websites, including hookah-hookah.com, hookahculture.com, hookah-bars.com, and smoking-hookah.com found 724 WTS establishments in the U.S. (Griffiths, Harmon, & Gilly, 2011). Also coming up with over 700 locations was a study that searched google.com, yahoo.com, and bing.com for WTS establishments. This study also found 19 hookah bar directories which they added for a total of 771 WTS establishments (Primack et al., 2012). A state-level study using Hoovers, Better Business Bureau and an online search using "hookah" and "California" identified 175 WTS establishments in California, with the majority of them being in Los Angeles (Rezk-Hanna, Macabasco-O'Connell, & Woo, 2014). The previous collection procedures from the four mentioned studies are mixed and missed potential sources to identified additional locations. Also there is not a recent national count of WTS establishments to gage the recent growth of the WTS industry. Correcting these discrepancies is part of the focus of the first study.

## 2.9 Theoretical Frameworks

The first study analyzed some of the business structures of waterpipe tobacco smoking establishments such as location selection in relation to their patrons. The entry barriers are minimal in many locations for this type of business throughout the United States. Many of these business operate under the exceptions to the state's indoor smoking ban for cigar bars and tobacco shops or as a private club. A review of the literature shows the concept of "entry barriers" for starting a business in a particular industry initial was discussed in industrial organizational publications in the mid-50s. The originator of the theory, identified three possible barriers which could be the source of supra-competitive profits: cost advantages by incumbent firms, product differentiation, and scale of

economies (Bain, 1956). Not agreeing with Bain's concept of scale of economies, George Stigler's (1968) alternative definition was that the cost of producing must be borne by the business entering the industry not the business already in the business (Stigler, 1968). Continuing in chronological order, in the 1970s economist James Franklin Fisher added to the definition of entry barriers. He noted that profit plays a significant role in entry, if firms are earning profits in the short run other firms enter the market thus expanding supply and bidding down price. The rewards follow the innovator or the first to market (Fisher, 1979). When discussing barriers to entry, government interventions need to be considered. Interventions can place limitations on incumbents resulting in regulating of their behavior or effect the allocation of resources to their competitors (von Weizsacker, 1980). The "ease of entry" or the ability of a new entrant in the market to earn a profit quickly is a disadvantage to current businesses (Porter, 1980). Porter developed a framework to analysis the level of competition as well as barriers of entry referred to as the *Five Forces* model (Figure 2.2).

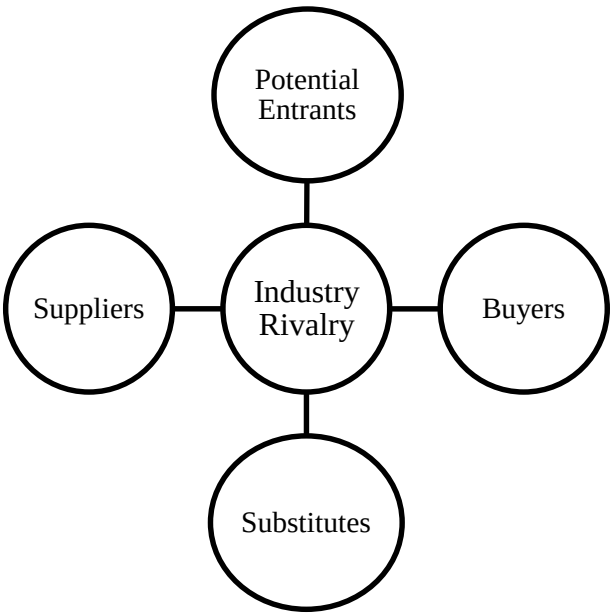


Figure 2.2 A Graphical Representation of Porter's Five Forces Model (Porter, 1980)

The time required to enter the market can be another barrier to entry. Anything preventing an entrepreneur from instantly entering a market should be considered a barrier (Carlton & Perloff, 1990)

The second study analyzed the demographic characteristics of 18-24 year olds in greater detail for different tobacco products from a weighted national survey. Therefore it is important to understand some of the theoretical constructs associated with the transition from adolescence to adulthood. Previous research has shown the process of maturity is complex, incorporating physical, social, emotional and behavioral components (Galambos, Kolaric, Sears, & Maggs, 1999; Tilton-Weaver, Vitunski, & Galambos, 2001). The 18-24 year old segment of the population includes 6 years, an 18 year old can be very different than 24 year old and change can happen quickly. Psychologists and sociologists often refer to these changes of maturity towards adulthood as social demographic transitions (Hogan & Astone, 1986). Data from a 1,500 participant longitudinal study revealed significant demographic transitions from age 19 to 21 where the subjects showed a greater propensity to take on individual responsibilities. This same study showed positive changes toward adulthood with labor market position (Benson & Furstenberg, 2003). This type of information influences the variable selection in the study, for example employment status was included in the model. This transitional period is associated also more freedom and less social control which can result greater experimentation and higher rates of substances use (Arnett, 2005). The transition to adulthood in industrialized countries is longer than in developing countries. Young Americans, even minority cultures with traditional ethnic backgrounds, experience this transition. Differences have been identified between whites and African Americans,

Latinos, and Asian Americans. The ethnic minority groups tend to have a greater obligation toward others described as a bicultural conception derived from the values of their ethnic culture which hastens the transition (Arnett, 2003). The overarching theory that describe this stage of life for 18-25 years old that usually ends with the adoption of adult roles such as marriage, parenthood or the start of a career is the Emerging Adult Theory (Arnett, 2000)

## 2.10 Research Objectives and Corresponding Hypotheses

Aim1: The first study attempts to describe the landscape of the waterpipe establishment industry and to examine the extent to which businesses are locating near college and universities.

H1: WTS establishments are locating near large colleges and universities.

Aim 2: The second study will analyze the demographic characteristics of 18-24 year olds in greater detail for different tobacco products from a national weighted survey.

H2: College students have a greater prevalence of waterpipe tobacco usage than non-college respondents.

H3: For the 18-24 year old segment of the population, age and the level of education are associated with different use patterns for different tobacco products.

# CHAPTER 3

# METHODS

## 3.1 FIRST STUDY METHODS

A database of U.S.-based waterpipe establishments and their street addresses was compiled during August/September 2014 using the following Internet directories: *Yelp* (N=3,842; www.yelp.com), *Yellow Pages* (N=875; www.yellowpages.com), *Hookah-Hookah* (N=567; www.hookahhookah.com), *Hoovers* (N=550; www.hoovers.com), and *Better Business Bureau* (N=136; www.bbb.org). *Yelp*, *Hoovers*, and *BBB* directories were searched using the keyword "hookah". The term "hookah bar" was used to search the *Yellow Pages*. This study builds on previous studies using *Hoovers*, *BBB*, and *Hookah-Hookah* directories (ALA, 2007; Griffiths et al., 2011) by including additional sources: *Yellow Pages* and *Yelp*. Data from *Yelp* provided additional locations serving waterpipe beyond the businesses using the term "hookah" in their business description Yelp's search algorithm captured all references of the word hookah from a variety of businesses; many with images of the facility post from the customer reviews. The Yelp reviews revealed bars, restaurants, coffee shops and other retail facilities were offering waterpipe smoking as a segment of their business, but are not using the terms, *hookah*, *hookah bar* or *hookah lounge* in the description of their business, therefore, were not captured in the other databases.

For establishments that did not have the terms “hookah lounge”, “hookah bar” or “hookah café” in the name, we called to verify whether waterpipe smoking was allowed on premises. If there was a designated area either inside or an outdoor patio area to facilitate the smoking of waterpipe tobacco at the business the business was then categorized as a WTS establishment.

The majority of the businesses excluded from the original list were “vape shops." Vape shops are specialty shops that exclusively sell electronic nicotine delivery systems (ENDS). A recent study on the expanding ENDS product market estimated as of 2014 there were over 3,500 ENDS specialty shops in the USA (Lee & Kim, 2014). These findings are consistent with the breakdown from the businesses were excluded from the final list, 3,387 total (Table 3.1).

Table 3.1 Exclusion Summary by Database

| | Hookah-Hookah | YP | BB | Hoovers | Yelp | Total |
|---|---|---|---|---|---|---|
| Search Results | 567 | 875 | 136 | 550 | 3842 | 5970 |
| Duplicates | 287 | 15 | 47 | 246 | 298 | 893 |
| Excluded | 29 | 240 | 24 | 88 | 3006 | 3387 |
| FINAL | 251 | 620 | 65 | 216 | 538 | 1690 |

The other businesses that were excluded were retailers that sold waterpipe tobacco products or an ENDS product called an e-hookah and did not have a smoking area. The e-hookah is usually much larger than an e-cigarette and has a larger battery and refillable cartridge. There are concerns about the e-hookah because it can be easily modified for different content delivery (Grana, Benowitz, & Glantz, 2013). Many convenience stores and gas stations were selling e-hookahs and were removed from the final database. Finally, smoking paraphernalia shops or “head shops” which sell products

used for the consumption of cannabis, (Pillay & Kelly, 2010) were examined. The Yelp algorithm captured locations that used the term hookah in the description of their products. After calling to verify if these businesses offered waterpipe tobacco smoking, several of these businesses were found to have a location on site to try different waterpipe tobacco and to test different waterpipes. The *Hookah-Hookah* directory was limited to waterpipe lounges and further refining was not required. Duplicates and those locations not serving hookah on premises were removed leaving a total of 1690 WTS establishments (Figure 3.1).

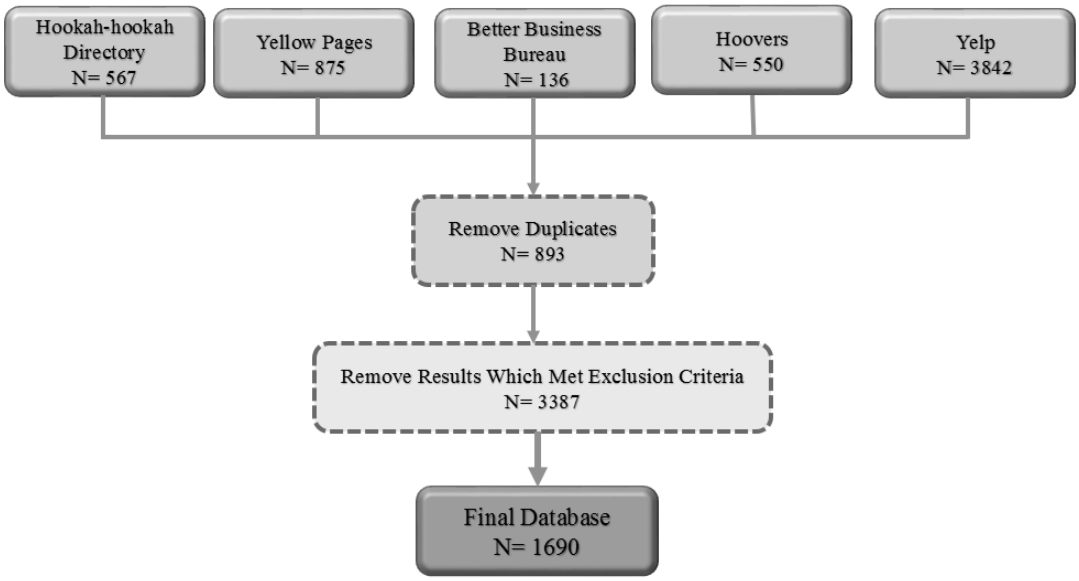


Figure 3.1 WTS Establishment Final Database

Our list of educational institutions included all accredited colleges and universities obtained from the Integrated Postsecondary Education Data System (U.S. Department of the Interior), which combines information on every institution that participates in federal student financial aid programs (n=2,847) (USGS, 2010). Institutions with dormitory capacity of less than 250 beds were excluded (n=1,393) to improve the readability of the final GIS maps. A primary focus of the study is on the

proximity of residential college/university students to waterpipe smoking establishments. By reducing the number of schools without a consistent student population living in campus dormitories many of the online satellite campuses, seminary, chiropractic, culinary, and art institutes were removed from the database. For each educational institution, city population density per square mile was linked using the zip code (ZipAtlas, 2014). We also linked smoke-free campus status for each college/university from the Americans for Nonsmokers' Rights web site, in order to determine if tobacco-free policies are associated with proximity of waterpipe establishments (ANR, 2015).

ArcGIS (version 10.2, ESRI, Redland, CA) was used to geocode the street addresses of waterpipe establishments and colleges/universities (mapping rate = 99.9%). We calculated the point straight-line (Euclidean) distance from each college/university to the nearest waterpipe establishment. A thematic map with gradient color was created to display the colleges and universities coded in 3-mile increments (0.1-3.0 miles, 3.1-6.0 miles, 6.1-9.0 miles and ≥ 9.1 miles) based on the distance to the nearest waterpipe establishment.

The initial proximity analysis was calculated on college dorm capacity of greater than 250+. 1000+, 2000+. 4000+, and 8000+. Preliminary findings suggested a possible association to dorm capacity to the nearest distance (0-3) with increment percentage increases (Table 3.2). Proximity analyses were ran on each capacity see Appendix A.

Table 3.2 Distance from Colleges to the Nearest WTS Establishment

| College Dorm Capacity | 0 – 3 miles | 3 – 6 miles | 6 – 9 miles | 9+ miles | Total |
|---|---|---|---|---|---|
| 250+ | 554 (38.1%) | 126 (8.7%) | 55 (3.8%) | 719 (49.4%) | 1454 |
| 1,000+ | 342 (41.6%) | 63 (7.7%) | 26 (3.2%) | 392 (47.6%) | 823 |
| 2,000+ | 207 (50.5%) | 27 (6.6%) | 11 (2.7%) | 165 (40.2%) | 410 |
| 4,000+ | 93 (63.7%) | 10 (6.8%) | 2 (1.4%) | 41 (28.1%) | 146 |
| 8,000+ | 22 (73.3%) | 4 (13.3%) | 1 (3.3%) | 3 (10.0%) | 30 |

Within 3 miles of a college/university the results consistently indicate that as the dorm capacity increases, the percentage of schools with a commercial WTS establishment within 3 miles increases 250+ = 554 (38.1%), 1000+ = 342 (41.6%), 2000+ = 207 (50.5%), 4000+ = 93 (63.7%), and 8000+ =22 (73.3%). An inverse relationship is seen when the distance to a commercial WTS establishment is 9 miles or greater. The distance from the WTS establishments to the nearest college was tabulated and the average distance was calculated (Table 3.3).

Table 3.3 Distance from WTS Establishments to Nearest College

| WTS Establishments. | 0 – 3 miles | 3 – 6 miles | 6 – 9 miles | 9+ miles | Total |
|---|---|---|---|---|---|
| All locations | 973 (57.6%) | 366 (21.7%) | 157 (9.3%) | 194 (11.5%) | 1690 |

In the initial investigation an overlay analysis was done on the GIS waterpipe establishment map overlaid on the GIS college map to visually verify that the closer colleges (darker gradient) were covered by the WTS establishments (red) (Figure 3.2).

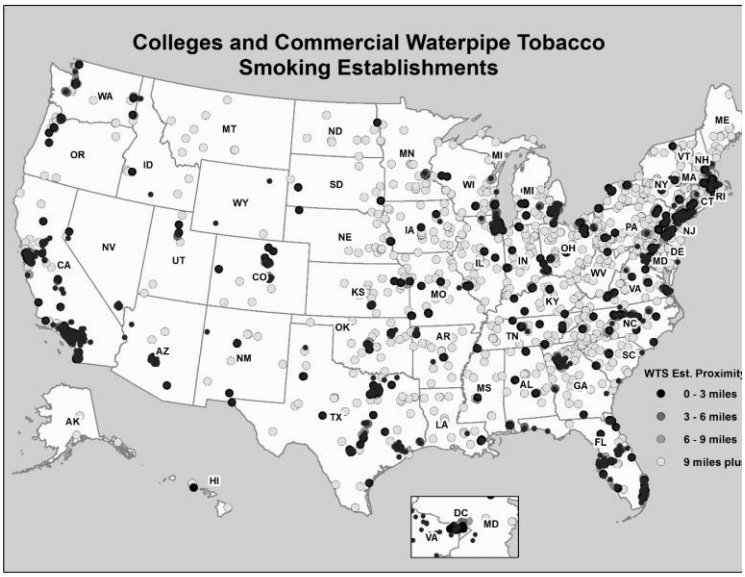


Figure 3.2 Overlay Analysis Results

A walkability analysis was also completed determine to walking access from college campuses to commercial WTS establishments (Table 3.4).The definition "within walking distance" or less than .5 mile was used, which is consistent with criteria used by state and local transit agencies in their transit-oriented development plans (Colabianchi et al., 2007; Fairfax & others, 2011; Greenwald & Boarnet, 2001).

Table 3.4 Colleges within Walking Distance to a WTS Establishment based on FTE

| Walking Distance ≤ .5 Miles | Full-time 0-2500 | Full-time 2500-5000 | Full-time 5000-10000 | Full-time 10000-20000 | Full-time >20000 | Total |
|---|---|---|---|---|---|---|
| Number of Colleges | 37 | 15 | 21 | 22 | 35 | 130 |
| Number of Students | 56,642 | 51,848 | 160,602 | 333,818 | 951,114 | 1,554,024 |

Another consideration came up during the initial analyses. The concern was how to justify using the closest proximity over the total number of WTS establishments surrounding each college/university as the unit of measure. Therefore, the three distance increments compared to the number of WTS establishments needed to be evaluated to see if there was any imbalances due to overlapping. To address this concern ArcGIS 10.2 was used to convert the geocoded sample points of the colleges/universities in the study to Thiessen polygons. The Thiessen polygon defines an area of influence around the sample point. Then the spatial join tool was used to join the WTS establishment point shapefile with the new college/university polygon shapefile. The multiple ring buffer tool was used to analyze the overlap of WTS establishments that can serve more than one college/university within radii of 3, 6, and 9 miles. This analysis tool creates multiple buffers or concentric circles at these specific distances around the college/university polygons. This allows identification of WTS establishments with multiple colleges within

the three buffers. This spatial analysis also provided an overall count of the number of WTS establishments within the established mile increments. In this spatial analysis the dissolve option was not used. As a result, all buffer areas were maintained regardless of any overlap. Each buffer covers its input features (i.e. the waterpipe establishments) plus any smaller buffer segments. The results were exported from GIS and uploaded into SAS 9.4 to create a frequency table for further analysis (Table 3.5).

Table 3.5 Multiple Ring Buffer Analysis

| WTS Establishment Count | Distance | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 – 3 Miles | | 3 - 6 Miles | | 6- 9 Miles | | Total | |
| | N | ( % ) | N | ( % ) | N | ( % ) | N | ( % ) |
| **0** | 905 | (20.75) | 775 | (17.77) | 719 | (16.48) | 2399 | (55.00) |
| **1** | 208 | (4.77) | 177 | (4.06) | 177 | (4.06) | 562 | (12.88) |
| **2** | 94 | (2.15) | 100 | (2.29) | 70 | (1.60) | 264 | (6.05) |
| **3** | 57 | (1.31) | 74 | (1.70) | 72 | (1.65) | 203 | (4.65) |
| **4** | 49 | (1.12) | 56 | (1.28) | 54 | (1.24) | 159 | (3.65) |
| **5** | 23 | (0.53) | 29 | (0.66) | 32 | (0.73) | 84 | (1.93) |
| **6** | 24 | (0.55) | 27 | (0.62) | 25 | (0.57) | 76 | (1.74) |
| **7** | 25 | (0.57) | 44 | (1.01) | 50 | (1.15) | 119 | (2.73) |
| **8** | 8 | (0.18) | 17 | (0.39) | 17 | (0.39) | 42 | (0.96) |
| **9** | 8 | (0.18) | 10 | (0.23) | 25 | (0.57) | 43 | (0.99) |
| **10** | 5 | (0.11) | 19 | (0.44) | 10 | (0.23) | 34 | (0.78) |
| **Greater Than 10** | 48 | (1.11) | 126 | (2.88) | 203 | (4.66) | 377 | (8.64) |
| **Total** | 1454 | (33.33) | 1454 | (33.33) | 1454 | (33.33) | 4362 | (100.0) |

The table has relatively consistent percentages across each column for each incremental increase of a WTS establishment for each of the three distance categories. For example, when there is only one WTS establishment within each of the three distance increments in relation to colleges/universities the frequency percentages are 4.77%, 4.06% and 4.06% respectively. This trend is relatively consistent moving down the table from zero to ten WTS establishments without any major unbalance between increments. There were some outliers with multiple overlapping buffers in areas with high population density, which makes a visual analysis difficult to project on a GIS map. For example, New York City which is 469 square miles had several areas within the city limits were the 9 mile overlapping buffers exceeded over 100 WTS establishments. Therefore, since the percentages were relatively consistent per distance increment to WTS establishment count for over 91.36% of the data the closest proximity of a college/university to a WTS establishment was used in the final model. Using the closest proximity removes the high concentration of overlapping buffer rings and improves the visual analysis because a thematic map could be used to display the colleges/universities by size and color. The thematic map used in the study displays the colleges/universities using graduated color indicating the distance increment to the nearest WTS establishment. For example, as the symbol representing the college/university gets darker the closer the school is to a WTS establishment. When this type of geographical data is displayed on a GIS map of the U.S. in this format, spatial patterns emerge and concentrations of colleges/universities can be easily identified visually.

After careful consideration dormitory capacity was replace with full-time student enrollment because it was more representative of the student population. A thematic map with gradient color was decided on as the best way to display the colleges/universities coded in 3-mile increments (0.1-3.0 miles, 3.1-6.0 miles, 6.1-9.0 miles and ≥ 9.1 miles) based on the distance to the nearest waterpipe establishment. Supporting tables and figures will be include in the results section of the first study. To determine the distribution of waterpipe establishments for various sized colleges and universities, thematic map data were stratified by full-time student enrollment, as follows: <2,500, 2,500-4,999, 5,000-9,999, 10,000-19,999, and ≥ 20,000 full-time students. To evaluate the impact of full-time student enrollment, population density, and smoke-free campus policies on the distance from colleges/universities to the nearest waterpipe establishment, a multinomial logistic regression model was estimated. The dependent variable included the four distance categories with the reference category being > 9.1 miles or distances not close enough for students to patronize the WTS establishment. SAS statistical software version 9.4 was used for all analyses which were conducted during February. A p-value of less than 0.05 was considered to be statistically significant.

## 3.2 Second Study Methods

### Data Source

Data were obtained from the Office on Smoking and Health (OSH) a division of the Centers for Disease Control and Prevention (CDC). The 2009-2010 National Adult Tobacco Survey is the first adult tobacco survey designed within the framework provided by the key outcome indicator (KOI) report. The background and the weighting of the NATS are summarized in the CDC methodology report. The primary purpose of the 2009-2010 NATS is to estimate tobacco use behaviors as a function of demographic characteristics as well as tobacco prevention and control outcome indicators (CDC, 2011), The NATS weighted design is a stratified, national, landline, and cell phone survey of noninstitutionalized adults aged 18 years and older representative at both national and state levels. The states were segmented in three strata - a listed landline stratum, a not-listed landline stratum, and a cell phone stratum. The target numbers for completes per state was 1863 landlines, cell phones varied in proportion to each state's population. States had the option to increase their number of cell phone completes. Four states added to their samples, Louisiana, New Jersey, North Dakota, and Oklahoma. The respondent selection and final disposition code varied by phone type. For landlines one adult $\geq$ 18 years odd was randomly selected from the household and after 15 call attempts the number was assigned a final survey disposition code. For cell phone numbers for adults $\geq$ 18 years odd the inclusion criteria was the cell phone was the only way to reach the home by telephone and used only by the person who answered. After 6 attempts the cell phone number was assigned a final survey disposition code. The survey weighting varied by phone type. Landlines were weighted by the probability of

selection of the telephone number, the probability of selecting the respondent in the household, and a nonresponse adjustment. The cell phone data were weighted only by the probability of selection of the cell phone number and a nonresponse adjustment. Then the data were poststratified by state to the demographic variables and phone type. Three weight sets were created, national, state, and landline only. The national weight used all the respondents in all the states. For the state weight the cell phone respondents were assigned a non-zero weight for states with ≥ 200 cell phone respondents and a weight of zero for states with ≤ 200. Including the cell phone respondents in states with low cell phone samples would create larger variances and smaller effective sample sizes. Finally the landline weight only used landline respondents. In total, the questionnaire contained 130 questions asking about tobacco use, cessation, secondhand smoke and smoke-free policies, tobacco-related opinions and attitudes, chronic diseases and demographic characteristics. The survey was run from October 20, 2009, to February 28, 2010 (CDC, 2011).

## Sample

The 2009–2010 NATS target population was noninstitutionalized adults ≥ 18 years old located in the 50 U.S. states and District of Columbia. The Office on Smoking and Health (OSH) established a target for landline sample size of (n = 95,013) which was equally distributed per state (n = 1863). The target number of cell phone completes per state varied in proportion to each state's population. In total, (n = 118,581) interviews were collected (n = 110,634) landlines and (n = 7,947) cell phones. The uniform formula for response rates established by Council of American Survey Research Organizations (CASRO) which is the number of completed interviews divided by the number of eligible

respondents in the sample was used for the survey (CASRO, 1982). For all states combined and for all eligible telephone numbers, the CASRO rate was (37.6%), landline (40.4%) and cell phone (24.9%). The national cooperation rate, calculated from the number of completed interviews divided by the number of eligible respondents contact total survey (62.3%), landline (61.9%) and cell phone (68.7%).

## Dependent Variable

The dependent variable used for this study was current water pipe smoking status of the respondents. See actual survey questions in Appendix B. The variable was derived from the two questions, e.g., "During the past 30 days, on how many days did you smoke cigarettes?" and "During the past 30 days, on how many days did you smoke tobacco in a waterpipe?" The variable was dichotomized in current and non-current waterpipe smoking categories with 'current' being one who smoked waterpipe in past 30 days and 'non-current' includes those who never smoked waterpipe and those who smoked but not in the past month.

## Independent Variables

The principal predictors for waterpipe smoking assessed in the study was cigarette smoking status as well as use of other tobacco products like cigars, other pipes, smokeless tobacco, and snuffs and snus. Cigarette smoking status variable was categorized into current and non-current as the waterpipe smoking status variable mentioned earlier. The other tobacco user variable contains the information about use of cigars, cigarillos, and other small cigarettes; other types of pipes than the waterpipe; smokeless tobacco products; and chewing tobacco, dips, snus or snuffs. This variable was coded into three categories, e.g., 'current' contains those who are currently using any of

the other types of tobacco products, 'ever' consists of those who used any of the products more than a month ago, and 'never' is made up with those who did not use either of the products in lifetime.

Also assessed were the following socio-demographic characteristics: age in years (18-21, 22-24), gender (male, female), education (0–12 years [no diploma] or Graduate Education Development (GED) recipient, high school diploma, some college [no degree] or associate degree, undergraduate or graduate degree), race (White, African American, Other), region (Northeast, Midwest ,South, West), sexual minority status (heterosexual/straight or lesbian/gay/bisexual/transgender [LGBT]), and employment status. The perceptions of the respondents regarding the allowance of smoking in bars, casinos, or clubs, restaurants, parks, and on the school ground was assessed using binary yes-no variables. See actual CDC survey questions in Appendix B.

## Statistical Analysis

The characteristics of the current waterpipe smokers and non-current waterpipe smokers was assessed. Also tested were any differences among the constituent categories of each independent variable on the current waterpipe smoking status using chi-square tests. Finally, a simple logistic regression model was fitted for identifying the significant predictors of current waterpipe smoking status. The national weighting was used while fitting the regression model to have the nationally generalizable estimates. Stata 13.1 was used for all analyses.(Stata, 2013)

## Conceptual Model Development

During the process of developing the methods for the two studies, the conceptual model took shape. The present business structure of the waterpipe tobacco market started

to emerge. The phone calls to businesses and the results from Yelp revealed bars, restaurants, coffee shops and other retail facilities offering waterpipe smoking as a segment of their business, but were that were not using the terms, *hookah*, *hookah bar* or *hookah lounge* in the description of their businesses. These are indicators the industry as a whole has a low barrier to entry and is not heavily regulated.

The second study revealed some of the characteristics of the WTS establishment customers. From previous NATS studies, we know current waterpipe smoking is highest among 18-24 years (Salloum et al., 2015) and has more than doubled with the current NATS release (Agaku et al., 2014). College studies on current waterpipe tobacco users have shown campuses were 65% of the current users are smoking at a WTS establishment (Sutfin et al., 2011). Coupled with the initial finding that 18-21 year olds are more likely to be a current waterpipe tobacco smokers than a 22-24 year olds it starts to warrant putting the information together to visually see the complexity of this public health issue.

Putting the findings in a conceptualize model such as Porter's 5-Forces Model can assist with further discussions. From a health policymakers prospective, it can be beneficial to evaluate the market from different angles to establish an effective multifaceted intervention strategy to reduce the number of WTS establishments serving tobacco to young adults. Another idea is to view the model in terms of supply and demand. The WTS establishments are supplying a bar like atmosphere to meet the demand of 18-20 years wanting a place to socialize. Improved education about the hazardous of WTS and greater knowledge about the loopholes in the Clean-Air Act, which has contributed to the growth of the waterpipe tobacco industry, can shift political

will. Political support and the changing the view WTS as a novel trend to a serious public health issue can assist with getting legislation passed that reduces the supply. For example, if legislation is passed and the age requirement is increased from 18 to 21 to enter a WTS establishment the default behavior of younger adult users immediately changes (Figure 3.3).

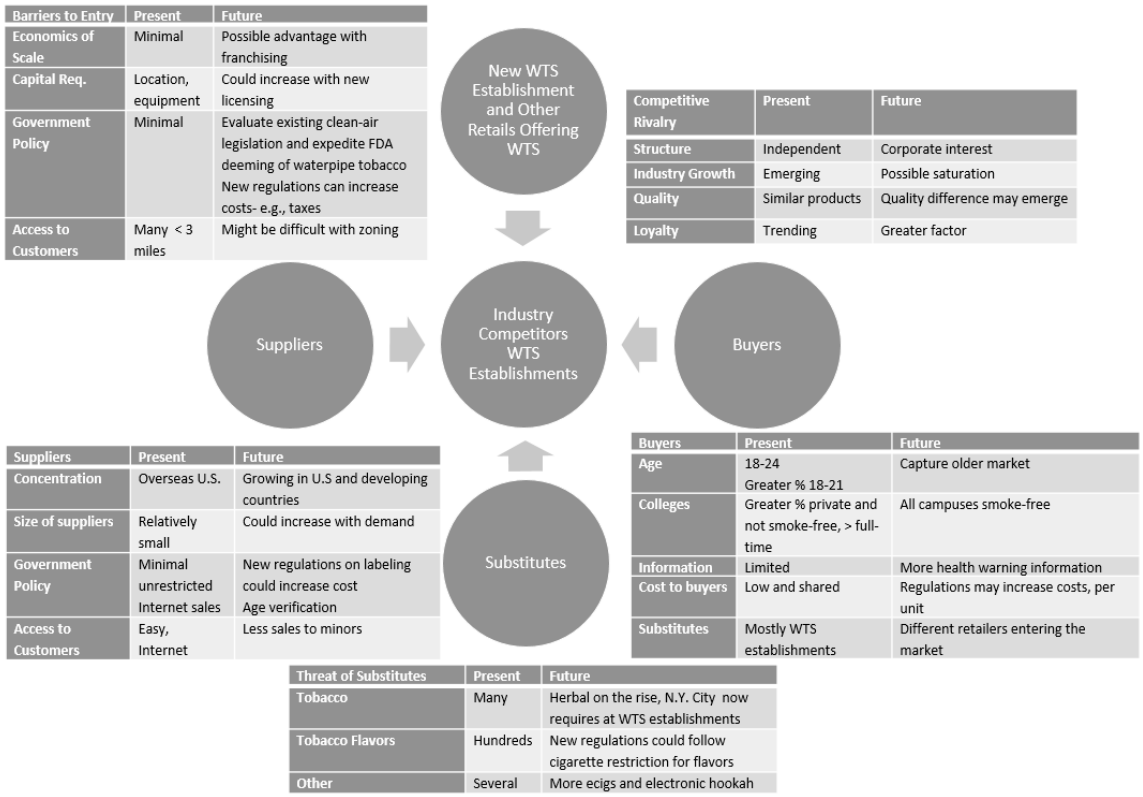


Figure 3.3- Application of Porter's 5-Forces Model (Porter, 1980)

Viewing an industry from different prospective, considering the present and future landscape with identified recommendations can be an effective strategy for tobacco control. The model is a comprehensive approach similar to the CDC's concept of using a coordinated effect of best practices to improve tobacco control, such as smoke-free policies, changing social norms, preventing initiation, regulatory and economic strategies (CDC, 2014).

# CHAPTER 4

## FIRST STUDY

### 4.1 GEOGRAPHICAL PROXIMITY OF WATERPIPE TOBACCO SMOKING ESTABLISHMENTS TO COLLEGE AND UNIVERSITIES IN THE UNITED STATES[1]

[1] Kates, F.R. To be submitted.

Abstract

**Introduction:** Waterpipe tobacco smoking is prevalent among college students in the U.S. and increasing in popularity. Waterpipe smoking establishments are almost completely unregulated and limited information exists documenting the expansion of this industry. The objective of this study was to survey U.S.-based waterpipe establishments and measure their proximity to colleges/universities.

**Methods:** Waterpipe establishments and their addresses were compiled using 5 Internet based directories during 2014 and analyzed in 2015. Addresses were geocoded and overlaid on a U.S. map of accredited colleges/universities. Proximity of colleges/universities to the nearest waterpipe establishment was measured in 3-mile increments. Multinomial logistic regression was used to model the factors associated with proximity of waterpipe establishments to colleges/universities.

**Results:** A total of 1,690 waterpipe establishments and 1,454 colleges/universities were included in the study. Overall, 554 colleges/universities (38.1%) were within 3 miles of a waterpipe establishment. Proximity of waterpipe establishments to colleges/universities was associated with higher full-time student enrollment. Public colleges/universities and those with a smoke-free campus policy were at lower odds of having waterpipe establishments within 3 miles of their campuses.

**Conclusions:** Waterpipe smoking establishments in the U.S. are located near large colleges/universities. This study should inform initiatives aimed at reducing retail tobacco establishment exemptions.

## Introduction

The landmark 1964 Surgeon General's report *Smoking and Health* celebrated its 50th anniversary. Over the past five decades, tobacco control efforts in the U.S. has more than halved cigarette smoking rates since the 1960s,(CDC, 2007a) but other forms of tobacco consumption are increasing. Most recently, waterpipe tobacco smoking (WTS) has become an emerging trend, especially among college students in the U.S.(Cobb et al., 2012; Grekin & Ayna, 2012; Noonan et al., 2011; Primack et al., 2013; Salloum et al., 2015; Sutfin et al., 2011). The view of cigarette smoking has changed from once being an acceptable pastime to a serious threat to public health(DHHS, 2014). Yet, WTS has not been affected by the same negative social stigmas as cigarette smoking (Eissenberg et al., 2008; Smith-Simone, Curbow, et al., 2008). Cigarette smoking has been driven "out of public view and out of public air space" in a large part due to smoke-free laws (DHHS, 2014). Yet, commercial WTS establishments have found a foothold from the nebulous wordings of generic tobacco retail establishment exemptions and because U.S. Food & Drug Administration (FDA) initially overlooked waterpipe tobacco in the statutory definition of "tobacco products" in the 2009 Tobacco Control Act.

This emerging WTS trend is not as visible as cigarettes nor as portable because of the needed smoking paraphernalia and elaborate set up process (Carroll, Shensa, & Primack, 2012).Therefore, most WTS is done in the privacy of one's home or at a commercial WTS establishment (Cobb, Ward, Maziak, Shihadeh, & Eissenberg, 2010; Griffiths et al., 2011; Primack et al., 2012; Shihadeh & Eissenberg, 2011).

The basic setup for WTS includes adding water, loading the bowl with tobacco, and igniting the charcoal on top of the tobacco. There are numerous other accessories associated with WTS including filters, mouthpieces, and aluminum foil. (Nakkash & Khalil, 2010). This time-consuming preparation can elevate the status of the waterpipe to the centerpiece of a social gathering (Carroll et al., 2014). WTS establishments provide a gathering point, an enticing location to socialize with friends, with many allowing access to older adolescents (Sterling & Mermelstein, 2011).

Experimentation of WTS starts at a young age. Prevalence has been identified within middle and high school students (Barnett et al., 2009; Martinasek et al., 2011; Primack et al., 2013; Smith-Simone, Curbow, et al., 2008; Sterling & Mermelstein, 2011). This WTS by adolescents may continue as these students enter college. The U.S. has seen a significant drop in cigarette smoking due to regulations and increased education about the health risks of smoking tobacco and yet more college students are participating in WTS even though they would not consider smoking a cigarette (Erin Nuzzo et al., 2013; Primack, Fertman, Rice, Adachi-Mejia, & Fine, 2010). Information about the dangers of WTS is not effectively reaching college students experimenting with WTS (Eissenberg et al., 2008; Smith-Simone, Maziak, et al., 2008). Not only are these college students inhaling the nicotine, tar, and carcinogenic nitrosamines from the tobacco during the waterpipe smoking process, they are also exposing themselves to high levels of toxic carbon monoxide (CO) and polycyclic aromatic hydrocarbons (PAH) from the charcoal. Numerous epidemiologic studies have reported associations between WTS and increased risks of lung cancer, respiratory illness, low birth weight, periodontal disease, and various infectious diseases (Bentur et al., 2014; Hakim et al., 2011; Jacob et

al., 2013; Knishkowy & Amitai, 2005; Maziak, Ward, et al., 2004; Raad et al., 2011; Shihadeh & Eissenberg, 2011; WHO, 2005).

Compounding the health risks of tobacco, burning charcoal is placed on top of the tobacco to heat the moist tobacco in the bowl at the top of the waterpipe. Studies have shown high concentrations of CO and PAHs at the mainstream of smoke of monitored waterpipes derived mainly from the charcoal (Monzer et al., 2008; Sepetdjian, Saliba, & Shihadeh, 2010).

Some of the increase in WTS has been contributed to the misconceptions many young people have about the actual health hazards associated with WTS. Several surveys have been conducted on college students and the findings indicate perceptions among many students are WTS is less harmful, less addictive, and delivers less nicotine than cigarettes because the smoke is filtered through water(Eissenberg et al., 2008; Grekin & Ayna, 2008; Primack et al., 2013; Smith-Simone, Maziak, et al., 2008). Health policymakers need to understand where this misinformation is coming from as well as where college students experience roadblocks obtaining accurate information about WTS. College students of today are digital natives who have grown up with computers and the Internet. When they have a question or concern, over 90% of these young people turn to some form of social media or an Internet site for the answer (Lenhart, Purcell, Smith, & Zickuhr, 2010). This is a developmental stage for college students moving from parental control to young adults establishing their own relationships with health professionals on and off campus, but this is also when health-risk activates are initiated (e.g., smoking, drug use, and other behaviors) (Skinner, Biscope, Poland, & Goldberg, 2003). The reality is adolescents have difficulty forming relationships and accessing services from

health care providers (Jacobson, Richardson, Parry-Langdon, & Donovan, 2001). When students turn to the Internet for health information the sheer volume of sites causes confusing and many resolve this by focusing on the first few results (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2005).

A recent study revealed Internet search queries related to WTS on Google, using the popular term, *hookah,* averaged approximately 190,000 weekly. WTS shopping searches in the U.S. increased by 291% between January 2004 and December 2013(Salloum et al., 2014). These types of WTS searches are reaching numerous delivery platforms (e.g., YouTube, Facebook, Twitter, WTS retailers, and blog sites). Social media allows WTS consumers to communicate with each other about their waterpipe knowledge and experiences. WTS businesses have the ability to market their products and services on the Internet with minimal restrictions. The limited regulation of the Internet and social media makes it difficult for anti-tobacco advocates and regulators to control the content and dissemination of information. This shift in information control is radically changing how consumers receive information (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011; Singh, Veron-Jackson, & Cullinane, 2008). Students that endorse the use of waterpipe tobacco smoking are more likely to post images of themselves and friends engaging in the activity in a positive context on Facebook (Brockman, Pumper, Christakis, & Moreno, 2012). Therefore, the Internet and social media where young people turn to peers, other consumers, and a vast variety of websites for information makes it challenging to provide college students with accurate information about the health hazards of WTS.

## Methods

A database of U.S.-based waterpipe establishments and their street addresses was compiled during August/September 2014 using the following Internet directories: *Yelp* (N=3,842; yelp.com), *Yellow Pages* (N=875; yellowpages.com), *Hookah-Hookah* (N=567; hookahhookah.com), *Hoovers* (N=550; hoovers.com), and *Better Business Bureau* (N=136; bbb.org). Duplicates and those locations not serving hookah on premises were removed (Figure 3.1). *Yelp*, *Hoovers*, and *BBB* directories were searched using the keyword "hookah". The term "hookah bar" was used to search the *Yellow Pages*. This study builds on previous studies using *Hoovers*, *BBB*, and *Hookah-Hookah* directories (ALA, 2007; Griffiths et al., 2011) by including additional sources: *Yellow Pages* and *Yelp*. Data from *Yelp* provided additional locations serving waterpipe beyond the businesses using the term "hookah" in their business description Yelp's search algorithm captured all references of the word hookah from a variety of businesses; many with images of the facility post from the customer reviews. The Yelp reviews revealed bars, restaurants, coffee shops and other retail facilities were offering waterpipe smoking as a segment of their business, but are not using the terms, *hookah*, *hookah bar* or *hookah lounge* in the description of their business, therefore, were not captured in the other databases. For establishments that did not have the terms "hookah lounge", "hookah bar" or "hookah café" in the name, we called to verify whether waterpipe smoking was allowed on premises. The *Hookah-Hookah* directory was limited to waterpipe lounges and further refining was not required.

Our list of educational institutions included all accredited colleges and universities obtained from the Integrated Postsecondary Education Data System (U.S.

Department of the Interior), which combines information on every institution that participates in federal student financial aid programs (n=2,847) (USGS, 2010). Institutions with dormitory capacity of less than 250 beds were excluded (n=1,393) to improve the readability of the final GIS maps. A primary focus of the study is on the proximity of residential college/university students to waterpipe smoking establishments. By reducing the number of schools without a consistent student population living in campus dormitories many of the online satellite campuses, seminary, chiropractic, culinary, and art institutes were removed from the database. For each educational institution, city population density per square mile was linked using the zip code (ZipAtlas, 2014). We also linked smoke-free campus status for each college/university from the Americans for Nonsmokers' Rights web site, in order to determine if tobacco-free policies are associated with proximity of waterpipe establishments (ANR, 2015).

ArcGIS (version 10.2, ESRI, Redland, CA) was used to geocode the street addresses of waterpipe establishments and colleges/universities (mapping rate = 99.9%). We calculated the point straight-line (Euclidean) distance from each college/university to the nearest waterpipe establishment. A thematic map with gradient color was created to display the colleges and universities coded in 3-mile increments (0.1-3.0 miles, 3.1-6.0 miles, 6.1-9.0 miles and ≥ 9.1 miles) based on the distance to the nearest waterpipe establishment. To determine the distribution of waterpipe establishments for various sized colleges/universities, thematic maps were stratified by full-time student enrollment, as follows: <2,500, 2,500-4,999, 5,000-9,999, 10,000-19,999, and ≥ 20,000 full-time students. To evaluate the impact of full-time student enrollment, population density, and smoke-free campus policies on the distance from colleges/universities to the nearest

waterpipe establishment, a multinomial logistic regression model was estimated. The dependent variable included the four distance categories with the reference category being > 9.0 miles. SAS statistical software version 9.4 was used for all analyses which were conducted during February. A p-value of less than 0.05 was considered to be statistically significant.

Another analysis was done to assess the walkability from college campuses to commercial WTS establishments. The definition "within walking distance" or less than .5 mile was used, which is consistent with criteria used by state and local transit agencies in their transit-oriented development plans(Colabianchi et al., 2007; Fairfax & others, 2011; Greenwald & Boarnet, 2001).

## Results

There were 1690 WTS establishments found across all five databases (Figure 4.1).

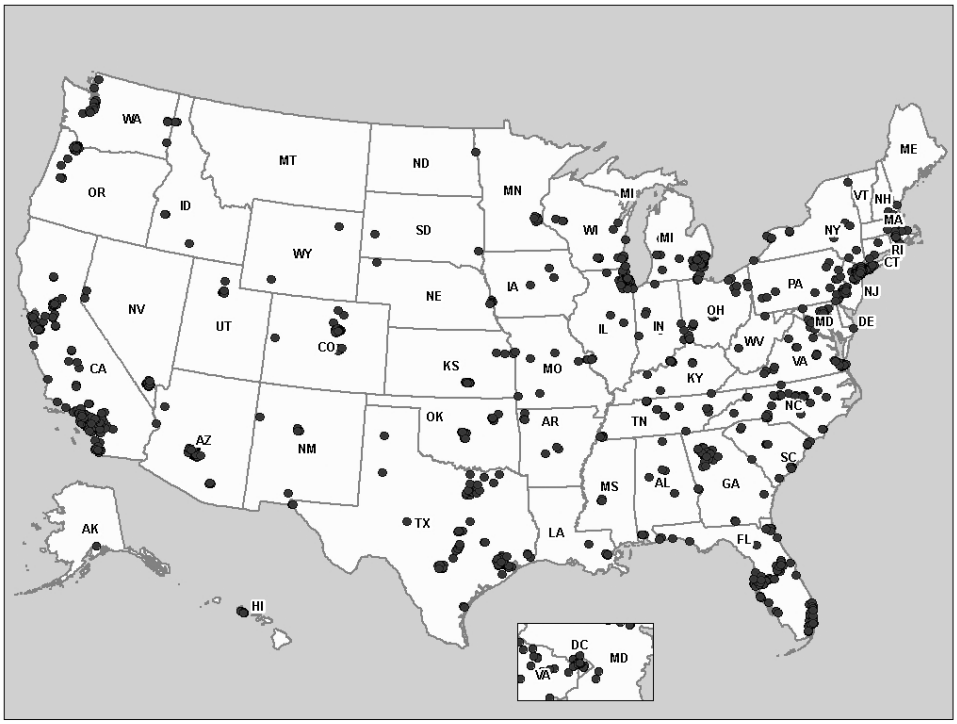


Figure 4.1 Commercial Waterpipe Tobacco Smoking Establishment in the U.S.

Overall, the largest clusters of waterpipe establishments coincided with large metropolitan areas across the country. These include: (Northeast) Boston, New York, Philadelphia, and Washington, DC; (Southeast) Atlanta, Tampa, Orlando, and Miami; (Midwest) Detroit and Chicago; and (West) Seattle, San Francisco, Los Angeles, San Diego, Phoenix, Dallas, and Houston. Among 1,454 colleges/universities, 554 (38.1%) had at least 1 waterpipe establishment within a 3-mile radius (Table 4.1).

Table 4.1 Distance from Colleges to the Nearest WTS Establishment, by FTE

| Full-time Enrollment | 0.1-3.0 miles | | 3.1-6.0 miles | | 6.1-9.0 miles | | 9.1+ miles | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) | N | (%) | |
| All | 554 | 38.1 | 126 | 8.7 | 55 | 3.8 | 719 | 49.9 | 1,454 |
| <2,500 | 229 | 29.7 | 64 | 8.3 | 34 | 4.4 | 445 | 57.6 | 772 |
| 2,500-4,999 | 99 | 35.9 | 34 | 12.3 | 12 | 4.3 | 131 | 47.5 | 276 |
| 5,000-9,999 | 89 | 44.7 | 13 | 6.5 | 6 | 3.0 | 91 | 45.7 | 199 |
| 10,000-19,999 | 79 | 60.8 | 10 | 7.7 | 3 | 2.3 | 38 | 29.2 | 130 |
| 20,000+ | 58 | 75.3 | 5 | 6.5 | 0 | 0 | 14 | 18.2 | 77 |

When the radius was expanded to >9 miles, the number of colleges/universities increased to 719 (49.9%). After stratifying colleges/universities according to full-time student enrollment, the percentage of academic institutions having at least one waterpipe establishment within a 3-mile radius ranged between 29.7% for institutions with minimum enrollment <2,500 students to 75.3% for institutions with minimum enrollment of at least 20,000 students. In Figure 4.2, the darker circles on the map represent colleges/universities that have at least one waterpipe establishment within a 3-mile radius. The darker circles become more apparent as the list of educational institutions is restricted by minimum full-time student enrollment of 2,500-4,999 and ≥ 20,000 students figures 4.2b and 4.2c respectively (Figure 4.2).


Figure 4.2 Distance from Colleges/Universities to the Nearest WTS Establishment, by Full-time Enrollment: (a) All; (b) Enrollment 2,500-4,999; (c) Enrollment ≥ 20,000

The results of the multinomial logistic regression model are presented in the table on the next page (Table 4.2). Higher full-time student enrollment was associated with higher odds of having a waterpipe establishment locating within 3 miles of a college or university (Odds Ratio [OR] = 1.16, 95% Confidence Interval [CI] = 1.08-1.24) or within 3.1-6.0 miles (OR = 1.10, CI = 1.01-1.20) compared to > 9-mile radius. Public

institutions, as compared to private institutions, were less likely to have a waterpipe establishment within a 3-mile radius (OR = 0.62, CI = 0.42-0.91) and within 3.1-6.0 mile radius (OR = 0.42, CI = 0.23-0.75), compared to > 9-mile radius.

Table 4.2 Multinomial Logistic Model: Colleges to the Nearest WTS Establishment[1]

| College/University Characteristics | 0.1-3.0 miles OR [95% CI] | 3.1-6.0 miles OR [95% CI] | 6.1-9.0 miles OR [95% CI] |
|---|---|---|---|
| Full-time student enrollment (per 1000 students) | 1.16 [1.08, 1.24]*** | 1.10 [1.01, 1.20]* | 1.03 [0.86, 1.24] |
| Public institution (vs. private) | 0.62 [0.42, 0.91]* | 0.42 [0.23, 0.75]** | 0.76 [0.35, 1.67] |
| Smoke-free campus | 0.57 [0.39, 0.83]** | 0.61 [0.35, 1.08] | 0.54 [0.24, 1.23] |
| Population density (per 1000 students per square mile) | 2.53 [2.22, 2.89]*** | 2.87 [2.08, 2.73]*** | 2.14 [1.81, 2.54]*** |

[1]Reference category: > 9.1 miles
Note: Model controlled for dormitory capacity and full-time faculty equivalent
* p <.05. ** p < .01. *** p < .001.

Colleges/universities that have implemented smoke-free campus policies had lower odds of having a waterpipe establishment within a 3-mile radius compared to > 9-mile radius (OR = 0.57, CI = 0.39-0.83). Finally, higher population density was associated with higher odds of a waterpipe establishment locating within 3 miles (OR = 2.53, CI = 2.22-2.89), 3.1-6.0 miles (OR = 2.87, CI = 2.08-2.73), and 6.1-9.0 miles (OR = 2.14, CI = 1.81, 2.54) compared to > 9-miles from a college/university.

## Discussion

The study identified a total of 1,690 distinct waterpipe smoking establishments in the U.S. were listed on 5 popular Internet directories in August/September 2014. Over one-third of U.S. colleges and universities had a waterpipe establishment within 3 miles of campus. Prevalence of waterpipe establishments nearby is highest for large institutions

with ≥ 20,000 full-time students, as over three quarters of such campuses had a waterpipe establishment within a 3-mile radius. After controlling for population density and various institutional characteristics, the higher the student enrollment the higher the odds that colleges and universities had one or more waterpipe establishments nearby. Other than size, type of institution (public, private) and institutional tobacco control policies were associated with having a waterpipe establishment nearby; public and institutions with smoke-free policies had a lower odds of having a waterpipe establishment within a 3-mile radius. These results build a clear map of the geo-trends in waterpipe establishments in the U.S., and their connection to institutions of higher education in the U.S. Such information is very timely for informing efforts to protect youth from targeting by tobacco vendors and for preserving the successes achieved in reducing tobacco smoking among youth in the U.S. Our findings suggest that waterpipe establishments are located near larger colleges and universities to capture the college student market. Consistently in our dataset, colleges and universities with higher full-time student enrollment seem to be more likely to attract these businesses. Private institutions seem more targeted as well, obviously for economic considerations given the likely stronger purchasing ability of their student bodies. Encouragingly, colleges/universities with smoke-free campus policies had lower odds of having a waterpipe establishment within a three-mile radius. This suggests that waterpipe establishments may be discouraged from locating their business in the immediate vicinity of a smoke-free campus, and merit further exploration of what underlies it. One possible explanation is that waterpipe vendors take such less favorable laws into consideration when deciding on a location. Clean indoor air

legislations were designed to protect employees and the general public from the dangers of secondhand smoke. However, gaps in regulation and the pleasant aroma of the waterpipe can mislead nonsmoking patrons and workers into believing a waterpipe establishment is less hazardous than a room filled with cigarette smoke (Maziak, Eissenberg, et al., 2004). These regulation gaps are making it possible to smoke inside waterpipe establishments as they can be classified as tobacco retail shops. One website misleads readers by referring to the generic tobacco retail establishment exemption as a permit for serving waterpipe (Kaput, 2014). Furthermore, these gaps in legislation may be contributing to the proliferation of waterpipe establishments. Comparing our estimate (1,690 establishments) to prior estimates (725 establishments in 2010) (Griffiths et al., 2011), it appears that new businesses are rapidly entering the waterpipe smoking industry. One of the keys to success for these new businesses is location. Web sites that promote starting a waterpipe smoking business advise that locating near a college is optimal because students are interested "in broadening their cultural horizons", making them more likely to visit a hookah bar, and recommend marketing to students aged 18-20 years because they cannot visit bars that serve alcohol (Bplans, 2014; Braun et al., 2012; Merritt, 2013). Some businesses do not identify themselves as a waterpipe establishment but offer waterpipe as a segment of their business. This practice raises questions whether waterpipe establishments are aware of and adhering to local ordinances.

The limitations of this study include the use of publically available data, which limits the number of variables to be included in the analysis. Further geo-analysis in conjunction with time-series data on waterpipe smoking trends can strengthen its implications for policy. The plotting of distances from single points representing

colleges/universities has its limitations as well, particularly for campuses covering sizeable geographical areas. This is germane to the plotting of walking distance from a large campus to the nearest waterpipe establishment, for example, the areas for 22 of the largest U.S. campuses range from 3,071 to 27,000 acres or (4.9 to 42.2 square miles)(Carnegie, 2015). In these cases, using the physical boundaries of the entire campus may be warranted to get more precise measurements of walking distances from different locations on campus to the nearest waterpipe establishments. Finally, our data were collected using Internet-based directories. Since there is no established method for surveying these businesses, search strategies using Internet-directories have been adopted from prior studies (ALA, 2007; Griffiths et al., 2011; Primack et al., 2012).

The limitation of collecting data using this method is that proprietary search engines used by the five online directories in the study can change over time and may not be inclusive of all businesses in this category. Some waterpipe establishments listed in these directories may no longer be in operation. Some may not be listed in online directories, and others such as restaurants, may not be listed under the hookah bar or lounge category even though they serve waterpipe tobacco. Therefore, it is likely that we excluded waterpipe establishments, and as such our results should be considered as a conservative estimate of the total number of waterpipe establishments the U.S.

## Conclusions

The rising prevalence of waterpipe smoking among youth, coupled with its harmful health effects and potential to lead to cigarette smoking should prompt cities to rethink the policy of allowing waterpipe tobacco to be served on a patio area without a permit. Geographic/spatial analyses such as the one used in the current study can provide

state and local governments with information to develop zoning laws. For example, distribution of waterpipe establishments can help identify areas of high waterpipe establishment density for targeting with intervention/regulations. Accordingly, governments need to consider placing limits on the distance of a waterpipe establishment to the nearest educational institution, as young people are more vulnerable to the allures of waterpipe establishments locating in the vicinity of their schools (Smith, Novotny, et al., 2011). Further, college and university administrators and health care practitioners can benefit from this information when designing and implementing tobacco-free campus policies. Preventive messages including all tobacco products need to be in place along with information to dispel the myth that waterpipe smoking is safer than cigarettes and to challenge campus norms about waterpipe smoking.

# CHAPTER 5

## SECOND STUDY

### 5.1 DETERMINANTS AND DISTRIBUTION OF YOUNG ADULT WATERPIPE TOBACCO USERS IN THE U.S.: FINDINGS FROM THE NATIONAL ADULT TOBACCO SURVEY[2]

[2] Kates, F.R. To be submitted.

Abstract

**Introduction:** The highest prevalence of any type of tobacco use in the US is among 18-24 year olds. This age group is entering a period of emerging adulthood, which is associated with change and exploration. Experimentation of different tobacco products is particularly high among this group. In the last, the use of waterpipe tobacco has similar health risks and the danger of long-term nicotine dependency. This study seeks to examine the distribution of waterpipe smoking and its predictors among 18-24 years age group.

**Methods:** The 2009-2010 National Adult Tobacco Survey (NATS) was used. The sample for this study was limited to the 18-24 years old five years, waterpipe tobacco smoking (WTS) has surged in popularity among this age group. A logistic regression model with national weight was fitted to assess the determinants of waterpipe smoking among this segment of US population.

**Results:** Among the weighted sample 8.5% (2,292,194) 18-24 year olds were current waterpipe smokers. Current cigarette smokers had higher odds of smoking waterpipe (OR= 1.73; 95% CI=1.18-2.53). Overall the young adults most likely to use waterpipe tobacco were 18-21 years old (OR=0.58; 95% CI=0.39-0.86), with some college or an associate degree (OR=2.00; 95% CI=1.00-3.99), and residing in the West (OR=1.69; 95% CI=1.05-2.70).

**Conclusions:** Policymakers should consider different tobacco products require multifaceted intervention and policy approaches. To reduce the use of waterpipe and other forms of tobacco it is imperative that health risk information effectively reaches all 18-24 year olds within and outside traditional high school or college settings.

## Introduction

Young adults of 18-24 years of age have the highest prevalence of tobacco use in the U.S. (Jarrett et al., 2012; Ling et al., 2009; Salloum et al., 2015). According to National Adult Tobacco Survey (NATS) 2009-2010 prevalence of any current tobacco use for the 18-24 years age group was much higher (35.6%) compared to all age groups (25.2%) (King et al., 2012). The theoretical concept of "emerging adulthood" identifies the transitional time from 18-25 years old as a period marked with demographic, subjective, and identity explorations before starting a career, entering marriage, or some other perceived attainment of adult status (Arnett, 2000). Even before WTS and electronic cigarettes, the 18-24 year age group was associated with the experimentation of different tobacco products. A 1999 national survey administered to college students found more than half (51.3%) of the tobacco users used more than one tobacco product in past year, while one-third (36.3%) of them used two and rest of them (14.4%) used three products (Rigotti, Lee, & Wechsler, 2000). Besides cigars, smokeless tobacco, and e-cigarettes in recent years waterpipe smoking prevalence among the young adults showed a steep increase. In the 2009-2010 NATS current waterpipe use was highest for 18-24 year olds at 7.8% and soared to 18.2% in the 2012-2013 NATS (Agaku et al., 2014; King et al., 2012).

Waterpipe smoking, like cigarettes delivers nicotine, 82 different toxicants from the tar, in addition to possible lethal levels of toxic carbon monoxide because the waterpipe uses charcoal to heat the tobacco (Cavus et al., 2010; Clarke et al., 2012; Shihadeh & Saleh, 2005). Epidemiologic studies have identified associations between

waterpipe smoking and increased risks of cancer and other chronic diseases (Akl et al., 2010; Hakim et al., 2011; Jacob et al., 2013; Maziak et al., 2014; Raad et al., 2011)

Because the smoke is filtered through water many college students misperceive waterpipe smoking as less harmful, less addictive, and delivering less nicotine than cigarettes (Eissenberg et al., 2008; Maziak et al., 2014; Primack et al., 2013; Smith-Simone, Maziak, et al., 2008). The social aspect and the excitement of waterpipe smoking in a bar-like atmosphere at a waterpipe establishment may appeal to young people under 21 who would not otherwise use tobacco(Barnett, Curbow, Soule Jr., Tomar, & Thombs, 2011; Maziak, Eissenberg, et al., 2004; Sterling & Mermelstein, 2011; Sutfin et al., 2011).

Given this backdrop understanding the factors affecting increase in waterpipe smoking pattern especially among the young adults is essential for dealing with this public health epidemic. The posit within this study is concurrent use of cigarette as well as other tobacco products is a contributing factor behind the uptake of waterpipe smoking within this age bracket. Recent studies have identified health hazards associated with concurrent use of cigarettes and waterpipe (Dugas et al., 2010; Jacob et al., 2013).

In 2012, there were 31.2 million adults of 18-24 years of age in the U.S. and overall college enrollment for this demographic group was 41%.(2014) For convenience colleges are ideal settings to study concentrations of 18-24 year olds, whereas 18-24 year olds not enrolled in college, which is almost 60% of that age group's total population, are difficult to recruit to make a comparison. (Lee, Bahreinifar, & Ling, 2014). Over 50% of young adults aged 18-24 years are not represented in studies surveying only college students. (Barnett et al., 2013; Heinz et al., 2013; Sidani, Shensa, & Primack, 2013). Few

studies have examined non-college 18-24 year olds- one national commercial online survey analyzed non-college and college participants using dual tobacco products, but not specifically waterpipe and cigarettes (Rath, Villanti, Abrams, & Vallone, 2012). The NATS provides the ideal opportunity to explore the association between cigarette and other tobacco use and waterpipe smoking in a nationally representative sample. The purpose of this study is to examine the distribution of waterpipe smoking and its predictors among 18-24 years age group at a national level. The study will enhance prior research based primarily on samples of college students by include both college and non-college participants. Education levels and age will be stratified in greater detail to identify explicit groups that warrant further investigation. The study may help researchers and practitioners understand the diversity of tobacco product use to improve specific population-level interventions.

## Methods

The data used in this study came from the 2009-2010 NATS, a stratified, national, landline, and cell phone survey of noninstitutionalized adults $\geq$ 18 years residing in the 50 States and the District of Columbia. The primary purpose of NATS is to assess the prevalence of tobacco use and the factors related to tobacco use among adults as a function of gender, age, and race/ethnicity (CDC, 2011). Each state was divided into at least three strata- a listed landline stratum, a not-listed landline stratum, and a cell phone stratum. Some states had additional landline strata based on counties or county-equivalents. The Office on Smoking and Health (OSH) established a target for landline sample size of (n = 95,013) which was equally distributed per state (n = 1863). The target number of cell phone completes per state varied in proportion to each state's

population. NATS was conducted from October 20, 2009, to February 28, 2010, in all (n = 118,581) interviews were collected (n = 110,634) landlines and (n = 7,947) cell phones. The uniform formula for response rates established by Council of American Survey Research Organizations (CASRO) was used for the survey. For all states combined and for all telephone numbers, the CASRO rate was (37.6%), the overall rate was (12.3%), and the cooperation rate was (62.3%). The NATS questionnaire includes (n = 130) questions including (n = 105) tobacco-specific questions, (n = 82) directly related to 42 indicators in the (OSH) Key Outcome Indicator Report focusing on preventing initiation of tobacco use among young people, eliminating nonsmokers' exposure to secondhand smoke, promoting quitting among adults and young people and identifying and eliminating tobacco-related disparities.(OSH, 2005)

## Dependent Variable

The dependent variable used for this study was current water pipe smoking status of the respondents. See actual survey questions in Appendix B. The variable was derived from the two questions, e.g., "During the past 30 days, on how many days did you smoke cigarettes?" and "During the past 30 days, on how many days did you smoke tobacco in a waterpipe?" The variable was dichotomized in current and non-current waterpipe smoking categories with 'current' being one who smoked waterpipe in past 30 days and 'non-current' includes those who never smoked waterpipe and those who smoked but not in the past month.

## Independent Variables

The principal predictors for waterpipe smoking assessed in the study was cigarette smoking status as well as use of other tobacco products like cigars, other pipes,

smokeless tobacco, and snuffs and snus. Cigarette smoking status variable was categorized into current and non-current as the waterpipe smoking status variable mentioned earlier. The other tobacco user variable contains the information about use of cigars, cigarillos, and other small cigarettes; other types of pipes than the waterpipe; smokeless tobacco products; and chewing tobacco, dips, snus or snuffs. This variable was coded into three categories, e.g., 'current' contains those who are currently using any of the other types of tobacco products, 'ever' consists of those who used any of the products more than a month ago, and 'never' is made up with those who did not use either of the products in lifetime.

Also assessed were the following socio-demographic characteristics: age in years (18-21, 22-24), gender (male, female), education (0–12 years [no diploma] or Graduate Education Development (GED) recipient, high school diploma, some college [no degree] or associate degree, undergraduate or graduate degree), race (White, African American, Other), region (Northeast, Midwest ,South, West), sexual minority status (heterosexual/straight or lesbian/gay/bisexual/transgender [LGBT]), and employment status. The perceptions of the respondents regarding the allowance of smoking in bars, casinos, or clubs; restaurants; parks; and on the school ground was assessed using binary yes-no variables.

## Statistical Analysis

The characteristics of the current waterpipe smokers and non-current waterpipe smokers was assessed. Also tested were any differences among the constituent categories of each independent variable on the current waterpipe smoking status using chi-square tests. Finally, a simple logistic regression model was fitted for identifying the significant

predictors of current waterpipe smoking status. The national weighting was used while fitting the regression model to have the nationally generalizable estimates. Stata 13.1 was used for all analyses.(Stata, 2013)

## Results

### Characteristics of the current waterpipe smokers

Among the weighted survey total 29,383,511 of age 18-24 years, 2,292,194 (7.8%) are represented as current waterpipe smokers. Waterpipe smoking was prevalent among the younger age group of 18-21 years (9.0%) and male (10.0%). High school graduates and some college or associate degree reported to be current waterpipe user were (8.0%) than groups consisting of other educational attainments. Weighted respondents belong to other races used waterpipe more (10.0%) along with the LGBT population (13.0%). Young people residing in the Western region of the US were using waterpipe currently more (12.0%) than respondents from other regions. However there was no significant difference in current use of waterpipe among employed and unemployed respondents (Table 5.1). The same analysis above was run using the sample non-weighted to compare the weighted estimates to the actual 18-24 year respondents in the survey to compare percentages. See Table B.1 labelled Non-weighted Characteristics for 18-24 Year Olds in Appendix B

Table 5.1 Nationally Weighted Characteristics for 18-24 Year Old Waterpipe Only Users

| Variables | Not Current Waterpipe Only Users | | Current Waterpipe Only Users | | Total | |
|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) |
| **Age- Years Old** | | | | | | |
| 18-21 | 16,731,243 | (91.0) | 1,605,470 | (9.0) | 18,336,714 | (100.0) |
| 22-24 | 10,360,074 | (94.0) | 686,724 | (6.0) | 11,046,798 | (100.0) |
| **Gender** | | | | | | |
| Female | 11,863,191 | (95.0) | 608,075 | (5.0) | 12,471,266 | (100.0) |
| Male | 15,225,033 | (90.0) | 1,684,119 | (10.0) | 16,909,152 | (100.0) |
| **Education** | | | | | | |
| < High School Graduate or GED[a] | 6,864,377 | (93.0) | 522,611 | (7.0) | 7,386,988 | (100.0) |
| High School Graduate | 15,353,453 | (92.0) | 1,403,236 | (8.0) | 16,756,688 | (100.0) |
| Some College or Associate Degree | 2,457,677 | (92.0) | 225,612 | (8.0) | 2,683,289 | (100.0) |
| Bachelor Degree or higher | 2,374,722 | (95.0) | 137,485 | (5.0) | 2,512,206 | (100.0) |
| **Race** | | | | | | |
| White | 17,349,107 | (92.0) | 1,588,517 | (8.0) | 18,937,624 | (100.0) |
| Black | 4,151,705 | (97.0) | 134,208 | (3.0) | 4,285,914 | (100.0) |
| Other[b] | 5,192,750 | (90.0) | 565,421 | (10.0) | 5,758,171 | (100.0) |
| **Region** | | | | | | |
| Northeast | 4,782,989 | (93.0) | 337,334 | (7.0) | 5,120,323 | (100.0) |
| Midwest | 6,185,199 | (93.0) | 443,623 | (7.0) | 6,628,822 | (100.0) |
| South | 10,125,809 | (94.0) | 668,994 | (6.0) | 10,794,803 | (100.0) |
| West | 5,997,321 | (88.0) | 842,243 | (12.0) | 6,839,564 | (100.0) |
| **Orientation** | | | | | | |
| Heterosexual | 24,213,266 | (92.0) | 2,023,488 | (8.0) | 26,236,754 | (100.0) |
| LGBT[c] | 1,559,470 | (87.0) | 231,790 | (13.0) | 1,791,259 | (100.0) |
| **Employment** | | | | | | |
| No | 15,226,157 | (98.0) | 365,119 | (2.0) | 15,591,276 | (100.0) |
| Yes | 6,888,003 | (91.0) | 709,826 | (9.0) | 7,597,829 | (100.0) |
| **Other tobacco- use of cigars, cigarillos, filtered little cigars, chewing tobacco, dip, snuff, or snus** | | | | | | |
| Never | 4,953,158 | (80.0) | 1,217,248 | (20.0) | 6,170,406 | (100.0) |
| Ever | 11,692,851 | (92.0) | 987,948 | (8.0) | 12,680,799 | (100.0) |
| Current | 15,285,868 | (92.0) | 1,301,501 | (8.0) | 16,587,369 | (100.0) |
| **Indoors- should smoking be allowed in restaurants, bars, casinos, or clubs?** | | | | | | |
| No | 9,291,653 | (95.0) | 441,525 | (5.0) | 9,733,177 | (100.0) |
| Yes | 17,743,335 | (91.0) | 1,850,669 | (9.0) | 19,594,004 | (100.0) |
| **Outdoors- should smoking be allowed in parks?** | | | | | | |
| No | 11,046,377 | (95.0) | 563,188 | (5.0) | 11,609,565 | (100.0) |
| Yes | 15,965,532 | (90.0) | 1,729,006 | (10.0) | 17,694,538 | (100.0) |
| **Schools- should tobacco be allowed on school grounds, include fields and parking lots, even for teachers and other adults?** | | | | | | |
| No | 21,491,634 | (94.0) | 1,380,486 | (6.0) | 22,872,120 | (100.0) |
| Yes | 4,893,707 | (85.0) | 891,052 | (15.0) | 5,784,759 | (100.0) |

[a] Graduate Education Development certification
[b] Asian, Pacific Islander, Native Hawaiian or Pacific Island, American Indian or Alaska Native, Other
[c] Lesbian, Gay, Bisexual and Transgender

Determinants of Waterpipe Smoking among Young Adults

In the multivariate analysis after controlling for the effect of covariates current cigarette smokers were more likely to smoke waterpipe (OR=1.73; 95% CI=1.18-2.53). Similarly the ever and current users of other tobacco products like cigars, pipes, smokeless and chewing tobacco, snuffs and snus were more likely to use waterpipe (OR=3.02; 95% CI=1.82-5.00 and OR=6.47; 95% CI=3.82-10.97 respectively) than the never users.

Among other socio-demographic covariates youths of age 22-24 years were less likely to use waterpipe (OR=0.58; 95% CI=0.39-0.86), while young adults with some College or Associate Degree had double chance of smoking waterpipe (OR=2.00; 95% CI=1.00-3.99) than high school graduate or GED recipients. Young people in the West had higher odds of using waterpipe smoking (OR=1.69; 95% CI=1.05-2.70).

Regarding the perception on the allowance of smoking in public places, respondents who did not support complete ban on smoking in school grounds were more likely to smoke waterpipe (OR=1.76; 95% CI=1.22-2.54). Those who opined for allowance of smoking in other public places like bars, restaurants, and parks had higher but not statistically significant odds of using waterpipe (Table 5.2).

Table 5.2- Survey Weighted Logistic Regression for Current Waterpipe Users

| Variables | OR[a] | (95% CI[b]) | p-value |
|---|---|---|---|
| **Current Cigarette User** | | | |
| No | Reference | | |
| Yes | 1.73 | (1.18- 2.53) | **0.005** |
| **Other tobacco- use of cigars, cigarillos, filtered little cigars, chewing tobacco, dip, snuff, or snus** | | | |
| Never | Reference | | |
| Ever | 3.02 | (1.82- 5.00) | **0.000** |
| Current | 6.47 | (3.82-10.97) | **0.000** |
| **Age, in Years** | | | |
| 18-21 | Reference | | |
| 22-24 | 0.58 | (0.39- 0.86) | **0.007** |
| **Gender** | | | |
| Female | Reference | | |
| Male | 1.22 | (0.84- 1.78) | 0.289 |
| **Education** | | | |
| < High School Graduate or GED[c] | Reference | | |
| High School Graduate | 1.40 | (0.87- 2.26) | 0.170 |
| Some College or Associate Degree | 2.00 | (1.00- 3.99) | **0.049** |
| Bachelor Degree or higher | 1.75 | (0.85- 3.59) | 0.128 |
| **Race** | | | |
| White | Reference | | |
| Black | 0.55 | (0.26- 1.17) | 0.123 |
| Other[d] | 1.41 | (0.90- 2.21) | 0.135 |
| **Region** | | | |
| Northeast | Reference | | |
| Midwest | 0.80 | (0.49- 1.32) | 0.379 |
| South | 0.75 | (0.47- 1.22) | 0.250 |
| West | 1.69 | (1.05- 2.70) | **0.029** |
| **Orientation** | | | |
| Heterosexual | Reference | | |
| Lesbian, Gay, Bisexual and Transgender | 1.39 | (0.78-2.48) | 0.262 |
| **Employment** | | | |
| No | Reference | | |
| Yes | 0.89 | (0.61- 1.30) | 0.553 |
| **Should smoking be allowed in restaurants?** | | | |
| No | Reference | | |
| Yes | 0.78 | (0.51- 1.20) | 0.260 |

| | | | |
|---|---|---|---|
| **Should smoking be allowed in bars, casinos, or clubs?** | | | |
| No | Reference | | |
| Yes | 1.31 | (0.81- 2.12) | 0.271 |
| **Should smoking be allowed in parks?** | | | |
| No | Reference | | |
| Yes | 1.30 | (0.81- 2.11) | 0.279 |
| **Should tobacco be allowed on school grounds, include fields and parking lots, even for teachers and other adults?** | | | |
| No | Reference | | |
| Yes | 1.76 | (1.22-2.54) | **0.002** |

## Discussion

The results suggest that younger adults (18-21 years old) are more prone to waterpipe smoking usage than 22-24 year olds. Similar results were found in earlier studies- current waterpipe use for 18-year olds was 11.2% compared to 4.2% of 24-year olds (Jarrett et al., 2012). The higher prevalence of waterpipe among 18-21 years may be an indication of earlier initiation based on findings of WTS in middle school and high school.(Barnett et al., 2009)

In this study the majority of the respondents (82.3%) had no college education. Therefore only 17.7% had some college or a college degree which is lower than the national average for 18-24 year olds enrolled in college (36.2%) in 2009. This difference may be contributed to the fact that NATS only included respondents who live in a primary residence and exclude anyone living in a dormitory or barracks. However this also allows examining the prevalence of waterpipe smoking and its predictors both in and outside of college settings.

The prevalence of cigarette smoking only was highest (30.0%) amount respondents with less than a high school diploma or GED recipients compared to 18.0% for high school graduates. Few health surveys distinguish between adults with a GED compared to a regular high diploma. Studies suggest that high school equivalency diploma holders are associated closer to high school dropouts than graduates with a greater risk of health conditions as well as increased use of tobacco and alcohol.(Zajacova, 2012) In the same vein, from our result we can see that some college or associate degree holders are even more prone (OR=2.00) to smoke waterpipe than the high school and GED graduates. Historically the South has had a highest prevalence of cigarette smoking in the U.S.(Marcus, Shopland, Crane, & Lynn, 1989). WTS was not similar, young adults residing in the West were more likely to smoke waterpipe than any other regions in the U.S.

It is intuitive that those who supported allowance of smoking in school grounds are more likely to smoke waterpipe. Nevertheless the indifferent attitude towards smoking in public while it is well-evident that second-hand smoking is equally harmful bears ominous sign. Measures should be taken to make people aware about the potential hazards for both active and passive smoking.

The study provides resources that may help public health officials evaluate specific characteristics related to 18-24 year old tobacco users. Utilizing publicly financed national surveys, such as NATS, is both cost-effective and more representative of the entire U.S. than college surveys. In keeping with Center for Disease Prevention and Control best practices, greater understanding of tobacco usage nationally is a foundational component for mass-reach health communication interventions.(CDC,

2014) Mass media tobacco control campaigns are effective in promote quitting and reduce adult smoking prevalence.(Durkin, Brennan, & Wakefield, 2012) In order to maximize the investment in mass media campaigns or local campaigns it is important to understand the usage characteristic for different tobacco products or combination of products within a target population and 18-24 years age group is perfect candidate for such campaign with increasing prevalence of waterpipe and other tobacco products use.

# CHAPTER 6

## CONCLUSION

This chapter provides an overview of the finding, implications, and recommendations from each of the two preceding studies. The first study addressed geographic proximity of waterpipe tobacco smoking establishments to college and universities. The study was one of the first of its kind to use all previously identified business databases and directories as mentioned in other studies focusing on the number of WTS establishments in the United States. This study is unique with the additional use of the Yellow Pages and Yelp. The use of Yelp was instrumental in identifying businesses such as restaurants, cafés, and coffee shops that offer WTS, but did not use the term "hookah" in their business description. This study identified 1,690 WTS establishments which is higher than previous studies which found over 700 WTS establishments (Griffiths et al., 2011; Primack et al., 2012).

This study supports other WTS research that WTS establishments are locating near large colleges and universities (Cobb et al., 2013; Holtzman, Babinski, & Merlo, 2013; Jacob et al., 2013). The multinomial logistic regression model added to the body of knowledge on WTS establishments by identifying additional variables associated with the proximity of WTS establishments. The model showed that higher full-time student enrollment was associated with higher odds of having a waterpipe establishment located within 3 miles of the college or university. Public institutions, as compared to private institutions, were less likely to have a waterpipe establishment within 3 miles and

colleges/universities that implemented smoke-free campus policies also had lower odds of having waterpipe establishment within a three-mile radius.

## First Study Implications

The finding from this study can assist policymakers and regulators in the development of a multifaceted approach to stem the growth of WTS establishments. An initial starting point is to develop a distinct definition of waterpipe tobacco smoking to avoid future consequences of overlooked tobacco products and their usage in clean-air legislation which resulted in an increase in waterpipe tobacco establishments. Therefore, a distinct definition of waterpipe smoking needs to be established to help close these loopholes. Local, state, and federal authorities should strive to close existing laws allowing exemptions for WTS establishments. The study also confirms the sentiments of many public health organizations that the FDA needs to expedite the deeming of waterpipe tobacco in the statutory definition of tobacco to protect the public's health (AUPH, 2014). Besides evaluating existing clean-air legislation and expediting deeming regulations new legislation may provide stop-gaps. Zoning and licensure are tools regulators have at their disposal to create barriers to entry to starting a WTS establishment. Regulations hinder entry and hinder the creation of new firms especially in industries with higher rates of entry (Bennett & Estrin, 2006; Klapper, Laeven, & Rajan, 2006).

## Second Study Implications

The second study provides resources that may help public health officials evaluate specific characteristics related to 18-24 year old tobacco users. Utilizing publicly financed national surveys, such as NATS, is both cost-effective and more representative

of the entire U.S. than college surveys. In keeping with CDCs best practices, greater understanding of tobacco usage nationally is a foundational component for mass-reach health communication interventions (CDC, 2014). Mass media tobacco control campaigns are effective in promote quitting and reduce adult smoking prevalence(Durkin et al., 2012). In order to maximize the investment in mass media campaigns or local campaigns it is important to understand the usage characteristic for different tobacco products or combination of products within a target population.

The findings from this study suggest a multifaceted approach is needed to educate non-college and college students. The emerging adult theory promoted our understanding that many 18-25 year old transition from a structured environment to environment where they have more independence. With this independence comes more responsibility to either abstain from or use different types of tobacco products. Educating college students may be a little easier than educating of non- college students because of the structured environment. In college there is an entry point, which usually begins when a student is a freshman. Policymakers, college health care providers, and college administrators need to take full advantage of educating students at the beginning of their college experience. This can begin with the initial correspondent after admittance to the college or university has been accepted. The first correspondence can be a simple one-page health warning letter which includes information about the dangers of waterpipe tobacco smoking. The aim of the initial correspondence should be to reach the student and parent. This can be followed with more information when the student arrives to the campus. Non-college young adults might have to be reached by some form of investment in Internet counter marketing messages which could benefit all waterpipe tobacco smokers. For example, if

they put in an Internet search for a hookah directory, anti-marketing message also come up with health warning information.

Regulators can affect the barriers to entry with increased licensing fees for new WTS establishments, additional taxes on waterpipe tobacco products or at point of sale, and more restrictive zoning for WTS establishments. These three strategies can increase the costs for entrepreneurs considering entering the market as well as lowering the profit margin. Continuing a multifaceted approach addressing suppliers and new regulations on labeling can drive up costs making waterpipe tobacco products less profitable and ultimately the costs get passed on resulting in higher consumer costs which can reduce consumption. Labeling is also effective in educating consumers about the hazards of WTS. Controlling and restricting the sale of waterpipe products on the Internet by requiring a verification of age can reduce the access and exposure to adolescents. Understanding the role of the buyers is important. The second study identified that younger adults (18-21 years old) are more prone to waterpipe smoking usage than 22-24 year olds. Many of the 18-20 years old were going to the WTS establishments for the bar like atmosphere. Regulations that increased the age from 18 to 21 to enter a WTS establishment immediate changes the default behavior for young adults 18-20 years old. Finally, regulators should consider substitutes if regulations allow herbal waterpipe products but not waterpipe tobacco. Are these regulations the best strategy with the continued exposure of carbon monoxide from the charcoal? Regulations restricting flavors like what was done with cigarettes might be a viable option to reduce the consumption of waterpipe tobacco. Regulators also need to consider substitutes closely because if they ban one form of consuming tobacco any method may emerge. For

example, if regulators ban the use of charcoal in hopes of controlling waterpipe usage and miss regulating electronic waterpipe heating systems then waterpipe tobacco smoking continues. The point of looking at a conceptual framework like Porters 5 Forces model is it helps researchers, policymakers, and regulators view the issue from multiple angles to close the gaps for the continuation of waterpipe tobacco smoking. This also helps to change the default behavior from one where WTS is easily accessible and relatively inexpensive to an activity where the risks are known, where it is not near the campus, where the hours are restricted and the cost is not worth the effort for the college students to drive to a WTS establishment.

## Limitations and Directions for Future Research

Some of the limitations of the first study includes the use of publically available data which limits the number of variable be included in the analysis. Geographical size of can be a limitation for particularly large campuses. For example, 22 of the largest U.S. campuses range from 3,071 to 27,000 acres or 4.9 to 42.2 square miles, respectively (Carnegie, 2015). Therefore, using physical boundaries rather than a single campus point would improve measurements of walking distances from different locations on campus to the nearest waterpipe establishments. Finally, there are limitations on collecting data using this method; the proprietary search engines used by the five online directories in the study can change over time and may not be inclusive of all businesses in this category. Both studies are a cross-sectional design which limit the control of unmeasured confounders. Therefore, replicating the study in conjunction with time-series data on waterpipe smoking prevalence can strengthen the importance for policy regulation.

Future research is needed on the impact of policies on behavior. Another area of need would be a comprehensive study on a state by state basis on the unintended consequences of clean-air legislation which resulted in the increase in waterpipe tobacco establishments. Also, now that increase prevalence of WTS has been established among 18 to 24-year-olds, national surveys should add more questions covering WTS. Now that non-college respondents have been shown to have similar WTS usage patterns as college students, strategies need to be developed to reach these young adults.

## Closing

Preventive messages should including information about all tobacco products that can reach all 18-24 year olds with definitive information that dispels the myth that waterpipe smoking is safer than cigarettes. The message needs to be clear that tobacco is tobacco regardless of the form of delivery and carries the same addictive characteristics and tobacco-related illness. Tobacco still remains the greatest preventable cause of death in the United States. Therefore, tobacco control should remain in the forefront of public health interventions regardless of political will or controversy.

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## APPENDIX A – FIRST STUDY SUPPLEMENTAL INFORMATION

The following figures are from the initial proximity analysis which was calculated on college dorm capacity of greater than 250+. 1000+, 2000+. 4000+, and 8000+. Preliminary findings suggested a possible association to dorm capacity to the nearest distance. Viewed in sequential order one can clearly see the color gradient getting darker as the dorm capacity increases to the point that at greater than 8000 almost every remaining school has a WTS establishment within 3 miles.

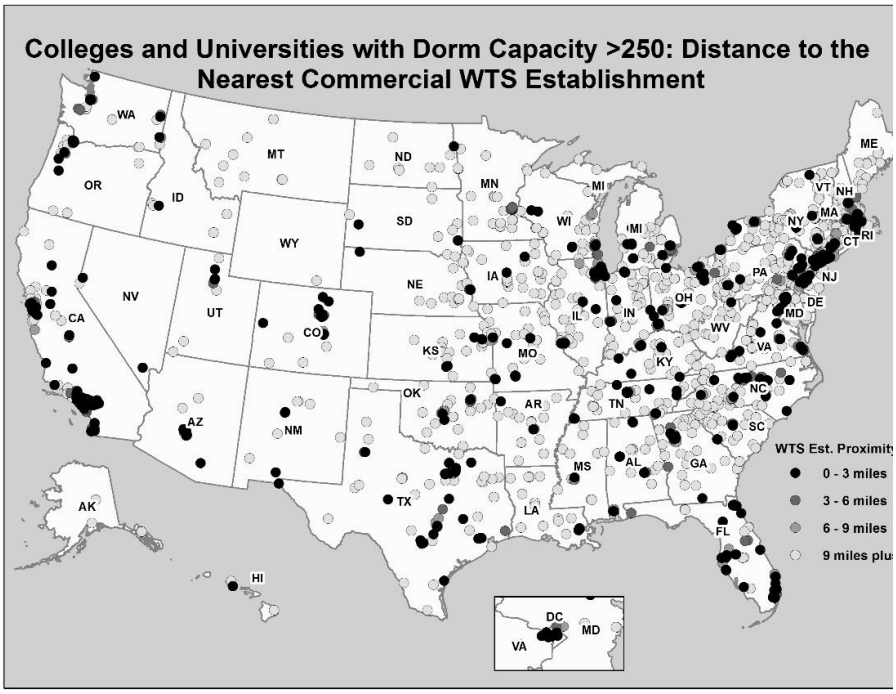


Figure A.1 Proximity Analysis Dorm Capacity Greater Than 250

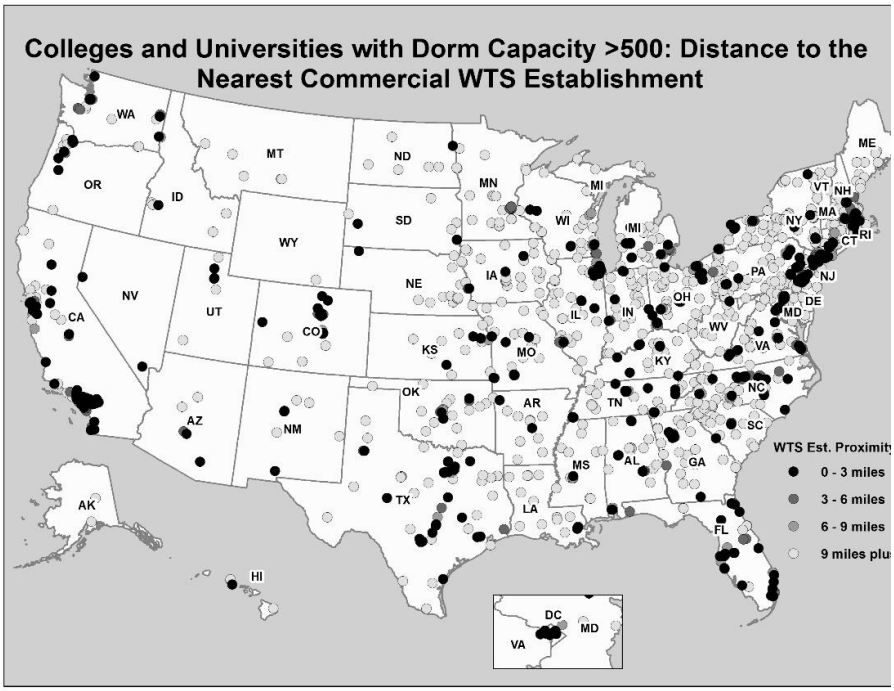


Figure A.2 Proximity Analysis Dorm Capacity Greater Than 500

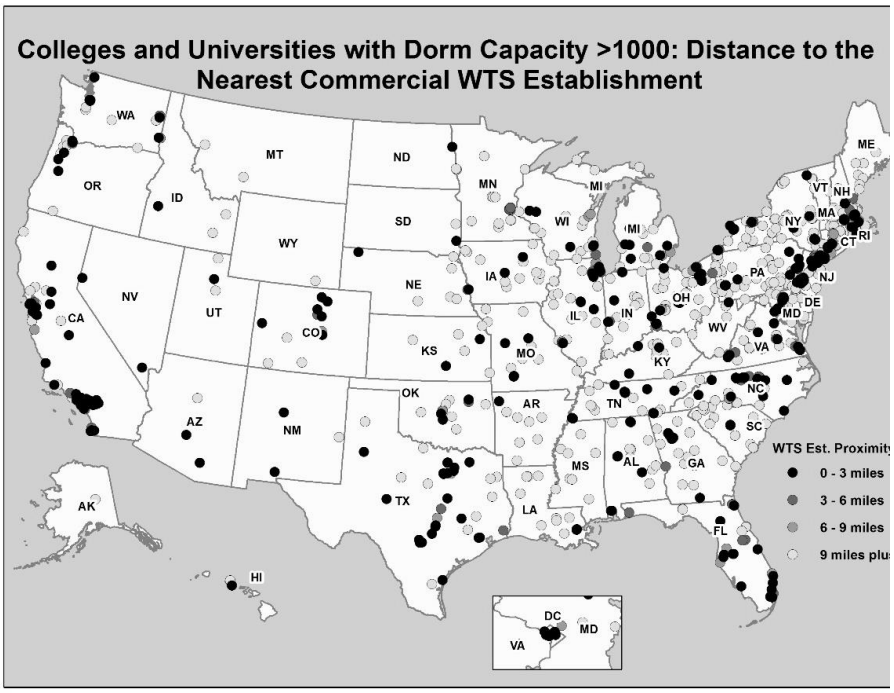


Figure A.3 Proximity Analysis Dorm Capacity Greater Than 1000

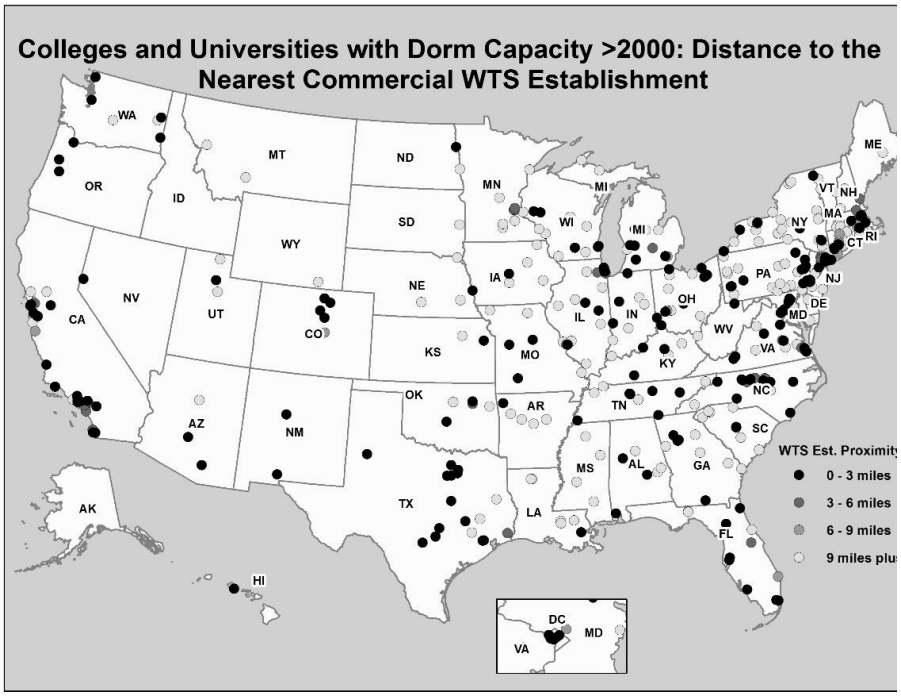


Figure A.4 Proximity Analysis Dorm Capacity Greater Than 2000

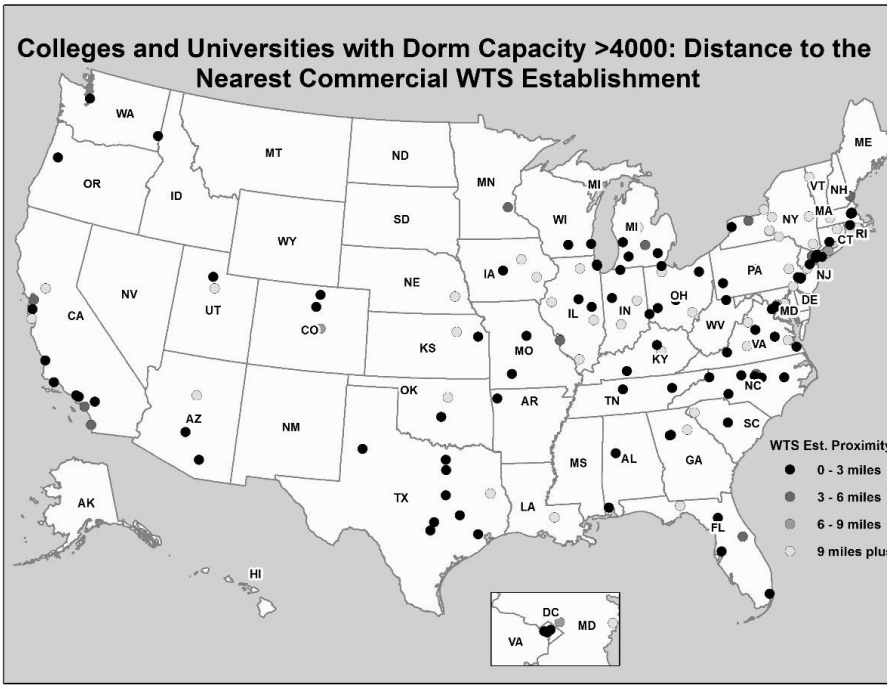


Figure A.5 Proximity Analysis Dorm Capacity Greater Than 4000

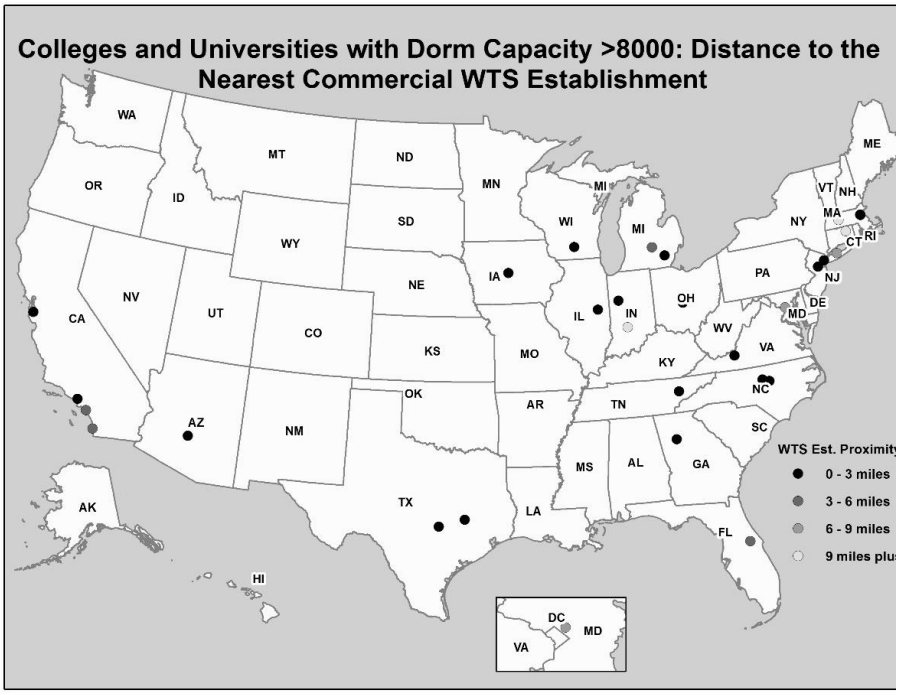


Figure A.6 Proximity Analysis Dorm Capacity Greater Than 8000

# APPENDIX B – SECONDS STUDY SUPPLEMENTAL INFORMATION

The following list of questions from the 2009-2010 NATS were used in the statistical analysis for study 2 and the non-weighted table for characteristics of 18-24 year old waterpipe only users (Table B.1).

National Adult Tobacco Survey Questionnaire, 2009-2010
Office on Smoking and Health, CDC

## TOBACCO USE

### CIGARETTE SMOKING

**SMOK100**

Rationale: Key Outcome Indicators 2.08.3, 3.14.1, 1.14.2

/ASK ALL/

HELP: 100 CIGARETTES = 5 PACKS

2. Have you smoked at least 100 cigarettes in your entire life?

1. YES
2. NO → GO TO Q5 SMOKEVER

7. DON'T KNOW/NOT SURE → GO TO Q5 SMOKEVER
9. REFUSED → GO TO PRE31

**SMOKNOW**

Rationale: Key Outcome Indicators 2.08.3, 3.14.1

/ASK IF Q2SMOK100=1/

3. Do you now smoke cigarettes every day, some days, or not at all?

1. EVERY DAY
2. SOME DAYS → GO TO Q8 SMOKDAYS30
3. NOT AT ALL → GO TO Q6 SMOKLAST

7. DON'T KNOW → GO TO Q6 SMOKLAST
9. REFUSED → GO TO PRE31

**PIPEWTREVER**

Rationale: Key Outcome Indicator 1.13.2, Skip for 1.14.2, 3.14.1

/ASK ALL/

39. The next question asks you about smoking tobacco in a water pipe. A water pipe is also called a hookah. Have you ever tried smoking tobacco in a water pipe in your entire life, even one or two puffs?

1. YES
2. NO → GO TO Q41 PIPEOTHEVER

7. DON'T KNOW/NOT SURE → GO TO Q41 PIPEOTHEVER
9. REFUSED → GO TO Q41 PIPEOTHEVER

**PIPEWTRDAYS**

Rationale: Key Outcome Indicator 1.14.2, 3.14.1

/ASK IF Q39 PIPEWTREVER EQ 1/

/RANGE: 1-30/

40. During the past 30 days, that is, since [DATE FILL], on how many days did you smoke tobacco in a water pipe?

_ _ NUMBER OF DAYS

88. NONE

77. DON'T KNOW/NOT SURE
99. REFUSED

**SHSINDROPN1**

Rationale: Key Outcome Indicator 2.03.7.
/ASK ALL/

INTERVIEWER: THE ORDER OF THE RESPONSE CATEGORIES FOR THIS QUESTION IS BEING RANDOMLY REVERSED

91. Should smoking **indoors** in restaurants…?

1. **Always** be allowed
2. Be allowed only at **some** times or in **some** places
3. **Never** be allowed

7. DON'T KNOW/NOT SURE
9. REFUSED

**SHSINDROPN2**

Rationale: Key Outcome Indicator 2.03.7.

/ASK ALL/

INTERVIEWER: THE ORDER OF THE RESPONSE CATEGORIES FOR THIS QUESTION IS BEING RANDOMLY REVERSED

92. Should smoking **indoors** in bars, casinos, or clubs…?

1. **Always** be allowed
2. Be allowed only at **some** times or in **some** places
3. **Never** be allowed

7. DON'T KNOW/NOT SURE
9. REFUSED

**SHSOUTDROPN**

Rationale: Key Outcome Indicator 2.03.7

/ASK ALL/

INTERVIEWER: THE ORDER OF THE RESPONSE CATEGORIES FOR THIS QUESTION IS BEING RANDOMLY REVERSED

93. Should smoking at parks…?

1. **Always** be allowed
2. Be allowed only at **some** times or in **some** places
3. **Never** be allowed

7. DON'T KNOW/NOT SURE
9. REFUSED

**SCHOOLOPN2**

Rationale: Key Outcome Indicator 1.06.7, 2.03.10

/ASK ALL/

123. Should tobacco use be **completely** banned on school grounds, including fields and parking lots, and at **all** school events, even for teachers and other adults?

1. YES
2. NO

7. DON'T KNOW/NOT SURE
9. REFUSED

IF Q103 AGE >= 30, GO TO Q125 PARENTING

Table B.1- Non-weighted Characteristics of 18-24 Year Old Waterpipe Only Users

| Variables | Non-Current Waterpipe Users (N=4,778) | | Current Waterpipe Users (N=339) | | p-value |
|---|---|---|---|---|---|
| | N | (%) | N | (%) | |
| **Current Cigarette Smoker** | | | | | |
| No | 3,788 | (95.5) | 180 | (4.5) | 0.000 |
| Yes | 984 | (86.1) | 159 | (13.9) | |
| **Other tobacco- use of cigars, cigarillos, filtered little cigars, chewing tobacco, dip, snuff, or snus** | | | | | |
| Never | 2,703 | (98.2) | 50 | (1.8) | |
| Ever | 1,293 | (91.8) | 116 | (8.2) | 0.000 |
| Current | 779 | (81.8) | 173 | (18.2) | |
| **Age, in Years** | | | | | |
| 18-21 | 2,636 | (91.8) | 235 | (8.2) | 0.000 |
| 22-24 | 2,142 | (95.4) | 104 | (4.6) | |
| **Gender** | | | | | |
| Female | 2,496 | (95.8) | 110 | (4.2) | 0.000 |
| Male | 2,281 | (90.9) | 229 | (9.1) | |
| **Education** | | | | | |
| < High School Graduate or GED[a] | 754 | (93.7) | 51 | (6.3) | |
| High School Graduate | 2,706 | (92.5) | 220 | (7.5) | 0.005 |
| Some College or Associate Degree | 541 | (93.9) | 35 | (6.1) | |
| Bachelor Degree or higher | 762 | (96.0) | 32 | (4.0) | |
| **Race** | | | | | |
| White | 3,375 | (93.3) | 244 | (6.7) | |
| Black | 594 | (97.1) | 18 | (2.9) | 0.000 |
| Other[b] | 754 | (90.8) | 76 | (9.2) | |
| **Region** | | | | | |
| Northeast | 934 | (92.7) | 74 | (7.3) | |
| Midwest | 968 | (94.8) | 53 | (5.2) | 0.000 |
| South | 1,818 | (94.7) | 101 | (5.3) | |
| West | 1,058 | (90.5) | 111 | (9.5) | |
| **Orientation** | | | | | |
| Heterosexual | 4,379 | (93.8) | 290 | (6.2) | |
| Lesbian, Gay, Bisexual and Transgender | 224 | (85.2) | 39 | (14.8) | 0.000 |
| **Employment** | | | | | |
| No | 1,899 | (93.8) | 126 | (6.2) | 0.341 |
| Yes | 2,860 | (93.1) | 212 | (6.9) | |
| **Should smoking be allowed in restaurants?** | | | | | |
| No | 3,335 | (95.0) | 177 | (5.0) | 0.000 |
| Yes | 1,435 | (89.9) | 162 | (10.1) | |

| | | | | | |
|---|---|---|---|---|---|
| **Should smoking be allowed in bars, casinos, or clubs?** | | | | | |
| No | 1,864 | (96.4) | 70 | (3.6) | 0.000 |
| Yes | 2,896 | (91.5) | 269 | (8.5) | |
| **Should smoking be allowed in parks?** | | | | | |
| No | 1,976 | (96.5) | 72 | (3.5) | 0.000 |
| Yes | 2,789 | (91.3) | 267 | (8.7) | |
| **Should tobacco be allowed on school grounds, include fields and parking lots, even for teachers and other adults?** | | | | | |
| No | 3,826 | (95.0) | 202 | (5.0) | 0.000 |
| Yes | 833 | (86.4) | 131 | (13.6) | |

[a] Graduate Education Development certification

[b] Asian, Pacific Islander, Native Hawaiian or Pacific Island, American Indian or Alaska Native, Other