

Spring 5-2023

Tobacco Smoking Among Saudi College Students: Validation of an Arabic Health Belief Model Instrument

Saad Abdullah S. Alotaibi
Old Dominion University, salot001@odu.edu

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**TOBACCO SMOKING AMONG SAUDI COLLEGE STUDENTS: VALIDATION OF AN
ARABIC HEALTH BELIEF MODEL INSTRUMENT**

by

Saad Abdullah S. Alotaibi
B.S. December 2012, University of Arkansas
M.S. December 2014, University of Arkansas

A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

HEALTH SERVICES RESEARCH

OLD DOMINION UNIVERSITY
May 2023

Approved by:

Praveen Durgampudi (Director)

Abdullah Al-Taiar (Member)

M'Hammed Abdous (Member)

ABSTRACT

TOBACCO SMOKING AMONG SAUDI COLLEGE STUDENTS: VALIDATION OF AN ARABIC HEALTH BELIEF MODEL INSTRUMENT

Saad Abdullah S. Alotaibi
Old Dominion University, 2023
Director: Dr. Praveen Durgampudi

This dissertation intended to learn more about Saudi college students' behavior in relation to the use of tobacco smoking. Multiple interrelated projects have been carried out in order to achieve this ambitious goal. The goal of the first study was to evaluate the scope of the existing smoking issue as indicated by research, by systematically estimating the prevalence of tobacco use among higher education students in Saudi Arabia. The second study aimed to systematically analyze and integrate the existing information on the determinants of smoking among Saudi college students. The last project aimed to develop a psychometric instrument to evaluate Saudi students' beliefs about cigarette smoking based on a theoretical model.

The meta-analysis (Project 1) estimated that the 17% of Saudi students were current smokers. In order to obtain a reliable prevalence rate over time, the study suggested implementing a nationwide surveillance system that measures and monitors Saudi students' smoking behaviors. The second systematic review (Project 2) determined that individual level factors were the most studied. Another finding was the limited usage of theoretical frameworks. The study advocated for the use of rigorous research methodologies and for the use of multi-level frameworks. The final project (3) was intended to generate and to validate a psychometric property to evaluate students' beliefs about cigarette smoking, using an individual level framework. The Arabic Health Belief Model questionnaire demonstrated its sound validity and

reliability. Future research is encouraged, in order to expand knowledge about smoking behaviors among college students in Saudi Arabia.

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This dissertation is dedicated to:

My parents: Abdullah S. Alotaibi, Mothi Alnafjan.

My family: Nada Alhassan, Wateen, Seba, Deem, and Norah, and many more InshaAllah.

My 10 brothers and 9 sisters, especially Monirah Alotaibi (May Allah have mercy on her soul).

إلى كل من يرى نور العلم ويهتدي به

ACKNOWLEDGMENTS

First and foremost, I would like to express my deep gratitude to my committee members, Dr. Praveen Durgampudi, Dr. Abdullah Al-Taiar, and Dr. Mohammed Abdous, for their invaluable guidance, support, and encouragement throughout the journey of my dissertation. Each of them has contributed significantly to the quality and success of my work, and I am truly grateful for their expertise and dedication.

Dr. Durgampudi, in particular, has been an excellent mentor who provided invaluable insights and suggestions that have helped me to shape the direction of my research, and I am deeply grateful for his patience and support. Dr. Al-Taiar has been a constant source of support, especially with technical matters. He provided me valuable guidance and encouragement throughout the process, and I am extremely thankful for his dedication and support. Dr. Abdous has been a constant source of motivation and inspiration, and I am grateful for his encouragement and support.

I would also like to express my heartfelt appreciation to my family, especially my wife, Nada Alhassan, for her constant love and support throughout my journey. She has been an incredible source of strength and support. Nada was always there for me even when I was away from home. She has made countless sacrifices to ensure that I had the time and resources to complete my dissertation, including a time when she brought my girls from school while it was raining. I am deeply grateful for her love and support. My mother and father have also been always here and there for me. They have offered a listening ear and a helping hand. I am extremely grateful for their love and care. Also, I appreciate my 19 brothers and sisters who have been always questioning me about a time when I finish my schooling. Now, I am happy that I

can comfortably answer their question that I am done with all traditional academia. However, my sister, Monirah Alotaibi, has lost her life to cancer before she sees me a doctor. This dissertation is also dedicated for you, my dearest sister!

I am pleased to thank my friends (e.g, Jafar Alabdullah and Mohammed Alsulaiman) for their motivation. Also, I am thankful to study participants who have shared their time and insights with me. Their contribution has been invaluable to my research, and I am deeply grateful for their participation.

I would also like to extend my sincere appreciation to the Kingdom of Saudi Arabia and Qassim University, whose generous funding has had a huge impact on my success. Without their support, I would not have been able to complete my dissertation, and I am deeply grateful for their generosity and belief in my work.

Last but not least, I would like to express my sincere gratitude to Old Dominion University for providing the resources and support I needed to succeed. From the professors (e.g., Dr. Bonnie Van Lunen and Dr. Qi Zhang) and staff to the facilities and resources, I have been fortunate to have everything I needed to complete my dissertation, and I am deeply grateful for their investment in my education.

هذا من فضل ربي، وآخر دعوانا أن الحمد لله رب العالمين...

TABLE OF CONTENTS

	Page
LIST OF TABLES	x
LIST OF FIGURES	xi
Chapter	
I. INTRODUCTION	1
BACKGROUND	1
HEALTH BELIEF MODEL.....	3
THE APPLICATION OF HEALTH BELIEF MODEL.....	4
STATEMENT OF THE PROBLEM	7
PURPOSE OF THE STUDY	7
SIGNIFICANCE OF THE STUDY.....	8
AIMS AND HYPOTHESES	9
OPERATIONAL DEFINITIONS.....	9
ASSUMPTIONS.....	10
DELIMITATIONS	10
LIMITATIONS.....	11
II. REVIEW OF THE LITERATURE: PROJECT I: SMOKING TOBACCO PREVALENCE AMONG COLLEGE STUDENTS IN THE KINGDOM OF SAUDI ARABIA: SYSTEMATIC REVIEW AND META-ANALYSIS	12
INTRODUCTION	12
METHODS	14
RESULTS	17
DISCUSSION.....	19
CONCLUSION.....	22
III. PROJECT II: FACTORS ASSOCIATED WITH TOBACCO SMOKING AMONG SAUDI COLLEGE STUDENTS: A SYSTEMATIC REVIEW	36
INTRODUCTION	36
METHODS	37
RESULTS	40
DISCUSSION.....	43
CONCLUSION.....	46
IV. PROJECT III: VALIDITY AND RELIABILITY OF AN ARABIC HEALTH BELIEF MODEL INSTRUMENT FOR STUDYING CIGARETTE SMOKING	55

	Page
INTRODUCTION	55
METHODS	57
ETHICS.....	61
RESULTS	61
DISCUSSION.....	64
CONCLUSION.....	66
V. CONCLUSIONS.....	77
REFERENCES	79
APPENDICES	87
VITA.....	91

LIST OF TABLES

Table	Page
1. Search strategy	24
2. Quality assessment of included articles based on Russell and Gregory's guidelines	25
3. Description of all included studies in this systematic review and meta-analysis.....	27
4. Search strategy	48
5. Quality assessment	49
6. Characteristics of included studies (n = 21)	50
7. Determinants or risk factors examined by included studies.....	52
8. Descriptive statistics of the six constructs of HBM items based on 925 participants.....	68
9. Comparing the actual EVs of this present study to the EVs of a similar artificial study	74
10. Factor loading for the six constructs of the HBM.....	75
11. Reliability coefficient for items.....	76

LIST OF FIGURES

Figure	Page
1. A sample of current cigarette smoking packaging in the KSA	3
2. Flow chart of literature review	30
3. Prevalence of smoking among male students before conducting sensitivity analysis	31
4. Prevalence of smoking among female students before conducting sensitivity analysis	32
5. Pooled estimate of smoking tobacco among all included studies (n=29)	33
6. Male prevalence of smoking after conducting the sensitivity analysis	34
7. Female prevalence of smoking after conducting the sensitivity analysis	35
8. Flow chart of the selection process	54

CHAPTER I

INTRODUCTION

Background

The only legal substance that devastates the lives of its users, as intended by its manufacturers, is tobacco.¹ A 2018 report indicated that tobacco-related diseases killed more than seven million people in 2016 alone.² The projection of mortality based on current tobacco consumption is believed to reach eight million cases by 2030.³ Moreover, cardiovascular diseases (e.g., coronary heart disease), several kinds of cancers (e.g., lung cancer), and respiratory diseases (e.g., chronic bronchitis) are simply a few examples of health-related conditions that are associated with tobacco smoking.² Although tobacco consumption has statistically declined in many of the developed countries, such as in the United States of America (USA), 80% of the 1.1 billion tobacco users who live in low-and-middle-income countries will suffer the burden of tobacco-related illness and death.²

Correspondingly, the Kingdom of Saudi Arabia (KSA), one of the high-income countries, had a statistically significant increase of smoking prevalence between 1980 and 2012.⁴ The KSA brought in more than SR 13 (USD \$4.5) billion worth of tobacco supplies from 2010 to 2014.⁵ Plus, the tobacco industry in the KSA has reported that the revenue from cigarettes increased from \$1 million to \$65 million in ten years.⁶ Saudis consume 15 billion cigarettes annually, which is worth \$1.5 billion; this signifies a public health concern. Thus, the Kingdom has become one of the largest importers of tobacco in the world.⁷ The KSA's economic burden due to tobacco consumption has resulted in a loss of \$20 billion, without accounting for smuggled tobacco products.⁸ Also, two national surveys have found an increase of tobacco smoking among

Saudi citizens.^{9,10} What's more, in addition to the increase in smoking prevalence, the KSA has lost 280,000 lives due to tobacco consumption in one decade.⁸

Moreover, tobacco smoking among Saudi college students has been thoroughly studied. For example, Bassiony¹¹ traced all of the articles published between 1987 and 2008. He found eleven studies that investigated college students in KSA. He reported that the prevalence ranged from 2.4% to 37%.¹¹ Almutairi¹² conducted a review study in which he presented six articles investigating the prevalence of tobacco smoking among Saudi college students. He found that the prevalence ranged from 4% to 19%.¹² Many researchers in the Kingdom have focused on studying the youth smoking problem, because youth are more susceptible to be starting to smoke and more likely to be challenged to quit later in life.¹²⁻¹⁴ In addition, several risk factors associated with tobacco smoking among Saudi college students have been examined.¹²⁻¹⁴ However, the problem is that no research yet has quantified the overall prevalence, synthesized the risk factors, and investigated smoking behavior from an individual theoretical framework. Understanding the overall prevalence, the risk factors, and the beliefs of Saudi college students about tobacco smoking is a key indicator to better comprehend the magnitude of the current public health problem.

Despite the dearth of studies in utilizing an individual level-model or theory among this population, some researchers have proposed some risk factors that have been associated with tobacco smoking among Saudi college students. These researchers have claimed, through the utilization of descriptive studies, that Saudi college students perceived some benefit from smoking, viewing it as a leisure activity,¹⁵ a pleasant habit,¹⁶ and a fun experiment.^{17,18} These types of studies, moreover, have reported some perceived barriers to smoking, such as having a strong Islamic belief,^{15,19} and parents' supervision.¹⁵ Additional studies have indicated that Saudi

college students who perceived the severity of developing lung cancer and believed that they were more susceptible to developing it, are more likely to be associated with non-smoking status.^{20,21} In addition to the reported perceived severity of tobacco smoking, the KSA has implemented a law requiring all cigarette smoking packages to include a picture and words of the probable effects of smoking cigarettes. Figure 1 depicts the outer look of some cigarette packs.

Figure 1. The verbiages and pictures shown on cigarette packs.¹



All of the above-documented risk factors were examined *without* utilizing a theoretical model, in order to determine the relationship between the predictors and the outcome. Noar and Zimmerman²² have emphasized the great need of using a theoretical model to guide research in understanding a health behavior, designing an intervention, and evaluating a program's success or failure. Based on the objectives of a project, a theory could inform program planners about why, what, or how people change their health behaviors and then could help them design a program to suit that need.²³

Health Belief Model

The Health Belief Model (HBM), an individual level-framework established in the late 1950s, was founded on the premise that individuals' perceptions and beliefs play an important role in their adoption of a behavior.^{24,25} Beliefs about an outcome are key factors that influence

¹ These pictures were taken by the author of this dissertation.

peoples' decisions, whether they engage in a behavior or not. Also, beliefs can be altered, and individuals' beliefs can be distinguished through their backgrounds.²⁶ Originally, the model attempted to answer the question of why some individuals did not seek a health preventative program when it was available to them.^{25,26} In the same vein, the HBM remains applicable in answering why some college students still smoke, even though tobacco cessation programs are available and free.^{26,27} Due to its popularity among health care providers and researchers, the model has become the framework most used to explain people's beliefs regarding a health change.²⁸ The model assumes that individuals' beliefs about their current health behavior are crucial in determining their expected goals.^{24,26} For instance, people who put a value on the avoidance of smoking may expect to be prevented from acquiring lung cancer. The HBM was initiated based on four constructs: perceived severity (i.e., beliefs about the severity of smoking-related diseases), perceived susceptibility (i.e., beliefs of chances of developing a smoking-related illness), perceived barriers (i.e., beliefs about the cons associated with smoking), and perceived benefits (i.e., beliefs about the pros of smoking cessation). Later, the model was enhanced by the addition of two other constructs: self-efficacy (i.e., one's confidence to quit smoking) and cues to action (i.e., cues or reminders to quit smoking from a doctor or a family member).²³⁻²⁶

The Application of Health Belief Model

Although there has been no study that investigates Saudi students' beliefs about smoking behavior based on the HBM, some international studies utilized the constructs of the HBM and have provided a direction for employing the model. For instance, Li and Kay²⁷ have utilized the four constructs of the HBM to predict Chinese college students' likelihood of cigarette smoking.²⁷ These four constructs were: perceived severity (e.g., an increase in the risk of

developing cancer) and susceptibility (e.g., being worried about getting a cough, often), perceived benefits of not smoking (e.g., saving money), and perceived barriers to non-smoking (e.g., limiting of social activity). They found that individuals' beliefs (i.e., higher scores on the measure of perceived severity of smoking-related health issues, the benefits of non-smoking, and the barriers to non-smoking) were statistically associated with Chinese smokers. However, the construct of perceived susceptibility did not show any significance. When the authors used multiple logistic regression, they found that the perceived benefits of non-smoking and the barriers to non-smoking predicted the status of non-smoking among Chinese college students.²⁷

Another example, Resis et al.²⁹ added two more constructs (i.e., self-efficacy and cues to action) and found that all of the HBM constructs, with the exception of perceived barriers, were significantly associated with cigarette smoking among Iranian students. Another study³⁰ indicated that higher scores in the measures of self-efficacy and cues to action predicted the current smoking status of Iranian students. Moreover, Mantler³¹ systematically reviewed articles that used the HBM to examine cigarette smoking among North American youth (12-22 years of age), and concluded that the youth believed that smoking was less harmful, demonstrating self-exempting beliefs about the likelihood of addiction, the health risks, and the impacts of smoking. Thus, Mantler³¹ suggested that the HBM could assist in understanding youths' perceptions and beliefs about cigarette smoking.³¹

Choi and Duffy³² ascertained that the biggest advantage of using the HBM is its simplicity of application in helping designers develop an intervention program for smokers.³² In fact, tobacco interventions based on the HBM have been shown to have successful results in reducing tobacco smoking.^{33,34} Two studies have indicated that the HBM was more appropriate than the non-theory-based studies in guiding the tobacco cessation program.^{33,34} A quasi-

experimental study³³ utilizing the HBM followed up with its 88 tobacco consumers for the course of the study. The participants, who were 20-35-year-old, were asked to watch a 16-minute video and to read a pamphlet that highlighted the negative effects of tobacco use on dental health. A pre-and a post-evaluation were conducted to determine whether participants altered their health beliefs about the danger of tobacco consumption. The major findings were that 51.2% of the participants stopped smoking in public places and 33.7% started seeking a tobacco cessation program. The results of the study indicated that an intervention designed based on the HBM is an effective strategy to encourage participants to enroll in tobacco cessation programs.³³

Another quasi-experimental study³⁴ that employed the HBM assigned 130 college students into either a treatment group or a control group. The treatment group received electronic educational sessions based on the HBM constructs about tobacco smoking through Telegram (an online communication platform), while the control group received no educational materials. The results indicated that the college students in the treatment group showed a statistically positive increase in their knowledge in all of the HBM constructs, as compared to the control group. The study concluded that the HBM is an effective guide in implementing a tobacco intervention among college students.³⁴

Before designing an intervention program, a basic tenet of understanding tobacco smoking among Saudis is to investigate the underlying beliefs and perceptions that contribute to the smoking problem. One major aspect of this dissertation is aimed at utilizing the constructs of the HBM to develop an Arabic instrument that measures Saudi students' beliefs towards cigarette smoking. The outcome of this project should suggest some tips for testing whether this model can be associated with or can predict cigarette smoking among Saudi college students.

Statement of the Problem

Problem 1

A number of studies that address the prevalence of tobacco smoking among Saudi college students have been published in recent years. The prevalence of smoking is a fundamental epidemiological concept that captures the current status of tobacco smoking in a specific population and at a specified time. However, there is a lack of a systematic synthesis regarding the prevalence of tobacco smoking among Saudi college students. This systematic synthesis serves as a background knowledge about the magnitude of tobacco smoking problem.

Problem 2

Several studies have investigated the risk factors of tobacco smoking among Saudi college students. Risk factors are characteristics, conditions, or behaviors that contribute to increase the likelihood of developing a disease or injury. Many studies have attempted to investigate some risk factors that have some degrees of association with tobacco smoking. Nevertheless, no study has systematically reviewed the extent to which those factors are associated with tobacco smoking among college students in KSA.

Problem 3

Studies elsewhere have tested the association between the constructs of the HBM and cigarette smoking. However, no study has yet developed a psychometric property based on the HBM that measures Saudi college students' beliefs in relation to tobacco smoking.

Purpose of the Study

Based on the three knowledge gaps identified above, there are three purposes of this dissertation. The first purpose is to systematically review and meta-analyze the literature to estimate the pooled prevalence of smoking tobacco among those in higher education in the KSA.

The second purpose is to systematically review the literature to synthesize the vast amount of information available on the determinants of smoking by Saudi college students and to identify the quantity of articles employing a theoretical framework. The final purpose is to create and validate an Arabic instrument that measures Saudi college students' beliefs and perceptions about tobacco smoking, using the framework of the Health Belief Model.

Significance of this Study

This dissertation is the first to develop an Arabic instrument to measure Saudi college students' beliefs about cigarette smoking, based on an individual-level framework. The current gap in Saudi tobacco research is the scarcity of utilizing individual frameworks. The use of a theoretical framework is solid method to describe, explain, or predict a health outcome.³⁵ The impacts of using a theoretical approach are deemed to lower the cost and to improve the delivery of tobacco intervention and prevention.^{36,37} Developing an Arabic psychometric tool that measures Saudi students' beliefs is critical to evaluate the baseline efforts of tobacco smoking. Validation this newly developed instrument should contribute to the foundation of a scientific body of knowledge. This dissertation was initiated in order to enable current researchers to assess the current tobacco smoking problem among the Saudi population, especially among college students, and to enhance the current understanding of the factors and beliefs that could be associated with Saudi college students' smoking. Based on the findings of this dissertation, researchers are now able to conduct more empirical research to enrich the current understanding of the factors that are associated with college students' smoking behavior, to offer some tips for tobacco prevention researchers and programmers targeting college students, and to set up a foundation for future research pertaining to the use of theories in smoking research.

Aims and Hypotheses

Project I

Aim 1: To systematically review the literature to estimate the pooled prevalence of smoking tobacco among higher education students in the KSA.

Hypothesis 1: Collected studies will provide evidence about the pooled prevalence of smoking tobacco among higher education students in KSA.

Project II

Aim 2: To systematically review the literature to qualitatively synthesize and to assimilate reported risk factors of smoking on Saudi college students.

Hypothesis 1: Collected studies will reveal substantial evidence about the risk factors associated with tobacco smoking among Saudi college students.

Project III

Aim 3: To create and validate an Arabic instrument that measures the beliefs and perceptions of Saudi college students about cigarette smoking using Health Belief Model.

Hypothesis 1: Generated items will load on their corresponding constructs of the HBM.

Hypothesis 2: The newly developed Arabic instrument based on the HBM will be valid and reliable to assess Saudi college students' beliefs about cigarette smoking.

Operational Definitions

- **Perceived Severity:** For this study, the construct of perceived severity is defined as Saudi college students' beliefs about the severity of smoking-related diseases.
- **Perceived Susceptibility:** For this study, the construct of perceived susceptibility is defined as Saudi college students' beliefs about the chances of developing a smoking-related illness.

- **Perceived Barriers:** For this study, the construct of perceived barriers is defined as Saudi college students' beliefs about the negative aspects of cigarette smoking abstinence.
- **Perceived Benefits:** For this study, the construct of perceived benefits is defined as Saudi college students' beliefs about the positive aspects of non-cigarette smoking.
- **Cues to Action:** For this study, the construct of cues to action is defined as cues and reminders enabling Saudi college students to avoid cigarette smoking.
- **Self-Efficacy:** For this study, the construct of perceived self-efficacy is defined as Saudi college students' confidence in their ability to maintain a non-cigarette smoking behavior.

Assumptions

The primary assumptions of this dissertation are the following:

- Students completed the questionnaire honestly and correctly, indicating their true beliefs of cigarette smoking.
- Students were able to understand the content of the questionnaire.
- Students fully understood the directions as they were intended.
- Students had a reliable internet to complete the questionnaire online.
- The Qassim University disseminated the online questionnaire to its students.

Delimitations

The term “delimitation” implies that the researcher may have selected certain parameters in such characteristics or boundaries to limit and clarify the scope of the study.³⁸ Some of the known delimitations of this study include these:

- 1- Selected databases were constrained to popular search platforms (e.g., PubMed or Science Direct).

- 2- The study population was limited to Saudi college students.
- 3- The sample was recruited from one specific university (i.e., Qassim University) in the kingdom of Saudi Arabia.
- 4- The survey instrument, based on the HBM, was created to capture only beliefs about cigarette smoking.
- 5- Students' feedback on the survey was counted as a source of evidence to conduct the study.

Limitations

The term "limitation" refers to the weaknesses of the study that are beyond the control of the researcher. There were few limitations associated with conducting the research for this dissertation.³⁸ First, collected studies were retrieved from selected databases known to encompass the literature related to the topic under investigation. Thus, other articles written in Arabic or stored in other Arabic databases were difficult to obtain. Second, self-reported surveys are prone to either over reporting or underreporting agreement with items, offering conflicting answers, and concealing the truth.³⁹ Finally, the findings cannot be generalized to all college students in the KSA, since the sample size is drawn from one single university (i.e., QU) through a convenience sampling. However, the instrument can be replicated again on different students' populations to improve its outcomes.

CHAPTER II

REVIEW OF THE LITERATURE: PROJECT I: SMOKING TOBACCO PREVALENCE AMONG COLLEGE STUDENTS IN THE KINGDOM OF SAUDI ARABIA: SYSTEMATIC REVIEW AND META-ANALYSIS

Introduction

Tobacco use, in its various forms, is responsible for many preventable diseases and deaths.² A 2018 report indicated that tobacco-related diseases killed more than 7 million people worldwide in 2016.² It is projected that, if the trend of tobacco consumption persists, 8 million people will die yearly by 2030.⁴⁰ Although tobacco use has declined in many developed countries, 80% of the 1.1 billion current smokers who live in low-and-middle-income countries continue to suffer the burden of tobacco-related illness and death.² Concurrently, some high-income countries, such as the Kingdom of Saudi Arabia (KSA), were found to have a statistically significant increase in tobacco smoking between 1980 and 2012.⁴ The KSA imported more than 3.4 billion US dollars' worth of tobacco products from 2010 to 2014.⁵ Thus, the KSA's economic burden, due to tobacco consumption, was 20.5 billion US dollars, and 280,000 premature deaths occurred from 2001 to 2010.⁸

For the past three decades, the KSA has implemented certain policies to control and reduce tobacco consumption.^{9,41} One policy is to ban the use of tobacco products in government and affiliated facilities; these include college campuses, parks, malls, airports and other shared public spaces designated as tobacco-free zones. Another policy imposes 100% taxation on tobacco products. The latest increase in tobacco products' prices was implemented in June, 2017.⁴¹ In addition to policy level-interventions, non-profit and government-funded tobacco cessation programs have been implemented periodically, across many cities in the KSA to

decrease the epidemic of tobacco use by the Saudi population.⁴¹ The Coordinating Committee for Anti-Smoking Associations organized some of these programs to meet its mission of smoking cessation.⁴¹ Above all, the KSA is an Islamic country which considers tobacco smoking a religiously and socially sinful practice. Nevertheless, smoking tobacco among Saudi college students is still a crucial concern.¹²

Although a 2013 Saudi national survey found that the prevalence of smoking across the population was 12.2%,⁹ a recent literature review discovered numerous epidemiological studies exploring Saudi college students' smoking behavior, providing conflicting percentages of smokers versus non-smokers and the frequencies of tobacco consumption.¹² The lifestyle associated with college experiences represents a newfound sense of independence for many students, one which makes them more inclined to partake in risky or dangerous behaviors, such as smoking tobacco.⁴² For instance, in most high-income countries,⁴³ 18-24 years old individuals (typically, college students) had no substantial change of smoking rate over the past two decades in spite of the decrease of tobacco consumption among both adults and teens.

Almutairi¹² reported studies that examined tobacco smoking behavior among college students in the KSA across diverse locations, diverse genders, and diverse colleges. He found that researchers in the KSA have been unable to come to a consensus about the actual prevalence of smoking among college-age students.¹² As a result, this systematic review and meta-analysis was intended to critically examine and to analyze existing data in order to estimate the pooled prevalence of smoking tobacco among those in higher education in the KSA. The objective was to compare this study's results to national-level findings for the KSA and to findings for other neighboring countries at the higher education level. The purpose of these comparisons is to understand the overall prevalence of tobacco smoking and its severity within the KSA and within

the region. The goal of this study is to inform decision makers, public health researchers and practitioners, and individuals in the communities about the current tobacco problem, so that they can design and ultimately implement effective tobacco control interventions.

Methods

This systematic review and meta-analysis was guided by the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) checklist.⁴⁴

Definition

In this study, the population and the topic of investigation were restricted to college students who smoked cigarettes, water-pipes (hookahs), and cigars. The researchers excluded other forms of tobacco, such as electronic cigarettes and smokeless tobacco (e.g., snuffing, dipping, and chewing tobacco) because of irrelevance to smoking behavior or the lack of existing research in their domains. Current smokers were defined as college students who had smoked at least once within the previous 30 days. For the convenience of reporting the findings, study researchers categorized *health science-related disciplines* as one term, to encompass medicine, dentistry, applied medical sciences, nursing, or pharmacy colleges.

Search Strategy

Two researchers (S. A. and M. A.) developed key terms that aligned with the purpose of this study (See Table 1.). These keywords were used to gather literature from five databases: PubMed, Science Direct, APA PsycNET, Web of Science, and CINAHL. Publication years were restricted to include literature published from 2010 to 2018. This time span was selected based upon the findings of a previous literature review, in order to further investigate what has already been contributed in this research domain.¹² No language restriction was used in this study. The literature search in each database was confined to the title, abstract, or both, except for APA

PsycNET, where all fields were used. An example of the keywords used for searching PubMed was: (Smoking[Title/Abstract] OR Tobacco[Title/Abstract] OR Cigarette[Title/Abstract] OR Waterpipe[Title/Abstract])) AND (College[Title/Abstract] OR University[Title/Abstract] OR Students[Title/Abstract])) AND (Saudi[Title/Abstract] OR KSA[Title/Abstract]). Data was gathered from February 1st through August 1st, 2018. We also sought additional articles that reported the prevalence of smoking among Saudi college students via articles' references or studies that cited the included articles.

Selection Criteria

The study had three inclusion criteria: 1) a focus on college students in the KSA, 2) data about smoking prevalence, and 3) a score of at least four out of five on Russell and Gregory's guide.⁴⁵ The researchers excluded articles that: 1) pre-dated 2010, 2) were conducted outside of the KSA, 3) utilized experimental designs, 4) compared tobacco to other addictive substances, 5) focused on smokeless tobacco or electronic cigarettes, 6) scored three points or less, and 7) restricted access to the full text.

Data Extraction

Two researchers (S. A. and M. A.) independently conducted an in-depth review of the articles' titles, abstracts, and full texts. After identifying articles that met all of the inclusion criteria, the researchers met to confirm similar findings. Then, they independently extracted data (i.e., gender, prevalence, number of smokers, sample size, population of study, and study location) from each article and evaluated them based on exclusion criteria and Russell and Gregory's guidelines.⁴⁵ A third investigator (P. D.) was brought in to resolve disagreements concerning articles' inclusion, using discussion and critical appraisal.

Quality Assessment

Two researchers (S.A. and M.A.) independently rated and assessed the risk of bias and the quality of each article based on Russell and Gregory's guidelines.⁴⁵ Articles had to accrue four points out of a possible five in order to be considered in this study. Any article that scored less than four points was excluded after discussion with the third investigator (P.D.). This exclusion was because the scores of studies with three points or less indicated that they did not maintain some of the fundamental research guidelines: rigor, credibility, trustworthiness, and believability.⁴⁵ The Russell and Gregory⁴⁵ five questions are: 1) Was the research question clear and adequately substantiated? 2) Was the design appropriate for the research question? 3) Was the method of sampling appropriate for the research question and design? 4) Were data collected and managed systematically? 5) Were the data analyzed appropriately? (See Table 2).

Statistical Analysis

We reviewed and compiled, using Excel 2016 (Microsoft Corporation, Redmond, CA, USA), the following data: gender, location, population size, number of smokers, name of college, and estimated prevalence of smoking tobacco. In addition, we used MetaXL 5.3 (www.epigear.com) to conduct the meta-analysis that produced graphs. The estimated pooled prevalence of smoking among college students was computed using the model of inverse variance heterogeneity (IVhet) with double arcsine transformation and a 95% confidence interval (CI).^{46,47} Doi et al.⁴⁷ recommended that, unlike random and fixed effects models, the IVhet and double arcsine models should be used to minimize the chance of overestimating the true prevalence and of underestimating the statistical error. The rational explanation for choosing this model was to deal with the issues of variance instability, which could overestimate each study's

weight in the meta-analysis, and to ensure confidence interval boundaries that lay outside the range of 0 to 1.^{46,47}

An I^2 statistic of heterogeneity was used to detect the percentage of variation across studies that resulted from how they were conducted, rather than from natural variation. An I^2 of 75%, 50%, or 25% indicates that the heterogeneity was high, moderate, or low, respectively.⁴⁸ Subgroup analyses were performed, based on gender, to determine any existing differences of smoking prevalence between males and females. We also ran a sensitivity analysis to assess between-study heterogeneity. Outlier studies were excluded, before conducting the meta-analysis based on Tukey method.⁴⁹

Results

Characteristics of the Studies

Out of the 295 published articles returned by the search method, 29 research articles were included for data synthesis (Figure 2).^{13-15,17,18,20,50-72} All of the included studies were cross-sectional descriptive studies that had been carried out primarily within governmental institutions. One study, however, was conducted in a private teaching college.⁶⁷ The overall sample size of all included studies was 23237 participants: 12719 males and 10518 females. Riyadh, the capital of the KSA, was the location of 11 (38%) of the studies. Of these 11 studies, 10 were conducted at two universities (King Saud University and King Saud bin Abdulaziz University - Health Sciences).

Of the articles included in this study, 55% examined tobacco smoking prevalence among health science-related students, while 38% of the articles addressed the smoking prevalence among all college students, including health science-related majors. The remaining 7% of articles were focused on smoking prevalence within colleges of education (Ed.) and sciences. Among the

included studies, 13 (45%) studies measured the prevalence of smoking among both males and females, ten (34%) focused only on males, and six (21%) addressed the prevalence of smoking solely among female students (See Table 3).

Meta-Analysis Findings

Among studies that included both males and females, the highest reported prevalence of smoking was 33.8% in two studies.^{59,62} Conversely, one study reported the lowest prevalence of 9.5%.⁵² Based on gender-specific (i.e., studies surveyed either males or females) studies, 42.3% was the highest prevalence of smoking reported among only male university students,⁶⁷ while the lowest prevalence was 15.6%.⁶⁹ Among studies reporting only females' smoking prevalence, the highest was 10.3%,⁵⁴ while the lowest prevalence was 0.9% (Table 3).⁵⁵

After we screened for outlier studies, the meta-analysis revealed that the overall prevalence of tobacco smoking among college students in the KSA was 17% (95% CI: 11%-23%) according to the IVhert model. However, the heterogeneity among all included studies was very high ($I^2 = 97\%$) (Refer to Figure 5 and Table 3). Further subgroup analysis was performed, in order to determine the pooled prevalence in each group (male and female) of college students. We found that male and female students had a pooled prevalence rate of tobacco smoking at 26% (95% CI: 24%-29%) and 5% (95% CI: 3%-7%), respectively. However, the heterogeneity among gender-specific studies remained high: male ($I^2 = 78\%$) and female ($I^2 = 90\%$) (See Figure 2 and 3).

We conducted a sensitivity analysis to examine the effect of each male-reporting study on the pooled male prevalence. We were unable to find any significant effect on the male pooled prevalence, even after systematically removing studies that had the most influence on the overall pool. For example, among 18 articles surveying male subjects, we found that the pooled

prevalence did not significantly change even when we removed the six most influential studies^{14,51,57,63,64,71} in the heterogeneity test and obtained a low heterogeneity ($I^2=38\%$). The change was only a 1% increase in the overall male pooled prevalence: 27% (95% CI: 25%-29%), compared to 26% (95% CI: 24%-29%) (Refer to Figure 6).

We performed a sensitivity analysis on the prevalence of smoking among female students in 17 studies and found no significant change in heterogeneity among these studies. After we systematically removed the eight most influential studies,^{18,20,53-55,61,63,72} we found a high homogeneity ($I^2=34\%$), but the pooled prevalence did not significantly differ from the previous calculation. The change was a 1% decrease in the overall female prevalence: 4% (95% CI: 3%-5%), compared to 5% (95% CI: 3%-7%) (Refer to Figure 7).

Discussion

To our knowledge, this study was the first comprehensive meta-analysis performed, that aimed to systematically review eligible articles reporting the prevalence of smoking tobacco among higher-education students in the KSA. This study also provided a close look at the current tobacco smoking problem among Saudi college students, when compared to national level prevalence and the prevalence in neighboring countries. The results of this study indicated that the pooled estimate of tobacco smoking among college students in the KSA was 17%, which was 5% higher than the average prevalence reported among Saudi daily current smokers aged 15 to 25 years old.⁹ This indicated that Saudi college students smoke at a higher rate when compared to a slightly similar age-group in the national representative study. Furthermore, two regional cross-sectional studies showed that the prevalence of smoking reached 12.4% in Yemen and 15.1% in the United Arab Emirates (UAE).^{73,74} To compare these prevalence rates to the findings of the present study, university students in the KSA recorded approximately 5% and 2% higher

prevalence of smoking than students in Yemen and the UAE,^{73,74} respectively. Based on a similar meta-analysis study, smoking prevalence among college students in the KSA was higher than that found in other countries in the same region, such as Iran, with prevalence of 17% compared to 11.6%, respectively.⁷⁵ Overall, Saudi college students in this study indicated a higher rate of smoking tobacco when compared to Saudi current and daily current smokers aged 15 to 25 years old and when compared to studies conducted in regional countries.

The pooled smoking prevalence among male university students reported in this meta-analysis was 4.5% higher than the national prevalence among Saudi males aged 15 and older.⁹ A meta-analysis study found that Iranian male college students had a smoking prevalence of 19.8%, which was 6.2% lower than what is reported in this meta-analysis for Saudi males.⁷⁵ The current study, moreover, did parallel with a nationally representative study which found that Saudi male individuals had a statistical increase of smoking prevalence from 1980 to 2012, when compared with 186 countries.⁴ The findings of the current study assert that there is a huge difference among the tobacco smoking prevalence rates between male and female college students in the KSA.

In the findings of this meta-analysis, Saudi male college students reported a smoking prevalence that was 21% higher than that of Saudi female college students. This notable difference may be attributed to a limited access to female participants in the KSA. One study reported that the researcher was not able to conduct his research on females because it was culturally unacceptable for a male investigator to survey female students.⁷¹ Another issue of female participation was social desirability bias tied to smoking behavior. Such behavior, especially among women in the KSA, is viewed as destructive to Saudi community values.

Therefore, female smokers may be deterred from accurately reporting their smoking status, for fear of societal rejection.⁷⁶

Through examining Saudi female college students' prevalence of smoking, we found one group of studies that had a prevalence range of 8% to 16%.^{18,20,53,54,62,63,72} This unusual range compared to 0-4% may result from the selection at a particular college, making it an exclusive population. For instance, the target populations in most of these studies reporting this range were selected from college students in health-science disciplines.^{20,54,62,63,72} Having a satisfying sample size to conduct the research does not mean it could represent the whole university population.⁷⁷

In comparison with the 2013 Saudi national survey, this meta-analysis revealed that the number of female college smokers was 4% higher than overall women aged 15 years or older.⁹ Similarly, this meta-analysis showed that the 5% prevalence of Saudi female college smokers was relatively higher than a similar meta-analysis study which reported a 2.2% rate of smoking among Iranian female college students.⁷⁵ In contrast, female college students in Yemen had a prevalence of 13%,⁷³ which was similar to that of Saudi female students (8-16%), but was far from the pooled female prevalence of 5% reported in our study findings.

The majority of studies reported high prevalence when the study sample was small and specific, whereas the prevalence would be more representative when the sample size was large and diverse. For instance, more than half of the included studies addressed smoking tobacco among health science-related students; this was not representative of the whole university population, and thus, most of them showed the highest prevalence of smoking. One explanation could be that the majority of health science-related researchers preferred to conduct their research on convenient and approachable health science-related students. This technique of

sampling could create a potential bias of self-selection, in where a student may be unduly influenced by motivation, interest, or health consciousness about the phenomenon.⁷⁷

Limitation

There were several limitations of the current study. Because of the high variation in instruments, data collection, and study locations among included studies, the result of this meta-analysis could not represent the smoking prevalence of higher-education students in the KSA. However, this was an attempt to estimate and to understand the pooled estimate of smoking tobacco prevalence among included studies in this meta-analysis. All of the included studies were cross-sectional in nature, which provided an epidemiological measurement of a certain population of interest rather than examining any association or causation. As is noted above, culture barriers play a crucial role in reporting the real prevalence. Thus, this study may have been influenced by the cultural and societal biases reported by some studies, which may have underestimated the actual pooled estimate among Saudi female participants.

Conclusion

Tobacco smoking is a public health problem among college students in the Kingdom of Saudi Arabia (KSA). The debate over the prevalence of tobacco smoking has been well investigated. College students in the KSA have a high tobacco smoking prevalence, compared with the national Saudi smoking prevalence and that of neighboring countries. Future studies should use available resources to shift from repeatedly addressing the prevalence of smoking behaviors among college students in the KSA, to focusing on intervention and prevention strategies. One idea to monitor the prevalence of smoking is through establishing a tobacco surveillance system that tracks and records Saudi college students' smoking behaviors. Future research should focus on the psychosocial and economic determinants, from theoretical and

experimental designs, as a means of finding strategies that encourage smoking cessation and prevention among college students in the KSA.

Table 1. Search strategy.

Databases	Search Keywords	Total
PubMed (2010-2018)	((Smoking[Title/Abstract] OR Tobacco[Title/Abstract] OR Cigarette[Title/Abstract] OR Waterpipe[Title/Abstract])) AND (College[Title/Abstract] OR University[Title/Abstract] OR Students[Title/Abstract])) AND (Saudi[Title/Abstract] OR KSA[Title/Abstract])	120
Science Direct (2010-2018)	(Smoking OR Tobacco OR Cigarette OR Waterpipe) AND (College OR University OR Students) AND (Saudi OR KSA); Note: Find articles in: Title, Abstract, Keywords. Restrict research to: Review articles & Research articles.	16
APA PsycNET (2010-2018)	Any Field: smoking OR Any Field: Tobacco OR Any Field: Cigarette OR Any Field: Waterpipe AND Any Field: College OR Any Field: University OR Any Field: Students AND Any Field: Saudi OR Any Field: KSA AND Peer-Reviewed Journals only AND Year: 2010 To 2018	71
Web of Science (2010-2018)	TITLE: (smoking OR tobacco OR Cigarette OR Waterpipe) AND TITLE: (college OR University OR Students) AND TOPIC:(Saudi OR KSA)	46
CINAHL (2010-2018)	AB (smoking OR tobacco OR cigarette Or Waterpipe) AND AB (College Or University Or Students) AND AB (Saudi OR KSA)	35
Hand Search		7
TOTAL		295

Table 2. Quality assessment of included articles based on Russell and Gregory's guidelines¹².

#	Source	Year	Q1	Q2	Q3	Q4	Q5	Quality Score
1	Abdulghani ⁵⁰	2017	Yes	Yes	No	Yes	Yes	4
2	Al-Mohaithef ⁵¹	2018	Yes	Yes	Yes	No	Yes	4
3	Abd El Kader ⁵²	2018	Yes	Yes	No	Yes	Yes	4
4	Dar-Odeh ⁵³	2017	Yes	Yes	No	Yes	Yes	4
5	Azhar ¹⁷	2012	Yes	Yes	Yes	Yes	Yes	5
6	AL-Saegh ⁵⁴	2017	Yes	Yes	Yes	No	Yes	4
7	Ansari ⁵⁵	2017	Yes	Yes	Yes	No	Yes	4
8	Awan ⁵⁶	2016	Yes	Yes	No	Yes	Yes	4
9	Al-Ghaneem ⁵⁷	2016	Yes	Yes	Yes	Yes	Yes	5
10	Ansari ⁵⁸	2016	Yes	Yes	No	Yes	Yes	4
11	Awan ⁵⁹	2016	Yes	Yes	No	Yes	Yes	4
12	Koura ¹⁸	2011	Yes	Yes	Yes	No	Yes	4
13	Mandil ¹³	2010	Yes	Yes	Yes	Yes	Yes	5
14	Al-Kaabba ¹⁵	2011	Yes	Yes	No	Yes	Yes	4
15	Allohidan ⁶⁰	2017	Yes	Yes	Yes	No	Yes	4
16	AlQahtani ⁶¹	2017	Yes	Yes	No	Yes	Yes	4
17	El-Fetoh ⁶²	2016	Yes	Yes	No	Yes	Yes	4
18	Mansour ⁶³	2015	Yes	Yes	No	Yes	Yes	4
19	Shah ⁶⁴	2015	Yes	Yes	Yes	No	Yes	4
20	Wali ²⁰	2011	Yes	Yes	No	Yes	Yes	4
21	Mahfouz ¹⁴	2014	Yes	Yes	Yes	Yes	Yes	5
22	AlSwuailem ⁶⁵	2014	Yes	Yes	No	Yes	Yes	4
23	Al-Haqwi ⁶⁶	2010	Yes	Yes	No	Yes	Yes	4
24	Hassan ⁶⁷	2014	Yes	Yes	No	Yes	Yes	4
25	Almogbel ⁶⁸	2016	Yes	Yes	No	Yes	Yes	4

26	Taha ⁶⁹	2010	Yes	Yes	Yes	Yes	Yes	5
27	Al-Mohamed ⁷⁰	2010	Yes	Yes	Yes	No	Yes	4
28	Almutairi ⁷¹	2016	Yes	Yes	No	Yes	Yes	4
29	Torchyan ⁷²	2016	Yes	Yes	Yes	No	Yes	4

Table 3. Description of all included studies in this systematic review and meta-analysis.

Source	Gender	Prevalence (%)			Number of Smokers			Sample Size			Popula tion of Study	Study Locat ion
		<i>Male</i>	<i>Female</i>	<i>Total</i>	<i>Male</i>	<i>Fema le</i>	<i>Tot al</i>	<i>Male</i>	<i>Femal e</i>	<i>Tot al</i>		
Abdulgha ni ⁵⁰	Female	--	4.3	--	--	39	39	--	907	907	All Colleg es	Riyad h
Al- Mohaithef ⁵¹	Male	18. 7	--	--	63	--	63	337	--	337	All Colleg es	Abha
Abd El Kader ⁵²	Both	19. 2	2.75	9.5	39	8	47	203	291	494	Health Scienc es	Jedda h
Dar- Odeh ⁵³	Female	--	9.8	--	--	21	21	--	214	214	All Colleg es	Al Madi nah
Azhar ¹⁷	Female	--	4.2	--	--	13	13	--	310	310	All Colleg es	Jedda h
AL- Saegh ⁵⁴	Female	--	10.3	--	--	32	32	--	310	310	Health Scienc es	Jedda h
Ansari ⁵⁵	Female	--	0.9	--	--	3	3	--	332	332	Health Scienc es	Dam mam
Awan ⁵⁶	Male	23	--	--	123	--	123	535	--	535	Health Scienc es	Riyad h
Al- Ghaneem ⁵⁷	Male	30. 6	--	--	284	--	284	927	--	927	All Colleg es	Majm aah
Ansari ⁵⁸	Male	28. 2	--	--	96	--	96	340	--	340	All Colleg es	Majm aah
Awan ⁵⁹	Both	--	--	33.8	na*	na*	162	303	177	480	All Colleg es	Riyad h
Koura ¹⁸	Female	--	8.6	--	--	88	88	--	1020	1020	Ed. & Scienc es	Dam mam

Mandil ¹³	Both	27.5	3.8	14.1	819	141	960	2973	3713	6686	Colleges All Colleges	Riyadh
Al-Kaabba ¹⁵	Both	28.9	4.3	17.6	24	3	27	83	70	153	Health Sciences	Riyadh
Allohidan ⁶⁰	Both	62.5	37.5	24.9	55	33	88	179	175	354	Health Sciences	Riyadh
AlQahtani ⁶¹	Both	30.1	0.5	30.5	68	1	69	226	207	433	Health Sciences	Najran
El-Fetoh ⁶²	Both	88.2	11.8	33.8	90	12	102	160	142	302	Health Sciences	Arar
Mansour ⁶³	Both	39.4	9.4	22.5	56	18	74	142	192	334	Health Sciences	Jeddah
Shah ⁶⁴	Male	17.3	--	--	66	--	66	380	--	380	All Colleges	Al-Kharj
Wali ²⁰	Both	24.8	9.1	14	50	40	90	202	441	643	Health Sciences	Jeddah
Mahfouz ¹⁴	Both	25.6	4.6	16.8	524	67	591	2165	1599	3764	All Colleges	Jazan
AlSwuail em ⁶⁵	Both	27.8	2.4	17	64	4	68	230	170	400	Health Sciences	Riyadh
Al-Haqwi ⁶⁶	Both	24	0	19	40	0	40	165	50	215	Health Sciences	Riyadh
Hassan ⁶⁷	Male	42.3	--	--	66	--	66	156	--	156	Health Sciences	Riyadh
Almogbel ⁶⁸	Male	24.3	--	--	82	--	82	337	--	337	All Colleges	Buraydah and Hassa

Figure 2. Flow chart of literature review.

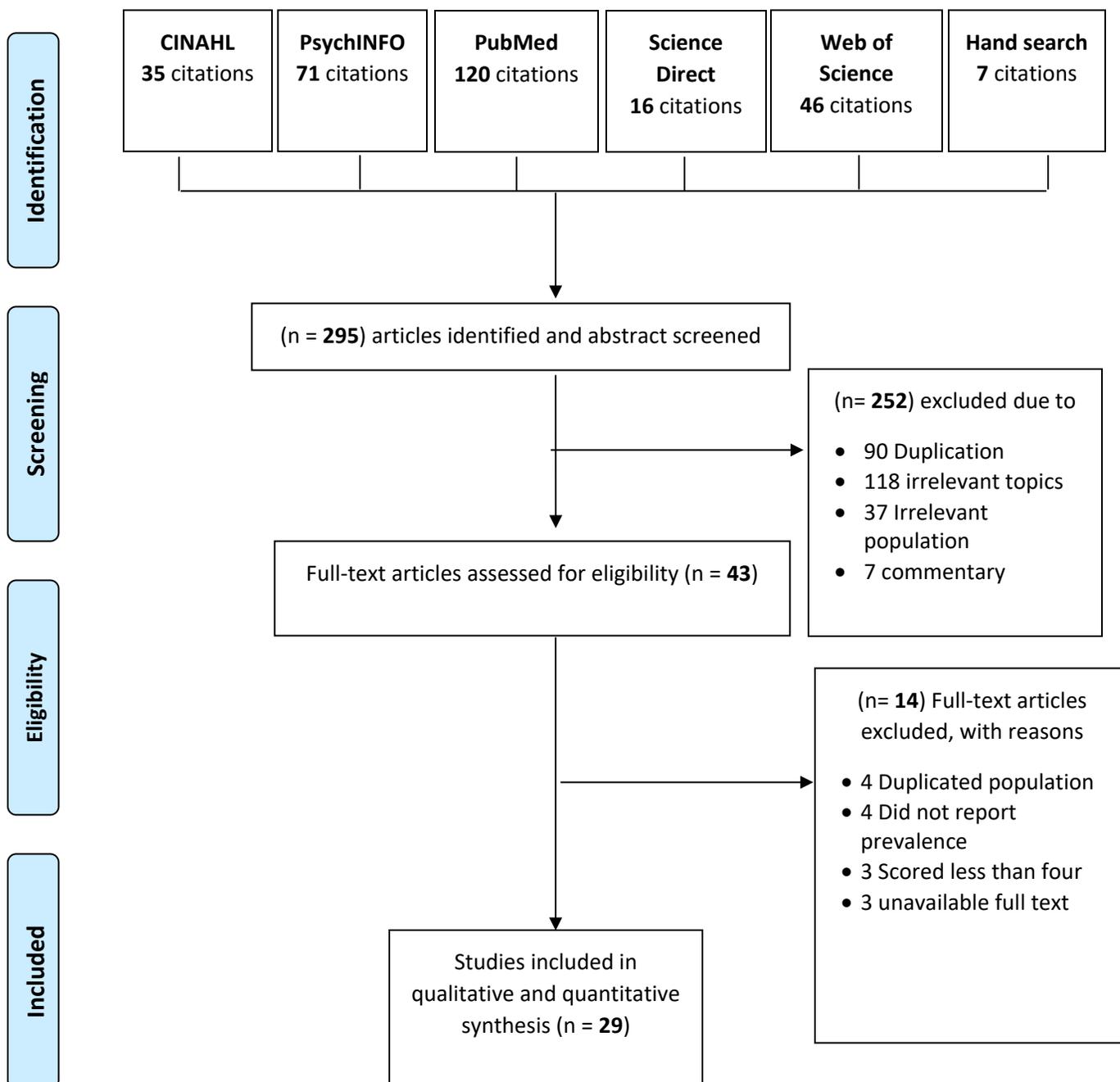


Figure 3. Prevalence of smoking among male students before conducting sensitivity analysis.

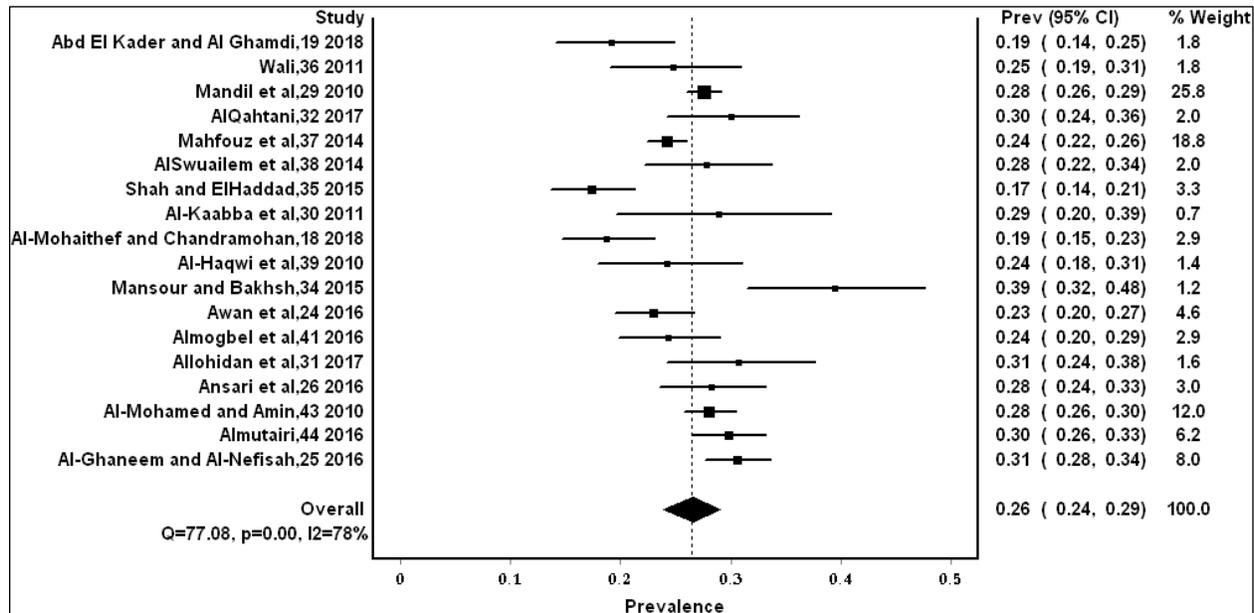


Figure 4. Prevalence of smoking among female students before conducting sensitivity analysis.

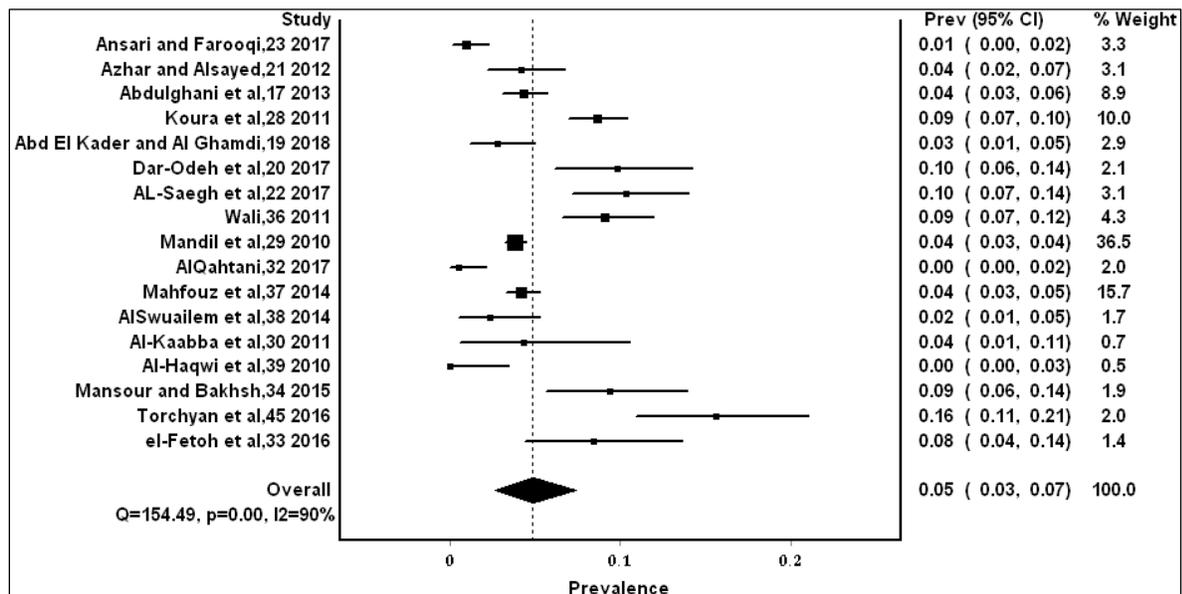


Figure 5. Pooled estimate of smoking tobacco among all included studies (n=29).

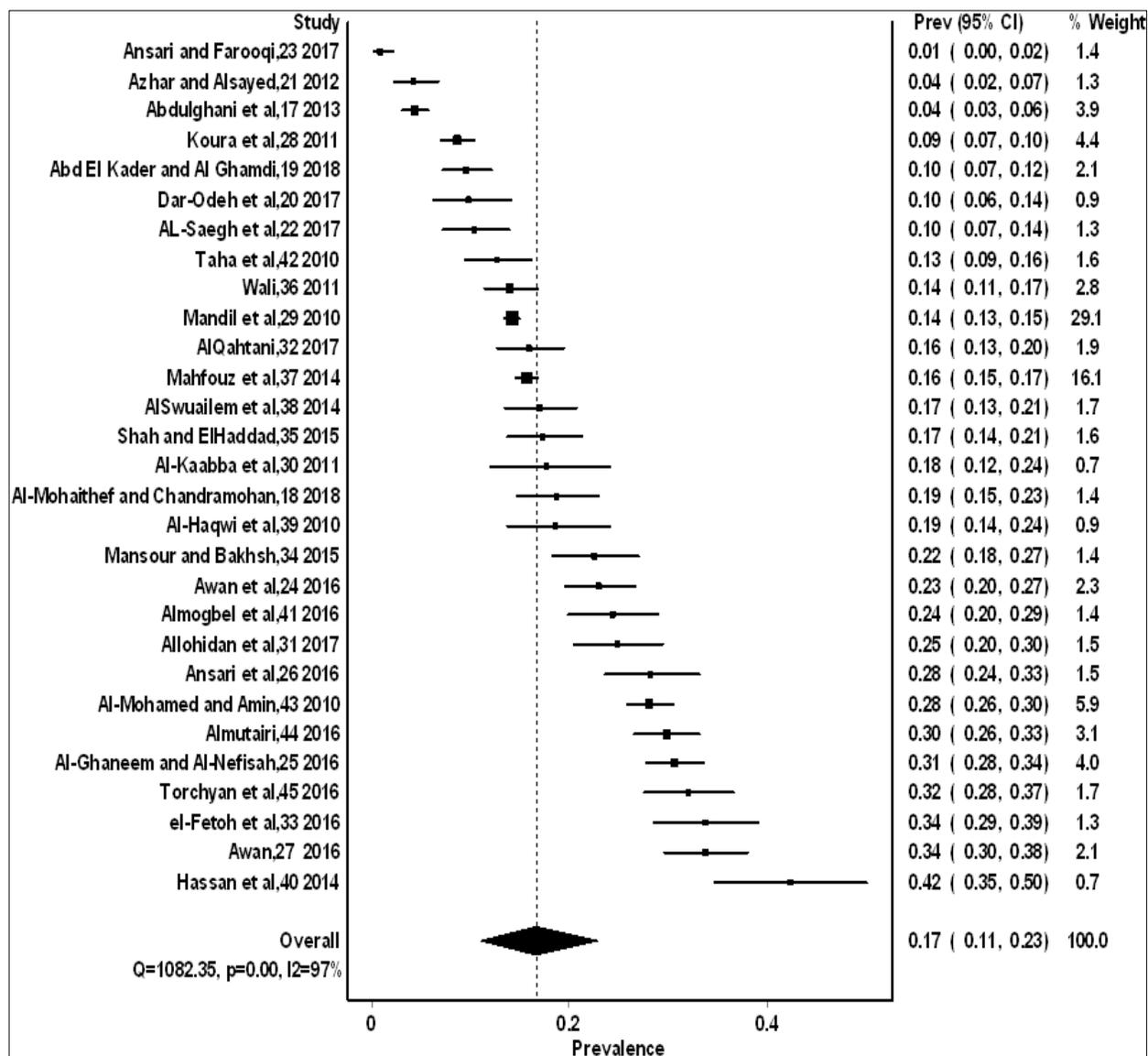


Figure 6. Male prevalence of smoking after conducting the sensitivity analysis.

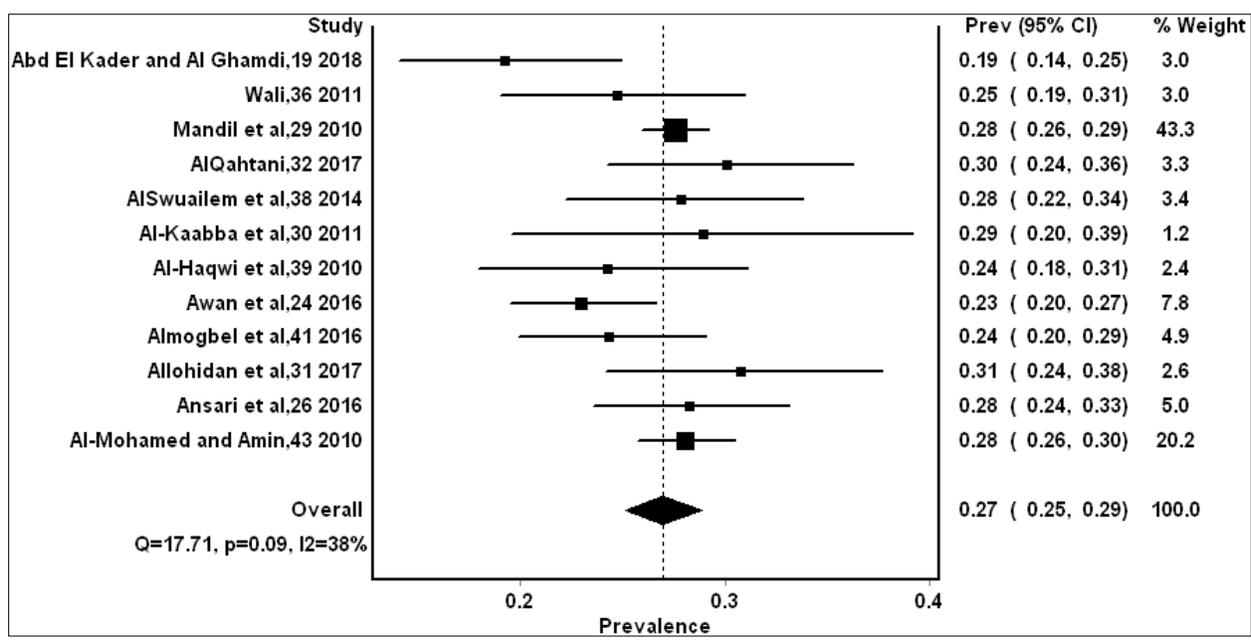
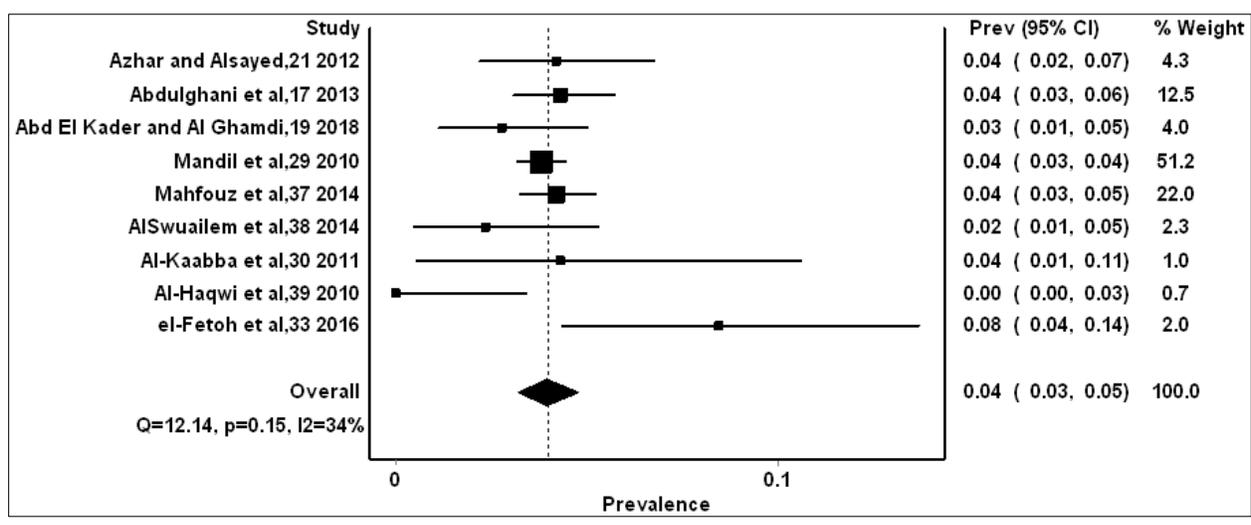


Figure 7. Female prevalence of smoking after conducting the sensitivity analysis.



CHAPTER III

PROJECT II: FACTORS ASSOCIATED WITH TOBACCO SMOKING AMONG SAUDI COLLEGE STUDENTS: A SYSTEMATIC REVIEW

Introduction

Tobacco consumption remains one of the most significant public health issues causing deaths, disease, and economic burdens.² Although, in the United States (US), tobacco smoking rates dropped by 5.4% in 2016 compared to the prevalence rate in 2005,⁷⁸ many developing countries, such as the Kingdom of Saudi Arabia (KSA), are experiencing an alarming increase in tobacco smoking among their populations.^{8,9,41} AlBedah and Khalil⁸ reported that the KSA has lost 280,000 lives and 20.5 billion US dollars due to tobacco smoking between 2001 and 2010, without accounting for smuggled tobacco.

Despite the tremendous efforts that the KSA is making to combat tobacco smoking,⁴¹ researchers have conceded the notion that the prevalence of tobacco smoking is alarming and warrants immediate actions from both Saudi policymakers and health professionals.⁸⁻¹⁰ For instance, two national surveys, conducted in 2013 and 2018, found that the prevalence rate of tobacco smoking among the Saudi population was 12.2 and 21.4%, respectively.^{9,10} This increase of 9.2% in tobacco prevalence within only a five year-period may indicate a poor evaluation of the current tobacco issue.

Saudi college students have shown a higher rate of tobacco consumption than the general Saudi population. A systematic review and a meta-analysis study, conducted during 2010-2018, indicated that the smoking prevalence among Saudi college students was 17%. The meta-analysis showed that the Saudi males' smoking rate was 21% higher than females' rate.⁷⁹ Another review¹² stressed the importance of monitoring tobacco consumption among youth before it

reaches a level of economic and healthcare burden. Alotaibi et al.⁷⁹ provided an epidemiological context about tobacco smoking prevalence among college students in the KSA.

Additionally, ample studies have investigated various determinants associated with tobacco smoking among Saudi college students.^{12,13,79} However, no systematic review has analyzed those determinants systematically. Thus, the purpose of this systematic review is to synthesize and to assimilate the vast amount of information available on the determinants of smoking by Saudi college students. The outcome of this review is to offer a foundation for specific recommendations concerning future research, theory, intervention aimed at reducing Saudi college students' smoking behavior. Our research questions are:

- a) What are the determinants/risk factors associated with tobacco smoking among Saudi college students?
- b) Which study designs have been used to address the determinants of tobacco smoking?
- c) Which theories (or models) have been previously used to explain students' smoking behavior?
- d) What statistical analyses have been used to determine whether risk factors were associated with smoking?

Methods

The study followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines.⁴⁴ In this systematic review, the outcome of interest is tobacco smoking, which is defined as the inhalation of the smoke of burning cigarettes, cigars, and waterpipes. Smokeless tobacco and electronic cigarettes were excluded from the study, due to insufficient prior research of Saudi college students. Because we are interested in understanding the factors associated with smoking, we excluded studies that assess factors associated with

tobacco cessation or with secondhand smoking. In accordance with a previous study,⁷⁹ studies that recruited students from a college of medicine, pharmacy, applied health sciences, nursing, and/or dentistry were coded as health-related studies.

Search Strategy

Two reviewers (S.A. and P.D.) independently searched for articles in four databases (i.e., PubMed, ProQuest, CINAHL, and Web of Science). These databases were selected due to either their comprehensiveness or their usage in previous research reviews.^{12,79} The research was restricted to articles that were published between 2010 and 2019, in order to ensure the most up-to-date research studies of the topic. Key terms were established based on the objectives of this study and in accordance with the previous study.⁷⁹ Keywords were used to identify articles through the title or the abstract with no language restrictions (Table 4). The investigators aimed to translate articles written in other languages (e.g., Arabic). Additional studies were added depending upon an investigation of each article's reference page or an online citation of included articles. The research ended on August 30, 2019.

Inclusion and Exclusion Criteria

Articles were included if they: 1) reported exclusively determinants of tobacco smoking, 2) focused on college students in the KSA, 3) published between 2010 and 2019, and 4) measured tobacco smoking as a dependent variable (i.e., outcome). Articles were excluded if they: 1) were conducted outside of the KSA, 2) were reviews, commentaries, presentation posters, brief reports or graduate theses or dissertations, 3) measured e-cigarettes or smokeless tobacco use, 4) were not full-text or original research studies, 5) measured tobacco smoking as an independent variable (i.e., predictor), or 6) assessed tobacco cessation or secondhand smoking.

Quality Assessment

All of the included articles were evaluated or appraised using the modified Reporting of Observational Studies in Epidemiology (STROBE).^{80,81} Any article scored between 12-15, 9-11, or 0-8 was considered to be of high, moderate, or low quality, respectively.⁸¹ Two reviewers (S.A. and P.D.) separately scored each article. Then, they met to discuss any disagreement.

Data Extraction and Data Synthesis

Using Excel software, two researchers (S.A. and P.D.) independently reviewed studies' titles and abstracts and extracted those that satisfied the inclusion criteria. After determining their final eligibility, full-texts studies were imported into NVivo software for data extraction. From each article, two researchers independently gathered data: the location of study, the year of study, the population of study, survey types, the sample size, the type of tobacco smoking, study design, the use of theories (Yes or No), the type of statistical tests, and the sampling techniques. Determinates that were tested with the outcome variable (i.e., tobacco smoking) were collected. Due to a huge variation of coding determinants among previous studies,^{82,83} we coded any tested determinant into one of three categories: individual, social, or environmental levels. Those factors that concern an individual, such as demographic characteristics (e.g., age, gender, etc.) or psychological wellbeing (e.g., stress and depression) are coded as an individual level. The social level encompasses any social connection or bond with the individual, such as friends and family. The environmental factors are those that mediate the structure of the surrounding community, such as a physical setting or place, policy, or media. Factors that showed significance at the $P \leq .05$ level were emphasized in a table. This systematic review is IRB exempt.

Results

Characteristics of Included Studies

Of the 300 studies, twenty-one met the inclusion criteria for this systematic review (Figure III.1). The characteristics of the included articles are presented in Table 6.^{13-15,17-20,50,51,55-58,65,66,70,71,84-87} The majority (43%) of studies investigated only male smoking behavior, while 38% and 19% of the included articles addressed risk factors of smoking among both genders and females, respectively. Almost half of the included studies were conducted among health-related students, either in the city of Riyadh or in the city of Jeddah. Moreover, 76% of the included studies combined waterpipe and cigarette smoking in their research as one term (i.e., tobacco smoking). Two studies investigated only cigarette smoking^{15,84} and one addressed waterpipe smoking.⁵⁶ Two research articles did not define which type of tobacco smoking was being measured.^{19,51} Twenty studies examined the determinants of tobacco smoking among Saudi college students, using a retrospective cross-sectional design and based on no particular theoretical framework. However, one study did utilize a longitudinal observational design (time 1 vs. time 2), using two theoretical frameworks (i.e., social learning theory and social control theory).¹⁹ 43% of the included studies utilized pre-designed questionnaires (Global Adults Tobacco Survey [GATS] or Global Youth Tobacco Survey [GYTS]). Despite the use of different sampling techniques (e.g., multi-stage sampling or random sampling) to recruit participants, 20 studies recruited participants from one campus. All of the included studies were written in English.

Quality Assessment

The two authors (S.A. & P.D.) agreed on 298 items out of 315 with 94% agreement. The 6% (n=17) disagreement was resolved by further discussion. Overall, four studies maintained a

high-quality score of 12 out of 15 points.^{13,14,70,84} Seven studies showed a moderate quality of assessment, as they obtained a median score of 9.^{15,18,19,50,51,71,86} Ten studies were rated as a poor quality, with a median score of 7 (Table 5).^{17,20,55-58,65,66,85,87}

Determinants of Tobacco Smoking

All but two studies found a range of risk factors that showed overall evidence for an association with tobacco smoking among Saudi college students. In our study, 21 risk factors were tested against the outcome variable (smoking behavior). Based on a bivariate analysis (i.e., the Chi-square test), 20 determinants were found significantly associated with Saudi tobacco smoking behavior, taking into consideration that some studies had tested more than one variable (Table 7). Seven studies indicated that some determinants were strong predictors of tobacco smoking among Saudi students, using multivariate analyses.^{13,14,19,70,71,84,86} Although almost all of the included studies were done in a cross-sectional design, which inhibits the conclusion of any causalities, results identified some possible risk factors associated with tobacco smoking.

Individual-Level Factors

Thirteen risk factors were coded as individual-level determinants. These risk factors were age, belief, college affiliation, employment status, gender, income, knowledge, material status, religion, residence, school performance (i.e., Grade Point Average [GPA]), school year, and psychological issues (i.e., stress). Gender was the single risk factor that was found significant in all of the eight studies performing the chi-squared test.^{13-15,20,65,66,85,86} However, based on multivariate analyses (i.e., logistic regression), only Mansour⁸⁶ found gender to be a statistically significant predictor of tobacco smoking among Saudi college current daily smokers. Being male has statistically been shown to be associated with tobacco smoking among Saudi college students.

Out of nine studies using bivariate analysis, five reported that being enrolled in non-health related colleges was statistically associated with tobacco smoking.^{13,17,18,57,70} However, all of the studies testing college affiliation did not retain their significance in multivariate analysis.^{13,70} Moreover, age was tested in nine studies but showed significance in only two studies.^{58,70} In two multivariate analysis studies, older students were more likely to smoke than younger students.^{13,70} Four of five studies testing knowledge of the harmful effects of smoking found a significant relationship with tobacco smoking.^{20,71,85,86} Only two studies indicated that having low knowledge of the side effects of smoking predicted smoking behavior among students.^{71,86} Seven studies demonstrated a statistically significant relationship between smoking status and being single,¹³ unemployment status,⁵¹ senior grade level,^{13,20,66,85} low GPA⁸⁴, urban residence,⁷⁰ and psychological issues. Jiang et al.¹⁹ tested two theories which did not show any significance, except for one construct (belief) of social control theory. College students who have a belief about nonsmoking practices were significantly associated with a decrease in tobacco smoking.¹⁹

Social Level Factors

Six risk factors (i.e., friends' substance abuse, teachers' smoking status, parents' education level, family smoking status, family occupational status, and friends' smoking status) were coded in the social level and were tested for an association with tobacco smoking. It was determined that college students whose friends were current smokers were more likely to be smokers.^{13-15,65,70,71,84} Five of the seven studies showed that friends' smoking status predicted smoking behavior among Saudi college students.^{13,14,70,71,84} Moreover, the presence of any smoker in a family was associated with college students' smoking status.^{13,18,65,70,84,86} In fact, four studies indicated that having any smokers in the family was a strong predictor for smoking

among students.^{13,70,84,86} An association between smoking status and students, whose friends use Khat (a substance drug),¹⁴ whose mothers are working or retired,¹⁵ or whose parents are educated,⁶⁵ was observed. Teachers' smoking status did not show any association with college students' smoking behavior.¹⁵

Environmental Level Factors

Media and policy were the two factors coded as environmental level. Al-Mohamed and Amin⁷⁰ reported, using bivariate and multivariate analyses, that exposure to high media messages of nonsmoking served as a protective factor against smoking, among Saudi college students. Meanwhile, Jiang et al.¹⁹ indicated that governmental policies on controlling tobacco use predicted the change from smoking to non-smoking behavior.

Three studies displayed a statistical significance of a risk factor in a table; however, the authors neglected to report that, in their results and discussion sections.^{55,56,70} Thus, we did not include them as significant factors, as we assumed that they could be typographical errors. Awan et al.⁵⁶ showed, in a table, that school year, age, and residence were significant, but they did not mention their significance in their writing. Ansari and Farooqi⁵⁵ and Al-Mohamed and Amin⁷⁰ neglected to mention the significance of GPA and school year, respectively.

Discussion

This systematic review is the first known attempt to synthesize the current literature on the determinants of tobacco smoking among college students in the KSA. This research sets a foundation for current and future research on tobacco smoking among Saudi college students. Although our study did not restrict itself to any specific research design, we found a lack of qualitative and other observational designs (e.g., experimental, case-control, or cohort), which could assist in better understanding some of the risk factors of tobacco smoking among Saudi

college students. In fact, Mandil et al.¹³ and Almutairi⁷¹ recognized the importance of conducting rigorous qualitative studies in order to understand the dynamics of Saudi college students' smoking behavior. Moreover, our study discovered that there was limited utilization of theoretical frameworks to guide the research. Among the 21 included studies, there was *only one study* that utilized the social learning theory and the social control theory.¹⁹ Theory-based research is needed to serve as a foundation for tobacco prevention and intervention programs.⁸³ Glanz and Bishop³⁵ posit that, through the utilization of a theoretical framework, researchers will be able to understand both the determinants of health behavior and the process of health behavior change. Theory can guide research, can explain behavior, and can offer direction for designing and implementing interventions.³⁵

In addition, all of the included studies relied heavily on retrospective methods of measuring tobacco smoking. Surveys are inclined to a number of biases and challenges, which could affect the results of the desirable outcome (studying smoking behavior). For example, several studies have found that self-reported measures of socially undesirable behaviors (smoking), are predisposed to underestimate the true amount smoked,⁸⁸ show digit bias (rounding to multiples of 10 or five),⁸⁹ and are subject to recall bias.⁸⁹ To minimize these biases, other collection methods of measuring tobacco smoking could take the form of prospective data collection, such as Time-Line Follow-Back (TLFB),⁸⁹ ecological momentary assessment (EMA),⁸⁹ or cigarette butt collection.⁹⁰ Finally, participants in 20 studies were recruited either from one campus or from one college. Despite their sampling techniques (e.g., random or multistage sampling) within the campus or college, results could produce a limited application regarding their ability to be generalized to all Saudi university-age students. As of 2019, there are 30 universities, not including private institutions, distributed in different regions of the

Kingdom.⁹¹ Giving a snapshot of one campus or college is not necessarily representative of all KSA's higher education students.⁹² Therefore, future research should attempt to recruit participants randomly from different institutions in the KSA. A final observation is that the majority of articles in the literature (n=16) did not make a clear distinction between cigarette smoking and waterpipe smoking, especially when measuring cognitive factors such as perceptions, beliefs, attitudes, or knowledge. Some college students may believe that using a waterpipe is less harmful than smoking a cigarette.⁹³

Risk Factors of Tobacco Smoking

A basic tenet of understanding tobacco smoking among Saudis is to understand the underlying risk factors that contribute to the smoking problems. It has been argued that preventing youth from starting smoking will reduce their chances of becoming smokers later in life.⁸³ The included studies tested many risk factors thought to be associated with Saudi students' tobacco smoking. There were many more individual factors tested for an association with Saudi college students' tobacco smoking than any other social or environmental factors. However, our study found that only four dominant risk factors (college affiliation, gender, knowledge, and school year) were statistically associated with Saudi students' smoking, in four or more studies. Being male was found statistically related to smoking in all studies testing the gender variable. A notable explanation of the gender difference is that Saudi male college students could have fewer social restrictions than females. Saudi men enjoy social freedoms, such as being able to purchase tobacco and smoke publicly, whereas women are socially discouraged.

The family's smoking status and friends' smoking status were the two major social factors that showed a statistical relationship in smoking behavior, in six or more studies. Environmental factors were the least tested for an association with tobacco smoking, and were

indicated in only two studies.^{19,70} A noteworthy finding is that exposure to media messages related to nonsmoking or to implementing a policy to control smoking was significant enough to influence Saudi students' decision to maintain their nonsmoking status or to change their smoking behavior, respectively.^{19,70} Moreover, having a strong belief in nonsmoking or practicing the Islamic faith produced significant evidence with changes in smoking behavior among Saudi university students.^{19,71} Finally, friends' substance abuse (Khat) was found to be a strong predictor of smoking tobacco among southern university students in the KSA.¹⁴

Limitations

Due to a significant variation in data collection, study design, sample size, study population, and/or age groups among the included studies, we cannot conclude a causal relationship between these factors and smoking among Saudi university students, nor can we generalize the findings. Instead, we infer that some individual factors and social factors *could* play a role in influencing Saudi students' smoking behavior given the data. Although the majority of included articles (n=16) categorized both cigarette and waterpipe smoking as "tobacco smoking" in their research, special attention should be paid to the degree to which tobacco smoking (cigarette vs. waterpipe) is more associated with each factor. Another limitation is that the search produced only English-published articles in selected databases. Thus, we may have missed other studies that were published in other languages (e.g., Arabic) or other databases.

Conclusion

Four of the individual-level and two of social factors were able to demonstrate the association between college students and tobacco smoking. To better understand the current problem, future research should address Saudi students' smoking behavior using other research

methodologies (experiment or prospective observational) or using theoretical models to explain Saudi smoking behavior. Utilizing theoretical models as described above could assist in the development of intervention programs. Moreover, researchers should test other measuring approaches (TLFB or EMA⁸⁹) to avoid certain biases and to arrive at an accurate estimate of tobacco smoking. More importantly, future research should make a clear definition and designation between cigarette and waterpipe smoking when measuring the association of certain factors (e.g., perceptions or knowledge), because the degree of each factor (e.g., knowledge) about tobacco could be different between cigarette smokers and waterpipe users.⁹³ Furthermore, we encourage future research to explore possible risk factors such as social, economic, environmental, biological, and physiological influences that may predict smoking behavior among Saudi college students.

Table 4. Search strategy.

Database	Keywords	total
Pubmed 01/01/2010- 08/30/2019	((((tobacco[Title/Abstract] OR smok*[Title/Abstract] OR cigar*[Title/Abstract] OR waterpipe[Title/Abstract] OR hookah[Title/Abstract])) AND (factor*[Title/Abstract] OR predictor*[Title/Abstract] OR reason*[Title/Abstract] OR determinant*[Title/Abstract] OR risk*[Title/Abstract])) AND (universit*[Title/Abstract] OR college*[Title/Abstract] OR student*[Title/Abstract])) AND (Saudi[Title/Abstract] OR KSA[Title/Abstract])	114
CINAHL 01/01/2010- 08/30/2019	AB (Tobacco OR smok* OR cigar* OR waterpipe OR Hookah) AND AB (Factor* OR Predictor* OR Determinant* OR Reason* OR Risk*) AND AB (College OR University OR Student*) AND AB (Saudi OR KSA)	33
Web of Science 01/01/2010- 08/30/2019	TI=(Tobacco OR Smok* OR Cigar* OR Waterpipe OR Hookah) AND TI=(Factor* OR Predictor* OR Determinant* Reason* OR Risk) AND TI=(College OR University OR Student*) AND TI=(Saudi OR KSA)	9
ProQuest 01/01/2010- 08/30/2019	AB(Tobacco OR Smok* OR Cigar* OR Waterpipe OR Hookah) AND AB(Factor* OR Predictor* OR Determinant* Reason* OR Risk) AND AB(College* OR Universit* OR Student*) AND AB(Saudi OR KSA)	140
Hand Search	Looking through Articles that were included	4
Total		300

Table 5. Quality assessment.

Reference	Number of the 15 Items of STROBE (1= Requirement met & 0= absent)															Total score
	4	5	6	7	8	9	10	12	14	15	16	18	19	20	21	
13	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	12
50	1	1	1	0	1	0	0	1	1	1	0	1	1	1	0	10
57	1	0	0	0	1	0	0	0	1	1	0	1	0	1	0	6
66	1	0	1	0	1	0	0	1	1	1	0	1	0	1	0	8
15	1	1	1	0	1	0	0	0	1	1	0	1	0	1	1	9
84	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	12
51	1	1	1	0	0	0	1	1	1	1	0	1	0	1	0	9
70	1	1	1	1	1	0	1	0	1	1	1	1	1	1	0	12
85	1	1	0	0	0	0	0	1	1	1	0	1	0	1	0	7
71	0	1	0	0	1	1	0	1	1	1	1	1	0	1	0	9
65	1	0	0	1	0	0	0	0	1	1	0	1	1	1	0	7
55	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	8
58	1	1	0	0	1	0	0	0	1	1	0	1	1	1	0	8
56	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	5
17	1	1	0	0	1	0	0	0	1	1	0	1	0	1	0	7
19	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	11
18	1	1	1	0	1	0	1	0	1	1	0	1	0	1	0	9
86	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	9
14	1	1	1	0	1	0	1	1	1	1	1	1	1	1	0	12
87	1	0	0	0	1	0	0	0	1	1	0	1	1	1	0	7
20	1	1	0	0	1	0	0	0	1	1	0	1	1	1	0	8
Assessment (median score)					High= 12-15 (12)					Moderate= 9-11 (9)					Low= 0-8 (7)	

Table 6. Characteristics of included studies (n = 21).

First author (year) ^{Ref.}	Gender of population (college)	Location	Sample size	Sample technique	Type of tobacco smoking	Survey type	# of factors found significant
Mandil (2010) ¹³	All (All)	Riyadh	6,793	Multi-stage	Cigarette & Waterpipe	GYTS	7
Abdulghani (2013) ⁵⁰	Female (All)	Riyadh	907	Convenient	Cigarette & Waterpipe	Self-developed	0
Alghaneem (2016) ⁵⁷	Male (Edu., Scien, & BA)	Majmaah	301	Multi-stage	Cigarette, Waterpipe & cigar	Not available	1
AlHaqwi (2010) ⁶⁶	All (Health: Medical)	Riyadh	215	Convenient	Cigarette & Waterpipe	GATS	2
AlKaabba (2011) ¹⁵	All (Health: Medical)	Riyadh	153	Convenient	Cigarette	WHO	2
Almogbel (2013) ⁸⁴	Male (Three campuses)	Hassa & Buraidah	467	Convenient	Cigarette	Self-developed	5
Almohaithef (2018) ⁵¹	Male (All)	Abha (KKU)	337	Multi-stage*	Not available	Not available	1
Al-Mohamed (2010) ⁷⁰	Male (All)	Hassa	1,382	Multi-stage	Cigarette & Waterpipe	GYTS	6
Alshehri (2019) ⁸⁵	All (Health: medical)	Tabuk	287	Random	Cigarette & Waterpipe	Self-developed	4
Almutairi (2016) ⁷¹	Male (Edu. & Scien)	Riyadh	715	Convenient	Cigarette & Waterpipe	Self-developed	4
Alswailem (2014) ⁶⁵	All (Health)	Riyadh	400	Convenient	Cigarette & Waterpipe	GATS	4

Ansari (2017) ⁵⁵	Female (Health: medical)	Dammam	332	Not available	Cigarette & Waterpipe	GYTS	2
Ansari (2016) ⁵⁸	Male (Health & BA)	Majmaah	340	Multi-stage	Cigarette & Waterpipe	WHO	1
Awan (2016) ⁵⁶	Male (Health)	Riyadh	535	Random Cluster	Waterpipe	Self-developed	3
Azhar (2012) ¹⁷	Female (All)	Jeddah	310	Not available	Cigarette & Waterpipe	GATS	1
Jiang (2018) ¹⁹	Male (All)	Riyadh	340	Random Cluster	Not available	Self-developed	3
Koura (2011) ¹⁸	Female (L&S)	Dammam	1,020	Multi-stage	Cigarette & Waterpipe	GYTS	2
Mansour (2017) ⁸⁶	All (Health: dental)	Jeddah	336	Convenient	Cigarette & Waterpipe	Self-developed	3
Mahfouz (2014) ¹⁴	All (All)	Jazan	3,764	Multi-stage	Cigarette & Waterpipe	GYTS	3
Venkatesh (2017) ⁸⁷	Male (All)	Buraidah	199	Convenient	Cigarette & Waterpipe	Self-developed	0
Wali (2011) ²⁰	All (Health: medical)	Jeddah	643	Convenient	Cigarette & Waterpipe	GATS	2

Table 7. Determinants or risk factors examined by included studies.

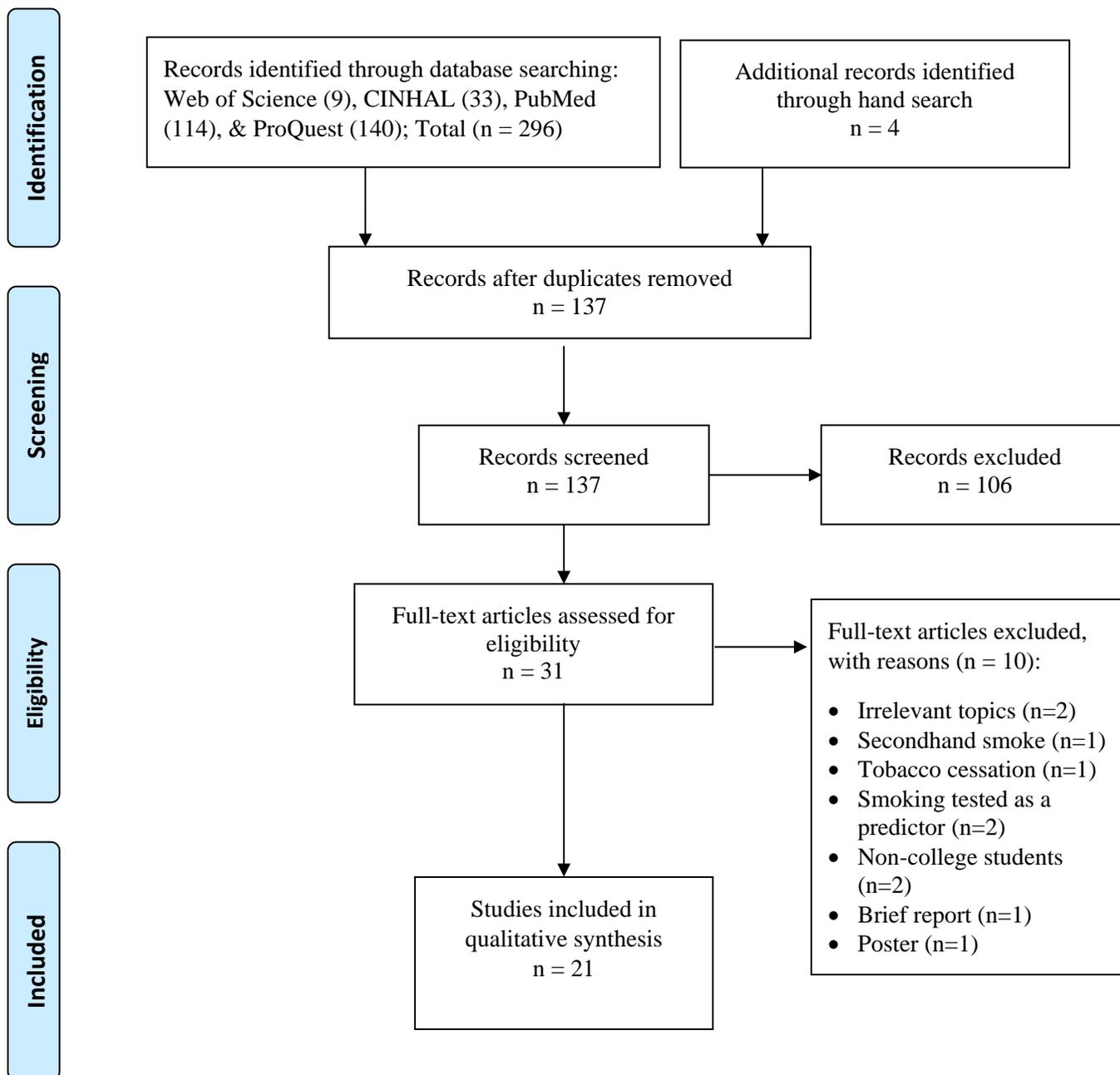
Theme	Factors	N Studies	n of studies found statistically significant association*		
			χ^2 Reference	Logistic Regression Reference	Direction
Individual	Age	9	2** 55,70	2 13,70	Older students had an association with smoking.
	Belief	1	1 19	1 19	Nonsmoking beliefs predict a change in the smoking status.
	College affiliation	9	5 13,17,18,57,70	0	Non-health related students are associated with smoking.
	Employment	1	1 51	-	Unemployment is associated with smoking.
	Gender	8	8 13-15,20,65,66,85,86	1 86	Being male is associated with smoking behavior.
	Income	6	2 55,84	0	High income is associated with smoking.
	Knowledge	5	4 20,71,85,86	2 71,86	Low knowledge is linked to the smoking status.
	Material status	6	1 13	1 13	Being single is associated with smoking.
	Religion	2	1 71	1 71	Low Islamic practice is associated with smoking behavior.
	Residence	4	1 **70	1 70	Urban residence was a risk factor of smoking.
Social	School performance	5	1 **84	1 84	Low GPA is associated with smoking.
	School year	10	4 **13,20,66,85	0	Senior students had an association with smoking
	Psychological issues	1	1 19	1 19	Stress is associated with tobacco smoking.
	Friends' substance use	1	1 14	1 14	Khat use (substance drug) is associated with smoking.

	Teachers' smoking status	1	0	-	-	
	Parents education	5	1 ⁶⁵	-	-	Students whose parents' education is college or higher are associated with tobacco smoking.
	Family smoking status	8	6 ^{13,18,65,70,84,86}	4 ^{13,70,84,86}	-	Any smoker in the family was a strong risk factor for smoking.
	Friends	7	7 ^{13-15,65,70,71,84}	5 ^{13,14,70,71,84}	-	Friends' smoking status was a strong risk factor for smoking.
	Family occupation	2	1 ¹⁵	-	-	Students whose mothers are working or retired are associated with tobacco smoking
	Media	1	1 ⁷⁰	1 ⁷⁰	-	Students who were exposed to antismoking media messages were less likely to smoke.
Environmental	Policy	1	1 ¹⁹	1 ¹⁹	-	Government's efforts to control smoking was associated with a decrease in smoking.

*($P \leq .05$)

**Three articles ^(21,25,27) tested one or all these factors but did not write them in the results section. Thus, factors were not included.

Figure 8. Flow chart of the selection process.



CHAPTER IV

PROJECT III: VALIDITY AND RELIABILITY OF AN ARABIC HEALTH BELIEF MODEL INSTRUMENT FOR STUDYING CIGARETTE SMOKING

Introduction

Tobacco manufacturers produce “a legal drug” that can destroy the lives of its consumers, as noted by the World Health Organization (WHO).¹ The research on tobacco has been a topic of interest for many years, due to its devastating impact on people, environment, and economy.² The WHO categorizes the use of tobacco as an epidemic that has ended nearly half of the lives of those who commonly consume it.⁹⁴ Based on 2016 statistics, 5.1 million male and 2.0 million female individuals across the globe have died as a result of their direct tobacco consumption; this signifies a public health threat.² Among the several ways to use tobacco, smoking tobacco has been responsible for the deaths of 7.69 million people as of 2019.⁹⁵

Despite the efforts to combat tobacco consumption in Saudi Arabia,⁴¹ the prevalence of smoking is alarmingly high.^{11,79} In a national survey conducted in 2018, smoking prevalence among the population in Saudi Arabia was 21.4%, whereas the prevalence had been 12.2% in 2013.^{9,10} These two national surveys reflect an alarming public health situation. Saudi Arabia is one of the top five largest importers of tobacco in the world, and its citizens smoke 15 billion cigarettes annually, at a value of approximately 1.5 billion American dollars.⁷ As a result of the tobacco crisis over a decade, 0.28 million Saudis have died and 20.5 billion US dollars have been lost.⁸

Smoking among young adults (22-23 years) who transitioned to daily smoking increased substantially from 2002 to 2018.⁹⁶ College students, typically between the age of 18 and 24, have been the central focus of many researchers, because the college years represent a critical period

for making decisions regarding cigarette smoking.^{11,12,79,97} According to a recent systematic review and meta-analysis, 17% of Saudi college students were found to be current smokers (26% for males and 4% for females after removing the influential studies).⁷⁹

Furthermore, many studies have investigated the extent to which factors are associated with, or predict, tobacco smoking. Alotaibi and Drugambudi⁹⁷ conducted a systematic review that presented 21 studied factors assumed to be associated with tobacco smoking. The authors found that the individual level variables had been investigated the most thoroughly. However, they argued that there is a dearth of theoretical frameworks guiding the research.⁹⁷ In light of this observation, we created a new Arabic instrument that measures the beliefs of Saudi college students about cigarette smoking, utilizing the Health Belief Model (HBM).

The Health Belief Model was founded to determine people's perceptions and beliefs about undertaking a specific health protective measure (e.g., screening for tuberculosis).^{23,25} The model assumes that individuals' values regarding their current behavior are a result of their expected goals.²⁵ For example, those who put a value on the avoidance of smoking may expect to be protected from lung cancer. The HBM initially involved four constructs: Perceived Severity (i.e., beliefs about the seriousness of getting a disease), Perceived Susceptibility (i.e., beliefs about the likelihood of getting a disease), Perceived Benefits (i.e., beliefs about the positive features of practicing a behavior), and Perceived Barriers (i.e., beliefs about the obstacles associated with adopting a behavior). Later, the model was enhanced by the addition of two more constructs: Self-Efficacy (i.e., one's confidence in performing a behavior) and Cues to Action (i.e., reminders of practicing a behavior).²³

No study has yet examined the smoking beliefs utilizing the HBM in Saudi Arabia or Arab States in the Gulf region.⁹⁷ Studies elsewhere have provided a direction for ways to employ

the HBM to unfold the current smoking problem in Saudi Arabia. For instance, Li and Kay²⁷ concluded that the Perceived Severity, Benefits, and Barriers of the HBM were associated with cigarette smoking status among Chinese college students. Another study²⁹ found that some constructs of the HBM, except for its barriers, were significantly associated with smoking behavior among Iranian students. Notably, neither of the aforementioned studies provided insights into the construct validity of their questionnaires.

The main purpose of the present study was to validate and uncover the underlying factors of a newly developed instrument that measures the smoking beliefs of Saudi college students. The validation of this Arabic instrument should determine empirically how many factors underlie a set of questions, and it should assess quality of the written questions within each factor. The findings of this study (1) should provide profound insights about the usability of exploratory factor analysis for Arabic researchers, (2) should encourage researchers to expand on this topic, and (3) should enable health agencies to utilize the results for use in tobacco intervention programs.

Methods

Design and Procedures

This study used a cross-sectional approach to validate a theory-based Arabic instrument that measures the beliefs of Saudi college students about cigarette smoking. Each student at a governmental institution in the Qassim district of Saudi Arabia received an email invitation to join the study. Students interested in participating in the survey read the study description and consented to participate by clicking “I Agree” before they proceeded to answer the survey questions on a Qualtrics website. The study included only college students who were 18 years of age or older. Data were collected from April to November 2021.

Participants

Students of a public university in Qassim region were invited via email to participate in this study. The total number of student enrollment at this university as of 2022 reached 65,000.⁹⁸ To conduct factor analysis, a minimum sample size is suggested, but no consensus has yet been established among statisticians as to what a “gold standard” number would be.⁹⁹ Everitt¹⁰⁰ suggested that a minimum of ten subjects for each item is recommended, prior to performing factor analysis. However, the use of only five participants for each question in the survey has been endorsed by Gorsuch¹⁰¹. Others have suggested an arbitrary minimum of participants per a survey questionnaire, suggesting that a sample of 100 is considered “unstable”, while a sample of 300 would produce “stable” factor analysis.³⁹ Nonetheless, the sample size ($N= 925$) of this study exceeded the threshold of any of the recommended numbers; thus, the study’s data were deemed appropriate for factor analysis.

Instrument

In order to create and validate an Arabic instrument that measures Saudi’s perceptions, based on the HBM, guidelines were adopted from Sharma and Petosa¹⁰² and from Di Iorio³⁹ for measuring a health behavior. The guidelines encompassed generating items, gleaning experts’ verification, pilot testing, and performing an exploratory factor analysis (EFA). The initial pool of 78 Arabic questions measuring HBM was driven from and was guided by a review of the literature,^{11,12,39,79,97,102} as well as by feedback from experts and by the survey of Li and Kay²⁷. From that pool, the study researchers determined that 60 questions would be considered as an appropriate measurement for the six HBM constructs, since 18 questions were found to be irrelevant. These included ten items for each construct which they were operationally defined as Perceived Severity [SV]- students’ beliefs about the severity of diseases due to smoking,

Perceived Susceptibility [SU]- students' beliefs about the chances of developing smoking-related illnesses, Perceived Benefits [BT]- students' beliefs about the positive aspects of non-smoking, Perceived Barriers [BR]- students' beliefs about the costs associated with smoking abstinence, Self-Efficacy [SE]- students' confidence in their ability to maintain a non-cigarette smoking behavior, and finally Cues to Action [CU]- cues and reminders enabling the students to avoid smoking.

Based on Sharma and Petosa's¹⁰² recommendation of survey validation, six experts (two experts in the HBM, two experts in survey measurement, and two experts in the target population) were recruited to validate this study questionnaire. All of the experts acknowledged that the questionnaire was both face and content valid, following two rounds of email verification.¹⁰² Furthermore, a pilot-testing of 60 Saudi participants (who were not part of the main study) was performed, in order to assess the survey's readability and participants' comprehension, participants' time of completion, and other survey-related issues. Participants in the pilot testing were given the option to evaluate the survey and to offer suggestions for its improvement. Results from the pilot study revealed that items were constructed appropriately, and minor errors were corrected.

Through the use of a five-point Likert scale, students indicated their level of agreement with each item. Accordingly, the possible responses ranged from 1=Strongly disagree to 5=Strongly agree. All questions were formulated positively except three cue-to-action items (i.e., CU6, CU7, CU10) and two self-efficacy items (i.e., SE3, SE9) which were negatively phrased and were recoded (5=Strongly disagree to 1= Strongly agree).

Data Analysis

The data records were deleted if participants (a) did not meet the inclusion criteria (n= 35), (b) consented but never started the survey (n= 75), (c) did not report their gender (n= 164), (d) did not answer at least one of the HBM questions (n= 552), or (e) had a perfect score of one or five throughout the survey (n= 4).

Data then were imported to SPSS (version 28) for analysis. To establish the construct validity of the survey, exploratory factor analysis (i.e., principal component analysis) was performed. General assumptions (i.e., scale measurement consisting of at least three responses and an adequate sample size) of factor analysis were met.³⁹ Because rated responses tend to be skewed or kurtotic, Field⁹⁹ and Di Iorio³⁹ relaxed the assumption of normality when performing factor analysis. Items were excluded if: (1) the communality value of an item was below 0.5,⁹⁹ (2) items cross loaded with other factors (>0.32),¹⁰³ (3) items loaded on unexpected factors, (4) items loaded under a factor with a value of 0.4 or below,¹⁰³ and/or (5) items did not load any of the factors.

A Kaiser-Mayer-Olkin (KMO) test result larger than 0.6, and a significance ($P < .05$) on the Bartlett's test for sphericity indicated the sample adequacy for factor analysis.^{104,105} Further, an eigenvalue larger than 1 was determined to be sufficient for factor extraction.⁹⁹ Because eigenvalues tend to overestimate the number of factors to be extracted, Patil and his colleagues¹⁰³ have urged public health researchers to utilize Parallel Analysis (PA) as a guide when obtaining parsimonious factors and to optimize external validity. PA is a tool that the authors used to compare the actual eigenvalues of this present study to the eigenvalues of a similar artificial study, with similar items and a similar sample size. Thus, this study should maintain greater eigenvalues than the eigenvalue generated by PA for extracting meaningful components with the

help of a Web-based PA engine.^{103,106} Varimax rotation, an oblique technique, was suggested because it attempts to facilitate the interpretation of factors; thus, it was considered.^{99,103}

Cronbach's Alpha was calculated to estimate the average correlation among all paired items in a single construct (i.e. factor).³⁹ The value of Cronbach's alpha ranges from 0 to 1, where 0 indicates no correlation and 1 reflects a strong correlation among items.¹⁰⁷ A commonly known rule of a minimum acceptable measure of Cronbach's alpha is 0.70.³⁹ Nonetheless, Di Iorio³⁹ explained that the coefficient alpha should be examined, in addition to the number of items in each scale. For example, a fewer number of items in a scale (i.e., factor) with 0.60 alpha could "demonstrate higher interrelatedness" than that scale with many items with 0.80 alpha (p. 193). Therefore, a factor that produced a small number of items with Cronbach's alpha ≥ 0.60 would be reported.

Ethics

Qassim University's Institutional Review Board approved this study (#62538) dated on April 15, 2021. Further, Old Dominion University's Health Sciences Human Subjects Review Committee acknowledged this study as exempt on January 29, 2022. Prior to enrolling in the study, interested participants were informed about the study and were queried about their consent.

Results

Data Description

From the pool of 1,755 respondents, a total of 925 eligible Saudi college students spent an average of 13 minutes completing the study questionnaire. The mean age (SD) of the study participants was 22 (3), and 60% of the respondents were females.

Validity

A principal component analysis was conducted on the 60 items of the survey questionnaire with varimax rotation. Table 8 encompasses all the six constructs of HBM and their items with rudimentary descriptive analyses. The initial Kaiser-Meyer-Olkin (KMO) produced a value of 0.920, which verified the adequacy for the analysis. Bartlett's test of sphericity additionally confirmed that the correlational matrix was significantly different from an identity matrix, $\chi^2 (1770, N= 925) = 41,292.5, P < 0.001$. However, three items (BT10, CU3, and SE7) were excluded due to their weak communality measures.

The second attempt, after deleting three items, produced a KMO value of 0.917, and the Bartlett's test was still significant, $\chi^2 (1596, N= 925) = 40,368.6, P < 0.001$. Yet, the PA mean score of 1.29 was greater than the mean of eigenvalues (1.27) at the ninth factor, suggesting a retainment of eight factors (see Table 9A). The results, after restricting the number to eight factors, showed that items were loaded on unexpected factors (SV8, SV9, SV10, and CU1); were cross loaded with other factors (CU2, CU5, CU6, CU7, CU10, SE4); and/or did not load on any factors (BR10). After the elimination of these 14 complicated items, the PA analysis suggested a retainment and extraction of six factors (PA= 1.27 > EV = 1.26) (see Table 9B).

With 46 questions remaining, the final KMO value remained marvelous at 0.914, indicating an adequacy of sampling with a significance on the Bartlett's test, $\chi^2 (1035, N= 925) = 33088.9, P < 0.001$. The measures described above supported the notion that the correlation matrix was suitable for exploratory factor analysis. As a result, the extracted six factors explained 60.5% of the total variance. These six factors were labeled in this order: **Factor 1:** Perceived Susceptibility [SU 1-10] had ten items with loading ranging from 0.800 to 0.912, and it accounted for 26.8% of the variance. **Factor 2:** Perceived Barriers [BR 1-9] had nine items with

loading ranging from 0.422 to 0.809, and it accounted for 14.83% of the variance. **Factor 3:** Perceived Benefits [BT 1-9] had nine items with loading ranging from 0.465 to 0.696, and it accounted for 6.6% of the variance. **Factor 4:** Perceived Severity [SV 1-7] had seven items with loading ranging from 0.597 to 0.777, and it accounted for 4.35% of the variance. **Factor 5:** Self-Efficacy [SE 1-3, 5, 6, 8-10] had eight items with loading ranging from 0.476 to 0.719, and it accounted for 4.19% of the variance. **Factor 6:** Cues to Action [CU 4, 8, 9] had three items with loading ranging from 0.482 to 0.737, and it accounted for 3.73% of the variance.

Table 10 provides comprehensive details for the factor loadings of each construct of the HBM in addition to eigenvalues, parallel analysis, and percentages for each construct's variance.

Reliability

The final version of the questionnaire has demonstrated a robust homogeneity, and the overall Cronbach's alpha of the questionnaire was 0.858. Each scale's reliability coefficient was assessed through an investigation of its items' interrelatedness (see Table 11). Ten items of Perceived Susceptibility produced a strong Cronbach's alpha of 0.969, with the item-total correlation ranging from 0.799-0.890. Nine items of Perceived Barriers had a strong Cronbach's alpha of 0.910, with the item-total correlation ranging from 0.423-0.818. Nine items of Perceived Benefits had a strong Cronbach's alpha of 0.845, with the item-total correlation ranging from 0.517-0.641. Seven items of Perceived Severity had a strong Cronbach's alpha of 0.875, with the item-total correlation ranging from 0.585-0.718. Eight items of Self-Efficacy had a strong Cronbach's alpha of 0.815, with the item-total correlation ranging from 0.321-0.572. Three items of Cues to Action had a weak Cronbach's alpha of 0.674, with the item-total correlation ranging from 0.368-0.591.

Discussion

This study is the first effort to develop and evaluate the psychometric properties of a newly developed Arabic questionnaire that measures beliefs regarding cigarette smoking among college students through the utilization of the Health Belief Model (HBM). The aim was to validate and to uncover the latent dimensions underlying the 60 items deemed to be valid by experts. The final version of the instrument contained 46 items that support the theoretical foundation of the HBM constructs, capturing the six factors. Additionally, the results of this study supported the evidence for the internal reliability of the instrument; PCA was able to extract the most variance from the developed items to produce a smaller set of six dimensions, revealing a satisfactory construct validity.²⁶

As the HBM suggested, items written to measure a construct should correspond to its factor.^{26,39} For example, a majority of statements about smoking, describing its seriousness (e.g., “Smoking could cause heart diseases”) and smokers’ vulnerability to illnesses (e.g., “Because of smoking, I am worried about lung cancer”) loaded on their assigned constructs. Also, decisional balance statements such as “Not smoking saves me a lot of money to do things I want, such as buying food, electronics, and saving money, etc.” and “smoking is an enjoyable lifestyle” corresponded to the constructs of benefits and barriers, respectively. Statements in regard to Self-Efficacy captured the students’ confidence in their ability to maintain a non-cigarette smoking behavior, indicating their relevance to the construct being measured. Most of Cues to Action statements did not capture the underlying factor. However, three statements loaded together, as some students indicated their agreement that anti-smoking associations, the Imam of the mosque, and their university were sufficient cues to remind them to avoid smoking. All of these items assigned to their respective constructs had a loading greater than 0.4, indicating that they shared

a significant amount of variance.³⁹ Abraham and Sheeran²⁶ stated that factor analysis is an approach that captures construct validity if the generated items loaded on their assigned constructs. Therefore, our questionnaire is construct valid.

Our study results showed a moderate-to-powerful consistency, compared to the findings of other studies. For instance, Li and Kay²⁷ created 34 questions that aimed at evaluating Chinese college students' beliefs and at testing four constructs of HBM. They found that the Cronbach's alpha was 0.99 for Severity, 0.90 for Susceptibility, 0.76 for Barriers, and 0.84 for Benefits. Another study²⁹ tested 33 items aiming to explore Iranian students' belief and to test the subscale items of five HBM constructs. The study discovered that the coefficients for five constructs exceeded the generally accepted measure of 0.70 (Susceptibility = 0.87, Benefits = 0.78, Barriers = 0.78, Self-Efficacy = 0.83, and Cues to Action = 0.813).²⁹

Abraham and Sheeran²⁶ asserted that a higher coefficient alpha of a scale means a lower random measurement error, which verifies that items are related. This present study had a powerful Cronbach's alpha of more than 0.80 for five constructs (Susceptibility = 0.96, Severity = 0.90, Benefits = 0.84, Barriers = 0.91, Self-Efficacy = 0.81). However, 70% of Cues to Action statements were problematic and did not depict the essence of a such construct. Thus, their reliability was below the acceptable value to 0.70. However, Di Iorio³⁹ argued that a threshold of 0.70 should not be a golden value, especially for a newly developed scale. Other researchers claimed that a Cronbach's alpha greater than 0.6 is considered satisfactory.^{38,108}

Nonetheless, Champion and Skinner²⁴ stressed that the construct of Cues to Action is especially challenging to measure using a questionnaire because it involves many aspects of cues, such as bodily or environmentally events. Abraham and Sheeran²⁶ argued that, because Cues to Action tends to measure several cues exerted by interpersonal communication, media,

and/or significant others, its coherence has been questioned. They stated that, as a result of its complexity, Cues to Action is rarely explored or even measured when employing the HBM. Therefore, the construct of Cues to Action in this study was deemed unstable and unsatisfactory as a consequence of the elimination of the majority of Cues to Action statements and the low reliability coefficient. The authors of this study encourage interested researchers to revisit Cues to Action questions and to modify them accordingly.

Overall, students' beliefs regarding cigarette smoking ought to be evaluated in order to understand their current perceptions about smoking related threats, decisional balance, cues, and confidence. In fact, Mantler³¹ conducted a systematic review in which she articulated that studying students' perceptions about smoking is fundamental in facilitating smoking behavior change. This study should serve the need to evaluate Saudi college students' perceptions. However, the study authors support the notion of replicating the study and employing other statistical procedures (e.g., confirmatory factor analysis [CFA] or structural equation modeling [SEM]) to further validate or confirm the findings of this study.¹⁰⁸

Conclusion

An Arabic instrument was developed to evaluate the beliefs of Saudi college students about cigarette smoking; it employed the Health Belief Model (HBM). The findings from this study supported the evidence that the newly developed Arabic questionnaire has sound psychometric properties for testing the constructs of the HBM, except Cues to Action. The results of the study could accelerate the necessary research (1) to unfold cigarette smoking ambiguity among Saudi college students, and/or (2) to assist health professionals or Saudi universities in designing tobacco prevention programs, and/or (3) to monitor the beliefs of students regarding cigarette smoking. Despite the rigorous findings of this study, the authors

recommend that those interested reexamine the findings and broaden the scope of the participants to a larger scale of Saudi college students, in a random sample. Because of the lack of prior study in this regard, future research should enhance the findings by replicating the study using other statistical tools.

Table 8. Descriptive statistics of the six constructs of HBM items based on 925 participants.

Code	Item	Mean	SD	Communality*
Perceived Severity (SV)				
SV1	التدخين يسبب أمراض القلب. Smoking could cause heart diseases.	4.47	.809	.671
SV2	التدخين يسبب أمراض الأوعية الدموية. Smoking could cause vascular diseases.	4.26	.865	.652
SV3	التدخين يسبب سرطان الحنجرة. Smoking could cause throat cancer.	4.54	.758	.687
SV4	التدخين يسبب سرطان الرئة. Smoking could cause lung cancer.	4.66	.655	.738
SV5	التدخين يؤدي إلى الإصابة بالربو. Smoking could increase the risk of asthma.	4.04	1.108	.655
SV6	التدخين يسبب كحة مزمنة. Smoking could result in chronic cough.	4.32	.905	.713
SV7	التدخين يسبب ضيق التنفس. Smoking could cause shortness of breath.	4.45	.797	.672
SV8	التدخين يقلل الخصوبة. Smoking could reduce fertility.	3.67	1.088	.850
SV9	التدخين يضعف الحيوانات المنوية. Smoking could impair sperm.	3.62	1.091	.895
SV10	التدخين يسبب الضعف الجنسي. Smoking could cause impotence.	3.55	1.115	.844
Perceived Susceptibility (SU)				
SU1	بسبب التدخين، أنا قلق من الإصابة بأمراض القلب. Because of smoking, I am worried about heart diseases.	3.84	1.237	.850
SU2	بسبب التدخين، أنا قلق من الإصابة بأمراض الأوعية الدموية.	3.79	1.232	.858

	Because of smoking, I am worried about vascular diseases.			
SU3	بسبب التدخين، أنا قلق من الإصابة بسرطان الحنجرة. Because of smoking, I am worried about throat cancer.	3.95	1.216	.887
SU4	بسبب التدخين، أنا قلق من الإصابة بسرطان الرئة. Because of smoking, I am worried about getting lung cancer.	4.01	1.205	.875
SU5	بسبب التدخين، أنا قلق من الإصابة بالربو. Because of smoking, I am worried about getting asthma.	3.69	1.298	.808
SU6	بسبب التدخين، أنا قلق من الإصابة بالكحة المزمنة. Because of smoking, I am worried about getting chronic cough.	3.83	1.242	.842
SU7	بسبب التدخين، أنا قلق من الإصابة بضيق التنفس. Because of smoking, I am worried about getting shortness of breath.	3.93	1.198	.858
SU8	بسبب التدخين، أنا قلق من الإصابة بقلة الخصوبة. Because of smoking, I am worried about getting fertility weaknesses.	3.44	1.267	.855
SU9	بسبب التدخين، أنا قلق من الإصابة بضعف الحيوانات المنوية. Because of smoking, I am worried about getting sperm impairment.	3.41	1.264	.851
SU10	بسبب التدخين، أنا قلق من الضعف الجنسي. Because of smoking, I am worried about getting impotence.	3.41	1.273	.819
Perceived Benefits (BT)				
BT1	عدم التدخين يوفر لي الكثير من المال للقيام بأشياء أريدها، كشراء الطعام، الأجهزة الالكترونية، الادخار، إلخ. Not smoking saves me a lot of money to do things I want, such as buying food, electronics, saving, etc.	4.59	.826	.582

BT2	عدم التدخين يقيني من بعض الأمراض الخطيرة مثل سرطان الرئة والربو وأمراض القلب وغيرها. Non-smoking protects me from some serious diseases such as lung cancer, asthma, heart diseases and others.	4.67	.670	.637
BT3	عدم التدخين مفيد لصحتي. Non-smoking is good for my health.	4.82	.527	.631
BT4	عدم التدخين يجعلني أكثر قبولا لأولئك الذين لا يحبون رائحة التدخين. Non-smoking makes me more suitable to those who do not like the smell of smoking.	4.56	.863	.583
BT5	عدم التدخين يحافظ على قدرتي الجسدية للاستمتاع بالتمارين التي أحبها. Non-smoking helps me keep my physical stamina for enjoying the exercises I like.	4.57	.817	.613
BT6	رائحة التدخين كريهة. Smoking smells bad.	4.45	1.046	.578
BT7	عدم التدخين يجعلني سعيداً. Non-smoking makes me happy.	4.34	1.100	.630
BT8	التدخين محرم في الإسلام. Smoking is prohibited in Islam.	4.40	.941	.789
BT9	عدم التدخين هو سلوك واجب دينياً. Non-smoking is a religiously obligatory behavior.	4.39	.970	.805
BT10**	عدم التدخين هو سلوك مقبول بين أصدقائي. Non-smoking is an acceptable behavior among my friends.	4.34	1.067	.448
Perceived Barriers (BR)				
BR1	التدخين يساعدني على إجراء محادثة لطيفة مع أصدقائي. Smoking helps me have a nice conversation with my friends.	1.75	1.118	.764

BR2	التدخين يساعدني في الحفاظ على أصدقائي. Smoking helps me maintain my friends.	1.61	.999	.749
BR3	التدخين يساعدني في مزاولة أنشطتي الاجتماعية، كالذهاب للاستراحة، المقهى، أو الجلوس مع أصدقائي بعد المحاضرة. Smoking helps me in my social activities, such as going to rest, Istiraha, or sitting with my friends after the lecture.	1.71	1.096	.761
BR4	التدخين يساعدني على التحكم في أعصابي عند التوتر. Smoking helps me control my nerves when stressed.	1.94	1.297	.770
BR5	التدخين يساعدني في التعامل مع الضغط الدراسي. Smoking helps me cope with school stress.	1.94	1.320	.782
BR6	التدخين يشعرنني بالسعادة. Smoking makes me happy.	1.89	1.247	.744
BR7	التدخين هو أسلوب حياة ممتع. Smoking is an enjoyable lifestyle.	1.62	1.045	.665
BR8	لا يوجد ضرر من التدخين. There is no harm from smoking.	1.25	.651	.618
BR9	شراء الدخان غير مكلف. Buying smoke is inexpensive.	1.44	.894	.561
BR10	التدخين ابتلاء من الله. Smoking is an affliction from Allah.	3.36	1.396	.593
Cues to Action (CU)				
CU1	لا يحب والداي رائحة التدخين. My parents do not like the smell of smoking.	4.54	.826	.683
CU2	لا أحب أن اكون مدمناً للدخان. I don't like being addicted to smoke.	4.76	.638	.572
CU3**	يشجعني أعز أصدقائي على عدم التدخين. My best friend encourages me not to smoke.	4.05	1.145	.420

CU4	تذكرني جمعيات مكافحة التدخين بالجوانب السلبية من التدخين. Anti-smoking associations remind me of the negative aspects of smoking.	4.06	1.146	.586
CU5	رؤية الأشخاص الذين أصيبوا بأمراض بسبب التدخين تجعلني أتجنب التدخين. Seeing people who developed illnesses due to smoking makes me avoid smoking.	4.40	.968	.545
CU6!	لوحات "ممنوع التدخين" تذكرني بالتدخين. "No smoking" signs remind me of smoking.	2.90	1.319	.561
CU7!	عندما أرى شخصاً يدخن، أريد أن أدخن أيضاً. When I see someone smoking, I want to smoke too.	3.84	1.431	.780
CU8	يذكرني إمام المسجد بعدم التدخين. The Imam of the mosque reminds me not to smoke.	3.03	1.257	.628
CU9	تذكرني الجامعة بالجوانب السلبية من التدخين. The university reminds me of the negative aspects of smoking.	3.15	1.344	.623
CU10!	عندما أشم رائحة الدخان، أريد أن أدخن. When I smell smoke, I want to smoke.	3.93	1.400	.750
Perceived Self-Efficacy (SE)				
SE1	أستطيع رفض أي سيجارة مقدمة لي. I can turn down any cigarettes offered to me.	4.59	.840	.588
SE2	أستطيع مغادرة المكان فوراً إذا أشعل أي شخص السيجارة. I can leave the place immediately if anyone lights a cigarette.	4.00	1.212	.535
SE3!	لا أستطيع رفض السجائر المعروضة من أعز صديق. I cannot reject the cigarettes offered by my best friend.	4.35	1.193	.525
SE4	أستطيع اختيار فقط الأصدقاء الذين لا يدخنون. I can choose only those friends who do not smoke.	3.52	1.350	.505

	I can only choose friends who do not smoke.			
SE5	لا أفكر في التدخين نهائياً. I do not think of smoking forever.	4.26	1.239	.610
SE6	أستطيع الامتناع عن التدخين حتى لو لمدة شهر. I can refrain from smoking even for a month.	4.23	1.109	.685
SE7**	أستطيع دعم حملات جمعيات مكافحة التدخين. I can support anti-smoking association campaigns.	4.02	1.120	.448
SE8	أستطيع أن أكون غير مدخن. I am able to be a non-smoker.	4.62	.748	.684
SE9!	إذا كنت متوتر، لا أستطيع الامتناع عن التدخين. If I'm stressed, I cannot stop smoking.	3.94	1.335	.613
SE10	أستطيع ان امتنع عن التدخين عندما أكون قلقاً. I can stop smoking when I'm worried.	3.90	1.302	.571
<p>*Initially Extracted Method: Principal Component Analysis.</p> <p>**Items (BT10, CU3, and SE7) will be deleted from the analysis due to maintaining a communality of below 0.5.</p> <p>! These items were phrased negatively, so they were reverse-coded (5= strongly disagree – 1= strongly agree).</p>				

Table 9. Comparing the actual EVs of this present study to the EVs of a similar artificial study.

A. First attempt of comparing Eigenvalues (EV) of this study with Parallel Analysis (PA) of a randomly generated study.		
Factor	EV	PA
1	14.132	1.518293
2	7.424	1.470549
3	3.631	1.434910
4	2.328	1.406083
5	2.177	1.380571
6	1.981	1.356846
7	1.644	1.333832
8 (Retain)	1.338	1.312155
9	1.276	1.293496
B. Second attempt of comparing Eigenvalues (EV) of this study with Parallel Analysis (PA) of a randomly generated study.		
Factor	EV	PA
1	12.327	1.454563
2	6.822	1.406666
3	3.038	1.370470
4	2.003	1.344295
5	1.928	1.319060
6 (Retain)	1.717	1.294423
7	1.269	1.270726

Table 10. Factor loading for the six constructs of the HBM.

Item	Components ^a					
	SU	BR	BT	SV	SE	CU
1	0.887	0.809	0.675	0.738	0.649	*
2	0.895	0.808	0.663	0.745	0.476	*
3	0.912	0.791	0.676	0.763	0.528	*
4	0.907	0.731	0.686	0.777	*	0.482
5	0.820	0.706	0.696	0.597	0.563	*
6	0.885	0.687	0.501	0.707	0.695	*
7	0.901	0.655	0.538	0.741	*	*
8	0.839	0.568	0.470	*	0.719	0.737
9	0.825	0.422	0.465	*	0.656	0.728
10	0.800	*	*	*	0.591	*
Number of Items	10	9	9	7	8	3
Eigenvalue	12.33	6.82	3.04	2.00	1.93	1.72
Parallel Analysis Value	1.45	1.41	1.37	1.34	1.31	1.29
% Variance explained	26.80%	14.83%	6.60%	4.35%	4.19%	3.73%

^a Extraction Method: Principal Component Analysis.

^a Rotation Method: Varimax with Kaiser Normalization.

Abbreviation: Perceived Susceptibility [SU], Perceived Barriers [BR], Perceived Benefits [BT], Perceived Severity [SV], Perceived Self-Efficacy [SE], Cues to Action [CU]

*Deleted.

Table 11. Reliability coefficient for items.

Item	Components' Corrected Item-Total Correlation					
	SU	BR	BT	SV	SE	CU
1	0.878	0.751	0.517	0.656	0.572	*
2	0.890	0.652	0.559	0.656	0.459	*
3	0.889	0.722	0.584	0.679	0.444	*
4	0.878	0.816	0.614	0.718	*	0.368
5	0.815	0.818	0.641	0.585	0.387	*
6	0.875	0.786	0.522	0.697	0.372	*
7	0.877	0.742	0.625	0.700	*	*
8	0.844	0.512	0.538	*	0.433	0.517
9	0.828	0.423	0.517	*	0.420	0.591
10	0.799	*	*	*	0.321	*
Number of Items	10	9	9	7	8	3
Cronbach's Alpha (α)	.969	.910	.845	.875	.815	.674

Cronbach's Alpha: corrected item-total correlation.

Abbreviation: Perceived Susceptibility [SU], Perceived Barriers [BR], Perceived Benefits [BT], Perceived Severity [SV], Perceived Self-Efficacy [SE], Cues to Action [CU]

***Deleted**

CHAPTER V

CONCLUSIONS

The aim of this dissertation was intended to gain insight about tobacco smoking behavior among Saudi college students. To attain this overarching goal, several intercorrelated projects were executed. The first project centered around understanding the pool prevalence of tobacco smoking among Saudi college students in a systematic approach to assess the magnitude of the current smoking problem reported by research. The second project aimed to systematically synthesize and assimilate the vast amount of data available on the variables associated with smoking by Saudi college students. The final project, an outcome of the previous two projects, aimed to generate a psychometric tool to assess the beliefs of Saudi students about tobacco smoking through the use of a theoretical model. Below is a summary of each project's findings.

The first project addressed the need to examine the current reported prevalence of tobacco smoking among Saudi college students as a reason for evaluating the degree of current tobacco smoking problem among students. The findings showed that 17% of Saudi college students were current smokers. The study also identified that the prevalence of male smokers (26%) was greater than those of female smokers (5%). Results revealed that smoking is a current public health issue among college students in Saudi Arabia. The study suggested that establishing a surveillance system that tracks and monitors smoking prevalence is a potent strategy to gain an accurate prevalence rate over time.

Project two was intended to systematically capture the enormous amount of information collected about the risk factors associated with tobacco smoking among Saudi college students. This project sought to gain insight about those factors investigated thoroughly and to evaluate current application of theories systematic collection of articles. The findings revealed that the

individual level factors (e.g., age and gender) were the most investigated. Another piece of evidence was that the deficiency of utilizing theoretical frameworks was observed. The study advocated for utilizing various research methodologies (e.g., experiments or case-controls) and/or using theoretical approaches.

Because there was a shortage of utilizing theories, the last project aimed to create and validate an instrument hypothesized to measure the beliefs of college students. This instrument was composed in accordance with the guidelines of health behavioral measurement in the field of health behavior. The final 46 items loaded on their respective constructs outlined by the Health Belief Model (HBM). The factor loadings ranged from 0.42 to 0.91, showing that they shared a significant amount of variance. The reliability of the instrument was greater than 0.80, except for the Cues to Action. Overall, the instrument was found to be valid and reliable in evaluating college students' beliefs about cigarette smoking behavior. The study recommended using other statistical techniques (e.g., confirmatory factor analysis or structural equation modeling) and revisiting the construct of Cues to Action.

In conclusion, the three projects provided evidence for estimating the tobacco smoking prevalence, for synthesizing and assimilating the risk factors of tobacco smoking, and for validating a psychometric measure that evaluates students' beliefs about cigarette smoking. Further research is needed to contribute to an understanding of Saudi college students' smoking behavior. This research should center around the utilization of the ecological models of health behavior, the effects of economic and media campaigns on curbing tobacco smoking, the implementation of experimental research about tobacco smoking, and/or the evaluation of tobacco cessation clinics.

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APPENDICES

APPENDIX A. THEORETICAL AND OPERATIONAL DEFINITIONS OF HBM

HBM constructs	Theoretical / Operational	Definition	Reference
Perceived severity	Theoretical	According to the Health Belief Model, the construct 'perceived severity' is one's belief about the seriousness of getting a disease or a condition.	Glanz et al. 2015 ¹⁸
	Operational	For this study, the construct of perceived severity is defined as Saudi college students' beliefs about the severity of cigarette smoking-related diseases.	
Perceived susceptibility	Theoretical	According to the Health Belief Model, the construct 'perceived susceptibility' is one's belief about the likelihood of getting a disease or condition.	Glanz et al. 2015 ¹⁸
	Operational	For this study, the construct of perceived susceptibility is defined as Saudi college students' beliefs about the chances of developing a cigarette smoking-related illness.	
Perceived benefits	Theoretical	According to the Health Belief Model, the construct 'perceived benefits' is one's belief about the positive features of adopting a health behavior.	Glanz et al. 2015 ¹⁸
	Operational	For this study, the construct of perceived benefits is defined as Saudi college students' beliefs about the positive aspects of non-cigarette smoking.	
Perceived barriers	Theoretical	According to the Health Belief Model, the construct 'perceived barriers' is one's belief about the obstacles features of adopting a health behavior.	Glanz et al. 2015 ¹⁸
	Operational	For this study, the construct of perceived barriers is defined as Saudi college students' beliefs about the negative aspects of cigarette smoking abstinence.	
Cues to action	Theoretical	According to the Health Belief Model, the construct 'perceived cues to action' is one's stimulus trigger to engage in healthy action.	Glanz et al. 2015 ¹⁸

	Operational	For this study, the construct of cues to action is defined as cues and reminders enabling Saudi college students to avoid cigarette smoking.	
Self-efficacy	Theoretical	According to the Health Belief Model, the construct 'perceived self-efficacy' is one's confidence in his or her ability to pursue a behavior.	Glanz et al. 2015 ¹⁸
	Operational	For this study, the construct of perceived self-efficacy is defined as Saudi college students' confidence in their ability to maintain a non-cigarette smoking behavior.	

APPENDIX B. OLD DOMINION UNIVERSITY IRB EXEMPT LETTER



OFFICE OF THE VICE PRESIDENT FOR RESEARCH



Physical Address

4111 Monarch Way, Suite 203
Norfolk, Virginia 23508

Mailing Address

Office of Research
1 Old Dominion University
Norfolk, Virginia 23529
Phone(757) 683-3460
Fax(757) 683-5902

DATE: March 28, 2021

TO: Praveen Durgampudi, MBBS, MPH, MSPH
FROM: Old Dominion University Health Sciences Human Subjects Review Committee

PROJECT TITLE: [1728694-2] Predictors of Cigarette Smoking among Saudi College Students:
Utilizing Health Belief Model

REFERENCE #:
SUBMISSION TYPE: Response/Follow-Up

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE:

REVIEW CATEGORY: Exemption category # 2

Thank you for your submission of Response/Follow-Up materials for this project. The Old Dominion University Health Sciences Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Harry Zhang at 757-683-6870 or qzhang@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Health Sciences Human Subjects Review Committee's records.

APPENDIX C. QASSIM UNIVERSITY IRB APPROVAL LETTER



SA ALOTAIBI <salot001@odu.edu>

طلب نشر استبيان علمي

اللجنة الفرعية الدائمة للأخلاقيات الحيوية <bioethics@qu.edu.sa>
 To: SA ALOTAIBI <salot001@odu.edu>

Thu, Apr 15, 2021 at 6:44 AM

تم تعميم الاستبانة بالرقم 62538 وتاريخ 1442/9/3 هـ

من: <SA ALOTAIBI <salot001@odu.edu>
 تم الإرسال: 23/شعبان/1442 06:04 ص
 إلى: اللجنة الفرعية الدائمة للأخلاقيات الحيوية <bioethics@qu.edu.sa>
 الموضوع: Re: طلب نشر استبيان علمي

[Quoted text hidden]

تحذير: هذه الرسالة وما تحويه من مرفقات (إن وجدت) تمثل وثيقة سرية قد تحتوي على معلومات محمية بموجب القانون. إذا لم تكن الشخص المعني بهذه الرسالة فيجب عليك تنبيه المرسل بخطأ وصولها إليك، وحذف الرسالة ومرفقاتها (إن وجدت)، ولا يجوز لك نسخ أو توزيع هذه الرسالة أو مرفقاتها (إن وجدت) أو أي جزء منها، أو البوح بمحتوياتها للغير أو استعمالها لأي غرض. علماً بأن فحوى هذه الرسالة ومرفقاتها (إن وجدت) تعبر عن رأي المرسل وليس بالضرورة رأي جامعة القصيم بالملكة العربية السعودية، ولا تتحمل الجامعة أي مسؤولية عن الأضرار الناتجة عما قد يحتويه هذا البريد.

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VITA

Saad Abdullah S. Alotaibi, PhD, MS, BS

Department of Study

Old Dominion University
College of Health Sciences
2114 Health Sciences Building
Norfolk, VA 23529

EDUCATION

- Doctor of Philosophy, Old Dominion University, Norfolk, VA** 2023
Major Area: Health Services Research
Cognate: Health Promotion
Dissertation: *TOBACCO SMOKING AMONG SAUDI COLLEGE STUDENTS: VALIDATION OF AN ARABIC HEALTH BELIEF MODEL INSTRUMENT*
- Master of Science, University of Arkansas, Fayetteville, AR** 2014
Major Area: Community Health Promotion
- Bachelor of Science in Education, University of Arkansas, Fayetteville, AR** 2012
Major Area: Community Health Promotion

SELECTED PUBLICATIONS

- Alsuliman, M. A., **Alotaibi, S. A.**, Zhang, Q., & Durgampudi, P. K. (2020). A systematic review of factors associated with uncontrolled diabetes and meta-analysis of its prevalence in Saudi Arabia since 2006. *Diabetes/Metabolism Research and Reviews*, e3395. <https://doi.org/10.1002/dmrr.3395>
- Alotaibi, S. A.**, Durgampudi, P. K. (2020). Factors associated with tobacco smoking among Saudi college students: A systematic review. *Tobacco Prevention & Cessation*, 6(June), 36. <https://doi.org/10.18332/tpc/122444>
- Alotaibi, S. A.**, Alsuliman, M. A., Durgampudi, P. K. (2019). Smoking tobacco prevalence among college students in the Kingdom of Saudi Arabia: Systematic review and meta-analysis. *Tobacco Induced Diseases*, 17(April), 35. <https://doi.org/10.18332/tid/105843>