

# A systematic review of the prevalence and risk factors of smoking among Saudi adolescents

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## ABSTRACT

**الأهداف:** لتقديم مراجعة منهجية فيما يتعلق بانتشار التدخين والعوامل المسببة له بين المراهقين في المملكة العربية السعودية.

**الطريقة:** باتباع إرشادات PRISMA تم تحديد الدراسات التي تفحص انتشار التدخين والعوامل المسببة له لدى المراهقين في المملكة العربية السعودية من خلال بحث إلكتروني أدبي في BIOSIS، Web of Science، SCOPUS، PubMmed حتى مارس 2018م. تم استخدام المصطلحات التالية للبحث: التدخين أو يدخن أو التبغ أو السيجار أو الشيشة والسعودية أو المملكة العربية السعودية. تم اختيار المقالات التي تمت مراجعتها ونشرت في الفترة من 2007م إلى 2018م. شملت الدراسات التي تم إدراجها بيانات عن انتشار وأنماط وعوامل حدوث التدخين بين المراهقين. تمت جدولة البيانات المستخرجة من كل دراسة، وتم توليف البيانات بشكل روائي.

**النتائج:** تم إدراج 32 دراسة ذكرت كل منها انتشار التدخين في الفئة العمرية للمراهقين في هذا الإستعراض الأدبي للأدلة. قد أجريت هذه الدراسات على طلاب المدارس الثانوية (العدد=11)، وطلاب الجامعات (العدد=14)، و للمراهقين بدون مؤهلات تعليمية (العدد=7). وفقاً للتقارير المنشورة خلال الفترة 2007م-2018م، تراوحت نسبة انتشار تدخين التبغ بين المراهقين في المملكة العربية السعودية من 2.4% إلى 39.6%. محاكاة وتأثير الأصدقاء، والإهمال العائلي كانت العوامل المسببة الأكثر شيوعاً للتدخين.

**الخاتمة:** تسلط هذه المراجعة الضوء على انتشار التدخين بين المراهقين في المملكة العربية السعودية. هناك حاجة إلى مزيد من إجراءات الصحة العامة لزيادة وعي المراهقين بأخطار التدخين ومضاعفاته، وكذلك لمساعدتهم على الإقلاع عن التدخين.

**Objectives:** To systemically review the evidence concerning the prevalence and reported risk factors of smoking among adolescents in Saudi Arabia.

**Methods:** Following the PRISMA guidelines, studies that examined the prevalence and risk factors of smoking among adolescents in Saudi Arabia were identified through a computerized literature search using the following databases up to March 2018: PubMed,

SCOPUS, Web of Science, and BIOSIS. The following search terms were used: smoking OR smok\* OR tobacco OR cigar\* OR shisha OR shesha OR sheesha AND Saudi Arabia OR KSA. Peer-reviewed articles published within the period from 2007 to 2018 were selected. Studies that reported prevalence data, patterns, and risk factors of smoking among adolescents were included. Extracted data from each study were tabulated, and data were narratively synthesized.

**Results:** Thirty-two studies that reported the prevalence of smoking in the adolescent age group were included in the narrative evidence synthesis. These studies were conducted on secondary school students (n=11), college students (n=14), and an adolescent age group without educational specifications (n=7). According to published reports between 2007 and 2018, the prevalence of tobacco smoking among adolescents in Saudi Arabia ranged from 2.4% to 39.6%. Influence of friends, and family negligence were the most commonly reported risk factors for smoking.

**Conclusion:** The prevalence of smoking is relatively high among adolescents in Saudi Arabia. The social influence of friends, teachers or parents, low academic performance, having spare time, living away from home, and the desire to relieve stress were the most commonly reported risk factors for smoking.

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Smoking is the greatest preventable risk factor of illness and death. The number of smokers worldwide is approximately 1.3 billion, with more than 80% of smokers living in low- and middle-income countries.<sup>1</sup> Recent reports showed a global decline in the prevalence of smokers between 1980 and 2012, mostly noticed in some north American and Scandinavian countries. However, the prevalence of smoking over the same period has risen dramatically in developing countries such as Cote d'Ivoire, Kazakhstan, Serbia, and Mauritania and in high-income countries including Croatia and Saudi Arabia.<sup>2</sup> Recent estimates demonstrate that approximately 20% of Saudi Arabia citizens are tobacco smokers and similar rates have been reported among adolescents.<sup>3,4</sup> According to the World Health Organization (WHO), the prevalence of smoking among adolescents in Saudi Arabia in 2016 was 21.2% among males and 9.1% among females. The smoking prevalence among Saudi adults was 23.7% for males and 1.5% for females.<sup>5</sup> It is worth pointing out that smoking was more prevalent in female adolescents compared with adult females. Unfortunately, the WHO statistical trends show that the rate of smokers increased gradually among Saudi adolescents from 12.45% in 2000 to 15.1% in 2010. If tobacco control in Saudi Arabia remains at the same intensity, WHO estimates that by 2025 38% of males and 2% of females aged 15-24 years will be smokers.<sup>6</sup> Smoking behavior often starts during the adolescence, and those who start smoking early in adolescence are less likely to quit smoking.<sup>7</sup> It is also estimated that approximately 90% of new smokers are younger than 18 years of age, highlighting the importance of commencing efforts to prevent or control smoking in the adolescent population.<sup>8</sup> Family history, companionship, personal character, and psychological problems are common risk factors for the commencement of smoking among adolescents. A WHO-collaborative study including students from 35 countries in North America and Europe found that youths from low-income families and those who have a poor relationship with their parents and other family members were more likely to be smokers.<sup>9</sup>

The aim of this review was to establish the evidence related to the prevalence of smoking and reported risk factors among adolescents in Saudi Arabia.

**Disclosure.** Authors have no conflict of interests, and the work was not supported or funded by any drug company.

**Methods.** The systematic review presented was conducted per the standards set out in PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) (Table 1) and MOOSE (Meta-analysis of Observational Studies in Epidemiology) statement guidelines.<sup>10,11</sup> The review was additionally conducted per the Cochrane Handbook of Systematic Review and Meta-analysis.<sup>12</sup> It included articles that were published in peer-reviewed journals between 2007 and 2018. All included articles reported prevalence and risk factors of smoking among adolescents in Saudi Arabia.

**Literature search strategy.** PubMed, SCOPUS, Web of Science, and BIOSIS were searched through to March 2018 using a combination of the following keywords as well as MESH keywords: smoking OR smok\* OR tobacco OR cigar\* OR shisha OR shesha OR sheesha AND Saudi Arabia.

**Study selection.** The first author and a research assistant independently screened the literature search results for relevant studies. The screening for included studies was performed in 2 steps; the first step was screening based on titles and abstracts of the retrieved records, and the second step was based on screening of full-text articles. Discussion with a third reviewer resolved any disagreement between review authors.

**Eligibility criteria.** Studies that met the following criteria were included in this review: 1) studies whose population was Saudi Arabian adolescents, 2) studies evaluating the prevalence or risk factors of smoking tobacco products among the Saudi Arabian adolescent population.

**Data extraction.** The final included papers were extracted independently by 3 reviewers. The extracted data include 1) characteristics of the study design of included studies, 2) characteristics of the study population, and 3) data related to the study outcomes including prevalence and risk factors of smoking.

**Quality assessment.** The Newcastle-Ottawa scale for risk of bias assessment among cross-sectional studies was employed. It consisted of 7 domains including sampling, statistical measures, and outcomes. Three independent authors assessed the quality of included studies and any discrepancies were resolved through discussion.

**Synthesis of results.** Included studies were classified according to the type of the population into: 1) studies on intermediate and secondary school students, 2) studies on college students, and 3) studies on an adolescent age group from various educational levels. Extracted data from each study were tabulated and data were reviewed narratively. Microsoft Excel

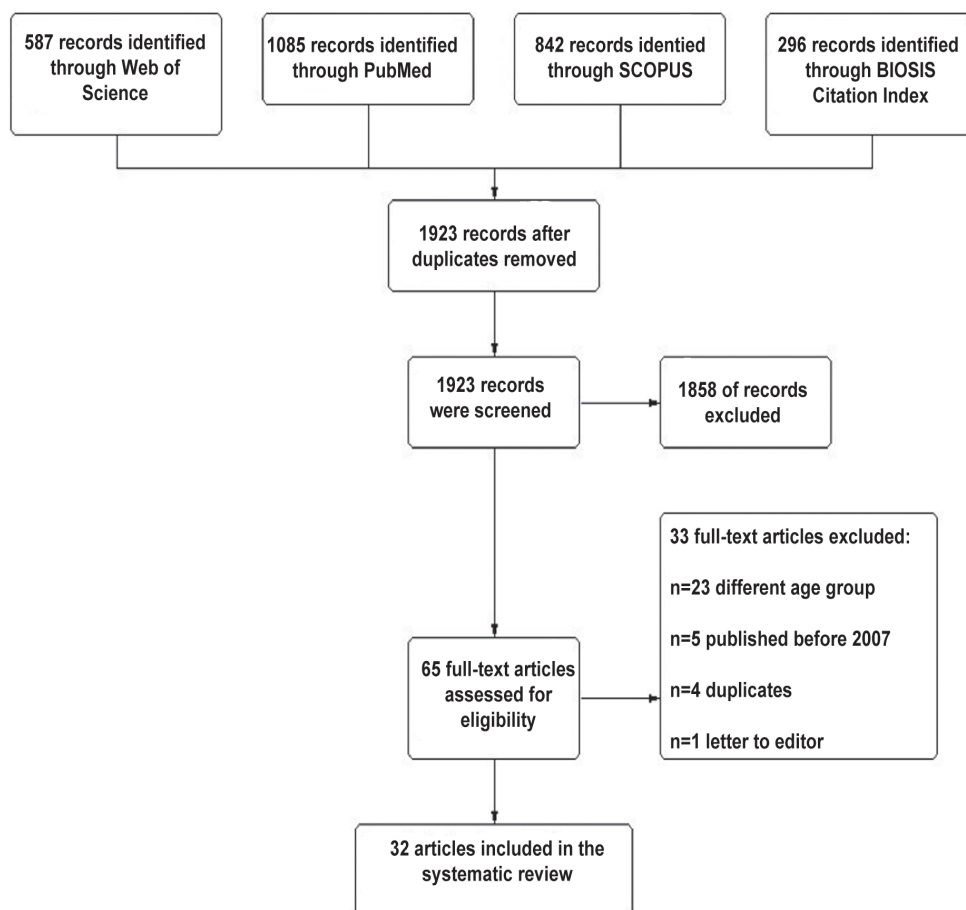
was utilized to provide simple descriptive statistics of numbers and proportions whenever needed.

**Results. Characteristics of included studies.** The search resulted in the retrieval of 32 unique studies published between 2007 and 2018 that met the inclusion criteria. These studies were undertaken in the following cities in Saudi Arabia: Riyadh (n=12), Western Region (n=5), nationwide multicenter (n=4), Madinah city (n=3), Al-Hassa (n=2), Eastern Region (n=3), Jazan Region (n=1), Northern Region (n=1), Tabuk (n=1). The study selection process is shown in Figure 1. The summary of included studies is shown in Table 1.

**Quality of included studies.** All studies rated as good quality with a total score of 7 to 8 stars. All articles showed stars regarding representativeness of the sample, satisfactory recruitment rate, validated measurement tool and clear statistical analysis. Self-report was granted a star since all studies were based on survey design.

**Prevalence of smoking among secondary school students.** Eleven studies investigated the prevalence of smokers among secondary school students in Saudi Arabia. Their prevalence estimate ranged from 9.72% to 37%. The highest prevalence of 37% was reported in a study that included 695 high school boys in Jeddah,<sup>19</sup> followed by 33% in a 2010 study included 1272 high school students in Riyadh,<sup>13</sup> followed by 28.6% in another study of 225 students in Riyadh.<sup>21</sup> The lowest prevalence of 9.72% was reported in a study of 1019 students in 2010 in Jeddah,<sup>26</sup> followed by 10.7% in a study conducted in 2011 in Jazan region with 3923 students.<sup>24</sup>

Three studies reported the prevalence of secondary school students who had ever smoked. The prevalence of students who had ever smoked was 17.3% in Riyadh 2010, 25.4% in Al-Hassa 2009, and 42.8% in Madinah 2013. Al Moamary et al<sup>13</sup> estimated prevalence of water-pipe smoking at 10.2% (8.6% in males, 1.6% in females), while they reported that 33% (65.9% in males



**Figure 1** - The PRISMA flow diagram of the study selection process.

versus 34.1% in females) had ever smoked. On the other hand, Amin et al<sup>15</sup> reported waterpipe smoking at a rate of 53.9%. Fida et al<sup>20</sup> found that the majority of students (83.7%) started smoking at the age of 14 years or less. In other studies, Al Moamary et al<sup>13</sup> reported that 68.1% initiated waterpipe smoking from the age of 11 years, and Al Nohair<sup>21</sup> reported that the majority (89%) of adolescent smokers began to smoke before the age of 15 years. Even more alarming is the study by Al Ghobain et al<sup>18</sup> who reported that 13.5% of adolescents reported using tobacco for the first time before the age of 10 years.

#### *Prevalence of smoking among college students.*

From 14 college studies, the findings showed that the smoking prevalence ranged from 2.7% to 8.5% among females and 13% to 30.9% among males. The highest prevalence of college students was 30.9% in a study that included 337 male college students,<sup>30</sup> followed by 29.8% in a study that included 715 male college students,<sup>35</sup> and 25% among a cohort of 336 dental students.<sup>31</sup> The lowest prevalence rate reported was 2.4% in a study of female medical students,<sup>33</sup> followed by 8.6% among female students who joined other schools in Dammam, Saudi Arabia,<sup>39</sup> and 11.1% in a study that included 910 medical students in Riyadh.<sup>37</sup> Al-Mohamed and Amin reported that at the time of their survey waterpipe smoking was 14.6% in a total of 1382 students in Al-Hassa at King Faisal University.<sup>29</sup>

*Knowledge and attitudes of smoking among adolescents.* A study by Al-Bedah et al<sup>27</sup> surveyed 825 students in health schools from different regions in Saudi Arabia and revealed that 65% to 85.6% of the participants knew the hazards of tobacco use/smoking, while only 35.3% to 40.5% knew about tobacco-related diseases. The study reported that 84.5% to 97.1% of health professional students agreed with banning smoking in restaurants, 87.1% to 100% to enforcing the banning of smoking in enclosed public places, 87.1% to 100% recommended banning smoking in cafes, 82.6% to 94.1% agreed with the banning of smoking advertisements, and 81.1% to 94.1% agreed with the prohibition of selling tobacco to adolescents. A 2017 study by Mansour<sup>31</sup> included 420 dental students and reported good awareness of the commonly risks of second-hand smoke; however, students were less aware of the risks of shortening life span. Al Moamary et al<sup>13</sup> in his study of 1272 high school students, reported that 86.4% of the participants perceived that smoking was harmful. The study also reported that 79.6% of the participants supported banning waterpipe smoking. In addition, 59% of the smokers were willing to quit waterpipe smoking, and 48% of the smokers reported

that they had tried to quit smoking. High awareness about smoking hazards was also reported in the studies by Amin et al,<sup>15</sup> Ansari and Farooqi,<sup>28</sup> Almutairi,<sup>34</sup> Baig et al,<sup>36</sup> and Algorinnees et al.<sup>44</sup>

#### *Smoking prevalence in Saudi Arabian cities.*

Regarding the geographical distribution, studies about the prevalence of smoking among adolescent age groups in Saudi Arabia were not consistent. However, all reports showed a relatively high prevalence rate of smoking, highlighting the need for public health interventions and educational campaigns to reduce the number of new and existing smokers in the adolescent age group. The highest prevalence rate of smoking among adolescents was found in Jeddah and Riyadh. The summary of prevalence rates according to the study setting (cities and geographical locations) are shown in Table 1.

#### *Smoking prevalence among adolescents by gender.*

Smoking prevalence rates among boys were greater than girls in all the included studies regardless of their age or educational levels. A study with a total of 1272 participants reported a smoking prevalence of 31.2% for males versus 8.9% for females in Riyadh city, Saudi Arabia from April to June 2010.<sup>18</sup> Another study reported that 30.3% of males, but only 8.5% of females smoked waterpipe.<sup>13</sup> A significant difference between males and females was also found in another study (12.43% for males and 6.65% for females).<sup>26</sup> Males smoke 2 to 6.4 times more than females. For shisha smoking, this was 1.2% to 5.7%.<sup>27</sup> Gaffar et al<sup>24</sup> reported that 16.2% of males and 3.8% of females were smokers. A recent study reported substantially higher rates of smoking among males than females in secondary schools (26.2% versus 7.9%), and among males than females in intermediate schools (17.1% versus 8.8%).<sup>23</sup> In Tabuk region, 34% of boys and 11.1% of girls in secondary school were smokers.<sup>41</sup> Al Moamary et al<sup>13</sup> reported 8.6% male waterpipe smokers versus 1.6% female waterpipe smokers.

*Risk factors of smoking among adolescents.* The included studies illustrated a number of risk factors for smoking among adolescents in Saudi Arabia. Smoking friends and/or families were the most commonly reported risk factors.<sup>18-20,23,29</sup> Amin et al<sup>15</sup> reported that outings with friends, company of friends, boredom, and spare time were the motives for waterpipe smoking. Having spare time (81.6%), stress relief (63.2%), and watching smoking teachers (61.8%) were the most common risk factors associated with smokers as reported by Al Nohair et al.<sup>21</sup> Being from high income families, receiving high daily allowances, studying less, skipping class, describing themselves as less religious and not

being involved in religious activities, being males, and spending more time away from home were the most common associated risk factors of smoking according to Al Agili 2012.<sup>26</sup> Al-Mohamed and Amin reported that the most common predictors of smoking were living outside home as well as having a family member or a friend who smoked.<sup>29</sup> Al Zalabani and Kasim<sup>23</sup> showed that smoking parents, understanding of smoking-related hazards, mass media, and pocket money were other important factors in predicting smoking among adolescents in Madinah, Saudi Arabia.

**Discussion.** The prevalence of smoking among adolescents in KSA varied immensely in different studies, ranging from 9.72% to 37% among secondary school students, 2.4% to 30.9% among college students, and 12.7% to 39.6% among adolescents age group regardless of their educational stages. In all studies, prevalence was reported to be significantly higher in males than in females. The prevalence of smoking ranged from 8.6% to 37% in male adolescents and 1.6% to 11.1% in female adolescents. A possible reason for Arab males having higher smoking rates may be because they spend free time with their peers without the restrictions and supervision females experience. Additionally, males believe that smoking could help increase the masculine image and the maturity perception among peers.<sup>23-26</sup> In contrast, social stigma may be responsible for the low smoking prevalence among females. Additionally, females believe that smoking could affect their feminine Islamic image and reputation, thus affecting marriage chances.<sup>48</sup> In addition, it is thought that the cultural censure of smoking among females may also contribute to the low prevalence.

Our findings also showed that waterpipe smoking prevalence ranged from 10.2% to 53.9%. The prevalence of those who had ever smoked ranged from 17.3% to 42.8%. There are variations in the prevalence of smoking in terms of year of research and location of residency (Table 1).

Addressing factors associated with smoking is a critical approach to reducing the prevalence of smoking and improving the health of a nation. The included studies reported several predictors of smoking in Saudi Arabia. Imitating friends and family negligence represented the most common risk factors for smoking.<sup>49</sup> Saudi Arabia is currently undergoing a rapid phase of modernization in which socialising out of the home environment is growing. Adolescents expressed their adulthood through spending more time with their peers out of the home, particularly in the hastily growing cafes/restaurants, thus, increasing smoking

prevalence among adolescents.<sup>14</sup> Other risk factors have been reported, such as older age,<sup>29,49</sup> male gender,<sup>16,18</sup> parental smoking,<sup>29</sup> friends smoking,<sup>20,24</sup> socioeconomic status,<sup>24</sup> perception of health hazards of smoking,<sup>49</sup> and single parent.<sup>24</sup> A study reported a strong association between khat chewing which is a natural stimulant on the central nervous system, extracted from the *Catha edulis* plant and tobacco smoking.<sup>24</sup> However, there are reductions to the risk of smoking by educated parents; approximately by 51% among fathers and 39% among mothers.<sup>23</sup> Religious beliefs are negatively associated with smoking attitudes and could be a strong predictor of the intention not to smoke.<sup>50</sup>

Religious values have a paramount effect in helping adolescents quit smoking. A study reported lower smoking prevalence in Islamic secondary school than in other schools.<sup>51</sup> Furthermore, Al-Mohrej et al<sup>53</sup> reported that the majority of ex-smokers (57%) had decided to quit because of religious and social reasons. Also, Health was another reason for 40% of the quitters, while only 3% stopped due to financial constraints.

Encouraging parents to abstain from smoking, advising students to avoid any gathering that includes smoking, and controlling the use of cigarettes among the young may be an effective strategy to reduce the prevalence/uptake of smoking. Broadening the knowledge of smoking-related hazards through enhancing the scholastic curriculum, mainly from the first year of school life, has proved to be one of the effective approaches. The media have a role in increasing the awareness of students and their families about the dangers of smoking. Ansari et al<sup>28</sup> reported that approximately 70% of smokers quit smoking because they had greater knowledge and information on smoking hazards. These findings are in agreement with the results of a previous study in King Faisal University with a total of 12400 students included (males=8200, females= 4200) in the academic year 2006 to 2007.<sup>29</sup>

Primary and secondary prevention programs have a vital role in reducing smoking among adolescents in Saudi Arabia. School-based tobacco control programs that pay particular attention at the sociocultural context of smoking habit, consider the associated risk and protective factors, and reflect the differences between male and female gender are useful methods in reducing the onset of smoking among students.<sup>54,55</sup> Anti-smoking clinics should be established to provide pharmacological and non-pharmacological treatments for smokers. Treatment of nicotine dependence and tobacco-related diseases should also be reinforced. Other interventions, including implementing strict rules regarding cigarette sales to minors under 18

**Table 1** - The summary of included studies.

Authors	City/Region	Population (age in years)	Sample size	Sampling method	Definition of smoking as measured in the study	Key outcomes	
						Prevalence	Risk factors
Al Moamary et al, <sup>13</sup> 2012	Riyadh, Saudi Arabia	High school students (16 to 18 years)	1272	Convenience sampling	Has smoked at least one time during the past 30 days	Waterpipe (WP) smoking was reported among 33% of participants.  Secondary schools' students in Riyadh had higher WP prevalence. 95% CI: 2.4-4.0	Participants reported beginning WP smoking in early adulthood.
Park et al, <sup>14</sup> 2012	Jeddah, Saudi Arabia	Middle school students (age mean±SD 14.3 ± 1.2)	1019	Stratified sample	Smoking at the time of the survey	10% of students reported tobacco use.	Gender varies in social influences and attitudes regarding tobacco consumption. Religious beliefs have a positive role in avoiding smoking and future intention of tobacco use.
Amin et al, <sup>15</sup> 2010	Al-Hassa, Saudi Arabia	Secondary school students (age mean±SD 17.5 ± 1)	1652	Multistage sampling method	Smoked at the time of the survey	30.3% of boys and 8.5% of girls were smokers  53.9% smoked WP, of them 20.7% smoked WP daily, 23.8% weekly, and 64.2% used flavored "Muassel" tobacco 95% CI: males 27.5-33.2/ females 6.6-10.9	
Al Ghobain et al, <sup>18</sup> 2011	Riyadh city, Saudi Arabia	Boys and girls (16 to 18)	1272	Cluster random sample	Anyone who was current smoker at the time of the survey.	42.8% of participants ever smoked  19.5% were smokers	Cigarette smoking is more prevalent among boys and among those who have smoker friends or parents. However, is not affected by the school type.
Fida and Abdelmoneim, <sup>19,20</sup> 2013	Jeddah, Saudi Arabia	Male secondary school students (mean±SD 17.06 ± 0.80)	695	Two-stage cluster random sample	Anyone who smoked before and remain as a smoker regardless of smoking frequency and did not define himself as a past smoker.	37% were smokers, of them, 83.7% had begun smoking at 14 years old or younger	Smokers at home (65, 9%) and smokers' friends (42.5%) were the most common causes of smoking. Family influence
Al Nohair, <sup>21</sup> 2011	National Guard area of Riyadh, Saudi Arabia	Secondary school students (16 to 22 years)	255	Random sample	Anyone smoking cigarettes or shisha.	28.6% were smokers	Reasons to smoke vary: having spare time (81.6%), stress relieving (63.2%) and watching teachers who smoked (61.8%).  89% of the smokers began tobacco use prior to 15 years old
Al-Zalabani, <sup>22</sup> 2015	Madinah city, Saudi Arabia	Intermediate and secondary school students (<13: n=469 13-16: n=1657 >16: n=1084)	3210	Convenience sampling	Has smoked at least one time during the past 30 days.	The prevalence of second- hand smoke (SHS) exposure was 32.7% inside home, 49.3% outside home, and 25% both inside and outside the home	Parents or friends who smoke were the highest risk of SHS smoking
Al-Zalabani and Kasim, <sup>23</sup> 2015	Madinah, Saudi Arabia	Intermediate and secondary schools (≤13: n=526 14: n=479 15: n=583 ≥16: n=1734)	3400	A multistage stratified cluster sample	Has smoked at least one time during the past 30 days.	The prevalence of cigarette smoking was 15.2% with wide variability in sociodemographic factors  95% CI: 13.95-16.39	Having most or all friends who smoke was the most common predictor for smoking.

**Table 1** - The summary of included studies. (continued).

Authors	City/Region	Population (age in years)	Sample size	Sampling method	Definition of smoking as measured in the study	Key outcomes	
						Prevalence	Risk factors
Gaffar et al, <sup>24</sup> 2013	Jazan region, Saudi Arabia	Intermediate and secondary school students (10 to 21)	3923	Convenience sampling	Using ≥1 tobacco product	17.3% ever smoked and 10.7% were current smokers  95% CI: 9.75-11.78	Academic performance, and having friends who smoked were the most common predictors of smoking.
Al-Bedah et al, <sup>25</sup> 2010	All regions in the Saudi Arabia	Intermediate schools, classes, and students	3829	Two-stage random sample	Anyone who was current smoker at the time of the survey.	39.5% of males and 16% of females ever smoked.  13% of males and 2.7% of females smoked	
Agil and Park, <sup>26</sup> 2012	Jeddah, Saudi Arabia	Middle school students (mean±SD14.3 ± 1.2)	1019	Stratified sample	Anyone who was current smoker at the time of the survey / Nicotine in saliva test	12.4% of boys and 6.7% of girls smoked tobacco	The most common causes of smoking were having families with high income, having higher daily allowances, studying less, skipping class, being less religious, being males, spending more time away from home.
Al-Bedah et al, <sup>27</sup> 2012	Health schools in Saudi Arabia	Professional health students	825	Two-stage sample design	Anyone who was current smoker at the time of the survey	Prevalence of cigarette smoking varies as of 2.9% among medical students to more than 25% for dentistry and pharmacy college students  Smoking shisha prevalence was 2.9 between students in medicine college and 34.3% among dentistry college students and 28.7% for students in pharmacy school	
Ansari and Farooqi, <sup>28</sup> 2017	College of Applied Medical Science, Dammam, Saudi Arabia	Female university students	332	Convenience sampling	Anyone who was current smoker at the time of the survey	13.3% of participants were smokers, 0.9% were active smokers	The associated factors for smoking were high-grade point average ( <i>p</i> =0.01).  61.3% reported that first smoking trial was after seeing a known person smoking ( <i>p</i> =0.01)
Al-Mohamed and Amin, <sup>29</sup> 2010	King Faisal University, Al-Hassa, Saudi Arabia	Male university students	1382	Random sample	Anyone who was current smoker at the time of the survey	21.6% were cigarette smokers, and 14.6% were WP smokers  95% CI: cigarette smokers 19.5-23.9/WP smokers 12.9-16.6	Among smokers, 41.4% were living with family members who smoke, and 17% started smoking before reaching 12 years old.  The most common predictors of smoking were living outside home, presence of family or friends who smoke.
Almogbel et al <sup>30</sup> 2013	Al Hassa, Saudi Arabia	Male college students	337	Convenience sampling	Anyone who was current smoker at the time of the survey.	The prevalence of smoking was 30.9%	The significant predictors of smoking were low academic performance, having friends and family members smokers.
Mansour, <sup>31</sup> 2017	Jeddah, Saudi Arabia	Dental students	336	Convenience sampling	Reported smoking any tobacco product at any point of time.	The prevalence of ever smoking was 25%	Most participants (96%) reported exposure to negative smoking.  Approximately 50% started smoking during the dental program.

**Table 1** - The summary of included studies (continued).

Authors	City/Region	Population (age in years)	Sample size	Sampling method	Definition of smoking as measured in the study	Key outcomes	
						Prevalence	Risk factors
Al-Kaabba et al, <sup>32</sup> 2011	King Fahad Medical City, Riyadh, Saudi Arabia	Students at year one and year 2 in the college of medicine	153	Convenience sampling	Has smoked at least one time during the past 30 days.		Free time, imitation of others and pressure relief were important causes for smoking. While health, religion were important reasons for not smoking.
Al-Turki et al, <sup>33</sup> 2008	Riyadh, Saudi Arabia	Female medical students	447	Convenience sampling	Anyone who was current smoker at the time of the survey	The prevalence of smokers was 2.4%, most of them were shisha smokers. Influence of friends has a substantial effect on initiating smoking in 30% of smokers.	Only 10% blame their smoking parents as a reason for starting smoking.  Three percent of students were positive smokers.
Almutairi, <sup>34</sup> 2014	Riyadh, Saudi Arabia	Medical students	805	Convenience sampling	Regular or irregular Smoking of any kind of tobacco at any point during the survey	11.3% experienced cigarette smoking  4.7% were smoking.	93.1% reported that training should be provided to healthcare professionals for quitting smoking
Almutairi, <sup>35</sup> 2016	King Saud University, Riyadh, Saudi Arabia	Male college students	715	Convenience sampling	Anyone who was current smoker at the time of the survey and those who smoked at least one cigarette every day during the past 30 days.	The prevalence of smoking was 29.8%  13.8% smoke cigarette only  7.3% smoke shisha only  27% used both cigarette and shisha	Students of education college smoked more than students of science college
Baig et al, <sup>36</sup> 2016	Faculty of Medicine, Rabigh, King Abdulaziz University, Jeddah, Saudi Arabia	Medical students	438	Random sample	Anyone who was current smoker at the time of the survey.	Approximately 25.3% of youngsters smoked about 1-10 while 60.7% of them smoked 11-30 cigarettes/day  Approximately 14% smoked >30 cigarettes/day	34.5% had more than one family member who smoked, and 19% had smoker brother and 13% had smoker father.
Subhan et al, <sup>37</sup> 2009	Riyadh, Saudi Arabia	University students	910	Convenience sampling	Combination of daily and occasional smokers.	11.1% of participants were smokers  Cigarettes only were used by 62 students, shisha only by 30, and both cigarettes and shisha by 9	Smoking was more common in males than females.
Mandil et al, <sup>38</sup> 2011	King Saud University, Riyadh, Saudi Arabia	Undergraduate students	6793	Convenience sampling	Anyone who smoke ≥1 tobacco products	14.5% of participants were smokers  22.2% of fathers' participants were smokers. Only 2.2% of mothers were smokers and 43.1% were males and 14.8% were female siblings  15% stated all or most of their friends were smokers  95% CI: for total 13.7-15.3 Fathers 21.2 - 23.2 Mothers 1.8 - 2.5 Males 39.4 - 46.8 Females 13.9 - 15.6	Family member smoker; being singles, and age were the main independent predictors of smoking.



**Table 1** - The summary of included studies. (continued).

Authors	City/Region	Population (age in years)	Sample size	Sampling method	Definition of smoking as measured in the study	Key outcomes	
						Prevalence	Risk factors
Koura et al, <sup>39</sup> 2011	Dammam, Saudi Arabia	Non-medical female college students	1020	Multi-stage stratified random sampling technique using proportional allocation	Anyone who was current smoker at the time of the survey.	8.6% of students were smokers  The prevalence of smoking was 12.1% among literature school students and 3.4% among science college students. Smoking started at a mean age of 16 ± 2.4 years.	
Taha et al, <sup>40</sup> 2010	Eastern area of Saudi Arabia	Male medical students	371	Convenience sampling	Anyone who was current smoker at the time of the survey.	12.6% were shisha smokers  63.8% initiated shisha smoking between age of 16 to 18 years  15% smoked shisha daily	
Abdalla et al, <sup>41</sup> 2007	Tabuk, Saudi Arabia	Adolescent cigarette smokers in grades 7-12 (mean±SD 15.62 ± 1.70)	1505	Two-stage cluster random sample	Has smoked one or more days during the past 30 days.	22.3% of participants were smokers	Gender significantly affected cigarette source, smoking place, smoking intensity, addiction knowledge, and education on tobacco.
Al-Zalabani, <sup>42</sup> 2015	Madinah City, Saudi Arabia	Male adolescents	900	Convenience sampling	Has smoked at least one time during the past 30 days.	The prevalence of smoking was 20.8%. Adolescents who had a higher prevalence of smoking had smoker friends (48.1%) or had a smoker parent (47.4%)	
Alsubaie, <sup>43</sup> 2018	Riyadh, Saudi Arabia	Male adolescent students (mean±SD 17.1 ± 1.33)	453	Convenience sampling	Has smoked at least one time during the past 30 days.	24.3% of adolescents were smokers	Private school students, smoking friends or parents, inadequate health services, and age were the main predictors of smoking.
Algorinnees et al, <sup>44</sup> 2016	Northern Saudi Arabia	Adolescent students (mean±SD 14 ± 11-19)	305	Convenience sampling	Anyone who was current smoker at the time of the survey.	27% smoked 1-3 cigarettes daily, 55.8% smoked 4-10, and 17.2% smoked more than 10  Most smokers had smoked for 26-36 months.	
Mohammed et al, <sup>45</sup> 2014	Saudi Arabia	Adolescents boys (11 to 16)	695	Convenience sampling	Anyone who was current smoker at the time of the survey.	39.6% of adolescents were smokers	Smokers were associated with higher pocket money, living in wealthy families and getting fewer academic degrees.
Al-Makadma et al, <sup>46</sup> 2015	Riyadh, Saudi Arabia	Adolescent students aged 14-19 from high schools	1430	Convenience sampling	Anyone who was current smoker at the time of the survey.	30% of adolescents were smokers in the last month  One in five students reported ever smoked. Boys used tobacco more than girls.	Smokers had substantial less school connectedness than those who never smoked.
Beaver et al, <sup>47</sup> 2016	Jeddah, Saudi Arabia	Youth (mean±SD 16.27 ± 1.24)	500	Convenience sampling	Anyone who was current smoker at the time of the survey.	The prevalence of students who smoked at least once was 12.7%, those who drank alcohol at least once was 2.6%, and those who consumed prohibited drugs was 3%	Having smoking friends was the most significant predictor of smoking, while low self-control had no significant relationship.

years, prohibiting smoking on health and educational premises and on public transport, banning smoking advertising in the media, and raising taxes and the cost of tobacco products, could be used to reduce the uptake and prevalence of smoking.<sup>23,28</sup> Moreover, a systematic review assessed adolescent smoking prevention programs and confirmed the need for new school-based programs to reduce the prevalence of smoking. These programs should target risky populations, depend on qualified health professionals, and use updated methods to achieve widespread success.<sup>57</sup>

Our findings are consistent with the results of a 2014 systematic literature review exploring the prevalence of smoking among Saudi students which was published in 2014 with 12 relevant studies published until October 2013. In that review, the prevalence of smoking among adolescents ranged from 10% to 30%.<sup>58</sup> The literature also suggests that males smoke more than women.<sup>59</sup> Likewise, the current study accords with a 2013 report of the WHO which reported that the prevalence of tobacco smoking was 25.2% among males and 1.9% among females in Saudi Arabia.<sup>5</sup>

In its 2011 report regarding smoking prevalence in the Middle East and North Africa, the WHO announced that the lowest smoking prevalence was found in Morocco (15.1%), whilst the highest prevalence was found in Lebanon (38.5%). Among males, the lowest smoking prevalence was reported in Saudi Arabia (20.2%) while the highest was found among the Syrians (62%). Among females, it varied from 0.2% among Moroccans to 31.5% among Lebanese.<sup>60</sup> Our results are in agreement with the results of western studies. In 2015, the proportion of smokers in the UK was 23.1%, while in the United States it was 22.3% among adults.<sup>5</sup> A systematic review of 59 studies published up to 2011 reported that the tobacco use ranged from 2.4% to 22% among Brazilian adolescents.<sup>61</sup>

This study has been limited by the lack of quantitative meta-analysis. The authors also included articles published between 2007 and 2018 which may introduce selection bias and affect the overall inferences. Nevertheless, our results have implications for the promotion of interventions to reduce tobacco use. These interventions should include approaches to progress school cohesion and involve family members as role models. Our findings can also be used to inspire authorities in the education sector to implement suitable actions to resolve the problems related to smoking and encourage religious education. It is highly recommended that further and detailed studies of

smoking prevalence be conducted at regular intervals to help in guiding policy changes and interventions to reduce the prevalence of smoking.

Multicenter future studies are recommended to investigate the variation in smoking prevalence among various regions of Saudi Arabia.

In conclusion, this review highlights that the prevalence of smoking is relatively high among adolescents in Saudi Arabia ranging from 9.7% to 37% among secondary school students, 2.4% to 30.9% among college students, and 12.7% to 39.6% among adolescents age group without educational specifications. The social influence of friends, teachers or parents, low academic performance, having spare time, living away from home, and the desire to relieve stress were the most commonly reported risk factors for smoking. It is noteworthy that strong religious beliefs could reduce the risk of tobacco use. Further public health interventions are needed to increase the awareness of adolescents of the dangers and consequences of smoking, and thereby help them to quit smoking. Future healthcare policies should consider the variable definitions and wide-ranging estimates of smoking among different populations and regions reported in the published literature.

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