

REVIEW ARTICLE

Towards Healthy Adolescents: A Review of Smoking Impact According to Dental Perspectives

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ABSTRACT

Nowadays, tobacco companies target to recruit new smokers among adolescents due to this age group was easy to be influenced by smoking behaviours. This narrative review aimed to explore the possible impact of smoking among adolescents. Knowing the negative impacts of smoking might result in avoiding continuing the habit or preventing from initiation of the habit. The literature search on PubMed, SCOPUS, and Epistemonikos database with related search terms of “adolescents”, “smoking” and “impact”. Only papers published within the year 2017 to 2021 and in the English language were included. However, articles without full text were excluded from this review. Fourteen articles were selected and divided impacts into three categories which are effect on oral health, effect on general health and other impacts. Possible impacts of smoking among adolescents were identified, and it could be beneficial in the development of customized smoking prevention or smoking cessation intervention for adolescents.

Malaysian Journal of Medicine and Health Sciences (2023) 19(1):316-324. doi:10.47836/mjmhs19.1.40

Keywords: Impact, Smoking, Adolescents, Oral health, Cessation

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INTRODUCTION

Adolescence is a stage of rapid maturation that remark with rapid growth, learning, and adaptation and is easily influenced by risky behaviours including smoking behaviour (1). Global Youth Tobacco Survey had reported a range between 1.7% to 35.0% among adolescents aged 13 to 15 years old were current tobacco smokers (2) and an average of 30% of adolescents have tried smoking at the age of 12 to 19 years old (3). Although the prevalence of cigarette smoking among adolescents decreased significantly from 11% in 2013-2014 to 7.9% in 2018-2019 (4), there was also about a 10% increase in the prevalence of e-cigarette users within a year especially in developed countries (4-7). With the changes in strategies of tobacco companies which focus to recruit new smokers among adolescents and women (1,8), there is a need for them to understand the consequences of smoking. Smoking can cause death reported around 7 million people die and had been projected by 2030, more than 8 million people would be affected by diseases caused by tobacco use if the global smoking pattern does not change (9). Various studies also reported on the detrimental effect of smoking on health which caused the loss of healthy life and contributed to non-communicable diseases (10)

and resulted in significant financial burdens attributable to smoking-related diseases (11).

The negative effects of smoking also have an impact on oral health. Previous study reported smoking associated with an increased risk of dental caries experience (OR = 1.88, 95% CI: 1.3-2.7) (12), periodontal diseases (RR =1.85, 95% CI:1.5, 2.2) (13) and halitosis (OR=2.00 [95% CI, 1.25-3.21 (14) compared to non smokers. Moreover, the highest chance of acquiring oral cancer was also reported among smokers (OR: 46.87, 95% CI: 31.84-69.00) (15). Large numbers of evidence reported on smoking impact among the adult populations and smoking impact focusing on adolescents are still scarce. Therefore, this review aimed to explore the possible impact of smoking on adolescents.

Furthermore, a previous study found that smokers have a one-decade shorter life expectancy compared to non-smokers (16), emphasising the need of raising knowledge about the impact of smoking among adolescents, thus smoking-related morbidity and mortality might be avoided at a younger age. In line with the previous finding which reports that knowing the negative impacts of the behaviour will prevent a person from continuing the behaviour (17,18) and it applies to smoking behaviour.

METHODS

Three online databases, namely PubMed, SCOPUS and Epistemonikos were used for literature search, including

manual search. The main keywords used in the search were ‘adolescent’, ‘youth’, ‘teen’, ‘smoking effect’, and ‘smoking impact’. Before running the searching process, the user guide of the database was referred to. Boolean operator, wildcard and truncation term were used appropriately in the search string. Inclusion criteria for eligible in this review were published studies of the last five years (2017 -2021), studies which involve adolescents (19), outcome measures on smoking impact related to adolescents and also limited to English language articles only. No restriction on study design or sex of participants. Articles which not available in full were excluded from the review. There were total of 3578 articles identified and all articles were imported to Mendeley referencing software and removed all the duplicates before screening the title and abstract. Full text articles were retrieved to identify potential studies that were relevant to the topic after screening articles which met inclusion criteria. Each full article was assessed by two authors independently. For the data collection process, two reviewers independently extracted and reported the following information including study design, population and outcomes. Finally, after undergoing the screening process, there were 14 articles included and this process is reflected in the flowchart as in Figure 1. The quality of research evidence for each study was assessed using critical appraisal tools according to STROBE or CASP checklist (20).

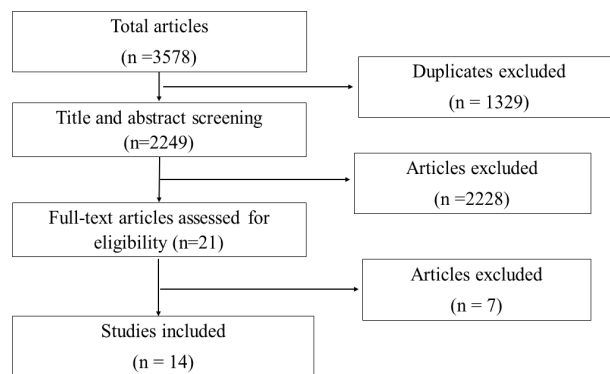


Figure 1: Flowchart of methods applied in this review

RESULTS

The findings from this review were divided into three categories which are oral health effect (21–27), general health effect (28–32) and other effects (33,34). A summary of data extraction for included articles was presented in Table I.

DISCUSSION

Effect of smoking on oral health

Smoking causes a change in bacterial profile in the oral cavity. The oral cavity serves as shelter which places more than seven hundred species of bacteria and these

Table I: Impact of smoking among adolescents

IMPACT OF SMOKING		COUNTRY	STUDY DESIGN/SAMPLES	RESEARCH TOOLS	KEY FINDINGS
ORAL HEALTH	Changes in bacterial profile	Jordan (21)	Cross-sectional/ 150 participants	Clinical examination & Molecular technique	Smoking increases the prevalence of other periodontopathogenic bacteria (<i>Slackia exigua</i> , <i>Selenomonas sputigena</i> and <i>Campylobacter rectus</i>) by 910%, 562%, and 462% times, respectively.
	Dental Caries	Karachi, India (22)	Cross-sectional/ 500 participants	Questionnaire & Clinical examination	Environmental tobacco smoking and dental caries had a statistically significant association (p<0.05) with an adjusted prevalence ratio was 1.25 for children exposed to <30 minutes of ETS (95% CI: 1.08- 1.46) in comparison to non-exposed children and adjusted prevalence ratio was 1.36 for children exposed for >30 minutes of ETS [95% CI: 1.09-1.70] compared to non-exposed children.
		Jiangxi Province, China (23)	Cross-sectional/ 8,160 participants	Questionnaire & Clinical examination	Adolescents who did not smoke were less likely to suffer from caries than those who smoked (OR = 0.644, 95%CI:0.485–0.854).
		Poland (24)	Cross-sectional/ 1,611 participants	Questionnaire & Clinical examination	Adolescents who smoked regularly had significantly more unfilled cavities (OR 2.10, p <0.001), more often suffered from oral pain or discomfort (OR 1.32, p <0.05), and had worse dietary habits (OR2.73, p <0.001) in comparison to 18-year-olds without these behaviours.
		Riyadh, Saudi Arabia (25)	Cross-sectional/ 302 participants	Questionnaire & Clinical examination	Decayed, missing, and filled teeth (DMFT) index was significantly higher among schoolchildren who had smoking mothers & fathers [mean DMFT-smoking mothers (SD): 9.1(4.70), p<0.05], [mean DMFTsmoking fathers (SD): 6.95 (3.95), p<0.05] compared to that among schoolchildren who had non-smokers parents [mean DMFT non-smoking mothers (SD): 6.29 (4.01)], [mean DMFT non-smoking fathers (SD): 6.01 (4.06)].
	Periodontal disease	Dammam and Khobar, Saudi Arabia (26)	Cross-sectional/ 685 participants	Questionnaire & Clinical examination	Current smoking was significantly associated with more severe gingivitis when consuming sugary drinks (Regression coefficient = 0.63, 95% CI: 0.04 -1.22). Gingivitis is a risk factor for periodontitis.
	Dental pain	Mexico (27)	Cross-sectional/ 638 participants	Questionnaire & Clinical examination	The multivariate model of binary logistic regression analysis shows those who reported being former smokers (OR 2.37, 95%CI:1.12–5.01) and current smokers (OR 1.25, 95%CI:0.79–1.97) are more likely to have experienced dental pain than those who had never smoked.

Table 1: Impact of smoking among adolescents (Continued)

IMPACT OF SMOKING		COUNTRY	STUDY DESIGN/SAMPLES	RESEARCH TOOLS	KEY FINDINGS
GENERAL HEALTH	Mental health	Brescia & Naples provinces, Italy (28)	Cross-sectional/ 3002 participants	CES-DC (Center for Epidemiological Studies-Depression Scale for Children) and SDQ (Strengths and Difficulties Questionnaire).	Tobacco and alcohol use, screen time, physical and psychological bullying, and negative school climate perception were associated with depressive symptoms with odds ratios ranging from 1.2 to 3.3
		Shandong Province, China (29)	Cross-sectional/ 4630 participants	Questionnaire & Symptom Checklist 90 (SCL-90).	Smoking in Chinese students was a positive predictor of psychological problems related to phobic anxiety (OR1.04, 95%CI:0.76–1.41, $p < 0.01$), psychoticism (OR1.12, 95%CI:0.91–1.39, $p < 0.01$), obsessive-compulsive disorder (OR 1.03, 95%CI:0.86–1.24, $p < 0.01$), and interpersonal sensitivity (OR1.02, 95%CI:0.73–1.38, $p < 0.01$).
	Quality of sleep	Taiwan (30)	Longitudinal study/ 1678 participants	Questionnaire & Sleep Quality Index (SIQ)	A study found that accumulated waves of sleep disturbance and social jetlag in adolescence were significantly associated with an increase in cigarette use in young adulthood.
	Asthma	Korea (31)	Cross-sectional/ 216,056 participants	Questionnaire	Active smoking was significantly associated with asthma (AOR smoking ≥ 20 days/month=1.57, 95%CI: 1.38–1.77, $p < 0.001$). Passive smoking was also related to asthma (AOR smoking ≥ 5 days/week =1.40, 95%CI:1.28–1.53, $p < 0.001$).
	Respiratory diseases	China (32)	Longitudinal study	Questionnaire	Life-course-adjusted smoking consumption is significantly positively associated with risks of incident respiratory diseases and these risks will further increase with age.
OTHER'S EFFECT	Dental fear	Finland (33)	Cross-sectional/ 2486 participants	Questionnaire	Adolescents reporting tobacco use were more likely to have dental fear than non-users, even when adjusting for oral health habits, gender, and parents' occupation.
	OHRQoL	Kathmandu, Nepal (34)	Cross-sectional/ 250 participants	Questionnaire & OHIP-14	Overall score of Oral health Impact Profile-14 (OHIP-14) among current smokers was significantly higher compared to non-smokers which indicates the current smokers had poorer OHRQoL compared to non-smokers.

bacteria usually colonize hard tissues such as teeth or soft tissues of the oral mucosa (35). Most bacteria coexist with their hosts in a symbiotic relationship. In health, these oral microflora acts as a “protector” against invasion from pathogenic bacteria into the human body. However, varieties of bacteria profiles can be found among smokers due to exposure to bacteria in cigarettes themselves which are derived from tobacco leaves (36) such as Bacillus, Pseudomonas, Lactococcus, Clostridium, Staphylococcus, Enterobacter, Aspergillus or Penicillium (37–39). Moreover, cigarette smokes also contains thousands of chemicals which are harmful to one’s health. The harmful compounds such as ammonia, tar, cadmium or benzene (40) can be produced during tobacco combustion or can be found in the tobacco itself (41). When a person smokes, oral surfaces are found to be the first contact with tobacco smoking. The content of toxic substances in cigarette smoke has the potential to cause damage to the mucosal tissue and other structures in the oral cavity (42). When oral dysbiosis occurs (35) it will lead to the development of oral diseases such as dental caries or periodontitis (43,44).

Besides, smoking also impaired immune processes and weaken the host’s ability to fight illness. The ingredients in cigarette contents can lower the bactericidal activity of neutrophils which has important roles in the immune system’s defence mechanism as well as in the formation of inflammatory reactions (45). In line with a previous

study reported low-level cigarette smoke exposure to be adequate to impair neutrophil activities without causing cell death. Compromised neutrophils will compromise the antimicrobial function which may put the host at risk of persistent infections (46).

In the oral cavity, the increasing number of cariogenic microorganisms was induced by the components in cigarettes. Furthermore, the caries susceptible environment occurs due to the influence of smoking on saliva by altering the bacterial component and buffer capability which contribute to the formation of dental caries (47). The demineralization process of hard tissues occurs by bacteria in the oral cavity when degrading the process of fermentable carbohydrates (48). Previous studies reported the effect of nicotine on cariogenic bacteria and the findings discovered that nicotine promotes the adhesion of cariogenic bacteria such as Streptococcus mutans to the dental surfaces, increasing the incidence and severity of dental caries (47,49).

Smoking behaviour shows a significant risk factor for periodontal disease and been reported smoking increased the destruction of periodontal structures (50). This finding is in line with previous studies which showed that periodontitis often occurs in smokers (51). This situation can be explained by low levels of many pro-inflammatory cytokines and chemokines, as well as several T-cell and NK-cell regulators among

smokers. This reflects smoking's immunosuppressive effects, which may lead to an increased vulnerability to periodontitis (52). Although smoking reduces the gingival bleeding response to plaque due to significantly reducing the size of 4 to 8mm in diameter of the blood vessel (53), there is evidence showing smokers had a higher plaque index compared to nonsmokers (53) which may contribute to severe gingivitis. Fortunately, within a week of quitting smoking, the inflammatory and bleeding responses to the plaque will changeable (50). Therefore, it is worth developing the specific preventive and provided treatment of chronic periodontitis or other destructive oral diseases induced by a dental plaque to be included in smoking cessation intervention programs for smokers.

Effect of smoking on general health

Smoking has been linked to a variety of psychological problems, including depression and anxiety disorders. One study found that the prevalence of depression among adolescents who smoked significantly increased from 15.98% in 2005 to 22.42% in 2013. This finding shows that more than one in five adolescents who smoke undergo depression (54). Moreover, there is evidence that shows the risk of depression increases due to smoking and this can be explained by the changes in neurophysiology caused by nicotine (55). Nicotine is the main ingredient in cigarette smoke that can bind to the receptors in the brain namely nicotinic acetylcholine receptors, as a result, it caused the release of dopamine which signals a pleasurable experience and lead to addiction (56). However, the pleasurable sensation is temporary and will shortly be followed by withdrawal symptoms and increased cravings. Later nicotine addiction occurs and leads to nicotine dependence which in turn encourages smokers to smoke more (57). Therefore, smokers will face more severe withdrawal symptoms related to anxiety, restlessness and depressed mood (58,59). Lawrence et al reported adolescents and young adults who were initiate smoking recently, had the greatest rates of mental illness which one-third of male smokers (37.2%, 95% CI: 28.0%–46.4%) and more than half of female smokers (58.7%, 95% CI: 48.7%–68.5%) had a 12-month mental illness (60).

Another impact of smoking due to the presence of nicotine in cigarettes can cause sleep disturbance (61). Nicotine can trigger the release of many neurotransmitters that together assist in regulating the sleep-wake cycle, which can alter sleep. Smokers also often experience acute withdrawal when the nicotine concentration in plasma decreases during sleep known as nocturnal sleep-disturbing nicotine craving (62). It usually happens to those who are unable to retain a sufficient level of nicotine through the night (62) and smoking can impact on airways which leads to sleep-related breathing disorders such as apnea (63). Poor sleep, on the other hand, has been connected to poor health-related quality of life (64).

Smoking can affect the respiratory system which is a high prevalence of the respiratory disease reported among smokers (65). Smoking can cause blackening of the lung tissue due to the accumulation of hydrophobic nano carbon black which is one of the ingredients in cigarettes (66). Smoking also can destroy the alveoli and surrounding capillary beds due to smoking-induced lung inflammation which can promote emphysema development (67).

Other effects of smoking

Dental fear was found as one of the smoking impacts and more prevalent in male adolescent smokers (68). Dental fear develops as a result of nicotine dependency which can lead to an increase in anxiety levels (68). According to a previous systematic study, dental fear is a prevalent condition among children and adolescents, with at least one person out of ten suffering from dental fear and avoid to accept any dental treatment (69). Avoidance of dental treatment causes poor dental health conditions (70) and at the same time might result in poor quality of life (71). It is critical to inquire about smoking behaviours as well as dental phobia as part of risk assessment when reviewing the oral health status among adolescents. Smokers with dental fear should treat using behavioural interventions, pharmacological interventions, or a combination of both (72).

There were few studies have examined the effect of smoking on the quality of life in various countries. Bakri et al examine dentate adults in England (73), Ahsan et al. examine patients aged above 18 years in India (74), Sagtani et al. examine the Nepalese population and Dube et al. examine adolescents in the United States (75). The main finding from these studies suggests smokers are more likely to report the worst quality of life. Therefore, it is important for public health efforts to concentrate on smoking cessation. Smoking has long been known to be hazardous to oral health and general health. Prevention programmes, cessation intervention efforts, and regulations should be in place to address this behaviour.

The important role of dentists in reducing smoking impact

Dentists must have the responsibility to fight tobacco use and realise the importance of combining dental treatment with tobacco use prevention and cessation interventions. In line with previous findings which reported dentists should have a favourable attitude toward commencing tobacco cessation programmes (76,77). According to Yahya et al (2018), a well-equipped dentist is capable to persuade smokers to quit and been suggested that brief intervention can be a convenient method for smoking cessation combined with other dental treatments (78). The involvement of dentists in smoking cessation activities brings benefits such as easier to identify signs and symptoms of smoking through a mouth examination and due to the importance of their facial appearance

and oral hygiene, patients will visit the dentist regularly (79). Thus, the dentist's role is to identify tobacco use, provide basic information regarding the harmful effect of smoking and recommend available referrals for smoking cessation services (80).

The ability of dentists to deliver effective smoking cessation interventions is not doubtful anymore. As members of the healthcare team, multidisciplinary concepts encourage dentists to integrate their professional abilities to deliver smoking cessation to their patients (81). According to previous research, patients who received dentist advice in tandem with cessation medications had nine times higher chances of quitting attempts (AOR: 9.85, 95% CI: 7.77–12.47) compares to the control group (82). Broadening the scope of dentists' involvement in managing their patients' overall health, the preventive message that they delivered broadened up to be included the risk factors for chronic diseases such as smoking or diet intake, both of which are linked to risk factors for oral diseases (83). Therefore, this could lead to improvement in oral health prevention practices. Furthermore, the dentist should play their role through collaboration with other stakeholders either at the individual level or community level (84). Nishina et al. demonstrate the efficacy of a collaborative smoking cessation programme comprising medical, dental, and pharmaceutical specialists who can promote short-term adherence to smoking cessation with 70% to 80% of participants remaining abstinent at one month and 6 months after completing the program (85). Implementation of smoking cessation program through School Dental Services also give benefit to schoolchildren which prevent smoking initiation at an early age (86). Moreover, such a program has shown effective in preventing smoking initiation among school children (87,88).

There may be a possible limitation in this review. Selected studies in this review did not represent all the possibilities of smoking's impact such as the smoking impact on halitosis or oral cancer. This might be explained due to a lack of previous research studies on this topic. Studies regarding the short term and long term impact of smoking, especially among adolescents, need to be explored in the future. Nevertheless, this review gives a perspective on the recently updated evidence base regarding the implication of smoking on adolescents' health.

CONCLUSION

In conclusion, this review emphasizes the possible impact of smoking among adolescents. From a dental perspective, smoking is linked to several chronic conditions to potentially life-threatening conditions which not only affected the oral cavity but also general health as a whole. It is possible to ensure that smokers are assisted at every opportunity by familiarising the

dental team with cessation guidance. Awareness of the harmful effects of smoking can increase by knowing the negative impacts and encouragement to quit this habit. Furthermore, early cessation could avoid nicotine dependence and improve adolescents' health.

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