The impact of peer pressure on cigarette smoking among high school and university students in Ethiopia: A systemic review and meta-analysis

Cheru Tesema Leshargie1,*, Animut Alebel1, Getiyi Dejenu Kibret1, Molla Yigzaw Birhanu1, Henok Mulugeta1, Patricia Malloy2, Fasil Wagnew1, Atsede Alle Ewunetie1, Daniel Bekele Ketema1, Alehegn Aderaw1, Moges Agazhe Assemie1, Getachew Mullu Kassa1, Pammla Petrucka3,4, Amit Arora5,6,7,8
1 College of Health Sciences, Debre Markos University, Debre Markos, Ethiopia, 2 Department of Nursing, College of Nursing, University of Saskatchewan, Regina, Canada, 3 Colleges of Nursing, University of Saskatchewan, Saskatoon, Canada, 4 School of Life Sciences and Bioengineering, Nelson Mandela African Institute of Science and Technology, Arusha City, Tanzania, 5 School of Science and Health, Western Sydney University, Penrith, NSW, Australia, 6 Translational Health Research Institute, Western Sydney University, Penrith, NSW, Australia, 7 Discipline of Child and Adolescent Health, Sydney Medical School, Faculty of Medicine and Health, The University of Sydney, Westmead, NSW, Australia, 8 Oral Health Services, Sydney Local Health District and Sydney Dental Hospital, NSW Health, Surry Hills, NSW, Australia

* chertesema@gmail.com

Abstract

Background

Cigarettes and their by-products (i.e., smoke; ash) are a complex, dynamic, and reactive mixture of around 5,000 chemicals. Cigarette smoking potentially harms nearly every organ of the human body, causes innumerable diseases, and impacts the health of smokers and those interacting with the smokers. Smoking brings greater health problems in the long-term like increased risk of stroke and brain damage. For students, peer pressure is one of the key factors contributing to cigarette smoking. Therefore, this systematic review and meta-analysis assessed the impact of peer pressure on cigarette smoking among high school and university students in Ethiopia.

Methods

An extensive search of key databases including Cochrane Library, PubMed, Google Scholar, Hinari, Embase and Science Direct was conducted to identify and access articles published on the prevalence of cigarette smoking by high school and university students in Ethiopia. The search period for articles was conducted from 21st September, 2018 to 25th December 2018. All necessary data were extracted using a standardized data extraction checklist. Quality and risk of bias of studies were assessed using standardized tools. Heterogeneity between the included studies was assessed using Cochrane Q-test statistic and I² test. To estimate the pooled prevalence of cigarette smoking, a random effects model was fitted. The impact of peer pressure on cigarette smoking was determined and was reported...
Results
From 175 searched articles, 19 studies fulfilled the eligibility criteria and were included in this study. The pooled prevalence of cigarette smoking among Ethiopian high school and university students was 15.9% (95% CI: 12.21, 19.63). Slightly higher prevalence of cigarette smoking was noted among university students [17.35% (95% CI: 13.21, 21.49)] as compared to high school students [12.77% (95% CI: 6.72%, 18.82%)]. The current aggregated meta-analysis revealed that peer pressure had a significant influence on cigarette smoking (OR: 2.68 (95% CI: 2.37, 3.03)).

Conclusion
More than one sixth of the high school and university students in Ethiopia smoke cigarette. Students who had peer pressure from their friends were more likely to smoke cigarette. Therefore, school-based intervention programs are needed to reduce the high prevalence of cigarette smoking among students in Ethiopia.

Introduction
Smoking cigarettes yields a complex, dynamic and reactive mixture of around 5,000 chemicals [1–3]. Globally, it is one of the leading preventable causes of respiratory tract complications, disability, and early deaths related to complications [4–7]. It accounts for six of the eight leading causes of morbidity and mortality [5]. Essentially, it is a legal drug that kills many of its users when used exactly as intended by manufacturers. Currently, the World Health Organization (WHO) estimates that the use of both smoking and smokeless tobacco account for around 6 million deaths worldwide annually, of which 600,000 deaths were among non-smokers due to exposure to the smoke [8]. More than 30% of world’s adult population are consumers of tobacco, which leads to a warning that a billion people will die of adverse health effects related to the tobacco epidemic within the 21st century unless effective preventative measures are undertaken [3].

Smoking affects almost every organ in the human body (such as circulatory, respiratory, gastrointestinal and musculoskeletal systems), increases the risk for several diseases, and reduces the health of smokers in general [9, 10]. The key effect of smoking cigarettes is primarily on the lungs with approximately 85% of chronic obstructive pulmonary disease (COPD) and lung cancer and about 33% of other cancers (i.e., esophagus, oral cavity, uterus, stomach, and pancreas) related to smoking [9–11].

Normal adolescent developmental stage is affected by high level of peer pressure that can influence risk-taking behaviors including substance use [12]. Globally, especially in low- and middle-income countries, an estimated 80% of the one billion adolescent smokers are suffering from tobacco-related morbidity and mortality [7]. Cigarette smoking negatively influences the physical and mental health of an individual [13]. This is particularly true for high school and university students who already face major health challenges such as stress [14]. Smoking is also associated with poor educational performance, high-risk drinking behavior, illegal drug use, and high-risk sexual behaviors [14, 15]. Peer pressure is widely recognized as a crucial
factor affecting young people’s early experimentation with tobacco and their willingness to continue smoking [16]. Several students attending higher education institutions practice cigarette smoking for several reasons, such as a way to cope with stress [17]. Factors that contribute to the continued use of tobacco include being male, drinking alcohol, having a friend who drinks alcohol, having a friend who smokes, having family members who smoke and being older in age, to mention some [18].

In sub-Saharan Africa, the prevalence of smoking is increasing and is projected to continue to increase [19, 20]. The current data in the region reveals substantial variation in smoking rates among countries ranging from 1.8% in Zambia to 25.8% in Sierra Leone [21]. In Ethiopia, cigarette smoking is among one of the most commonly used substances, which leads to addiction [22]. It has deleterious effects on the health of the young users, significantly reduces academic performance in students and increases risk of contracting HIV and other sexually transmitted diseases. Several primary studies on the prevalence and associated factors of cigarette smoking among high school and university students have been conducted in Ethiopia [23–37]. According to earlier reviews of the literature, prevalence of smoking in Ethiopia ranges from 2.99% in Addis Ababa [38] to 28.6% in Hawassa and Jimma University [30]. Therefore, this systematic review and meta-analysis aimed to review the pooled prevalence of cigarette smoking among high school and university students in Ethiopia and the impact of peer pressure on cigarette smoking among high school and university students in Ethiopia.

Method and materials

This systematic review is based on the Preferred Reporting Items of Systematic Reviews and Meta-Analysis (PRISMA) checklist guidelines to ensure scientific rigor [39] (S1 Table). Prospective registration of systematic review and meta-analysis promotes transparency, helps reduce potential for bias, and improves review’s credibility. However, this meta-analysis and systematic review was not registered on the prosperous, and we have acknowledged this gap in the limitation section.

Setting

This systematic review and meta-analysis reports data from Ethiopia. Ethiopia is located in the north-eastern part of the African continent or what is known as the “Horn of Africa”. The country is divided into nine regional states and two administrative cities [40] containing a total of 108,386,391 million population with a national density of 94 people per square kilometer, 2019 [41]. Ethiopia shares land borders with five countries: Sudan, Somalia, Djibouti, Eritrea, and Kenya [42].

Inclusion and exclusion criteria

Eligibility criteria. This systematic review and meta-analysis included studies only conducted in Ethiopia that assessed the prevalence of cigarette smoking. Published articles were reviewed and rated for inclusion. Full articles were retrieved if a specific outcome of interest (smoking status) was defined. This review included all observational study designs (cross-sectional studies, case-control studies, and cohort studies). However, case reports or case series, duplicate reports, and inconsistent outcome measures were excluded. Moreover, we excluded articles that were published in a language other than English. Documents that were not accessible after contacting the principal investigator three times by email were also excluded. Articles that reported measures other than Relative Risk (RR) or equivalent values, or from which an Odds Ratio (OR) could not be calculated were also excluded from consideration. The eligibility criteria for each individual article were checked by three authors independently (CT, AA1, and...
AA2). If there was a disagreement between the two authors, a third person (UGM) resolved the disagreement. All reviewers came together in person and discussed the assessment results.

**Information sources**

This systematic review and meta-analysis were conducted by considering all the available studies (both published and open grey reports), governmental and other stakeholder annual reports, and national surveys on children and adolescents which have data on cigarette smoking among high school and university students in Ethiopia. An extensive search was done from the following international databases, including Cochrane Library, PubMed, Google Scholar, Hinari, Embase, CINAHL, Web of Science, and Science Direct to access articles conducted on the prevalence of smoking cigarette. The following keywords “prevalence”, (“cigarette smoking” OR “cigarette smoking” OR “cigarette smoking” OR “cigarette smoking” OR “cigarette smoking” AND “smoking” AND “cigarette smoking” AND “smoking”) OR “cigarette smoking” AND “substance”) OR “high” OR “school” OR “university”) AND (“students”) AND (“Ethiopia”) were used to obtain published articles. Boolean operators particularly pairing aspects of “OR” or “AND” were used as search terms to separate articles. The search for all articles was conducted from 21st September, 2018 to 25th December, 2018 (S2 Table).

**Data items**

This systematic review and meta-analysis had two outcomes. The first outcome was the pooled prevalence of cigarette smoking among high school and university students in Ethiopia, which was calculated by dividing the number of smokers to the total students (sample size) multiplied by 100. The second outcome was the impact of peer pressure on cigarette smoking practice. We adjusted the effect size into Odd Ratio (OR) since all the studies were cross sectional and the appropriate effect size estimate for cross sectional design is OR to estimate the impact of peer pressure on cigarette smoking.

**Data extraction**

The necessary data (primary author, publication year, region, study design, sample size, prevalence of cigarette smoking) were extracted from the eligible articles by two authors (CT, AA and AA1) independently using prepiloted data extraction format prepared in Microsoft Excel spreadsheet (S3 Table). Any disagreements between the three reviewers in the review process were discussed with the three reviewer team members (GD, DB and PM) until consensus was reached. Moreover, the data of kappa of agreement during the systematic searches was also used to solve the disagreements among two independent reviewers (CT and AA4). The kappa agreement was interpreted as less than chance agreement if less than 0, slight agreement if 0.01–0.20, fair agreement if 0.21–0.40, moderate agreement if 0.41–0.60, substantial agreement if 0.61–0.80 and moderate agreement if the kappa was 0.81–0.99 [43].

The four authors (CT, FW, MA and AA1) also independently extracted data on the association of cigarette smoking and peer pressure. If studies did not report OR, RR, or equivalent measures, raw data were screened to determine whether OR could be calculated. When the studies reported both the crude OR/RRs and the adjusted OR/RRs, the adjusted figures were extracted.
Quality assessment of the included studies

We assessed the quality of the included studies according to the Newcastle-Ottawa Scale (NOS) [44] (S4 Table). The NOS has three main domains and uses a star-based grading system with each study scoring a maximum of 10 stars. The first domain focuses on the methodological quality of the study (sample size, response rate, and sampling technique) with the possibility of a five-star grading (1 = poor to 5 = excellent). The second domain of the tool deals with the comparability of the study cases or cohorts, with the possibility of two stars. The last domain deals with the outcomes and statistical analysis of the study with a possibility of three stars. Three authors (MA, UGM, and DB) independently assessed the quality of each included study using the NOS. Any disagreement between the three authors was resolved by requesting other two authors (MY and PP) to independently assess the methodological quality to reach a consensus. Finally, studies with stars of ≥ 7 out of 10 were considered to be of a high quality [45]. Moreover, we assessed the quality of each included articles using National Institutes of Health (NIH) (S5 Table) which is a more detail tool on quality assessment than NOS. The tool has 14 criteria to assess the article independently with a response of "Yes, No and Not Applicable". Articles with NIH assessment result of 85% and more (that means number of articles with yes divided by total criteria minus not applicable) were considered as good quality.

Risk of bias

For each included study, the risk of bias was assessed independently by two authors (UGM and CT). Risk of bias assessment was carried out using Holly 2012 tool which contain 10 recommended criteria for the internal and external validity tool [46]. This tool includes: representation of the population, sampling frame, methods of participants’ selection, non-response bias, data collection directly from subjects, acceptability of case definition, reliability and validity of study tools, mode of data collection, length of prevalence period; and appropriateness of numerator and denominator. Each item was classified as low and high risk of bias. Unclear assessment was classified as high risk of bias. The overall score of the risk of bias was then categorized according to the number of high risk item scores for bias per study: low (≤ 2), moderate (3–4), and high (≥ 5) (S6 Table).

Statistical data analysis

Standard error for all included studies was computed using the binomial distribution formula. Heterogeneity across studies were assessed by determining the p-values of Cochrane Q-test and I²-test statistics [47]. For meta-analysis result with significant heterogeneity, univariate meta-regression was used to assess the source of heterogeneity across each study. A funnel plot was also used for visual assessment of the publication bias. Asymmetry of the funnel plot is an indicator of potential publication bias. Furthermore, Egger’s test was used to determine if there was significant publication bias, and a p-value less than 0.10 was considered to indicate the presence of significant publication bias [48]. We selected Egger’s test to assess the publication bias because, the value of Egger’s test is more specific than Begg’s test [49, 50]. We conducted the log relative risk to assess the effect of peer pressure on students’ cigarette smoking status. Furthermore, sensitivity analysis using a random effects model was performed to assess the influence of a single study on the pooled prevalence estimates. Subgroup analysis was used to minimize the random variations between the point estimates of the primary study subgroup, and analysis was done based on study settings (i.e., institution). Univariable meta-regression analysis was also conducted with year of publication and the outcome variable. All data manipulation and statistical analysis were performed using Stata™ software (Version 14; Stata Corp, College Station, TX).
Results
The electronic database search identified a total of 179 published articles. Of these, 121 duplicate articles were removed. Furthermore, 28 articles were removed after reviewing the titles and the abstract as they were not relevant to the focus of the review. Finally, one article was excluded due to inaccessibility of the full text despite three requests to the primary author on data, and 10 articles were excluded after reviewing their full text. Finally, 19 articles met all the prior criteria and were included in this analysis (Fig 1).

Overview of the original included articles
All of the 19 articles included in this study were published between 1999 to 2017 in peer-reviewed journals. A total of 16,486 study participants were included in this systematic review and meta-analysis. The smallest sample size was 155 from a study conducted at Bahir Dar University [36], and the largest sample size was 1,984 in a study conducted in Gondar Medical College, Amhara Region [34]. All included studies were cross-sectional in design. The characteristics of the studies included in this review are described in (Table 1).

Quality assessment result of the included articles
The qualities of individual articles were assessed using different tools; namely NOS and NIH quality assessment tools. Accordingly, NOS assessment result all articles had good quality using the NOS criteria. However, when assessed using NIH quality assessment tool, 1 (5.3%) study [36] was categorized as poor and the rest [11, 15, 23–35, 37, 38, 51] were categorized as good quality (S5 Table).

Kappa agreement
Disagreements between the two reviewers during data extraction process were assessed using the Kappa agreement. Therefore, a = 9 and b = 2 represent the number of times the two reviewers agreed while c = 1 and d = 7 represent the number of times the two reviewers disagree. If there are no disagreements, b and c would be zero, and the reviewers agreement (po) is 1, or 100%. If there are no agreements, a and d would be zero, and the reviewers agreement (po) is 0. Interobserver agreement was 68% that indicate a substantial agreement between the two main reviewers who extracted data.

Risk of bias
Risk of bias was performed for each included study using the risk of bias assessment tool that includes ten different items [46]. From the 19 included studies, the risk of bias summary assessment revealed that 94.7% of the included studies had a low risk of bias [15, 23–35, 37, 38, 51] while only one (5.3%) of the included studies had a moderate risk of bias [36].

Prevalence of cigarette smoking
The overall pooled prevalence of cigarette smoking in Ethiopia using the 19 studies was 16.31% (95% CI: 12.17, 20.45). A random-effects model was used because of the significant heterogeneity ($I^2 = 98.1\%$, p-value <0.001) across the studies (Fig 2). Additionally, univariate meta-regression analysis was conducted to identify possible sources of heterogeneity. The different covariates included in the analysis were publication year and sample size. However, none of these variables were found to be statistically significant.

The existence of publication bias was assured by funnel plot asymmetry. The funnel plot graph indicates that there is a significant variability within the findings of the 19 individual
primary articles included in this meta-analysis (Fig 3). The publication bias checked by objective measurement namely Egger’s tests also showed a statistically significant publication bias (Egger’s test \( p\)-value = 0.001). To handle the observed publication bias, we performed the trim and fill analysis, which is a nonparametric methods for estimating the number of missing studies that might exist and helps in reducing and adjusting publication bias in meta-analysis.
Assessment of heterogeneity

We used $I^2$ statistics to investigate the presence of variation across the included studies. Accordingly, the result of $I^2$ statistics using a random effects model revealed a significant heterogeneity across the included studies ($I^2 = 98.1\%, p-value < 0.001$).

Subgroup analysis

The findings from the subgroup analysis showed that the highest and lowest cigarette smoking was observed among university students $17.35\%$ (95% CI: 12.97, 22.16) and high school students $13.76\%$ (95% CI: 7.24, 20.27), respectively (Fig 4).

Similarly, the regional subgroup analysis result revealed the pooled prevalence of smoking from highest to lowest was $[20.11\%$ (95% CI: 11.39, 28.84)] in Ethio-Somalia and Harari.
region, [18.96% (95% CI: -0.03, 38.01)] in Tigray region, [17.35% (95% CI: 13.21, 21.49)] in South Nation Nationality and People of Ethiopia (SNNPE), [15.34% (95% CI: 10.84, 19.83)] in Amhara region, [14.98% (95% CI: 7.37, 22.55)] in Oromia region, and [5.9% (95% CI: 0.02, 11.79)] in Addis Ababa region (Fig 5).

The linear trend of cigarette smoking status of students in Ethiopia

The cumulative univariate meta-analysis on cigarette smoking status among high school and university with the year of 1984–2017 was performed. The result from cumulative univariate meta-analysis showed the trend in prevalence estimates of cigarette smoking status among high school and university over time. The finding revealed that there is more or less constant trend (Fig 6).

The univariate meta-regression using bubble plot was also performed. The bubble plot figure indicates that the trend was slight increment (Fig 7).
The effect of peer pressure on cigarette smoking status

Five of the 19 included studies reported the effect of peer pressure on cigarette smoking. From this, three studies [11, 30, 37] showed a positive effect of peer pressure on cigarette smoking, while the other two studies [31, 51] showed no relationship between peer pressure and cigarette smoking. However, the aggregated meta-analysis revealed a higher odds of cigarette smoking among students who experienced peer pressure than those who didn’t (OR: 2.68, 95% CI: 2.37, 3.03) (Fig 8).

Discussion

Cigarette smoking has major health and social consequences, and it reduces the educational performance of students [52, 53]. This systematic review and meta-analysis, therefore, was conducted to assess the pooled prevalence of cigarette smoking and its association with peer pressure among high school and university students in Ethiopia. Accordingly, the pooled
prevalence of cigarette smoking among Ethiopian high school and university students was
15.92%. This finding is lower than a study conducted among students in South Africa which
reported a prevalence of 16.9% [50]. Conversely, the current reported pooled prevalence of cig-
eararette smoking was higher than a study conducted among government and private schools
and college students in Bengaluru, India (12.8%) [54] and amongst university students in Iran
(13.8%) [55].

In this review, the pooled prevalence of cigarette smoking was lower than a study finding
observed among Kenyan secondary school students (38.6%) and Cameroon university stu-
dents (93.1%) [56, 57]. In addition, our finding was slightly lower than a study conducted
among high school students in Shiraz- Iran (19.7%) [58]. This might be due to the difference
between sample size and socio-demographic nature of the two study populations. There is also
cultural variation among the study communities. Moreover, the higher prevalence of cigarette
smoking in the current study could be due to the dominance of male participants as evidence
suggests that males tend towards different types of substance abuse than females [59, 60].

Similarly, the current pooled prevalence of cigarette smoking is also lower than a systematic
review conducted in Africa [50] and the Middle East [61]. This variation might be due to the
differences in the study period and sample size between these two studies. In addition, the

### Table: Pooled Prevalence of Cigarette Smoking Among High School and University Students

| Study ID       | Prevalence (95% CI)       |
|----------------|--------------------------|
| University     |                          |
| Zein (1984)    | 25.10 (23.19, 27.01)     |
| Wakgari (2011) | 9.00 (6.75, 11.25)       |
| Measho (2013)  | 9.50 (7.41, 11.59)       |
| Tesfahun (2013) | 14.20 (10.87, 17.53)   |
| Andargachew (2014)| 14.90 (12.02, 17.78) |
| Andualem (2014)| 11.30 (9.00, 13.60)     |
| Gezahagn (2014)| 22.00 (19.46, 24.54)    |
| Nebiyu (2014)  | 28.60 (26.43, 30.77)     |
| Tadele (2014)  | 28.90 (22.57, 35.23)     |
| Tiriwork (2016)| 27.70 (20.65, 34.75)    |
| Ashete (2017)  | 7.90 (5.83, 9.97)        |
| Tadele (2017)  | 14.50 (11.68, 17.32)     |
| **Subtotal (I-squared = 97.4%, p = 0.000)** | **17.57 (12.97, 22.16)** |

| High School    |                          |
|----------------|--------------------------|
| Yigzaw (2002)  | 13.30 (11.30, 15.30)     |
| Emmanuel (2007)| 3.00 (2.23, 3.77)        |
| Ayalu (2012)   | 12.40 (10.84, 13.96)     |
| Ahmed (2014)   | 11.40 (7.20, 15.60)      |
| Antoneh (2014) | 22.90 (19.67, 26.13)     |
| Tesla (2017)   | 19.90 (16.99, 22.81)     |
| **Subtotal (I-squared = 98.6%, p = 0.000)** | **13.76 (7.24, 20.27)** |
| **Overall (I-squared = 98.5%, p = 0.000)** | **16.31 (12.17, 20.45)** |

**NOTE:** Weights are from random effects analysis

Fig 4. Forest plot of the pooled prevalence of cigarette smoking among high school and university students across regions in Ethiopia.

https://doi.org/10.1371/journal.pone.0222572.g004
Fig 5. Forest plot graph indicates, subgroup analysis of cigarette smoking among the region, in high school and university students in Ethiopia.

https://doi.org/10.1371/journal.pone.0222572.g005
previous review was conducted only among university students, while the current review included both high school and university students.

The current review also considered subgroup analysis to appreciate the variability or heterogeneous characteristics of the included studies. Accordingly, a higher prevalence was observed among university students (17.35%) than high school students (12.77%). This could be because most high school students live with their families which may limit them from cigarette smoking because of parental control. Additionally, in most cases, students during their high school time live with families and that may not encourage smoking cigarette. On the contrary, when they join to the university, almost all students become independent of their family supervision. This independency and pressure from their friends increases the proportion of students who smokes cigarette [62]. Educational institutions can be a challenging environment and everyone copes with stress in different ways [17]. Moreover, as students enter to university, they start a new life away from their families in a different and strange environment which can contribute to their behavior or involvement in substance abuse like cigarette smoking [55]. Evidence also supports that as the level of education increase, the proportion of smoking increases [63, 64].

### Table: Prevalence of Cigarette Smoking among High School and University Students in Ethiopia

| Study ID          | Prevalence (95% CI) |
|-------------------|---------------------|
| Zein [34] (1984)  | 15.92 (12.21, 19.63) |
| Yigzaw[27] (2002) | 15.41 (11.68, 19.15) |
| Emmanuel[38] (2007)| 11.88 (6.87, 16.90)  |
| Wakgari [33] (2011)| 15.56 (11.58, 19.54) |
| Ayalu [24] (2012) | 13.38 (9.84, 16.92)  |
| Measho [28] (2013)| 12.47 (8.26, 16.68)  |
| Tesahun [11] (2013)| 15.31 (10.98, 19.63) |
| Ahmed [29] (2014) | 11.36 (7.17, 15.55)  |
| Andargachew[51] (2014)| 13.45 (10.10, 16.80) |
| Andualem [35] (2014)| 12.56 (10.14, 14.98) |
| Anteneh [37] (2014) | 15.11 (9.87, 20.35) |
| Gezahegn[25] (2014)| 13.17 (7.84, 18.50)  |
| Girmay [26] (2014)| 12.81 (8.10, 17.51)  |
| Nebiyu [30] (2014)| 13.97 (8.89, 19.05)  |
| Tadele E [31] (2014)| 15.05 (10.36, 19.73) |
| Tiruwork[36] (2016)| 15.99 (11.75, 20.24) |
| Ashele [23] (2017)| 13.62 (8.73, 18.51)  |
| Tadele K [32] (2017)| 14.01 (9.24, 18.78)  |
| Tesfa [66] (2017)| 15.39 (10.85, 19.93) |

![Fig 6. Linear trend of cigarette smoking among high school and university students in Ethiopia.](https://doi.org/10.1371/journal.pone.0222572.g006)
A subgroup analysis by regions of the country also showed a higher prevalence of cigarette smoking among universities in other category (i.e., Harar region, Somalia region and Oromia region). This finding might be due to typical local practices of substances like cigarette and khat in these regions. Therefore, the government, school management, local communities and other concerned bodies need to implement school-based intervention programs in order to reduce the pooled prevalence of cigarette smoking.

Students who felt peer pressure were more likely to smoke cigarette than those who had no peer pressure. This finding was similar to a study conducted in Kenyan students and Shiraz-Iran [57] where peer pressure was found to have a significant (positive) effect on the likelihood of cigarette smoking [56, 58]. Peer group pressure is widely known as a decisive factor which affects the early onset of experimentation with tobacco and the individual’s subsequent willingness to continue smoking [16]. Similarly, other systematic reviews state the most common factors influencing students’ smoking status was having smoker friends [55, 65]. Therefore, the school management needs to implement youth association focusing on counseling and rehabilitation service for to seize students already practicing smoking and also those who are not practicing yet now.
Strengths and limitations of the study

This review has several strengths including: this review focus on the adolescent and young adult populations who are vulnerable to initiating substance use/abuse behaviors. In addition, this review rigorous adherence to the PRISMA checklist which improves its quality for the readers. Moreover, this finding will give an insight into developing a health promotion policy for the country. Whereas, on top of the above strength, this review has the following limitations: This review included studies that were published only in English language which may limit the number of studies that were reported in other languages. Moreover, the other limitation of this review was the risk of self-report bias introduced from the original studies included in the review. On top of these the protocol of this manuscript was not registered online before conducting it.

Conclusions

This systematic review and meta-analysis indicate that the prevalence of cigarette smoking among Ethiopian high school and university students was high. More than one sixth of the high school and university students smoke cigarettes. This higher cigarette smoking proportion of students was influenced by peer pressure. Variations were also observed in the prevalence of cigarette smoking by different regions in the country. Therefore, school-based intervention programs aimed at prevention of cigarette smoking is recommended. In particular, educational programs on how to resist and handle peer pressure are essential to prevent cigarette smoking among high school and university students in Ethiopia.
Supporting information

S1 Table. PRISMA 2009 checklist.
(DOC)

S2 Table. Searches for databases.
(DOCX)

S3 Table. Data extraction tools Smoke.
(XLSX)

S4 Table. Quality assessments.
(DOCX)

S5 Table. NIH quality assessments.
(DOCX)

S6 Table. Risk of bias for each study.
(XLSX)

Acknowledgements

The authors of this work would like to forward great and deepest gratitude for Debre Markos University for creating convenient environment and internet service. Furthermore, the authors would like also to forward special acknowledgement for authors of primary studies.

Author Contributions

Conceptualization: Cheru Tesema Leshargie.

Data curation: Cheru Tesema Leshargie, Getiye Dejenu Kibret, Molla Yigzaw Birhanu, Patricia Malloy, Daniel Bekele Ketema.

Formal analysis: Animut Alebel, Getiye Dejenu Kibret, Molla Yigzaw Birhanu, Henok Mulugeta, Fasil Wagnew.

Funding acquisition: Fasil Wagnew.

Investigation: Getiye Dejenu Kibret, Fasil Wagnew, Daniel Bekele Ketema, Alehegn Aderaw.

Methodology: Cheru Tesema Leshargie, Getiye Dejenu Kibret, Patricia Malloy, Fasil Wagnew, Atsede Alle Ewunetie, Pammla Petrucka, Amit Arora.

Project administration: Molla Yigzaw Birhanu, Fasil Wagnew, Atsede Alle Ewunetie, Alehegn Aderaw.

Resources: Animut Alebel, Atsede Alle Ewunetie, Daniel Bekele Ketema.

Software: Cheru Tesema Leshargie, Molla Yigzaw Birhanu, Patricia Malloy, Atsede Alle Ewunetie, Alehegn Aderaw, Moges Agazhe Assemie, Amit Arora.

Supervision: Animut Alebel, Molla Yigzaw Birhanu, Atsede Alle Ewunetie, Alehegn Aderaw, Moges Agazhe Assemie, Getachew Mullu Kassa, Pammla Petrucka, Amit Arora.

Validation: Getiye Dejenu Kibret, Patricia Malloy, Fasil Wagnew, Atsede Alle Ewunetie, Daniel Bekele Ketema, Alehegn Aderaw, Moges Agazhe Assemie, Getachew Mullu Kassa.

Visualization: Henok Mulugeta, Patricia Malloy, Fasil Wagnew, Atsede Alle Ewunetie, Daniel Bekele Ketema, Moges Agazhe Assemie, Getachew Mullu Kassa, Amit Arora.
Writing – original draft: Henok Mulugeta, Patricia Malloy, Daniel Bekele Ketema, Moges Agazhe Assemie, Getachew Mullu Kassa, Amit Arora.

Writing – review & editing: Cheru Tesema Leshargie, Patricia Malloy, Daniel Bekele Ketema, Alehegn Aderaw, Moges Agazhe Assemie, Getachew Mullu Kassa, Pammla Petrucka, Amit Arora.

References

1. Nikolic M, Stankovic A, Airic IM: Household Environmental Tobacco Smoke Exposure and Respiratory Health in School Age Children. SciFacult Med in Nis 2012, 29(4):175–180.

2. Talhoult R, Schulz T, Florek E, Benthem J, Wester P, Opperhuizen A: Hazardous Compounds in Tobacco Smoke. 10.3390/ijerph8020613. Inter J Environ Res Public Health, 2011, 8(2).

3. Gashaw A, Teshtita A, Getachew T: Environmental tobacco smoke exposure and its health impacts: a review. International Journal of Biological and Chemical Sciences 2016, 10(3):1371–1380.

4. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn SMC: Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. The Lancet 2002, 360(9343):1347–1360.

5. World Health Organization: “WHO Report on the Global Tobacco Epidemic,” Geneva, Switzerland 2008.

6. Centers for Disease Control and Prevention, Surgeon General’s Report: How Tobacco Smoke Causes Disease. The Biology and Behavioral Basis for Smoking-Attributable Disease, Centers for Disease Control and Prevention 2010.

7. World Health Organization. WHO Report on the global tobacco epidemic, 2015. Geneva, Switzerland: WHO. 2015.

8. World Health Organization: WHO Global Report on Trends in Prevalence of Tobacco Smoking. Geneva, SW: WHO 2015.

9. Courtney R: The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General, 2014 Us Department of Health and Human Services Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Drug and Alcohol Review 2015, 34(6):694–695.

10. US Department of Health and Human Services: How Tobacco Smoke Causes Disease: What It Means to You. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2010

11. Tesfahun A, Gebeyaw T, Girmay T: Assessment of Substance Abuse and Associated Factors among Students of Debre Markos Poly Technique College in Debre Markos Town, East Gojjam Zone, Amhara Regional State, Ethiopia. 14 2013, 4(1).

12. Gina Tomé, Margarida Gaspar de Matos, Celeste Simões, Inês Camacho, José AlvesDiniz: How Can Peer Group Influence the Behavior of Adolescents: Explanatory Model. Glob J Health Science 2012 4(2):26–35.

13. Fit for Work team: Smoking and its impact on mental health. March 6, 2017.

14. Leonard M, et, al.: MHADIE background document on disability prevalence across different diseases and EU countries (http://www.mhadie.it/publications.aspx, accessed 21 January 2010). Milan, Measuring Health and Disability in Europe, 2009.

15. Tesfa M, Wubalem F, Tefera CM, Shimelash BW: Substance Use as a Strong Predictor of Poor Academic Achievement among University Students. Psychiatry Journal 2017.

16. Denscombe M: Peer Group Pressure, Young People and Smoking: new developments and policy implications. Drugs: Education, Prevention and Policy 2009, 8(1).

17. Anna Lussier: How does tobacco use impact your academic performance? 2015.

18. Mbatchou Ngahane B. H., Luma H., Mapoure Y. N., Fotso Z. M., Afane Ze E.: Correlates of cigarette smoking among university students in Cameroon. 2014, 17(2).

19. Owusu-Dabo E, Lewis S, McNeill A, Anderson S, Gilmore A, Britton J: Smoking in Ghana: a review of tobacco industry activity. Tob Control 2009, 18(3):206–211. https://doi.org/10.1136/tc.2009.030601 PMID: 19399263

20. World Health Organization: WHO Report on the Global Tobacco Epidemic, 2015. Accessed November 4, 2016.
21. Brathwaite R, Addo J, Smeeth L, Lock K: A Systematic review of tobacco smoking prevalence and description of tobacco control strategies in sub-Saharan African countries; 2007 to 2014. *PLoS One* 2015, 10(7):e0132401. https://doi.org/10.1371/journal.pone.0132401 PMID: 26162085

22. Kebede Y, Abula T: Substance Abuse For the Ethiopian Health Center Team. 1st edition. Addis Ababa: Ethiopian Public Health training Initiative 2005.

23. Adere A, Yimer NB, Kumsa H, Liben ML: Determinants of psychoactive substances use among Woldia University students in Northeastern Ethiopia. *BMC Research Notes* 2017, 10(1):441. https://doi.org/10.1186/s13104-017-2763-x PMID: 28870246

24. Ayalu A Reda, Asmamaw M, Berhanu Y, Shibhatu B: Determinants of cigarette smoking among school adolescents in eastern Ethiopia: A cross-sectional study. *Harm Reduction Journal* 2012.

25. Gezahegn T, Andualem D, Mitiku TH: Substance Use and Associated Factors among University Students in Ethiopia: A Cross-Sectional Study. Hindawi Publishing Corporation 2014.

26. Girmay T, Ahmed E: Psychoactive Substances Use (Khat, Alcohol and Tobacco) and Associated Factors among Debre Markos University Students, North-West Ethiopia, 2013. *Defense Management* 2014, 4(1).

27. Yigzaw Kebede: Cigarette smoking and Khat chewing among college students in North West Ethiopia. *Ethiopian Journal of Health Development* 2002, 16(1):9–17.

28. Gebreslassie M, Feleke A, Melese T: Psychoactive substances use and associated factors among Axum University students, Axum Town, North Ethiopia BMC public health 2013, 13(1):693.

29. Ahmed Yasin Mohammed: Assessment of substance use and associated factors among high school and preparatory school students of Ginnir Town, Bale Zone, Southeast Ethiopia. *American Journal of Health Research* 2014, 2(6):414–419.

30. Nebiyu D, Sabit A, Abiot G: Prevalence and Predictors of Cigarette Smoking among Adolescents of Ethiopia: School Based Cross Sectional Survey. *Journal of Child & Adolescent Behavior* 2014, 3(1).

31. Tadele Kinat Banti, Desalegn Shiferaw Mengesha, Gamachu Fufa Mamade: Prevalence of Cigarette Smoking and Factors Associated with it Among Undergraduate Students of Jigjiga University. *International Journal of Psychological and Brain Sciences* 2017, 2(3):87–91.

32. Wakgari D, Akilu A: Substance use and its predictors among undergraduate medical students of Addis Ababa University in Ethiopia. *BMC Public Health* 2011.

33. Zein ZA, Admasu M, Tadesse M, Laeke N, Olango P, Rassu TA, Asfaw T: Patterns of cigarette-smoking among Ethiopian medical and paramedical students. *Ethiopian Medical Journal* 1984 22(4):165–671. PMID: 6479155

34. Andualem D, Assefa S, Chalachew M: Assessment of substance use and risky sexual behaviour among Haramaya University Students, Ethiopia. *Science Journal of Public Health* 2014, 2(2):102–110.

35. Tiruwork T: Substance Use and Feelings of Self-determination of Summer Students at Bahir Dar University. *The Ethiopian Journal of Education* 2014, 2(1).

36. Anteneh MB, Telake AB, MW S: High prevalence of substance use and associated factors among high school adolescents in Woreta Town, Northwest Ethiopia: multi-domain factoranalysis. BMC Public Health 2014.

37. Emmanuel R, Abdurahman A, Adamson SM: Prevalence and determinants of adolescent tobacco smoking in Addis Ababa, Ethiopia. BMC Public Health 2007.

38. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D: The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol* 2009, 62(10):e1-34. https://doi.org/10.1016/j.jclinepi.2009.06.006 PMID: 19631507

39. Ethiopia—Historical Attractions, Regions, Cities and Population.

40. Ethiopia—Historical Attractions, Regions, Cities and Population.

41. Ethiopia People: CIA World Factbook and Other Sources 2019

42. Amber Pariona: Which Countries Border Ethiopia? World Facts. May 24, 2018.

43. Adejumo AO, Heumann C, Toutenburg H: A review of agreement measure as a subset of association measure between raters, https://epub.ub.uni-muenchen.de/1755/. Collaborative Research Center 2004.

44. Newcastle: Newcastle-Ottawa Scale customized for cross-sectional studies. In. available from https://static-content.springer.com/esm/t/12889_2012_5111_MOESM3_ESM.doc. 2012.

45. Islam MM, Iqbal U, Walther B, Atique S, Dubey NK, Nguyen PA, Poly TN, Masud JH, Li YC, Shabbir SA: Benzodiazepine Use and Risk of Dementia in the Elderly Population: A Systematic Review and
46. Hoy D, Brooks P, Woolf A, Blyth F, March L, Bain C, Baker P, Smith E, Buchbinder R: Assessing risk of bias in prevalence studies: modification of an existing tool and evidence of interrater agreement. *Journal of Clinical Epidemiology* 2012, 65(9):934–939. https://doi.org/10.1016/j.jclinepi.2011.11.014 PMID: 22742910

47. Rücker GS, Guido Carpenter, James R, Schumacher Martin: Undue reliance on I 2 in assessing heterogeneity may mislead. *BMC medical research methodology* 2008, 8:79. https://doi.org/10.1186/1471-2288-8-79 PMID: 19036172

48. Borenstein M, Hedges LV, Higgins J, Rothstein HR: A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods* 2010, 1(2):97–111. https://doi.org/10.1002/jrsm.12 PMID: 26061376

49. Borenstein M, Hedges LV, Higgins J, Rothstein HR: A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods* 2010, 2(1):97–111.

50. Mahomed B, Fam M, Basil JP, Mohammed HC, Fam M: Cigarette Smoking Behavior among South African Indian High School Students. 1998.

51. Andargachew K, Serawit D: Prevalence and Determinants of Active and Passive Cigarette Smoking among undergraduate students at Hawassa University, Hawassa, Ethiopia. *Journal of Tropical Diseases and Public Health* 2014, 2(4).

52. US Department of Health and Human Services: How Tobacco Smoke Causes Disease: What It Means to You. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health., 2010.

53. US Department of Health and Human Services: The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2014.

54. Vasudha S, Hiremath SS, Manjunath P, Shweta S: Prevalence of tobacco use among 15–20 years old college students in Bengaluru city. 2017.

55. Haghdoost Ali Akbar, Moosazadeh Mahmood: The prevalence of cigarette smoking among students of Iran’s universities: A systematic review and meta-analysis. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences* 2013, 18(8):717.

56. Kwamanga DHO, Odihambo JA, Amukoye EJ: Prevalence and Risk Factors of Smoking among Secondary School Students in Kenya. *East African Medical Journal* 2003.

57. Mbatchou N’gahane BH, Luna H, Mapoure YN, Fotso ZM, Afane Ze E: Correlates of cigarette smoking among university students in Cameroon *The International Journal of Tuberculosis and Lung Disease* 2013, 17(2):270–274. https://doi.org/10.5588/ijtld.12.0377 PMID: 23317965

58. Masoud K, Mohammad HK, Mohammad AM, Ali D, Ghasem D: Cigarette Smoking Experience and its related Socio-demographic and Environmental Risk Factors in High School Boys Students, Shiraz- Iran. *International journal of Pediatrics* 2017, 5(2).

59. Warren CW, Jones NR, Eriksen MP, Asma S: Global Tobacco Surveillance System (GTSS) collaborative group. Patterns of global tobacco use in young people and implications for future chronic disease burden in adults. *The lancet* 2006, 367(9512):749–753.

60. Reddy KP, Kong CY, Hyle EP, Baggett TP, Huang M, Parker RA, Paltiel AD, Losina E, Weinstein MC, Freedberg KA et al: Lung cancer mortality associated with smoking and smoking cessation among people living with HIV in the United States. *JAMA internal medicine* 2017, 177(11):1613–1621. https://doi.org/10.1001/jamainternmed.2017.4349 PMID: 28975270

61. Saba K, Mohammed J, Ray C, Elie AA: The Epidemiology of Tobacco Use among Khat Users: A Systematic Review. BioMed Research International 2015.

62. Kandel DB, Griesler PC, Schaffran C: Educational attainment and smoking among women: risk factors and consequences for offspring. *Drug and alcohol dependence* 2009, 104(5):24–33.

63. Denise B. Kandela, Pamela C. Grieslerb, Christine Schaffran: Educational Attainment and Smoking Among Women: Risk Factors and Consequences for Offspring. *Drug Alcohol Depend* 2009 104(1): S24–S33.

64. Wayne J. Millar: Reaching Smokers with Lower Educational Attainment. Health Reports 1996, 8(2).

65. Patricia Culpepper: Smoking Peer Pressure Facts. 2017.

66. Tesfa M, Wubalem F, Tefera CM, BW S: Substance Use as a Strong Predictor of Poor Academic Achievement among University Students. *Hindawi Psychiatry Journal* 2017. https://doi.org/10.1155/2017/517450 PMID: 28680879