RESEARCH ARTICLE

Editorial Process: Submission:08/03/2023 Acceptance:02/11/2024

Smoking-Related Disease Impact in the Eastern Mediterranean Region: A Comprehensive Assessment Using Global Burden of Disease Data

Yaseen Sultan[1], Zeena Salman[2], Mohammed Alzaatreh[3], Adib Edilbi[4], Ruba Alani[4], Iyad Sultan[5,6], Ahmad Samir Alfaar[7], Ibrahim Qaddoumi[2]*

Abstract

Background: Smoking remains a significant risk factor for numerous health issues, including lung cancer, chronic obstructive pulmonary disease, ischemic heart disease, stroke, and respiratory infections. This study investigates the burden of tobacco-related diseases in the Middle East and North Africa (MENA) region. **Methods:** Utilizing the GBD data, we examined the risk of smoking and second-hand smoke exposure and their related causes of death and disability in the 22 MENA countries. Smoking prevalence and disease burden data were analyzed with estimates reported as age-standardized rates. **Results:** Tobacco abuse accounted for 14.5% of all deaths and 23.2% of deaths tied to known risk factors, with an age-standardized death rate of 110.8 per 100,000. Cardiovascular diseases were the primary cause of smoking-related deaths and DALYs, representing 53.4% of all deaths and 50.3% of all DALYs. This was followed by neoplasms (24.6% of all deaths and 20.3% of all DALYs), chronic respiratory diseases(12.4% of all deaths and 11.9% of all DALYs), and respiratory infections and tuberculosis(4% of all deaths and 3.4% of all DALYs). Second-hand smoking caused 20.5% of tobacco-related deaths and 21.5% of tobacco-related DALYs, disproportionately affecting younger individuals. An increasing disease burden was observed in Lebanon, Turkey, Syria, Tunisia, UAE, and Libya, and declining rates were most evident in Oman and Qatar. **Conclusion:** Our study emphasizes the impact of smoking on cardiovascular disease, the primary cause of smoking-related mortality and morbidity in the MENA region. Our findings highlight the urgent need for effective tobacco control policies and interventions.

Keywords: Smoking- Second-hand smoking- burden of disease- prevalence- Eastern Mediterranean Region

Asian Pac J Cancer Prev, **25 (2)**, 495-505

Introduction

Tobacco use remains a significant global public health concern, contributing to millions of deaths annually, and is a considerable burden on health systems worldwide. Despite progress in tobacco control, certain regions have been experiencing upward trends in smoking prevalence and related diseases. The Middle East and North Africa (MENA) region is one area where data on smoking patterns and associated disease burden remain limited but hint at variable prevalence with expected male dominance [1]. Understanding the prevalence and impact of smoking-related diseases in this region is crucial for developing targeted and effective tobacco control policies [2].

Previous studies have estimated that tobacco use kills more than 8 million people annually, with more than 7 million deaths attributable to direct tobacco use and approximately 1.2 million resulting from nonsmokers' exposure to second-hand smoke. The burden of smoking-related diseases extends beyond mortality, significantly affecting millions of individuals' morbidity and quality of life worldwide [3]. Smoking has been linked to various conditions, including cardiovascular diseases, neoplasms, chronic respiratory diseases, respiratory infections, tuberculosis, musculoskeletal disorders, and diabetes and kidney diseases [4, 5].

According to a previous Global Burden of Disease (GBD) study, smoking is the second-leading risk factor for disability-adjusted life years (DALYs) in the MENA region, accounting for 10.7% of the total disease burden [1]. Furthermore, smoking is responsible for 21.4% of deaths and 10.1% of years of life lost due to premature

*[1]Univ of Iowa, Iowa City, Iowa, United States. [2]Department of Global Pediatric Medicin, St. Jude Children's Research Hospital, Memphis, Tennessee, United States. [3]St. Richard's Hospital, University Hospitals Sussex NHS Trust, West Sussex, England. [4]Research Office, King Hussein Cancer Center, Amman, Jordan. [5]Department of Pediatrics, King Hussein Cancer Center, Amman, Jordan. [6]Artificial Intelligence and Data Innovation Office; King Hussein Cancer Center, Amman, Jordan. [7]Charité Universitätsmedizin Berlin, Berlin, Germany. [8]Department of Oncology, St. Jude Children's Research Hospital, Memphis, Tennessee, United States. *For Correspondence: Ibrahim.qaddoumi@stjude.org*

mortality. This study showed that the burden of smoking in the MENA region is higher among men than among women and has shown that the health impact of smoking extends to those around the smoker. In fact, such second-hand smoke exposure is responsible for a significant proportion of the disease burden due to smoking in the MENA region, particularly in children.

Despite advances in tobacco control and decreasing global smoking prevalence, the MENA region has witnessed a substantial increase in the number of smokers over the past few decades [6]. The complex interplay of sociocultural factors, weak regulations, and tobacco industry interference presents unique challenges for tobacco control in this region. Consequently, examining the prevalence and burden of smoking-related diseases in the MENA region is vital to inform evidence-based policy development and interventions. In this study, we aimed to explore the prevalence and burden of smoking-related diseases in the MENA region, focusing on the relationship between smoking prevalence and sociodemographic index (SDI) and the distribution of smoking-related deaths and disability-adjusted life years (DALYs) across countries. By providing an in-depth analysis of smoking trends and associated disease burden in the region, our findings can serve as a foundation for the development of tailored and comprehensive tobacco control policies that address the unique challenges in the MENA region, ultimately contributing to a reduction in the global burden of smoking-related diseases.

Materials and Methods

Study Design and Data Sources

The GBD project, managed by the Institute for Health Metrics and Evaluation (IHME), has produced estimates on 369 diseases and injuries and 87 risk factors across 204 countries and territories between 1990 and 2019 [7]. We obtained the data on smoking prevalence, smoking-related deaths, and disability-adjusted life years (DALYs) from the Global Burden of Disease Study 2019 [8]. Data on sociodemographic factors, including sex, age distribution, and sociodemographic index (SDI), were also collected from GBD datasets [8, 9]. The SDI is a composite index based on income per capita, education, and fertility rates that can be used to classify countries according to their level of development.

Country Selection

Our analysis included all countries in the MENA region, as defined by the World Bank classification. The 22 countries comprising the MENA region are Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, the Syrian Arab Republic (Syria), Tunisia, Turkey, the United Arab Emirates (UAE), Lebanon, and Yemen. The total population of the MENA region was estimated to be 608.7 million in 2019.

Measures

The GBD study collects data from national records and surveys, with death certificates as a crucial information source. When such data are unavailable, GBD resorts to modeling, utilizing regions with similar geographic and sociodemographic characteristics to approximate values [7, 10]. Although the process has flaws, it is the most effective method for studying disease burden.

The SDI is based on three indicators: income per capita, average years of education, and total fertility rate. Income is measured by using the gross domestic product (GDP) per capita adjusted for purchasing power parity. Education is measured by the average number of years of schooling completed by individuals aged 15 years and older. Fertility is measured by the number of live births per woman. The SDI ranges from 0 to 1, with higher values indicating higher levels of socioeconomic development. The GBD study uses the SDI to assess the impact of diseases, injuries, and risk factors on populations with different levels of socioeconomic development. It is also used to compare the burden of disease among different regions and countries.

Statistical Analysis

Descriptive statistics were used to summarize smoking prevalence and its associated disease burden in the MENA region. We calculated the median and interquartile range of smoking prevalence for males and females and the overall prevalence in each country. To explore the relationship between smoking prevalence and its associated disease burden, we performed correlation analyses between smoking prevalence, smoking-related deaths, and DALYs using Spearman's rank correlation coefficient. To investigate the impact of sociodemographic factors on smoking prevalence and disease burden, we conducted a multivariable linear regression analysis with smoking prevalence, smoking-related deaths, and DALYs as the dependent variables and SDI, gender, and age as the explanatory variables.

GBD predominantly uses Disability-Adjusted Life Years (DALYs) to measure disease burden, a composite metric combining years of life lost and years lost to disability. All estimates were reported as age-standardized rates per 100,000 population and their corresponding 95% uncertainty intervals (95% UIs). Smoking prevalence is presented as percentages, and data were obtained from the IHME website. Values were selected for the year 2019.

To enable comparison among different regions, we included standardized age, which provided us with the standardized incidence for death and DALYs, correcting for population differences relative to the global population pyramid. Descriptive statistics were utilized to represent our data, with all calculations made using R version 4.2.3 [11].

Ethical Considerations

This study used secondary data from publicly available sources; no human subjects were directly involved. Therefore, ethical approval and informed consent were not required.

Results

Smoking prevalence

The smoking prevalence in the MENA region was 19.6% (95% UI, 19.3-19.9), which is comparable to the global prevalence (19.6%; 95% UI, 19.4-19.8) (Table1). Three MENA countries showed prevalence rates above the upper global quartile: Lebanon (35.8%), Jordan (34.3%), and Turkey (30.9%). Conversely, the lowest prevalence was observed in Afghanistan (10%, 9.2-10.8). Our data reveal a strong correlation between smoking and SDI (rho = 0.52, S = 4.29e+05, p < 0.001) (Figure 1A).In all MENA countries, smoking prevalence was higher in males (32.4%; 95% UI, 31.9-32.9) than in females (5.6%; 95% UI, 5.3-6) (Figure 1B). Smoking prevalence has slowly declined in all MENA countries except Lebanon, Jordan, and Afghanistan (Figure 1C). A steadily high prevalence in Turkey was observed.

Tobacco-related Disease Burden

Tobacco abuse was responsible for approximately 8.7 million deaths worldwide in 2019, comprising 15.4% of all deaths and 24.9% of deaths attributable to known risk factors. In the MENA region, tobacco abuse was estimated to cause 450,358 deaths (95% UI, 401,337-504,061), accounting for 14.5% of all deaths and 23.2% of deaths linked to known risk factors. The age-standardized death rate was estimated to be 110.8 (99.5-123.1) per 100,000

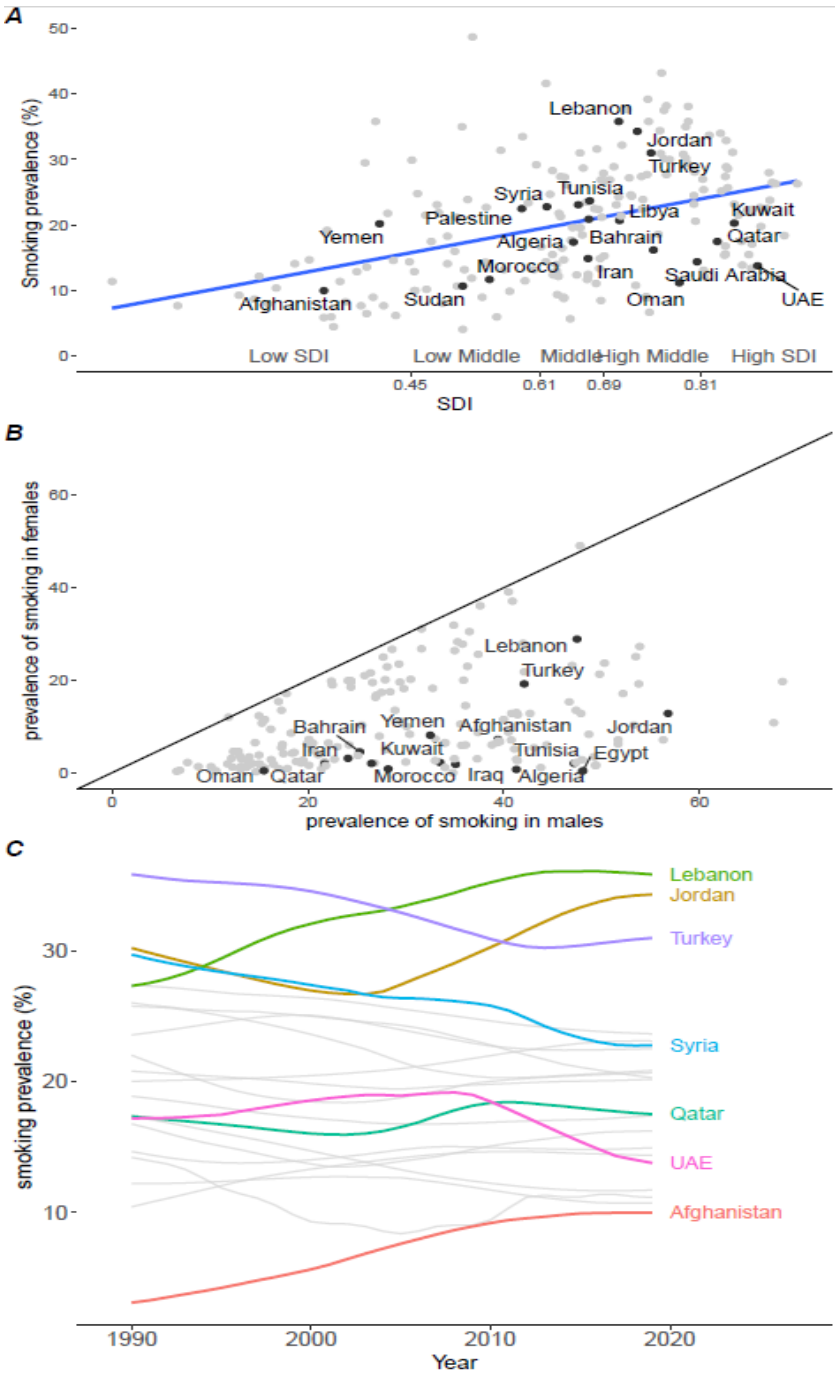

Figure 1. Scatter Plots Showing (A) smoking prevalence in relation to sociodemographic index (SDI) in the world; (B) the correlation between smoking prevalence in males and females, with black dots representing MENA countries in both panels; and (C) trends in smoking prevalence in the MENA region over time.

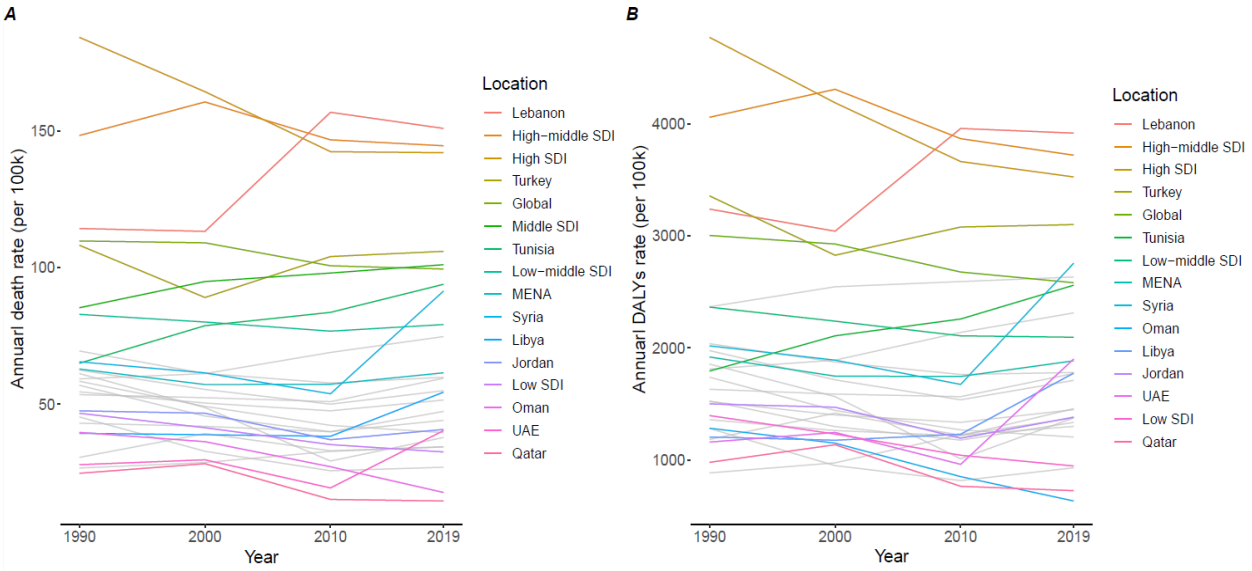

Figure 2. Trends of Smoking-Related Deaths and DALYs Over Time in the MENA Region; Selected Countries and Regions are Labeled.

(Table 1). The age-standardized death rate due to smoking also varies widely, with the lowest rate in Iran (57.4, 53.4-62.1) and the highest in Lebanon (150.7, 131.3-171.7) (Table 1). Globally, the disease burden measured by DALYs was estimated to be 229 million, representing 9% of all DALYs and 18.8% of all DALYs with known risks. In the MENA region, the burden was estimated to be 14,013,882 (95% UI, 12,394,849-15,726,637),

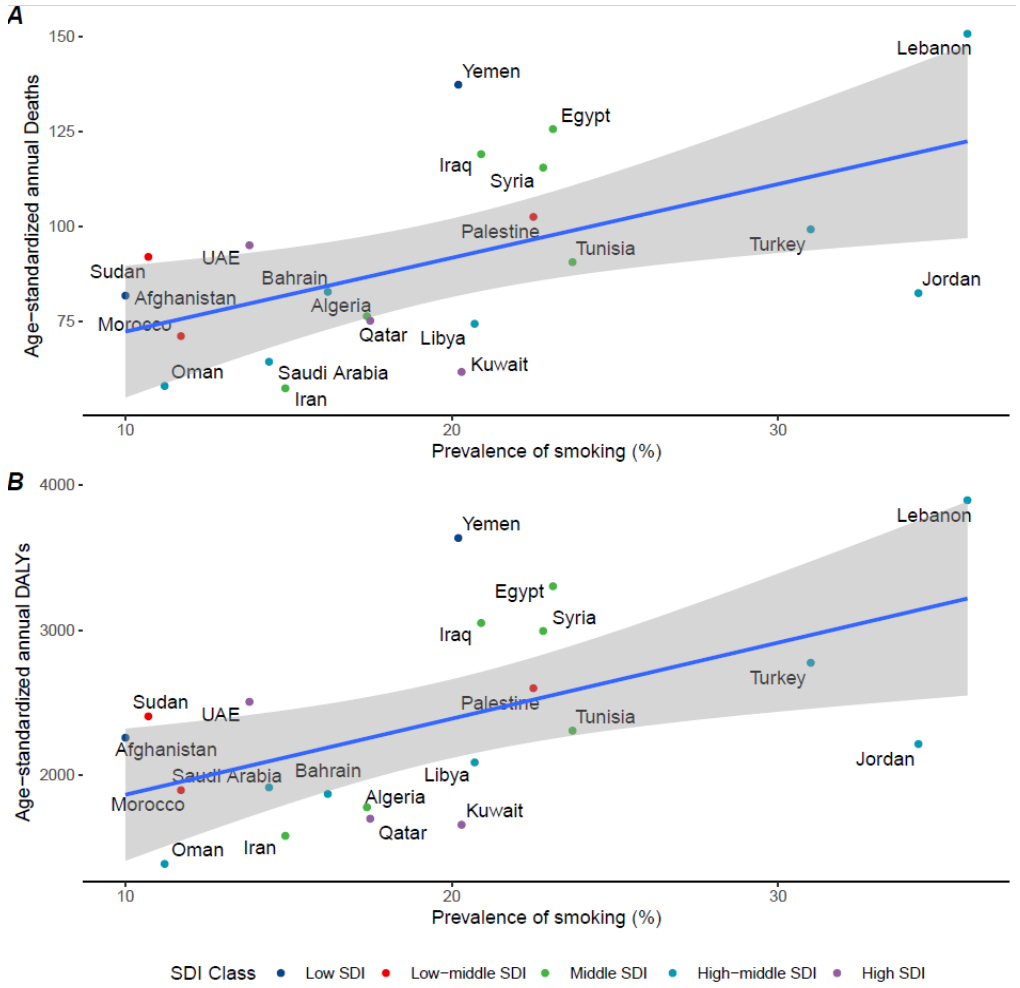

Figure 3. Scatter Plots Showing the Correlation between Prevalence of Smoking and (A) age-standardized death rates and (B) DALYs rates per 100,000.

Table 1. Prevalence of Smoking, Age-Standardized Deaths, and Total Annual Deaths Attributable to Smoking, Second-Hand Smoke, and All-Causes in the MENA Region in 2019.

Location	Smoking prevalence % (95% CI)	Age-standardized Death rate per 100,000			Total annual deaths		
		Smoking	Second-hand smoke	All risk factors	Smoking	Second-hand smoke	All risk factors
Afghanistan	10 (9.2-10.8)	81.7 (63.7-99.5)	40.1 (29.7-51.3)	825.8 (687.7-954.5)	10,305.90 (7,826.8-12,975.3)	6,061.60 (4,308.3-7,992.7)	124,347.20 (103,910.1-145,285.3)
Algeria	17.4 (16.3-18.4)	76.3 (63.1-91.5)	27.2 (21.3-34.1)	510.6 (441.4-589.1)	21,555.40 (17,664.2-26,056.6)	7,670.40 (5,902.8-9,679.3)	133,820.50 (114,270.7-156,756.9)
Bahrain	16.2 (14.9-17.7)	82.7 (67.4-101.4)	24.4 (17.0-32.7)	492.9 (419.1-575.9)	545.5 (433.7-676.6)	148 (103.9-199.9)	2,756.90 (2,280.3-3,310.6)
Egypt	23.1 (22.4-23.8)	125.6 (98.6-160.2)	32.1 (23.3-41.8)	677.8 (546.0-821.9)	74,032.50 (57,380.1-96,218.7)	19,666.90 (14,110.3-25,878.6)	361,890.00 (284,838.2-449,609.1)
Iran	14.9 (13.9-15.9)	57.4 (53.4-62.1)	15.8 (12.6-19.0)	378.8 (359.0-397.0)	39,926.00 (37,335.8-43,016.2)	10,606.70 (8,404.4-12,725.1)	243,052.00 (231,290.5-254,791.1)
Iraq	20.9 (19.7-22)	119 (94.2-141.1)	31.7 (23.9-39.5)	591.2 (499.1-679.4)	25,199.20 (19,581.7-30,286.1)	6,635.00 (4,927.7-8,443.7)	117,127.80 (96,849.7-137,737.0)
Jordan	34.3 (33.2-35.5)	82.4 (67.5-99.0)	17.5 (13.4-21.9)	397.2 (347.6-457.9)	4,741.60 (3,858.8-5,769.7)	1,014.30 (785.0-1,270.2)	20,707.60 (17,862.1-24,291.9)
Kuwait	20.3 (19-21.6)	61.7 (50.6-74.9)	15.3 (11.6-19.5)	289.5 (251.6-335.0)	1,524.20 (1,249.3-1,848.9)	357.2 (273.3-449.5)	6,380.40 (5,490.4-7,416.5)
Lebanon	35.8 (33.9-37.8)	150.7 (131.3-171.7)	26.2 (20.8-31.9)	463.1 (406.0-510.9)	7,810.70 (6,797.3-8,896.7)	1,352.30 (1,076.1-1,643.1)	23,597.00 (20,683.3-26,095.9)
Libya	20.7 (19.4-21.9)	74.3 (60.5-91.9)	23.7 (18.1-30.5)	411.1 (341.4-495.6)	3,662.60 (2,961.3-4,606.3)	1,161.20 (885.5-1,500.5)	18,939.20 (15,632.2-23,058.7)
Morocco	11.7 (10.9-12.5)	71.1 (55.4-83.0)	23.2 (17.7-28.8)	594.6 (494.3-659.0)	21,382.20 (16,345.1-25,336.2)	6,615.80 (4,981.0-8,215.4)	156,478.90 (128,677.0-176,333.5)
Oman	11.2 (10.2-12.2)	58 (50.9-66.3)	25.1 (19.7-31.1)	623 (574.3-676.1)	811.6 (702.2-944.7)	305.5 (239.6-376.9)	7,184.10 (6,556.1-7,900.4)
Palestine	22.5 (21.3-23.8)	102.5 (87.8-119.0)	29.4 (22.4-36.8)	559 (498.6-625.6)	2,185.40 (1,866.6-2,546.3)	615.3 (470.2-768.3)	10,841.50 (9,646.6-12,192.6)
Qatar	17.5 (16.3-18.9)	75.1 (58.5-94.7)	28.3 (20.1-38.4)	603 (505.6-716.7)	418.1 (316.2-543.1)	117.1 (82.8-160.7)	2,339.20 (1,853.3-2,897.7)
Saudi Arabia	14.4 (13.5-15.3)	64.3 (53.2-76.7)	23.5 (18.1-29.2)	473.8 (405.3-539.8)	12,270.50 (9,710.4-15,247.5)	4,037.20 (3,104.3-5,117.0)	68,910.40 (56,763.0-81,893.9)
Sudan	10.7 (9.9-11.6)	92 (73.6-115.3)	24.4 (18.5-31.2)	646.1 (567.7-753.3)	16,147.10 (12,643.7-20,547.5)	4,567.50 (3,417.4-5,914.5)	126,539.30 (110,035.8-146,365.7)
Syria	22.8 (21.2-24.4)	115.5 (88.1-151.2)	27.2 (20.1-35.9)	581.3 (468.3-718.7)	13,239.90 (9,919.3-17,583.8)	3,013.40 (2,171.7-4,035.0)	55,579.30 (43,557.0-71,137.3)
Tunisia	23.7 (22.5-24.8)	90.6 (69.1-116.9)	20.5 (14.4-27.7)	419.4 (330.5-525.4)	10,858.80 (8,220.1-14,108.6)	2,405.00 (1,678.8-3,267.4)	46,791.50 (36,512.3-59,188.6)
Turkey	30.9 (29.7-32.2)	99.2 (80.2-120.8)	17.5 (12.8-22.9)	369.5 (310.5-439.0)	86,170.30 (69,436.0-105,168.1)	14,606.40 (10,701.0-19,076.0)	300,697.60 (251,239.3-358,560.8)
UAE	13.8 (12.8-14.9)	95 (75.8-116.5)	33 (24.8-42.9)	563.3 (480.7-663.3)	3,725.70 (2,735.9-4,913.2)	936.6 (660.9-1,275.3)	16,978.00 (13,081.0-21,728.5)
Yemen	20.2 (18.8-21.6)	137.3 (112.4-174.4)	33.9 (26.1-44.0)	680.2 (588.7-823.2)	17,305.90 (13,742.3-22,470.5)	4,466.70 (3,353.7-5,877.0)	96,593.90 (81,359.9-117,091.8)
MENA	19.6 (19.3-19.9)	91.6 (82.7-101.4)	23.9 (19.0-29.0)	507.9 (461.8-553.4)	374,199.10 (335,684.2-417,432.9)	96,458.00 (76,076.9-117,651.5)	1,943,526.80 (1,750,242.8-2,135,282.9)
Global	19.6 (19.4-19.8)	95.6 (89.1-101.8)	16.5 (12.8-20.4)	453.2 (426.4-478.8)	7,693,367.90 (7,158,449.6-8,200,590.6)	1,304,318.30 (1,006,960.8-1,605,391.4)	35,000,050.00 (32,937,413.3-36,938,465.5)
Low SDI countries		79 (70.9-87.8)	16.7 (12.0-21.2)	684.4 (633.7-741.1)	366,990.30 (329,206.2-411,910.6)	90,096.70 (64,031.2-116,874.5)	4,399,291.70 (3,986,060.0-4,902,225.2)
Low-middle SDI countries		111.4 (101.3-122.4)	24.5 (18.2-31.0)	598.4 (553.5-644.3)	1,395,790.30 (1,265,134.5-1,536,588.8)	303,484.40 (227,265.5-380,913.5)	7,626,987.40 (7,057,191.5-8,266,727.8)
Middle SDI countries		104.6 (94.5-115.5)	22 (17.0-27.1)	474 (441.0-507.4)	2,421,045.80 (2,174,281.3-2,683,149.6)	483,105.10 (378,516.3-594,107.8)	10,280,091.30 (9,564,809.1-11,003,544.1)
High-middle SDI countries		101.4 (92.9-109.7)	15.9 (12.5-19.4)	391.3 (365.3-416.7)	2,067,130.60 (1,891,193.0-2,235,411.4)	315,042.00 (248,208.1-383,716.7)	7,609,594.70 (7,105,433.7-8,112,013.3)
High SDI countries		73.4 (70.6-76.6)	5.8 (4.5-7.2)	252.2 (239.9-264.2)	1,438,676.70 (1,379,109.5-1,507,374.5)	111,901.10 (85,856.8-139,225.9)	5,064,430.90 (4,766,547.4-5,328,350.0)

SDI, sociodemographic index; UAE, United Arab Emirates; CI, confidence intervals.

representing 8.5% of all DALYs and 19% of all DALYs with known risks. The age-standardized tobacco-related DALYs rate was estimated to be 2,982.6 (2,652.9-3,323.9) per 100,000. Egypt had the highest rate, and Iran had the lowest (Table 2).

The burden of smoking-related diseases in the MENA region was strongly correlated with socioeconomic factors. Countries with higher gross domestic product (GDP) per capita and higher education levels tended to have lower smoking-related death and DALY rates. However, exceptions, such as Lebanon and Turkey, were observed: both showed high smoking prevalence

Table 2. Age-Standardized DALYs, and Total Annual DALYs Attributable to Smoking, Secondhand Smoking, and All-Causes in the MENA Region in 2019 along with the Prevalence of Smoking

Location	Age-standardized DALYs rate per 100,000			Total annual DALYs		
	Smoking	Second-hand smoke	All risk factors	Smoking	Second-hand smoke	All risk factors
Afghanistan	2,257.50 (1,760.5-2,768.9)	1,192.70 (871.9-1,545.6)	24,772.70 (21,007.1-28,580.6)	356,460.60 (275,128.6-450,108.5)	288,743.10 (197,182.1-401,334.2)	6,811,261.20 (5,705,034.9-8,021,748.7)
Algeria	1,778.00 (1,495.1-2,111.1)	645.1 (500.9-810.1)	12,612.80 (10,883.5-14,584.3)	606,610.70 (508,010.7-726,610.9)	223,805.80 (171,125.6-282,892.6)	4,395,141.20 (3,774,454.8-5,090,417.6)
Bahrain	1,869.80 (1,539.4-2,236.3)	536.9 (360.9-726.8)	11,641.80 (10,043.9-13,442.9)	19,850.40 (16,240.9-24,193.9)	5,371.30 (3,567.3-7,425.7)	117,584.50 (99,784.4-137,180.6)
Egypt	3,301.80 (2,642.0-4,180.2)	912.6 (656.7-1,197.2)	17,551.50 (14,310.2-21,262.5)	2,291,192.90 (1,823,108.3-2,925,788.8)	683,728.10 (487,624.6-903,539.2)	12,470,501.60 (10,160,111.4-15,231,673.2)
Iran	1,581.10 (1,463.3-1,716.6)	408.6 (317.9-502.4)	10,286.00 (9,481.9-11,112.5)	1,229,499.90 (1,132,673.3-1,337,837.5)	310,766.10 (243,898.9-381,734.0)	7,686,073.80 (7,031,339.5-8,350,065.4)
Iraq	3,048.30 (2,434.4-3,626.3)	815.2 (599.7-1,034.8)	15,408.90 (12,986.1-17,709.7)	750,256.70 (591,225.5-911,060.7)	211,033.80 (153,119.6-272,736.4)	4,219,818.80 (3,538,727.8-4,912,947.6)
Jordan	2,214.10 (1,866.6-2,629.2)	482.9 (364.4-609.9)	10,846.40 (9,477.4-12,567.6)	160,889.00 (135,486.8-191,644.6)	36,427.30 (27,816.3-45,881.6)	840,888.10 (726,714.7-985,413.8)
Kuwait	1,657.70 (1,388.0-1,961.4)	418.4 (316.3-535.2)	8,742.10 (7,498.7-10,114.9)	57,575.40 (48,222.1-68,624.1)	13,471.00 (10,160.6-17,206.7)	286,227.20 (245,301.7-330,579.3)
Lebanon	3,894.80 (3,352.4-4,446.4)	699.2 (551.7-862.5)	12,313.70 (10,848.8-13,850.6)	202,767.90 (174,285.9-231,472.3)	36,583.90 (28,932.5-45,004.9)	642,787.40 (566,600.4-723,243.1)
Libya	2,087.50 (1,713.2-2,556.5)	696.5 (530.6-884.7)	11,977.10 (10,104.6-14,120.9)	119,557.10 (97,680.6-147,757.8)	39,423.40 (29,948.8-50,554.0)	664,404.60 (558,672.9-785,485.8)
Morocco	1,896.20 (1,478.9-2,244.9)	600.6 (458.9-752.4)	15,659.70 (13,258.6-17,923.4)	637,126.60 (492,654.8-768,236.9)	195,276.60 (148,426.0-247,407.2)	4,878,164.10 (4,096,092.4-5,640,167.0)
Oman	1,387.70 (1,218.7-1,582.1)	521.3 (404.7-648.6)	13,924.40 (12,756.6-15,225.4)	29,119.00 (25,180.2-33,819.6)	9,772.60 (7,564.2-12,217.0)	303,477.80 (272,135.2-338,344.1)
Palestine	2,598.80 (2,236.6-2,999.8)	731.9 (553.1-925.2)	13,748.60 (12,356.4-15,381.2)	66,223.60 (56,961.2-76,700.7)	19,385.30 (14,613.7-24,244.4)	392,835.90 (351,032.0-441,273.7)
Qatar	1,699.40 (1,369.8-2,079.3)	574.1 (389.9-775.3)	12,717.50 (10,801.7-14,891.8)	20,817.00 (16,575.7-25,643.6)	5,735.40 (3,795.3-8,043.2)	151,496.00 (126,261.0-179,760.7)
Saudi Arabia	1,914.70 (1,589.1-2,289.1)	631.3 (490.9-787.2)	12,658.10 (10,933.1-14,490.7)	491,512.20 (394,542.6-604,784.2)	154,346.50 (117,041.3-196,417.2)	2,956,001.50 (2,483,218.9-3,477,697.0)
Sudan	2,405.20 (1,890.5-3,032.6)	660.6 (493.8-845.9)	19,481.70 (17,082.6-22,407.0)	491,951.00 (379,108.6-629,753.3)	163,124.20 (118,820.0-211,827.0)	5,916,398.00 (5,091,382.9-6,954,740.0)
Syria	2,993.10 (2,340.6-3,879.3)	725 (546.8-944.4)	14,145.10 (11,512.5-17,297.5)	399,326.60 (309,455.1-525,518.1)	94,255.20 (69,836.2-124,926.6)	1,720,441.50 (1,388,023.9-2,133,730.0)
Tunisia	2,306.30 (1,802.7-2,918.9)	536.3 (380.6-719.2)	11,018.20 (8,956.2-13,375.8)	296,187.00 (230,766.6-375,928.9)	67,416.10 (47,675.8-90,324.7)	1,316,552.40 (1,066,863.8-1,609,673.4)
Turkey	2,774.10 (2,309.5-3,319.2)	437.8 (324.8-562.5)	10,618.80 (9,213.4-12,238.9)	2,522,586.40 (2,098,418.1-3,021,845.7)	378,321.30 (279,814.8-489,291.1)	8,787,360.60 (7,613,201.9-10,205,031.7)
UAE	2,505.10 (2,024.6-3,085.8)	779.9 (574.2-1,013.2)	14,585.90 (12,402.0-17,222.1)	175,680.20 (135,615.8-227,842.2)	40,663.20 (29,095.2-55,461.4)	900,114.30 (734,034.0-1,106,053.4)
Yemen	3,634.40 (2,922.8-4,663.8)	898.4 (677.0-1,176.7)	21,126.60 (18,148.6-25,245.6)	538,915.20 (425,460.0-705,877.7)	164,146.90 (117,933.9-220,820.1)	5,028,183.10 (4,287,259.5-5,976,706.4)
MENA	2,455.00 (2,195.9-2,745.0)	656.4 (510.6-805.2)	14,562.10 (13,021.8-16,071.7)	11,475,764.60 (10,196,258.3-12,925,331.5)	3,144,992.10 (2,422,510.0-3,855,567.5)	70,557,398.70 (62,742,478.6-78,420,491.2)
Global	2,412.70 (2,241.2-2,579.0)	463.3 (356.4-565.4)	15,746.50 (14,498.4-17,192.4)	199,794,745.50 (185,451,306.1-213,815,712.3)	37,002,067.50 (28,634,295.1-45,125,997.8)	1,213,261,691.00 (1,118,887,000.3-1,319,484,142.5)
Low SDI countries	1,958.00 (1,762.4-2,175.5)	482.5 (347.5-620.1)	24,702.10 (22,365.9-27,405.8)	10,692,265.10 (9,536,988.7-11,938,121.0)	3,811,790.60 (2,538,949.7-5,203,666.6)	252,094,285.00 (220,955,650.8-290,299,529.3)
Low-middle SDI countries	2,662.20 (2,424.3-2,920.3)	652.4 (483.3-817.3)	20,011.40 (18,316.0-21,906.3)	36,965,821.60 (33,555,308.6-40,646,664.8)	9,385,393.60 (7,010,276.4-11,746,134.9)	304,761,189.10 (277,928,142.0-334,160,922.3)
Middle SDI countries	2,488.10 (2,246.2-2,743.2)	545 (429.3-664.0)	13,758.10 (12,626.3-14,812.3)	63,098,685.30 (56,829,332.3-69,795,320.4)	13,176,786.70 (10,398,273.1-15,986,566.1)	326,325,612.70 (299,935,707.2-352,532,107.2)
High-middle SDI countries	2,612.60 (2,391.3-2,836.3)	399.7 (318.1-484.9)	10,854.70 (9,963.0-11,797.1)	53,206,858.40 (48,716,597.4-57,720,348.5)	7,724,039.00 (6,156,446.1-9,398,011.4)	199,985,973.90 (184,037,624.8-217,563,595.2)
High SDI countries	2,065.40 (1,921.5-2,224.1)	177.6 (137.0-218.8)	8,395.00 (7,606.5-9,252.6)	35,727,488.00 (33,440,895.3-38,249,427.4)	2,881,118.30 (2,223,968.8-3,566,995.4)	129,374,865.30 (118,130,723.1-141,323,206.8)

SDI, sociodemographic index; UAE, United Arab Emirates; CI, confidence intervals.

and burden despite higher GDP per capita and higher education levels.

Age-standardized Death Rates and DALYs by Sex

Males experienced the most smoking-related deaths (79.8%) and DALYs (78.8%). The age-standardized death rates for males and females were 174.3 (95% UI, 157-193) and 45.7(95% UI, 39.9-51.7), respectively. The age-standardized DALYs rates for males and females were 4,604.3 (95% UI, 4,115.3-5,125.9) and 1,287.1(1,102.8-1,469.4), respectively.

Tobacco-related Disease Burden

Globally, the annual death rate and DALYs attributable

Table 3. Age-Standardized DALYs and Death Rates per 100,000 Related to Causes attributed to Smoking in the MENA Region in 2019.

Measure	Cause	Middle East and North Africa	Global	Low SDI	Low-middle SDI	Middle SDI	High-middle SDI	High SDI
DALYs	All causes	2,455.00 (2,195.9-2,745.0)	2,412.70 (2,241.2-2,579.0)	1,958.00 (1,762.4-2,175.5)	2,662.20 (2,424.3-2,920.3)	2,488.10 (2,246.2-2,743.2)	2,612.60 (2,391.3-2,836.3)	2,065.40 (1,921.5-2,224.1)
	Cardiovascular diseases	1,198.00 (1,047.8-1,379.1)	853.9 (788.2-918.0)	637.7 (563.7-725.4)	912 (821.0-1,007.8)	952.6 (857.6-1,054.8)	1,021.10 (936.2-1,114.8)	517.8 (489.5-549.6)
	Chronic respiratory diseases	326.7 (280.3-368.5)	449.5 (403.9-493.6)	548.4 (467.9-623.1)	797.8 (669.6-905.5)	474.7 (419.5-531.1)	323.8 (289.1-368.7)	331.5 (297.7-369.5)
	Diabetes and kidney diseases	103 (77.9-132.1)	78.1 (59.6-98.7)	62.1 (45.8-79.4)	84.7 (65.2-106.7)	86.1 (66.8-106.9)	72.8 (53.8-92.5)	74.3 (53.2-98.4)
	Musculoskeletal disorders	141.1 (88.8-200.7)	123.2 (79.3-172.5)	65.7 (42.8-92.1)	76.6 (50.7-106.8)	95.1 (62.0-132.7)	148.1 (96.6-207.6)	228.3 (145.9-322.6)
	Neoplasms	515.6 (454.9-585.4)	677.3 (616.4-740.3)	273.9 (235.2-311.1)	424.4 (380.9-474.7)	674.5 (583.0-775.7)	859.2 (773.1-952.3)	776 (731.4-817.1)
	Respiratory infections and tuberculosis	82.5 (64.9-102.2)	144.9 (120.2-169.8)	307.1 (237.1-380.3)	274.1 (224.7-328.9)	122.7 (102.0-144.6)	97.4 (80.6-113.8)	53.8 (42.4-65.4)
Deaths	All causes	91.6 (82.7-101.4)	95.6 (89.1-101.8)	79 (70.9-87.8)	111.4 (101.3-122.4)	104.6 (94.5-115.5)	101.4 (92.9-109.7)	73.4 (70.6-76.6)
	Cardiovascular diseases	46.3 (40.6-52.8)	33 (30.4-35.5)	24 (21.3-27.1)	34.9 (31.5-38.4)	38.1 (34.2-42.1)	40 (36.5-43.6)	19.3 (18.0-20.4)
	Chronic respiratory diseases	13.1 (11.1-15.1)	21.1 (18.8-23.4)	27.5 (22.7-31.8)	41.3 (33.8-47.2)	25.2 (22.0-28.6)	15.5 (13.5-18.1)	11.3 (9.9-12.7)
	Diabetes and kidney diseases	2 (1.6-2.5)	1.5 (1.2-1.8)	1.6 (1.2-2.0)	2.1 (1.6-2.5)	1.9 (1.5-2.3)	1.1 (0.9-1.4)	0.9 (0.7-1.2)
	Musculoskeletal disorders	0 (0.0-0.0)	0 (0.0-0.1)	0 (0.0-0.1)	0.1 (0.0-0.1)	0 (0.0-0.1)	0 (0.0-0.1)	0 (0.0-0.1)
	Neoplasms	22.4 (19.8-25.4)	30.6 (28.0-33.3)	11.8 (10.2-13.2)	18.4 (16.6-20.6)	30.7 (26.6-35.1)	37.5 (33.7-41.5)	35.4 (32.9-37.4)
	Respiratory infections and tuberculosis	3.8 (2.9-4.8)	5.7 (4.7-6.8)	11.4 (8.7-14.2)	10.7 (8.6-13.0)	5.2 (4.2-6.3)	3.8 (3.1-4.6)	3 (2.3-3.7)

SDI, sociodemographic index

to smoking-related causes are declining. However, increasing rates were observed in middle SDI countries. Among the MENA region, rising death rates and DALYs were noticed in Lebanon, Turkey, Tunisia, Syria, Libya, and UAE. In contrast, declining rates were most noticeable in Oman and Qatar (Figure 2).

Correlation between Smoking Prevalence and Disease Burden

Our analysis showed a statistically significant and considerable effect size of smoking prevalence on deaths related to smoking (rho = 0.54, S = 712.00, p = 0.013), as well as DALYs related to smoking (rho = 0.52, S = 744.00, p = 0.018) (Figure 3). Several countries had more deaths and DALYs than expected, including Yemen, Iraq, Egypt, and Syria (Figure 4).

Causes of Deaths and DALYs

Smoking contributed to most of the tobacco use deaths and DALYs in the MENA region, with an estimated 374,199 deaths (95% UI, 335,684-417,432) and 11,475,764 DALYs (95% UI, 10,196,258-12,925,331) attributable to smoking and 96,458 deaths (95% UI, 76,076-117,651) and 3,144,992 DALYs (95% UI, 2,422,510-3,855,567) attributable to second-hand smoke. Cardiovascular diseases were the leading cause of death and DALYs related to smoking, accounting for 53.4% of all deaths and 50.3% of all DALYs, followed by neoplasms (24.6% of all deaths and 20.4% of all DALYs), chronic respiratory diseases (12.4% of all deaths and 11.9% of all DALYs), and respiratory infections and tuberculosis (4% of all deaths and 3.4% of all DALYs) (Table 3). Although musculoskeletal disorders (6.8% of all DALYs) and diabetes and kidney diseases (4.3%) were significant contributors to DALYs, they did not contribute to a substantial proportion of deaths. All other causes, including neurological disorders, digestive diseases, sense organ diseases, transport injuries, unintentional injuries, self-harm, and interpersonal violence, accounted for 3.3% of deaths and 2.9% of DALYs (Figure 1s).

Comparison to Global Burden of Smoking-related Diseases

The burden of smoking-related diseases in the MENA region was comparable to that in the middle SDI of the rest of the world. However, there was one significant exception, namely CVD, where the age-standardized annual rates of DALYs and deaths associated with smoking were higher in the MENA region than in all other areas, measuring 1,198 (95% UI, 1,047.8-1,379.1) and 46.3 (95% UI, 40.6-52.8) per 100,000, respectively, compared to global rates of 853.9 (788.2-918.0) and 33.0 (30.4-35.5), respectively. However, the burden of chronic obstructive pulmonary disease in the MENA region was similar to that in high SDI regions, which was lower than the global average (Table 3).

Neoplasms Related to Tobacco Use

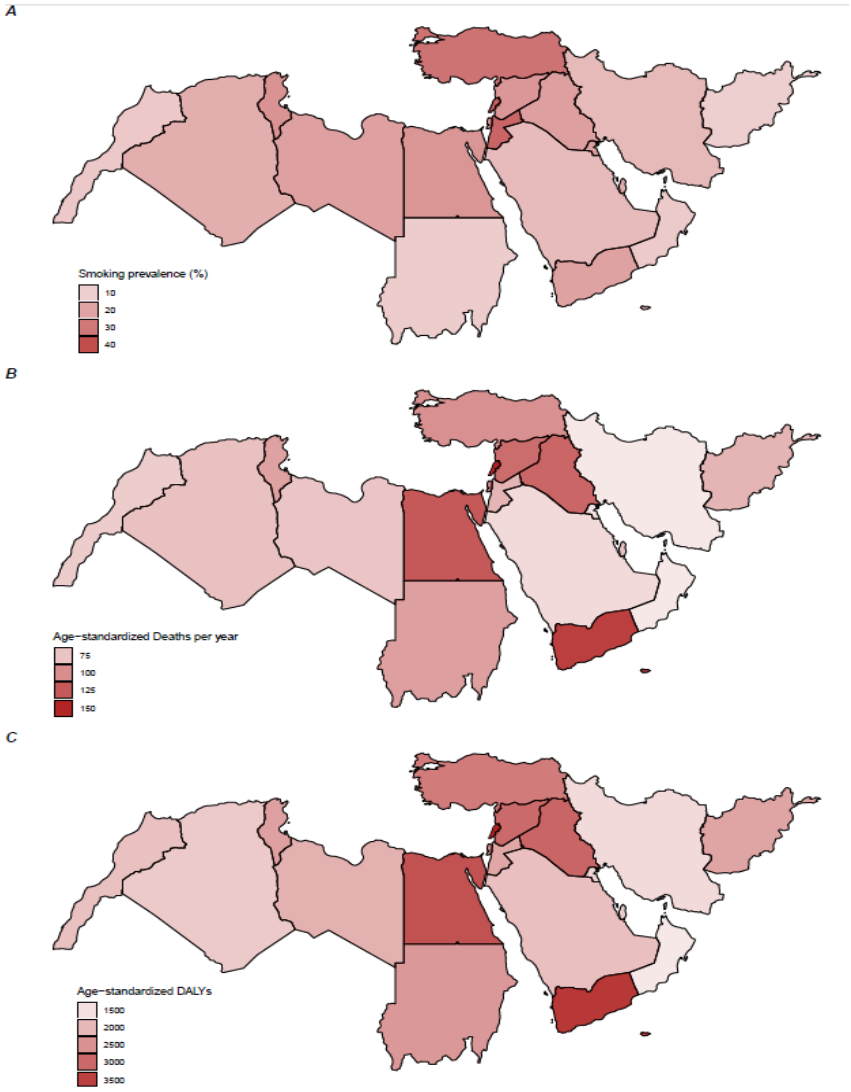

Figure 4. MENA Countries Map Showing (A) smoking prevalence, (B) age-standardized annual smoking-related death rate (per 100,000), and (C) age-standardized annual smoking-related DALYs rate (per 100,000).

Neoplasms associated with tobacco use accounted for a substantial portion of the disease burden in the MENA region, with an estimated 95,169.3 deaths (95% UI, 84,118.1-107,975.3) and 2,434,479.2 DALYs (95% UI, 2,144,120.1-2,768,119.1). Males were disproportionately affected, comprising 89% of these deaths. The age-standardized annual DALY rates for males and females were 931.0 (95% UI, 820.9-1,060.9) and 123.0 (95% UI, 103.2-145.3) per 100,000, respectively.

The most prevalent forms of cancer linked to tobacco use were tracheal, bronchus, and lung cancer, accounting together for 52% of deaths and 51% of DALYs. Other significant neoplasms contributing to the remaining deaths and DALYs included bladder, stomach, laryngeal, and liver cancers (Figure 2s).

Age Distribution of Tobacco-related Diseases

The distribution of smoking-related diseases varied across different age groups. Although cardiovascular diseases remained the leading cause of death and disability related to smoking in all age groups, musculoskeletal disorders contributed significantly to the burden of DALYs among younger age groups. Neoplasms were more prominent in DALYs and deaths among older age groups. The total burden of smoking-related diseases increased with age, peaking in the 64-69 age group (Figure 3s).

Second-hand Smoke

In 2019, second-hand smoke accounted for 96,458 (95% UI, 76,076-117,651) deaths, accounting for 20.5% of all tobacco-related deaths. The age-standardized death rate due to second-hand smoke shows a similar pattern of variation, with the lowest rate in Iran (95% UI, 15.8, 12.6-19.0) and the highest in Yemen (33.9, 26.1-44.0). Additionally, 3,144,992 DALYs (95% UI, 2,422,510-3,855,567) were attributed to second-hand smoke, representing 21.5% of all DALYs related to tobacco abuse. UAE has the highest rate (779.9), and Bahrain has the lowest rate (536.9). With the same pattern, the total annual DALYs attributable to smoking, second-hand smoke, and all risk factors are highest in Egypt, with 2,291,192.9, 683,728.1, and 12,470,501.6, respectively. Afghanistan has the highest proportion of DALYs attributable to second-hand smoke rather than

smoking, with 81% of smoking-related DALYs coming from second-hand smoke.

Young individuals were particularly affected by second-hand smoke, with high rates of DALYs and deaths observed in those younger than 20 years (Figure 4s). Diabetes, kidney diseases, and respiratory infections significantly contributed to the burden caused by second-hand smoke. Almost all DALYs and deaths of those younger than 25 years were attributed to respiratory infections and tuberculosis.

Discussion

This study investigated the prevalence and burden of smoking-related diseases in MENA region, where data on smoking trends and associated disease burden are scarce. Our findings showed that the smoking prevalence in MENA is 19.6%, comparable to the global prevalence. Our data also revealed a strong correlation between smoking prevalence and SDI, indicating that a higher SDI is associated with higher smoking prevalence. Cardiovascular diseases were the leading cause of death and DALYs related to smoking in our study, highlighting the importance of early screening of smokers for hypertension, obesity, and other risk factors for cardiovascular diseases.

The impact of smoking prevalence on smoking-related deaths and disability was variable, perhaps reflecting the complex interplay of smoking with other factors, such as healthcare and income, that contribute to the outcome of smokers. Interestingly, countries with low and middle SDIs exhibited the highest relative age-standardized deaths and DALYs caused by smoking. Globally, the annual death rate and DALYs attributable to smoking-related causes are declining, but increasing rates were observed in middle SDI countries [6]. Rising death rates and DALYs were noticed among the MENA region in Lebanon, Turkey, Tunisia, Syria, Libya, and the United Arab Emirates (UAE). In contrast, declining rates were most noticeable in Oman and Qatar.

Given the increasing prevalence of smoking in some MENA countries and population growth, the burden of smoking-related diseases is likely to increase. It is essential to recognize a time gap between changes in smoking prevalence and the reflected changes in disease burden. As such, the coming decades may see a rise in the number of individuals with smoking-related illnesses in the MENA region, and countries should be prepared for the increasing demands on their health systems. Strengthening primary health care to address problems that interact with smoking, such as obesity, diabetes, and hypertension, is crucial. Improving cancer care is also important.

In addition to healthcare improvements, good smoking-control programs must take precedence in these countries. The causal relationship between smoking and various diseases is well-established. Approximately one-fifth of the cancer burden can be attributed to smoking, with lung cancer accounting for nearly half of the deaths and DALYs associated with cancer in the MENA region. Furthermore, exposure to second-hand smoke has been linked to breast cancer and represents most smoking-related deaths and DALYs among women diagnosed with this form of cancer [12, 13].

Tobacco control programs in the MENA region face many challenges, including sociocultural factors, weak regulations, and industry interference. In the MENA region, smoking is often considered a socially acceptable behavior; in some countries, it is even considered a cultural norm [14]. The enforcement of tobacco control policies, such as smoke-free environments, advertising restrictions, and taxation, varies significantly among the MENA countries [15]. In some cases, weak regulations and the lack of proper enforcement can lead to ineffective tobacco control measures [16]. The most critical issue is with the tobacco industry, which has been known to interfere with tobacco control policies through lobbying, funding, and public relations campaigns. Strategies that may work include raising the price of cigarettes and mobilizing religious leaders [17, 18].

Planning tobacco control in the MENA region requires a multi-dimensional approach. MENA countries should consider adopting and implementing comprehensive tobacco control policies in line with the World Health Organization's Framework Convention on Tobacco Control [19]. This includes the implementation of smoke-free environments, restrictions on tobacco advertising, and raising tobacco taxes. Culturally tailored public awareness campaigns can effectively inform the population about the risks associated with tobacco use and promote smoking cessation [20]. Such campaigns should target the general population and specific high-risk groups, such as young people and women. Strengthening the capacity of healthcare professionals, policymakers, and civil society organizations in the MENA region can contribute to more effective tobacco control efforts [21]. Training programs, workshops, and seminars can be organized to enhance the knowledge and skills of these stakeholders.

The relationship between smoking and certain illnesses, such as diabetes and musculoskeletal disorders, is complex. Type 2 diabetes is 30 to 40% more likely to develop in smokers than in nonsmokers. Managing the disease and regulating insulin levels can be more difficult for smokers because high levels of nicotine can lessen the effectiveness of insulin, necessitating more insulin to regulate blood sugar levels [22, 23, 4]. Smoking negatively impacts musculoskeletal health: it can lead to decreased bone density, an increased risk of osteoporosis, and a higher risk of bone fractures [24, 25]. Smoking has also been associated with an increased risk of developing rheumatoid arthritis, a chronic autoimmune disease that affects the joints [25]. Furthermore, smoking is a risk factor for low back pain and spinal disorders. Studies have found that smoking is associated with an increased risk of developing degenerative disc disease, which can cause chronic low back pain [24, 25].

Our study highlights the urgent need to address the significant burden of secondhand smoking in the MENA region. Efforts should focus on implementing and enforcing strict smoke-free policies in public spaces, workplaces, and homes to protect individuals, particularly young people, from exposure to secondhand

smoke. Additionally, targeted educational campaigns should be developed to raise awareness about the health risks associated with secondhand smoke and promote behavioral changes. Furthermore, integrated approaches that address the underlying causes of increased secondhand smoking, such as socioeconomic disparities and cultural norms, are crucial for effective prevention and control. By prioritizing these strategies, we can reduce the morbidity and mortality of secondhand smoking in the MENA region and improve public health outcomes.

This study's limitations include potential inaccuracies in GBD estimates due to data gaps and varying reporting standards across countries. The study does not account for interactions between tobacco use and other risk factors or variations in second-hand smoke exposure. SDI may not capture all aspects of development relevant to health outcomes, and the cross-sectional design limits the ability to establish causal relationships. Longitudinal studies are needed to better understand the relationship between smoking prevalence and disease burden and to assess the impact of tobacco control policies in the MENA region.

In conclusion, smoking continues to significantly contribute to the burden of diseases in the MENA region, particularly among males. Although the overall trend of smoking-related deaths and DALYs is declining globally, several countries in the MENA region exhibit increasing trends. Our findings highlight the need for interventions and policies to curb smoking prevalence and its related burden in the region. Further research is needed to explore the complex interplay of smoking and other factors affecting smoking outcomes, particularly in low and middle-SDI countries.

Author Contribution Statement

Yaseen Sultan: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Visualization; Zeena Salman: Conceptualization, Methodology, Writing - Review & Editing, Supervision, Project Administration; Mohammed Alzaatreh: Investigation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision; Adib Edlibi: Formal Analysis, Data Curation, Writing - Original Draft; Ruba Alani: Methodology, Formal Analysis, Writing - Review & Editing; Iyad Sultan: Conceptualization, Methodology, Writing - Original Draft, Project Administration; Ahmad Samir Alfaar: Writing - Review & Editing, Visualization, Supervision; Ibrahim Qaddoumi: Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Supervision, Project Administration.

Acknowledgements

We would like to express our profound gratitude to the Institute for Health Metrics and Evaluation (IHME) for granting us access to the Global Burden of Disease (GBD) study datasets. This extensive compilation of health-related data from the GBD, led and maintained by the IHME, has significantly influenced the direction and capacity of our research efforts. We extend heartfelt thanks to Cherise Guess, PhD, ELS, for her exceptional editorial support that has greatly enhanced the quality of our manuscript.

Funding

None of the authors received funding for this research. Editorial support was provided based on the institutional support for the last author by St. Jude Children's Research Hospital.

Conflict of Interest

None to be disclosed for any of the authors.

Ethical approval

ot applicable so no ethical approval was sought.

Data Availability

Data is available publicly through the GBD study.

References

1. Khattab A, Javaid A, Iraqi G, Alzaabi A, Ben Kheder A, Koniski ML, et al. Smoking habits in the middle east and north africa: Results of the breathe study. Respir Med. 2012;106 Suppl 2:S16-24. https://doi.org/10.1016/s0954-6111(12)70011-2.
2. Glynn TJ, Manley MW, Gerlach KK, Shopland DR. Public health approaches to tobacco use prevention and cessation in the US. J Public Health Manag Pract. 1996;2(2):17-26.
3. Collaborators GT. Smoking prevalence and attributable disease burden in 195 countries and territories, 1990-2015: A systematic analysis from the global burden of disease study 2015. Lancet. 2017;389(10082):1885-906. https://doi.org/10.1016/s0140-6736(17)30819-x.
4. Will JC, Galuska DA, Ford ES, Mokdad A, Calle EE. Cigarette smoking and diabetes mellitus: Evidence of a positive association from a large prospective cohort study. Int J Epidemiol. 2001;30(3):540-6. https://doi.org/10.1093/ije/30.3.540.
5. Zhang L, Tong Z, Han R, Guo R, Zang S, Zhang X, et al. Global, regional, and national burdens of ischemic heart disease attributable to smoking from 1990 to 2019. J Am Heart Assoc. 2023;12(3):e028193. https://doi.org/10.1161/jaha.122.028193.
6. Dai X, Gakidou E, Lopez AD. Evolution of the global smoking epidemic over the past half century: Strengthening the evidence base for policy action. Tob Control. 2022;31(2):129-37. https://doi.org/10.1136/tobaccocontrol-2021-056535.
7. Diseases GBD, Injuries C. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: A systematic analysis for the global burden of disease study 2019. Lancet. 2020;396(10258):1204-22. https://doi.org/10.1016/S0140-6736(20)30925-9.
8. Institute for Health Metrics and Evaluation (IHME) (-a). Global Burden of Disease Study 2019 (GBD 2019) Smoking Tobacco Use Prevalence 1990-2019. Available from: https://ghdx.healthdata.org/record/ihme-data/gbd-2019-smoking-tobacco-use-prevalence-1990-2019
9. Institute for Health Metrics and Evaluation (IHME) (-b). Global Burden of Disease Study 2019 (GBD 2019) Socio-Demographic Index (SDI) 1950–2019. Available from: https://ghdx.healthdata.org/record/ihme-data/gbd-2019-socio-demographic-index-sdi-1950-2019
10. Murray CJ, Lopez AD. Measuring the global burden of disease. N Engl J Med. 2013;369(5):448-57. https://doi.

org/10.1056/NEJMra1201534.
11. Team RC. R: A language and environment for statistical computing. R foundation for statistical computing, vienna, austria. 2022.
12. Johnson KC, Miller AB, Collishaw NE, Palmer JR, Hammond SK, Salmon AG, et al. Active smoking and secondhand smoke increase breast cancer risk: The report of the canadian expert panel on tobacco smoke and breast cancer risk (2009). Tob Control. 2011;20(1):e2. https://doi.org/10.1136/tc.2010.035931.
13. Kim AS, Ko HJ, Kwon JH, Lee JM. Exposure to secondhand smoke and risk of cancer in never smokers: A meta-analysis of epidemiologic studies. Int J Environ Res Public Health. 2018;15(9). https://doi.org/10.3390/ijerph15091981.
14. Nakkash R, Khalil J. Health warning labelling practices on narghile (shisha, hookah) waterpipe tobacco products and related accessories. Tob Control. 2010;19(3):235-9. https://doi.org/10.1136/tc.2009.031773.
15. Heydari G, Talischi F, Masjedi MR, Alguomani H, Joossens L, Ghafari M. Comparison of tobacco control policies in the eastern mediterranean countries based on tobacco control scale scores. East Mediterr Health J. 2012;18(8):803-10. https://doi.org/10.26719/2012.18.8.803.
16. Initiative WTF. Tobacco industry interference with tobacco control. Retrieved may 1, 2023, from https://www.Who.Int/publications/i/item/9789241597340. 2023.
17. Sweis NJ, Chaloupka FJ. The economics of tobacco use in jordan. Nicotine Tob Res. 2014;16 Suppl 1:S30-6. https://doi.org/10.1093/ntr/ntt058.
18. Gavlak D. Smoke alarm from afghanistan to morocco. Bull World Health Organ. 2008;86 2:89-90.
19. World Health Organization (WHO) . WHO Framework Convention on Tobacco Control. Retrieved May 1; 2023. Available from: https://www.paho.org/en/documents/who-framework-convention-tobacco-control
20. Salloum RG, Abu-Rmeileh N, Hamadeh R, Thomas J, Mostafa A, Yusufali A, et al. Policy-relevant context of waterpipe tobacco smoking among university students in six countries across the eastern mediterranean region: A qualitative study. Asian Pac J Cancer Prev. 2017;18(9):2533-40. https://doi.org/10.22034/apjcp.2017.18.9.2533.
21. Ekpu VU, Brown AK. The economic impact of smoking and of reducing smoking prevalence: Review of evidence. Tob Use Insights. 2015;8:1-35. https://doi.org/10.4137/tui.S15628.
22. Chiolero A, Faeh D, Paccaud F, Cornuz J. Consequences of smoking for body weight, body fat distribution, and insulin resistance. Am J Clin Nutr. 2008;87(4):801-9. https://doi.org/10.1093/ajcn/87.4.801.
23. Madsbad S, McNair P, Christensen MS, Christiansen C, Faber OK, Binder C, et al. Influence of smoking on insulin requirement and metbolic status in diabetes mellitus. Diabetes Care. 1980;3(1):41-3. https://doi.org/10.2337/diacare.3.1.41.
24. Al-Bashaireh AM, Haddad LG, Weaver M, Kelly DL, Chengguo X, Yoon S. The effect of tobacco smoking on musculoskeletal health: A systematic review. J Environ Public Health. 2018;2018:4184190. https://doi.org/10.1155/2018/4184190.
25. Tarakji B, Cil A, Butin RE, Bernhardt M. Adverse effects of smoking on musculoskeletal health. Mo Med. 2017;114(4):268-71.