



Building a House on Sand: How Tobacco Use Is Devouring Resources

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Abstract

Background: Tobacco is a major cause of preventable morbidity and mortality, with a considerable economic burden. The purpose of this systematic review was to summarize the evidence on the economic burden of tobacco use by searching national and international databases so as to generate useful information about the costs of tobacco use globally.

Methods: A systematic search was conducted in Scopus, PubMed, EMBASE, ProQuest, and Web of Science (ISI) databases to identify relevant studies from 1990 to June 2021 using keywords like burden, productivity, indirect cost, direct cost, economic, monetary, expenditure, tobacco, smoking, and cigarettes. Cost estimates were converted into 2020 international dollars per adult.

Findings: A total of 1,781 articles were identified, of which 361 were deemed to be eligible for inclusion. Eventually, 23 articles were found eligible. In most studies, cost estimates were provided using a prevalence-based approach. The highest total cost, as a percentage of gross domestic product (GDP), was reported for South Korea (1.19%). Noteworthy, in all studies, indirect costs accounted for the highest proportion of all costs. The mean total cost amounted to 5,866 million dollars. The direct costs ranged from 179 million dollars in South Korea to 8,156 million dollars in Israel. Meanwhile, the indirect costs ranged from 289 million dollars in Hong Kong to 9,808 million dollars in India.

Conclusion: The evidence demonstrated the considerable economic burden of tobacco use in various countries, ranging from 0.33 to 1.19% of the GDP of the investigated countries, indicating the necessity of taking immediate measures. Hence, policies are needed to address the economic burden of smoking.

Keywords: Tobacco, Economic burden, Total cost, Systematic review

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Introduction

As a leading cause of preventable mortality and morbidity, tobacco use claims more than eight million lives annually, based on the World Health Organization (WHO).^{1,2} This number is expected to increase considerably by 2030.³ Meanwhile, smoking causes considerable premature disability and mortality. Non-communicable diseases (NCDs), particularly cancer and cardiovascular diseases, claim 41 million lives annually with 85% of these premature deaths occurring in low- and middle-income (LMICs). Noteworthy, tobacco use, lack of physical activity, excessive use of alcohol, and inappropriate diets increase the risk of NCDs.⁴ About 80% of deaths are attributed to NCDs, mostly due to cardiovascular and respiratory diseases as well as lung cancer.³ It is difficult and resource-consuming to manage these diseases as therapeutic interventions, which are mostly expensive, must be administered in specialized health settings.⁵ This indicates the necessity of using effective tools to reduce the demand for tobacco use.

Moreover, smoking-related diseases lead to a

considerable economic burden, as evidenced by several studies.^{6,7} There are estimates indicating an annual economic loss of US\$ 500 billion worldwide, including productivity loss, morbidity, and premature deaths,⁸ accounting for 1-4% of GDP in high-income countries (HICs) (e.g., 2.1–3.4% of GDP in Australia, 1.3–2.2% in Canada, and 1.4–1.6% of GDP in the United States).⁹ Nevertheless, the topic seems to be flown under the radar of researchers in HICs.

Globally, tobacco use is rising, with higher prevalence among lower socioeconomic groups, and Iran is no exception.¹⁰ The health system of Iran has three tiers, with major contribution of private players and a poorly equipped public sector, which along with considerably high out-of-pocket expenditures, yields health inequalities.¹¹ Hence, it can be argued that the overall burden of tobacco use, either mortality or morbidity, is disproportionately higher among the disadvantaged groups, leading to higher public health expenditures and exacerbating health inequalities.¹²

Traditionally, policymakers tried to promote tobacco



cessation by highlighting its far-reaching consequences for the health of smokers and people around them while not paying sufficient attention to its direct economic impact.¹³ Therefore, estimation of the direct and indirect costs of tobacco use would be a valuable solution for following evidence-based policies to promote tobacco use cessation. However, in comparison to HICs, there is relatively little evidence in LMICs driven by lower per capita health expenditures and higher unemployment rates. The economic burden is often divided into direct and indirect components. The former refers to the total cost directly imposed on individuals, families, and society. The latter refers to the loss of the present and future value of society and family.¹⁴ In this regard, the purpose of this systematic review was to summarize the evidence on the economic burden of tobacco use by searching national and international databases so as to generate useful information about the costs of tobacco use globally.

Methods

The present study was conducted following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations, including identification, screening, eligibility, and inclusion for systematic reviews and meta-analyses.¹⁵

Search strategy and selection criteria

A systematic search was conducted in Scopus, PubMed, EMBASE, ProQuest, and Web of Science databases to identify relevant articles from 1990 to June 2021 using keywords such as burden, productivity, indirect cost, direct cost, economic, monetary, expenditure, tobacco, nicotine, smoking, and cigarettes. Google Scholar was also searched to enhance the chance of finding potentially relevant articles. Moreover, reference lists of the identified articles were hand-searched.

The search strategy used for various databases is described in [Table 1](#).

Title and abstract screening was performed by one

of the researchers, followed by full-text screening by two researchers. Disagreements were resolved through consensus or consulting a third reviewer. The search strategy was repeated by a second independent reviewer to ensure the adequacy of the search process. After searching the aforementioned databases, all identified studies were transferred to Endnote X7, and duplicates were removed.

Inclusion criteria

The inclusion criteria were the original articles being published in the English language up to 2020, referring to direct or indirect costs of the whole country, full-text availability, and evaluation of at least three diseases.

Exclusion criteria

The exclusion criteria included studies published in languages other than English, studies whose full text was not available, and studies that did not obtain a passing score in quality assessment. In addition, review articles, dissertations, working papers, comments, and letters to editors were excluded.

Study selection and data extraction

Data extraction was performed by one researcher, followed by an independent evaluation by another researcher for accuracy, according to a similar study.¹⁶ Cost estimates were extracted as: (1) total costs; (2) categories within level one (total costs), including direct, indirect, and intangible costs; (3) categories within level two, including health expenditures as part of the direct costs; and (4) categories within level three, including inpatient costs as part of the health expenditures or GDP. If costs were in US dollar, they were converted into the 2020 US Dollar; afterward, turned into the 2020 US Dollar based on the currency exchange rate in that period. The data form contained information on the year of publication, direct, indirect, and total costs, number of smoking-related diseases included in the study, and

Table 1. Search Strategies used for various databases

Database	Search strategy	Number
PubMed	Search: #1 AND #2 Filters: from 2000-2021 (("cost"[Title] OR "economic"[Title] OR "monetary"[Title] OR "expenditure"[Title] OR "economic burden"[Title]) AND ("smoking"[Title] OR "tobacco"[Title] OR "cigarette"[Title] OR "nicotine") AND (2000:2021[pdat]))	800
Scopus	(*tiab) OR burden*(tiab) OR productivity*(tiab) OR indirect (tiab) or direct cost*(tiab) AND (*tiab) OR *(tiab) OR *(tiab) cost OR economic OR monetary OR expenditure OR economic OR burden Smoking OR tobacco OR cigarette OR nicotine	273
EMBASE	(*tiab) OR burden*(tiab) OR productivity*(tiab) OR indirect (tiab) or direct cost*(tiab) AND (*tiab) OR *(tiab) OR *(tiab) cost OR economic OR monetary OR expenditure OR economic OR burden Smoking OR tobacco OR cigarette OR nicotine	382
ProQuest	(*tiab) OR burden*(tiab) OR productivity*(tiab) OR indirect (tiab) or direct cost*(tiab) AND (*tiab) OR *(tiab) OR *(tiab) cost OR economic OR monetary OR expenditure OR economic OR burden Smoking OR tobacco OR cigarette OR nicotine	38
Web of Science	(*tiab) OR burden*(tiab) OR productivity*(tiab) OR indirect (tiab) or direct cost*(tiab) AND (*tiab) OR *(tiab) OR *(tiab) cost OR economic OR monetary OR expenditure OR economic OR burden Smoking OR tobacco OR cigarette OR nicotine	288

costs as a percentage of the national health expenditures or GDP. Two independent reviewers extracted the data using a researcher-made checklist.

Quality evaluation

The quality evaluation was performed using the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) checklist, which is an appropriate tool for the qualitative evaluation of observational studies. This checklist has 22 general items, each with a series of sub-items (a total of 32 sub-items). All sections of the articles, including title, abstract, objective(s), problem statement, study type, sampling, participants, variables, data collection, statistical analysis, findings, and discussion were reviewed to evaluate the overall quality. Each of the aforementioned topics was scored one or zero. The minimum and maximum scores of the STROBE checklist are zero and 32, respectively. Articles with a score of at least 16 were considered of high and moderate quality while those with a score less than 16 were defined as poor quality articles.

Results

Initially, a total of 1781 articles were identified; 800 from PubMed, 273 from Scopus, 382 from EMBASE, 38

from ProQuest, and 481 from Web of Science databases. Following reviewing titles and abstracts, 361 articles were deemed to be eligible for inclusion in this review (Figure 1). Besides, three articles were identified through a search of reference lists. Eventually, 23 studies were found eligible. Table 2 presents a summary of the key information of the reviewed articles.

From among the 23 eligible studies providing estimates of smoking-related costs, either direct or indirect, 15 were conducted in Asian countries, one in Africa, four in Europe, and three in North America. Respiratory diseases, cardiovascular diseases, and lung and larynx cancers were the most commonly investigated diseases. Two studies investigated all diseases.^{33,36} In addition, cardiovascular diseases, chronic obstructive pulmonary disease (COPD), and lung and larynx cancers were considered by most studies. Except for two studies, the rest reported both indirect and direct costs. Furthermore, 16 studies estimated the total cost as a percentage of GDP. Most studies used prevalence to estimate the costs.^{7,18,19,28-30,36,38} The highest and lowest rates of the total cost as a percentage of GDP were reported for South Korea; 1.19%¹⁷ and 0.33%,²⁷ respectively. Noteworthy, for all studies, indirect costs accounted for the highest share of all costs, except for one study conducted in Canada.³¹

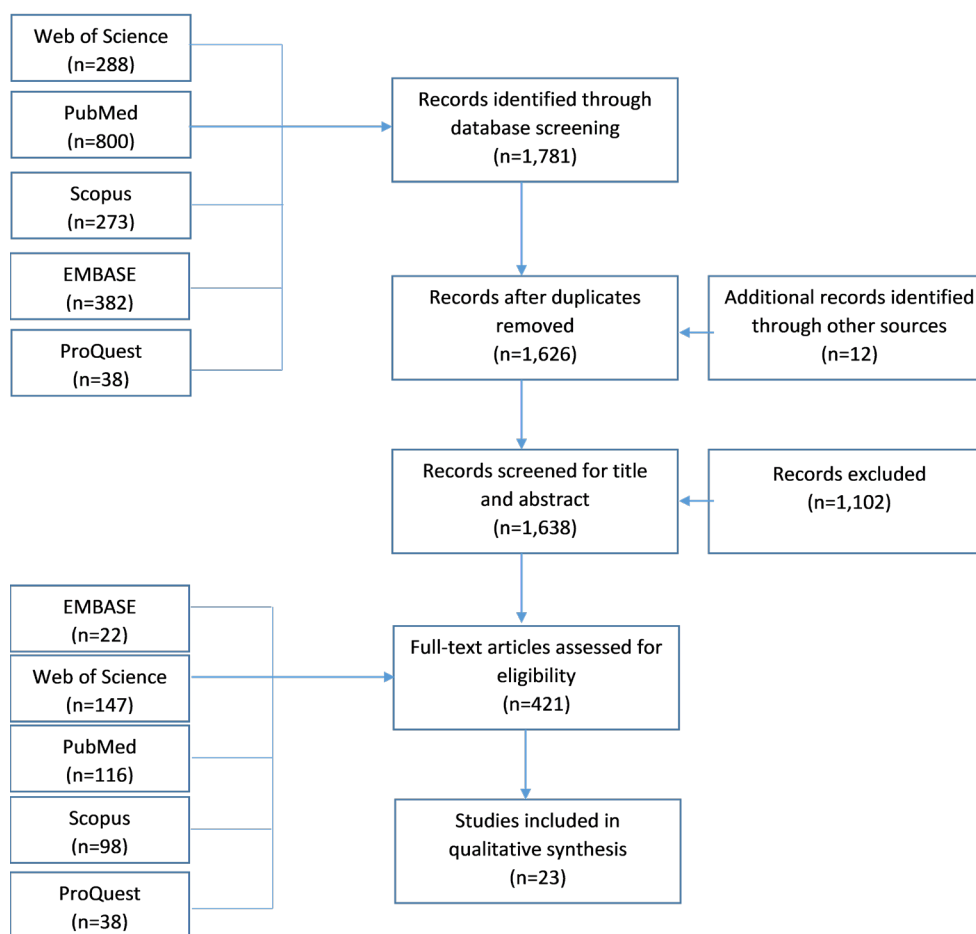


Figure 1. The process of study selection

Table 2. The key information of the studied articles

Authors	Country	Year of reported costs	Total cost (US million \$)	Direct Costs	Indirect Cost	TC as % of GDP	Diseases included	Methodology
Kang et al (2002) ¹⁷	Korea	1998	4712-6950	179	4531-6769	0.82-1.19	Cancers, respiratory diseases, asthma, pneumonia, IHD stroke, emphysema, vascular diseases, hypertension, gastrointestinal diseases, gastric ulcer, duodenal ulcer, cirrhosis	Epidemiologic approach- PAR
Yang et al (2005) ¹⁸	Taiwan	2001	2350	522	1827	0.5	Cancers, diabetes mellitus, rheumatic heart disease, IHD, cardiac arrest and other heart diseases; cerebrovascular disease, chronic bronchitis, asthma, chronic airways obstruction, peptic ulcer, hemorrhage, liver cirrhosis, kidney diseases	A prevalence-based approach
Sung et al (2005) ¹⁹	China	2000	9495	3216	6279	NA	Malignant neoplasm cancer, stroke, IHD, rheumatic heart disease, respiratory diseases including COPD and TB	A prevalence-based, disease-specific approach
McChee et al (2005) ²⁰	Hong Kong	1998	864	576	289	NA	Lung, esophageal, stomach, liver, mouth, pharynx, larynx, pancreas, and bladder cancers; COPD, pulmonary heart disease, and other respiratory diseases; stroke, IHD, and other vascular diseases; peptic, gastric, duodenal, and gastrojejunal ulcers; regional enteritis; idiopathic proctocolitis	Health-related impacts
Jha et al (2000) ²¹	USA	1999				1.4-1.6		A prevalence-based approach
Chung et al (2007) ²²	Taiwan	2001	NA	382-441	NA	NA	Lip, oral cavity, pharynx, esophagus, stomach, rectum, liver, gallbladder, lung, cervix, and uteri neoplasms; Stroke; Acute myocardial infarction; COPD	Survival analysis
Bolin et al (2007) ²³	Sweden	2001	1420	374	1045	NA	Malignant neoplasms in the upper aerodigestive tract, lungs, pancreas, urinary bladder, and kidney; COPD and other respiratory diseases; IHD	Published estimates on relative risks and Swedish smoking patterns were used to calculate attributable risks for smokers and former smokers
John et al (2008) ²⁴	India	2004	2799	1968	829	NA	TB, respiratory diseases, cardiovascular diseases, neoplasm	A prevalence-based, disease-specific, cost-of-illness approach
Allender et al (2009) ²⁵	UK	2005	NA	4039	NA	NA	Mouth and oral cancer; trachea, bronchus, and lung cancers; COPD; cardiovascular diseases; and other medical conditions	Systematic literature review
Yang et al (2011) ²⁶	China	2008	37949	8156	9792	0.7	Cancers, cardiovascular diseases, and respiratory diseases	A disease-specific approach, PAR
Oh et al (2012) ²⁷	Korea	2008	3646	977	2669	0.33	lip, oral cavity, pharynx, esophagus, pancreas, larynx, trachea, lung, bronchus, cervix uteri, urinary bladder, kidney, stomach, liver, and colorectal cancers	The smoking-attributable fraction (SAF) was calculated using the prevalence rate of current smoking, the prevalence rate of former smokers and the nonsmoking rate
Boachie et al (2009) ¹²	UK	2009	NA	5200	NA	5200	All deaths attributed to tobacco use recorded by the NHS	A mixed approach was utilized based on data provided by the WHO, global burden of diseases, and national death toll
Ginsberg et al (2014) ²⁸	Israel	2014	1030	482	548	0.42	Respiratory cancers; cardiovascular diseases; Digestive system, and Endocrine metabolic system	A disease-specific approach, PAR
Hoang Anh et al (2016) ²⁹	Vietnam	2011	1173.2	9896	2576	0.97%	Lung and upper aerodigestive tract cancers, COPD, IHD, stroke	A prevalence-based, disease-specific, cost-of-illness approach
Bundhamcharoen et al (2016) ³⁰	Thailand	2006	NA	372	NA	0.48	Lung cancer, COPD, and coronary heart disease	A prevalence-based, disease-specific, cost-of-illness approach

Table 2. Continued

Authors	Country	Year of reported costs	Total cost (US million \$)	Direct Costs	Indirect Cost	TC as % of GDP	Diseases included	Methodology
The research team assigned by the ministry of health (2012) ³¹	Canada	2011	171.5	16.2	9.5	NA	The study focused on mortality, morbidity, and direct healthcare costs of cigarette smoking and did not include the consumption of cigars, smokeless tobacco, pipe tobacco, or other forms of tobacco consumption	A prevalence-based, disease-specific, cost-of-illness approach
USA CDC (2012) ³²	USA	2015	22.5	15.6	38.1		All diseases	The cost-of-illnesses approach
Nargis et al (2017) ³³	Uganda	2014	126.57	41.56	85.01	0.5%	All diseases	The cost-of-illnesses approach
Amarasinghe et al (2018) ⁷	Sri Lanka	2015	121.2	42.1	79.1		Tobacco-related cancers	Prevalence-based cost-of-illness approach
John et al (2019) ³⁴	India	2017	12.4 billion	20.9%	79.1%	0.5%	All diseases and deaths in India in 2017 for persons aged 30–69 years	A prevalence-based attributable-risk approach
Koronaoui et al ³⁵	Greece	2017	7.2 billion			4%	Total economic cost of tobacco smoking and secondhand smoke (SHS) exposure	A cost-of-illness approach
Komompaisarn (2021) ³⁶	Thailand	2017	289.63	265.97	23.66	0.65%	All diseases	A prevalence-based cost-of-illness approach
John et al (2021) ³⁷	India	2017	27.5 billion	6 billion	21.5 billion	1.04%	All diseases	A prevalence-based attributable-risk approach

Abbreviations: NA, stands not available; TC, total cost; IHD, ischemic heart disease; PAR, population attributable risk; COPD, chronic obstructive pulmonary disease; TB, tuberculosis.

The direct costs ranged from 179 million dollars in South Korea¹⁷ to 8,156 million dollars in Israel.²⁸ The indirect costs ranged from 289 million dollars in Hong Kong²⁰ to 9808 million dollars in India.³⁴ The mean total cost amounted to 5866 million dollars.

Discussion

There are more than one billion smokers in the world, 80% of whom live in LMICs.³⁹ Nearly 25% of world smokers are 13 to 15 years old. Nowadays, inclination towards tobacco use is on the rise worldwide due to several reasons such as stress, high costs of living, etc. In Iran, the skyrocketing inflation rate, in combination with some other significant factors such as restrictions imposed due to the COVID-19 pandemic, can be considered a major predictor of increasing tobacco use. Currently, societies are facing two major problems: the high and increasing number of tobacco users and the high social, economic, and health burden of tobacco use. Tobacco use related costs are high in various societies, not to mention high rates of morbidity and mortality.^{40,41} In fact, tobacco use is a major factor of mortality globally.³⁴ On the other hand, the total economic costs associated with smoking are estimated to account for 1.5% of the global GDP.³⁹

The present systematic review aimed to provide a detailed summary of the economic costs of smoking worldwide. In this regard, a total of 23 articles were reviewed to assess smoking-related diseases. The findings indicated the considerable burden of smoking-related costs, ranging from 0.33 to 1.19% of the GDP in the investigated countries. Noteworthy, indirect costs contributed to the highest proportion of the total costs of tobacco use, except for one study in Canada. The identified studies were homogeneous in many respects, including investigated disease conditions, cost categories, sources of costs, and methodological approaches.

While tobacco use contributes to the occurrence of a wide spectrum of diseases, several studies only focused on a limited number of diseases (e.g., cancers and respiratory diseases), which probably affects the results. For instance, the evidence supported the major effect of tobacco on perinatal outcomes, leading to substantial health-related costs, but few studies investigated this.⁴² Although this review did not intend to compare costs related to various diseases and states, a wider range of diseases was expected to have been studied. Nevertheless, this limitation may reflect the unavailability of information required across countries. Another important finding was the lack of a standard list of diseases and conditions caused by tobacco, which resulted in the investigation of different diseases in various studies. In some cases, this limitation faded comparability of the findings, even in countries located in a similar region.^{43,44} Despite this shortcoming, the findings indicated the considerable economic burden of tobacco, either direct or indirect.

Another important finding was the large variation concerning reported costs. Meanwhile, there was a methodological homogeneity, with prevalence-based approach as the most commonly used method (n=9). The methodologies ranged from epidemiological, health impact, and survival impact to cost-of-illness approaches. Prevalence-based approaches consider both existing and new cases for determining economic costs attributable to a particular condition.⁴⁵ Despite their extensive difference, evidence produced by these approaches can stimulate policy-makers to take immediate measures to curb the tobacco epidemic.⁴⁶ Noteworthy, all of them were complementary, not contradictory. In addition, choosing the appropriate method depends on several factors, including study context, available data, study question, and so on. When evaluating the effectiveness of a policy or an intervention, incidence-based approaches can provide valuable evidence. On the other hand, prevalence-based approaches are appropriate for budgeting purposes. Surprisingly, only two studies used the WHO methodology to calculate the costs associated with tobacco use.^{7,33} This method is based on using the cost-of-illness approach.⁴⁷ The literature supported the following measures to improve the validity of studies intended to estimate tobacco-related costs: (a) using a standard set of conditions/diseases; (b) following a general, standard method (i.e., WHO guidelines); and (c) the standard inclusion of cost areas (i.e., tangible, intangible, etc).⁴²

Comparing costs among various countries is always problematic. Even in cases where local currency is reported using purchasing power calculator, it is unlikely to overcome considerable differences between countries concerning cost items, including health-related costs or estimation of the number of deaths. Health surveillance data are available in few countries. Nevertheless, adoption of the WHO FCTC paved the way for taking serious measures to access such data.⁴⁸⁻⁵⁰

While intangible costs were not considered in most of the studies, such as those related to premature mortality, the reported costs attributable to tobacco use were substantial. Notably, a recent study in Australia reported that intangible costs accounted for nearly 85% of the total social costs of smoking.⁵¹ In addition, according to the Global Burden of Diseases, years lived with a disability account for nearly 33% of the disability-adjusted life years related to tobacco use.⁵² Hence, considering intangible costs can significantly improve the accuracy of estimates regarding tobacco use costs.

The present study had some limitations, such as not including studies in languages other than English, which probably has led to publication bias. Moreover, due to challenges in accessing grey literature, evidence provided by such studies could not be included in the present study. Thus, caution should be taken when generalizing

the findings.

Conclusion

The present review study demonstrated the considerable economic burden of tobacco use in various countries, ranging from 0.33 to 1.19% of the GDP of the investigated countries, indicating the necessity of taking immediate measures. Therefore, policies are needed to address the economic burden of smoking. In comparison to previous studies, this study provided a wider range of evidence to compare countries and make necessary decisions. For instance, separate estimates of both direct and indirect costs, as well as a percentage of the GDP were provided paving the way for a better understanding of the big picture.

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Authors' Contribution

Conceptualization: Mohammad Bakhtiari Ali Abad, Mehdi Jafari.

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Formal analysis: Mohammad Bakhtiari Ali Abad.

Investigation: Mohammad Bakhtiari Ali Abad, Mehdi Jafari, Iravan Masoudi-Asl; Masoud Abolhallaje.

Methodology: Iravan Masoudi-Asl, Masoud Abolhallaje.

Project administration: Mohammad Bakhtiari Ali Abad, Mehdi Jafari.

Software: Mohammad Bakhtiari Ali Abad.

Supervision: Iravan Masoudi-Asl, Masoud Abolhallaje.

Visualization: Mohammad Bakhtiari Ali Abad, Mehdi Jafari.

Writing—original draft: Mohammad Bakhtiari Ali Abad, Mehdi Jafari.

Writing—review & editing: Mohammad Bakhtiari Ali Abad, Mehdi Jafari, Iravan Masoudi-Asl, Masoud Abolhallaje.

Competing Interests

The authors declare no conflict of interest regarding the publication of this paper.

Ethical Approval

The study was approved by the Ethics Committee of Iran University of Medical Sciences (Code: IR.IUMS.REC.1401.179).

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