



School of Public Health
AIIMS Jodhpur

HEALTH AND ECONOMIC BURDEN DUE TO BIDI CONSUMPTION IN INDIA





School of Public Health AIIMS Jodhpur

HOW TO CITE

Health and Economic Burden due to Bidi Consumption in India. Jodhpur: School of Public Health, AIIMS Jodhpur and Vital Strategies, India; 2024 January. Available from: <http://treesphaiimsjdj.org/reports>

AIIMS Jodhpur acknowledges that this document has been produced with the help of a grant managed by the Vital Strategies, India and funded by Bloomberg Initiative to Reduce Tobacco Use. The content of this document is the sole responsibility of the authors and can under no circumstances be regarded as reflecting the position of Vital Strategies, India or the Bloomberg Philanthropies

ABOUT THE INSTITUTIONS

School of Public Health, All India Institute of Medical Sciences (AIIMS) Jodhpur

School of Public Health at AIIMS Jodhpur was established to address public health issues and offer highest standard of care to community. Since inception, we have taken many initiatives for tobacco sensitization in the community through screening camps, awareness sessions and IEC development. Tobacco control has been a major component of the flagship School Health Promotion Program of SPH since 2019. Faculty members including the PI are designated Nodal persons for Scientific Group, National Tobacco Testing Laboratory (NTTL) under the MoHFW since Sep 2020.

In the past two years, we have worked to quantify the holistic burden due bidi by generating national and state estimates of environmental, health and economic burden due to bidi smoking. By partnering with other partners of The Union and Vital Strategies, SPH AIIMS Jodhpur has developed 3 major national reports with corresponding state factsheets for states/UTs. “Environmental Burden due to Tobacco Consumption in India” enumerated the indiscriminate amount of waste disposed in the environment by bidi and other tobacco products. “The Lifecycle Approach to Bidi Trade in India” deciphered the fragmented data on bidi lifecycle which today, serves as a comprehensive document on every aspect of bidi lifecycle from raw material to labour statistics, working conditions and even an estimation of annual bidi production. “Tax and Regulatory Implications of Bidi Industry” was a novel document which projects implications of increased taxation and regulation of bidi with increase in government revenue and resultant decreased health burden. Due to the strong government liaisons, these reports were disseminated amongst the top-ranking governmental stakeholders across all relevant ministries in the country.

Vital Strategies, India

Vital Strategies is a global public health and scientific organization supporting Data for health, Partnership for healthy city, control of lead poisoning, civil registration and vital statistics (CRVS), tobacco control and environmental health/ climate change. Vital Strategies India is a social enterprise with office in New Delhi and serves as regional hub for Southeast Asian countries viz. India, Bangladesh, Maldives, Bhutan, Nepal and Sri Lanka. Vital Strategies India office has a potential to reach 2 billion low and middle- income population in South Asian countries. Tobacco Control Division, Vital Strategies is working closely with its partners and state governments in adopting digital means to monitor and report Cigarettes and Other Tobacco Products Act, 2003 or COTPA, 2003 and Tobacco Free Educational Institutions (ToFEI) compliance.

CONTRIBUTORS

School of Public Health, All India Institute of Medical Sciences, Jodhpur

Dr. Pankaj Bhardwaj

School of Public Health & Community Medicine and Family Medicine
AIIMS Jodhpur

Dr. Nitin Kumar Joshi

School of Public Health
AIIMS Jodhpur

Dr. Manoj Kumar Gupta

School of Public Health & Community Medicine and Family Medicine
AIIMS Jodhpur

Dr. Akhil Dhanesh Goel

School of Public Health & Community Medicine and Family Medicine
AIIMS Jodhpur

Dr. Yogesh Kumar Jain

School of Public Health & Community Medicine and Family Medicine
AIIMS Jodhpur

Mr. Amandeep Parmar

School of Public Health
AIIMS Jodhpur

Vital Strategies, India

Dr. Rana J Singh

Vital Strategies, India

Dr. Shivam Kapoor

Vital Strategies, India

Vital Strategies Inc., New York, USA

Mr. Ashish K. Pandey

Vital Strategies Inc. New York, USA

Reviewers

Mr. Deepak Mishra

Socio Economic and Educational Development Society
Bihar and Jharkhand

Ms. Jael Thomas

State Tobacco Control Programme
Karnataka

Ms. Jyoti Choudhary

Shikshit Rojgar Kendra Prabandhak Samiti
Rajasthan

Mr. Mukesh Sinha

Madhya Pradesh Voluntary Health Association
Madhya Pradesh

Dr. Nirmalaya Mukherjee

Manbhum Ananda Ashram Nityananda Trust
West Bengal

Mr. Prakash Kumar Shrivastava

National Tobacco Control Programme
Chhattisgarh

Dr. Sumesh Kumar

International Institute Of Health Management Research
New Delhi

Mr. Vivek Awasthi

Uttar Pradesh Voluntary Health Association
Uttar Pradesh

Acknowledgements

In addition, we acknowledge the valuable contributions provided by Mr. Pranay Lal, Independent Public Health Consultant, Dr Rijo M John, Rajagiri College of Social Sciences, Kerala, Dr. Sarith Rout, PHFI, Bhubaneswar. We also acknowledge financial support by Vital Strategies under Bloomberg Initiative to Reduce Tobacco Use.

FOREWORD



In the face of a shifting global landscape in tobacco consumption, this comprehensive report meticulously investigates the alarming prevalence of bidi smoking in India, shedding light on its multifaceted dimensions and far-reaching consequences. Tobacco, a persistent global public health concern, claims over 8 million preventable lives annually, with a notable transition from high-income to low and middle-income nations. This transition is particularly pronounced in India, where bidi smoking poses a unique challenge.

The groundbreaking findings of this report unveil a staggering toll on public health and the national economy, the impact of which provide a grave and substantial evidence against bidi consumption and the disproportionate burden borne by certain regions of the country. The report also emphasizes an urgent need for policy reconsiderations, rigorous regulatory measures, increased taxes, and enhanced tobacco cessation programs. Through its meticulous examination of the health and economic repercussions of bidi smoking, this report aspires to catalyze prompt and effective policy reforms, contributing significantly to the discourse on public health and the national economy.

Dr. Madhabananda Kar

Executive Director

All India Institute of Medical Sciences, Jodhpur

FOREWORD



In the realm of public health, there are challenges that demand unwavering attention, and the issue of bidi smoking in India stands as one such critical concern. This report unfolds an insightful exploration into the intricate web of factors surrounding bidi consumption, a challenge that not only jeopardizes the health of millions but also casts a shadow on the economic well-being of the nation. As the global narrative on tobacco consumption evolves, with a discernible shift toward low and middle-income countries, India grapples with the distinctive complexity of bidi smoking.

Woven into the fabric of this report is a deep analysis of the health implications and economic ramifications of bidi smoking. Through a meticulous meta-analysis, the report elucidates the grim reality that over 72 million active smokers, primarily from the most economically vulnerable and youthful demographics, face. The calculated toll of death and disability serves as a powerful call to action. The report also presents a novel estimation of state-wise breakdown of the disproportionate burdens highlighting an undeniable need for urgent policy reforms. By bringing to light the nuanced dimensions of bidi consumption, this report aims to fuel informed discussions, inspire proactive policy changes, and contribute significantly to the broader discourse on safeguarding public health and economic prosperity.

Dr. Shalini Singh

Director

ICMR - National Institute of Cancer Prevention and Research (NICPR)

Noida

PREFACE



In the complex landscape of global public health, our report addresses a specific and urgent concern—bidi smoking in India. Our country faces distinct challenges presented by bidi use, where the users are mostly from a vulnerable background and the industry is being portrayed as a harmless alternative to tobacco use. This report unfolds substantial health implications and economic repercussions of bidi consumption through a comprehensive meta-analysis of diseases such as lung cancer, tuberculosis, oral cancer, chronic obstructive pulmonary diseases, and ischemic heart disease, and documenting the proportion of death and disability due to such diseases, which is directly attributable to bidi smoking.

The findings reveal a sobering reality, estimating an annual toll exceeding 5.5 lakh deaths, 1.5 crore Disability-Adjusted Life Years (DALYs), and economic losses surpassing USD 30.4 billion or INR 21.43 lakh crores solely due to bidi consumption. Furthermore, the report presents state-wise analysis highlighting the disproportionate burden carried by specific states, prompting a call for targeted interventions. The report underscores the need for prompt and effective policy reforms to safeguard the well-being of our nation. The insights within these pages aim to inform and inspire collective action for a healthier tobacco-free future.

Dr. Pankaj Bhardwaj

Academic Head, School of Public Health

All India Institute of Medical Sciences, Jodhpur

TABLE OF CONTENTS

S. No.	Section	Page No.
1.	Executive Summary	09
2.	Background	10
3.	Methdology	11
4.	Key findings	
	National Health and Economic Burden	13
	Sub - National Overview	14
5.	Recommendations	21
6.	List of Tables and Figures	22
7.	References	23

Health and Economic Burden due to Bidi Consumption in India

Executive Summary

Tobacco consumption, recognized as a persistent global public health concern leading to over 8 million preventable deaths annually, is undergoing a significant shift from high-income countries to low and middle-income nations. Within this complex landscape, India grapples with a distinct challenge of bidi smoking. Bidi contains tobacco wrapped in tendu or temburni leaf. The product is often promoted with misleading narratives of being organic in origin, with a predominantly home-based manufacturing processing, and is perceived as a less harmful alternative to other tobacco products. Yet, alarming prevalence amongst over 72 million active smokers, with an early median age of initiation of 10.5 years, marks the product as a huge health hazard, specifically catering to the vulnerable masses belonging to the poorest socio-economic strata and the youth. This comprehensive report delves into the multifaceted dimensions of bidi smoking, spanning its health implications and economic repercussions. Through a meta-analysis involving studies enumerating risk from the prominent threats such as lung cancer, tuberculosis, oral cancer, chronic obstructive pulmonary diseases and ischemic heart disease, arising due to bidi smoking, Population Attributable Fraction (PAF) was calculated to underscore the substantial proportion of diseases directly attributable to bidi smoking. Using the PAF values, estimations were made to cater to the broader context of state-wise and national disease burden. This report estimates a staggering annual toll—over 5.5 lakh deaths, 1.5 crore Disability-Adjusted Life Years (DALYs), and economic losses exceeding USD 30.4 billion or INR 21.43 lakh crores, attributable solely to bidi consumption. The state-wise analyses further underscores the disproportionate burdens borne by the states of Uttar Pradesh, Maharashtra, Tamil Nadu, Rajasthan, Karnataka, Gujarat, West Bengal, Bihar, Madhya Pradesh, Uttarakhand and Punjab across various measured indicators of death, disability and economic burden. The report's recommendations call for urgent policy reconsiderations, rigorous regulatory measures, increased taxes, and enhanced tobacco cessation programs. By shedding light on these critical aspects, the report aims to contribute substantively to the discourse on the impact of bidi smoking on public health and the national economy, urging for prompt and effective policy reforms.

BACKGROUND

Tobacco consumption, recognized as the foremost cause of preventable deaths, stands as a paramount global public health concern. Extensive research delves into diverse facets of tobacco, encompassing its carcinogenic potential, direct and indirect health effects, and broader implications on both health and non-health domains. The World Health Organisation attributes 8 million annual global deaths to tobacco, with specific estimates spotlighting mortality linked to distinct forms of tobacco.¹ For instance, the Centers for Disease Control and Prevention cites 480,317 annual deaths in the United States solely attributable to cigarette consumption, while the Interheart study (2017) approximates over a quarter of a million deaths worldwide due to smokeless tobacco.^{2,3}

The landscape of tobacco consumption is evolving, with a notable shift from high-income countries to low and middle-income nations. While in the 20th century, 100 million tobacco-related deaths were reported predominantly in high-income countries, projections for the 21st century project over a billion deaths, predominantly in low and middle-income countries.⁴

In India, bidi, often perceived as a less harmful alternative to conventional tobacco products, assumes significance.¹ Classified as a cottage industry, the bidi sector enjoys regulatory leniency, spanning safety standards and taxation, despite a prevalence of 7.7%, translating to more than 72 million active bidi smokers. This sizable demographic amplifies the burden of cancer, heart diseases, and respiratory ailments, contributing to pronounced health disparities. The peril is exacerbated by the early initiation age of bidi smoking, starting at 10.5 years on average.⁵ Given the typical onset of health effects after two or three decades of tobacco use, the nation faces a looming threat from the consequences of high prevalence and early initiation.⁶ The need to ascertain precise mortality and morbidity figures and the associated economic burden due to productivity losses is imperative for influence definitive policy reforms and create policy windows.

Despite numerous studies highlighting relative risks and odds of disease occurrence linked to bidi smoking, a significant research gap exists. There remains a paucity of literature which quantifies annual deaths, Disability-Adjusted Life Years (DALYs), Years of Life Lost (YLLs), Years Lived with Disability (YLDs) and associated economic impacts of the productivity losses, directly attributable to bidi smoking.

This report endeavors to address these gaps by conducting a comprehensive analysis of health effects due to bidi smoking in India. The focus is on estimating absolute numbers of deaths, DALYs, and YLLs, with an additional exploration of the morbidity's economic toll through potential GDP losses. By shedding light on these critical aspects, the report aims to contribute substantively to the discourse on the impact of bidi smoking on public health and the national economy.

METHODOLOGY

A meta-analysis was conducted to account the data from all published studies concerning with disease occurrence as a result of tobacco consumption. Most common diseases due to bidi consumption were searched through review of available literature. Due to greater availability, case-control studies, done in any part of India, from the year 2000 to 2022, which contained individual data of odds of disease occurrence due to bidi smoking were included for the analysis, while those studies which contained generalised results due to “smoking” or “tobacco” were excluded.

For the purpose of estimating the proportion of health burden due to the risk factor of bidi consumption, meta-analysis was done and pooled odds ratio (OR) and relative risk (RR) values were calculated to determine population attributable fraction (PAF). (Table 1) In cases where multiple studies were not available, PAF was calculated using RR values from the available studies with representative sample size. (Annexure A)

After obtaining the value of PAF, the same was applied to the total number of deaths, DALY, and YLL, as obtained from the Global Burden of Disease (GBD) data for India, to obtain the estimates of morbidity and mortality specifically attributable to bidi.⁹(Tabel 2)

DALYs are the sum of years of potential life lost due to premature death and the years of productivity life lost due to disability compared to a standardised life expectancy. The obtained DALY values were then multiplied with the GDP per capita of the nation to obtain the potential productivity losses to the nation. The statistical analysis was carried out using MetaXL v4.0 add-in for MS Excel (2019) and SPSS v23.

PAF is the proportion of cases for an outcome that can be attributed to a certain risk factor among the entire population. In other words, the number of deaths or DALYs attributable to tobacco consumption in the population could be estimated by applying the population attributable fraction due to bidi consumption, to the total number of deaths or DALYs lost due to a particular disease.

Population attributable fraction (PAF) was calculated using the formula:

$$PAF = Pe \cdot \frac{(OR - 1)}{OR}$$

Where ‘Pe’ is the proportion of cases amongst the exposed and ‘OR’ is the Pooled Odds Ratio (Pooled Relative Risk (RR) in instances, where case-control studies were not found for the specific disease).

Odds ratio (OR) represent how likely is a person who smokes bidis, to develop a specific disease or outcome compared to those who do not smoke bidis. The odds ratio is a measure of the strength of association between an exposure (in this case, bidi smoking) and an outcome (disease).

Disability Adjusted Life Years (DALYs) are the sum of years of potential life lost due to premature death and the years of productive life lost due to disability compared to a standardised life expectancy.

KEY FINDINGS

From the review of literature, most common diseases that occur due to use of bidi consumption were enlisted as lung cancer (Lung Ca) oral cancer (Oral Ca), chronic obstructive pulmonary disorder (COPD), ischemic heart disease (IHD) and Tuberculosis (TB).^{10,11} Considering the inclusion criteria, a total of 20 studies were included for the meta-analysis. Detailed characteristics of the studies are provided in Annexure 1. The pooled odds and PAF values as obtained from the analysis have been tabulated in Table 1.

Highest odds of disease occurrence due to bidi smoking were observed for lung cancer (4.45) followed by tuberculosis (3.63) and oral cancer (3.32), IHD (2.68) and COPD (2.58), revealing the approximate times a person smoking bidis is more likely to develop such diseases compared to those who do not smoke bidis.

Obtained population attributable fraction was highest for lung cancer (0.39) followed by oral cancer (0.32), tuberculosis (0.21), COPD (0.19) and IHD (0.17), indicating the proportion of diseased individuals in the entire population who may be directly attributable to bidi smoking.

Table 1: Pooled odds ratio and population attributable fraction for bidi smoking obtained by meta-analysis

Disease attributable to Bidi	Pooled Odds Ratio	95% Confidence Interval	Population Attributable Fraction
Lung Cancer	4.54	3.25-6.34	0.39
Oral Cancer	3.32	2.67-4.12	0.32
Tuberculosis	3.63	3.17-4.15	0.21
COPD	2.58	2.00-3.33	0.19
IHD	2.68	2.11-3.40	0.17

NATIONAL HEALTH AND ECONOMIC BURDEN

The PAF values when applied to the disease burden due to the corresponding diseases as obtained from the Global Burden of Disease database (GBD – 2019) provided the final values of the national and state-wise values of Deaths, DALYs, and YLLs specifically attributed to bidi consumption.

Annually, over 5.5 lakh deaths, 1.5 crore DALYs, 1.3 crore YLLs and 13.5 lakh YLDs were quantified to be attributed solely because of diseases occurring due to bidi consumption in the country. (Table 2)

Table 2: Disease burden directly attributable to bidi consumption in India

	Death	DALY	YLL	YLD
Lung Cancer	24,923.36	6,35,422.48	6,29,734.26	5,688.22
Oral Cancer	18,143.99	5,32,015.19	5,21,928.55	10,086.63
Tuberculosis	88,526.62	32,78,391.78	29,51,181.27	3,27,210.51
COPD	1,67,845.40	39,66,243.75	30,63,009.33	9,03,234.43
Ischemic Heart Disease	2,56,143.48	62,78,097.02	61,78,501.45	99,595.57
Total	5,55,582.85	1,46,90,170.22	1,33,44,354.86	13,45,815.37
Abbreviations: DALY: Disability Adjusted Life Years, YLL: Premature Life Years Lost, YLD: Years Lived with Disability, COPD: Chronic Obstructive Pulmonary Disease				

Considering a national GDP per capita of USD 2,100, the productivity losses as a result of disability and death due to bidi consumption are calculated to be USD 30,440,970,752.26 (USD 30.44 billion). Thus, at the annual national GDP of USD 2,869 billion (2019), the economic losses as result of potential productivity losses due to bidi smoking amount to 1.08% of the total GDP of the country. Taking the average USD to INR exchange rate for 2019 to be INR 70.4 per USD, the economic losses equate to a loss of INR 21,43,04,43,40,959.11 (INR 21.43 lakh crores annually)

Total annual DALYs lost due to bidi consumption (2019): 14,690,170
Total annual YLLs lost due to bidi consumption (2019): 13,344,355
Total annual deaths due to bidi consumption (2019): 555,583
Total potential GDP loss due to bidi (2019): INR 21.43 lakh crores or USD 30.44 billion
Percentage of national GDP lost: 1.08%

SUB-NATIONAL OVERVIEW

Largest number of deaths were estimated from the states of Uttar Pradesh (18.6%), Maharashtra (9.5%), Tamil Nadu (7.3%), Rajasthan (6.4%), Karnataka (6.2%).

Table 3: States/UTs-wise annual deaths due to bidi consumption

State/UT	Lung Cancer	Oral Cancer	TB	COPD	IHD	Total Deaths	% of National Burden
Andhra Pradesh	934.66	483.44	2,429.19	6,429.65	13,764.13	24,041.07	4.33
Arunachal Pradesh	22.99	10.37	82.28	96.92	88.21	300.77	0.05
Assam	645.28	625.10	2,843.37	3,469.53	3,086.66	10,669.94	1.92
Bihar	1,256.38	460.38	6,177.36	10,601.67	15,371.37	33,867.15	6.10
Chhattisgarh	461.49	387.17	2,817.21	3,064.02	4,281.76	11,011.65	1.98
Delhi	456.30	296.97	736.47	1,385.53	3,358.12	6,233.38	1.12
Goa	32.01	21.53	45.14	103.24	426.09	628.02	0.11
Gujarat	1,310.46	1,607.90	6,262.78	9,070.85	16,203.62	34,455.61	6.20
Haryana	490.11	324.29	1,550.52	3,381.82	5,957.81	11,704.55	2.11
Himachal Pradesh	189.32	109.06	414.26	1,764.02	1,629.67	4,106.33	0.74
J&K and Ladakh	393.68	42.47	450.07	2,192.99	2,672.37	5,751.58	1.04
Jharkhand	354.00	273.09	1,747.01	3,025.83	3,920.50	9,320.43	1.68
Karnataka	1,443.93	1,293.34	3,289.73	10,267.80	18,367.71	34,662.51	6.24
Kerala	1,548.40	870.61	771.23	3,666.60	10,901.24	17,758.07	3.20
Madhya Pradesh	1,394.89	1,696.30	5,586.91	11,007.15	13,262.47	32,947.72	5.93
Maharashtra	2,407.85	1,951.10	6,835.34	13,357.40	28,534.09	53,085.77	9.55
Manipur	117.98	19.46	225.52	223.06	351.77	937.80	0.17
Meghalaya	63.89	57.60	208.30	155.03	183.34	668.16	0.12
Mizoram	89.05	10.45	44.09	149.96	46.63	340.17	0.06
Nagaland	23.87	16.86	102.06	93.46	171.74	408.00	0.07
Odisha	758.95	645.30	4,177.72	2,435.90	4,000.59	12,018.47	2.16
Punjab	668.62	250.04	1,369.28	1,912.40	11,344.43	15,544.78	2.80
Rajasthan	1,169.89	681.00	7,305.78	16,584.64	9,706.81	35,448.13	6.38

Sikkim	16.20	6.25	31.98	59.01	77.62	191.07	0.03
Tamil Nadu	1,631.44	1,248.38	4,206.22	6,179.99	27,452.07	40,718.10	7.33
Telangana	574.31	279.38	1,230.38	3,460.55	7,986.72	13,531.34	2.44
Tripura	105.63	51.75	130.21	502.92	593.60	1,384.11	0.25
Uttar Pradesh	3,786.70	3,101.13	23,006.60	41,141.91	32,492.79	1,03,529.13	18.63
Uttarakhand	343.10	160.36	1,026.57	2,425.29	2,272.24	6,227.56	1.12
West Bengal	2,169.76	1,093.22	3,256.83	9,418.90	16,894.56	32,833.26	5.91
Other UTs	62.22	69.69	166.21	217.35	742.76	1,258.22	0.23

Largest DALYs lost were estimated from the states of Uttar Pradesh (19.5%), Maharashtra (9.2%), Tamil Nadu (7.1%), Rajasthan (6.6%), Gujarat (6.5%).

Table 4: State-wise annual DALYs due to bidi consumption

State/UT	Lung Cancer	Oral Cancer	TB	COPD	IHD	Total DALYs	% of National Burden
Andhra Pradesh	21,546.17	12,413.16	78,172.38	1,52,757.35	3,20,046.57	5,84,935.63	3.98
Arunachal Pradesh	618.56	312.57	3,119.07	2,483.97	2,212.33	8,746.48	0.06
Assam	17,624.16	19,739.88	1,10,633.18	86,342.10	82,327.50	3,16,666.82	2.16
Bihar	30,145.25	13,422.75	2,20,084.30	2,61,451.40	3,73,919.56	8,99,023.26	6.12
Chhattisgarh	11,789.68	11,425.05	1,01,641.79	77,557.08	1,13,642.68	3,16,056.28	2.15
Delhi	12,057.92	9,196.40	30,374.31	36,199.68	80,520.12	1,68,348.44	1.15
Goa	745.20	527.30	1,393.62	2,955.12	8,787.45	14,408.69	0.10
Gujarat	35,329.55	50,394.35	2,30,554.22	2,13,479.45	4,18,626.44	9,48,384.00	6.46
Haryana	13,184.82	9,300.67	56,762.66	81,093.84	1,55,040.29	3,15,382.28	2.15
Himachal Pradesh	4,877.26	3,005.95	13,882.24	36,597.23	38,790.27	97,152.96	0.66
J&K and Ladakh	10,576.19	1,190.54	15,696.96	47,973.74	63,715.53	1,39,152.95	0.95
Jharkhand	8,149.42	7,533.21	62,661.32	74,869.66	90,649.92	2,43,863.53	1.66
Karnataka	36,316.94	36,518.88	1,23,266.63	2,20,342.89	4,59,834.49	8,76,279.83	5.97
Kerala	37,594.94	22,245.93	24,455.90	91,012.48	2,22,242.38	3,97,551.62	2.71
Madhya Pradesh	36,205.03	50,834.85	2,19,191.48	2,57,102.97	3,39,534.06	9,02,868.38	6.15
Maharashtra	58,157.12	57,850.05	2,48,145.95	3,24,084.50	6,67,770.00	13,56,007.63	9.23
Manipur	3,024.15	563.96	7,371.42	5,669.75	8,303.11	24,932.40	0.17

Meghalaya	1,655.51	1,738.35	7,538.83	4,144.47	4,345.71	19,422.88	0.13
Mizoram	2,260.94	310.78	1,598.90	3,419.68	1,089.17	8,679.46	0.06
Nagaland	574.82	493.63	3,571.81	2,324.94	3,777.08	10,742.28	0.07
Odisha	18,094.51	18,025.86	1,42,525.19	68,677.70	1,00,460.55	3,47,783.81	2.37
Punjab	16,403.25	7,623.05	47,351.82	54,282.42	2,83,657.87	4,09,318.41	2.79
Rajasthan	31,341.11	20,516.29	2,90,724.07	3,55,403.65	2,64,346.04	9,62,331.16	6.55
Sikkim	400.50	179.83	1,126.83	1,415.99	1,812.94	4,936.09	0.03
Tamil Nadu	40,658.18	36,223.61	1,37,063.11	1,68,662.28	6,64,379.25	10,46,986.44	7.13
Telangana	13,608.00	7,540.29	42,835.05	86,717.54	1,94,913.96	3,45,614.85	2.35
Tripura	2,704.53	1,528.48	4,567.56	11,586.58	13,837.24	34,224.39	0.23
Uttar Pradesh	1,01,568.86	93,531.31	8,87,239.10	9,45,122.29	8,39,627.12	28,67,088.68	19.52
Uttarakhand	9,476.70	4,730.14	36,202.11	54,796.30	59,429.40	1,64,634.65	1.12
West Bengal	57,129.09	31,171.65	1,22,698.73	2,31,662.27	3,83,236.85	8,25,898.59	5.62
Other UTs	1,604.14	1,926.41	5,941.22	6,054.47	17,221.13	32,747.36	0.22

Largest prematurely lost life years (YLLs) were estimated from the states of Uttar Pradesh (19.8%), Maharashtra (9.1%), Tamil Nadu (7.2%), Rajasthan (6.6%), Gujarat (6.5%)

Table 5: State-wise annual YLLs due to bidi consumption

State/UT	Lung Cancer	Oral Cancer	TB	COPD	IHD	Total YLLs	% of National Burden
Andhra Pradesh	21,340.53	12,147.02	70,058.81	1,09,513.36	3,14,983.24	5,28,042.97	3.96
Arunachal Pradesh	613.25	306.33	2,749.69	1,738.15	2,148.03	7,555.44	0.06
Assam	17,473.37	19,409.33	1,00,745.23	66,011.78	80,567.21	2,84,206.92	2.13
Bihar	29,862.73	13,170.66	1,97,892.37	1,98,331.16	3,67,605.58	8,06,862.50	6.05
Chhattisgarh	11,686.56	11,229.83	94,238.44	59,048.40	1,11,687.81	2,87,891.04	2.16
Delhi	11,951.22	9,012.19	24,939.44	24,601.68	79,060.18	1,49,564.72	1.12
Goa	737.91	514.34	1,224.72	1,696.16	8,623.78	12,796.91	0.10
Gujarat	35,021.71	49,462.26	2,10,655.08	1,67,075.49	4,13,446.44	8,75,660.98	6.56
Haryana	13,070.36	9,123.12	51,395.48	60,217.73	1,52,695.12	2,86,501.82	2.15
Himachal Pradesh	4,834.09	2,946.98	12,404.25	29,864.40	38,055.54	88,105.27	0.66
J&K and Ladakh	10,486.10	1,165.20	13,925.20	38,535.51	62,756.25	1,26,868.26	0.95
Jharkhand	8,070.74	7,391.99	54,894.30	53,667.22	88,418.45	2,12,442.70	1.59

Karnataka	35,992.66	35,825.82	1,09,410.06	1,77,320.49	4,54,385.45	8,12,934.47	6.09
Kerala	37,245.16	21,716.21	19,991.26	57,760.67	2,17,281.50	3,53,994.80	2.65
Madhya Pradesh	35,886.43	49,941.82	1,93,115.62	2,03,149.14	3,34,508.56	8,16,601.57	6.12
Maharashtra	57,613.28	56,675.17	2,21,243.15	2,26,077.28	6,55,654.53	12,17,263.41	9.12
Manipur	2,997.87	552.90	6,709.70	3,850.78	8,099.16	22,210.41	0.17
Meghalaya	1,641.24	1,707.03	6,892.31	2,755.98	4,202.30	17,198.86	0.13
Mizoram	2,241.71	304.63	1,423.16	2,624.46	1,030.80	7,624.77	0.06
Nagaland	569.54	484.08	3,252.85	1,534.41	3,670.48	9,511.37	0.07
Odisha	17,924.93	17,697.83	1,29,690.43	44,706.58	97,259.85	3,07,279.62	2.30
Punjab	16,251.55	7,467.04	41,731.10	34,815.33	2,80,266.11	3,80,531.12	2.85
Rajasthan	31,070.37	20,137.45	2,65,003.31	3,02,803.15	2,59,730.56	8,78,744.84	6.59
Sikkim	396.87	176.07	979.24	993.12	1,764.55	4,309.86	0.03
Tamil Nadu	40,285.22	35,472.69	1,20,019.63	1,11,108.81	6,56,115.83	9,63,002.19	7.22
Telangana	13,479.33	7,372.51	36,265.00	60,487.60	1,91,949.40	3,09,553.84	2.32
Tripura	2,680.73	1,500.09	4,060.66	8,750.67	13,544.35	30,536.50	0.23
Uttar Pradesh	1,00,702.60	91,954.75	8,14,152.65	8,00,598.20	8,28,134.03	26,35,542.24	19.75
Uttarakhand	9,397.46	4,641.85	33,345.59	46,247.78	58,562.08	1,52,194.76	1.14
West Bengal	56,619.10	30,535.22	1,03,577.32	1,63,274.05	3,75,357.09	7,29,362.77	5.47
Other UTs	1,589.63	1,886.15	5,195.18	3,849.79	16,937.19	29,457.94	0.22

Largest numbers of years lived with disability due to diseases as a result of bidi consumption (YLDs) were estimated from the states of Uttar Pradesh (17.2%), Maharashtra (10.3%), West Bengal (7.2%), Bihar (6.9%), Madhya Pradesh (6.4%)

Table 6: State-wise annual YLDs due to bidi consumption

State/UT	Lung Cancer	Oral Cancer	TB	COPD	IHD	Total YLDs	% of National Burden
Andhra Pradesh	205.64	266.14	8,113.56	43,243.99	5,063.33	56,892.66	4.23
Arunachal Pradesh	5.31	6.24	369.38	745.81	64.30	1,191.04	0.09
Assam	150.79	330.55	9,887.95	20,330.32	1,760.29	32,459.90	2.41
Bihar	282.52	252.09	22,191.92	63,120.24	6,313.98	92,160.76	6.85
Chhattisgarh	103.12	195.22	7,403.35	18,508.68	1,954.87	28,165.24	2.09
Delhi	106.70	184.21	5,434.87	11,597.99	1,459.95	18,783.72	1.40

Goa	7.29	12.96	168.90	1,258.96	163.67	1,611.78	0.12
Gujarat	307.84	932.09	19,899.14	46,403.96	5,179.99	72,723.02	5.40
Haryana	114.46	177.55	5,367.17	20,876.11	2,345.17	28,880.46	2.15
Himachal Pradesh	43.16	58.97	1,478.00	6,732.83	734.73	9,047.69	0.67
J&K and Ladakh	90.09	25.34	1,771.76	9,438.22	959.28	12,284.69	0.91
Jharkhand	78.67	141.22	7,767.02	21,202.44	2,231.47	31,420.83	2.33
Karnataka	324.28	693.06	13,856.57	43,022.40	5,449.04	63,345.35	4.71
Kerala	349.78	529.72	4,464.63	33,251.81	4,960.88	43,556.82	3.24
Madhya Pradesh	318.60	893.03	26,075.86	53,953.83	5,025.50	86,266.81	6.41
Maharashtra	543.85	1,174.89	26,902.80	98,007.22	12,115.47	1,38,744.22	10.31
Manipur	26.27	11.07	661.73	1,818.97	203.96	2,721.99	0.20
Meghalaya	14.27	31.33	646.52	1,388.49	143.41	2,224.02	0.17
Mizoram	19.22	6.15	175.74	795.21	58.36	1,054.69	0.08
Nagaland	5.28	9.55	318.96	790.52	106.60	1,230.92	0.09
Odisha	169.58	328.03	12,834.75	23,971.12	3,200.71	40,504.19	3.01
Punjab	151.71	156.01	5,620.72	19,467.08	3,391.76	28,787.29	2.14
Rajasthan	270.74	378.84	25,720.76	52,600.49	4,615.48	83,586.32	6.21
Sikkim	3.63	3.75	147.59	422.87	48.39	626.23	0.05
Tamil Nadu	372.96	750.92	17,043.48	57,553.47	8,263.42	83,984.25	6.24
Telangana	128.67	167.78	6,570.05	26,229.94	2,964.56	36,061.01	2.68
Tripura	23.79	28.39	506.89	2,835.92	292.89	3,687.89	0.27
Uttar Pradesh	866.26	1,576.56	73,086.45	1,44,524.09	11,493.09	2,31,546.44	17.20
Uttarakhand	79.24	88.28	2,856.52	8,548.53	867.32	12,439.89	0.92
West Bengal	509.99	636.43	19,121.41	68,388.22	7,879.77	96,535.82	7.17
Other UTs	14.51	40.26	746.04	2,204.68	283.94	3,289.43	0.24

Largest economic burden in terms of potential GDP losses as a result of bidi consumption were estimated from the states of Maharashtra (14.2%), Tamil Nadu (10.9%), Gujarat (10.3%), Uttar Pradesh (9.8%), Karnataka (9.7%). Moreover, the highest losses in terms of state annual GDP were estimated from Uttarakhand (1.43%), Gujarat (1.36%), Tamil Nadu (1.35%), Punjab (1.30%), Karnataka (1.30%).

Table 7: State-wise annual economic losses through potential GDP losses due to bidi consumption

State/UTs	Gross State Domestic Product (GSDP) (Bn USD)	GSDP per capita (USD)	Potential GDP loss (USD)	% of GSDP
Andhra Pradesh	131.08	2,480.00	1,45,06,40,355.46	1.11
Arunachal Pradesh	3.74	2,253.00	1,97,05,830.24	0.53
Assam	47.98	1,365.00	43,22,50,207.98	0.90
Bihar	80.56	659.00	59,24,56,325.17	0.74
Chhattisgarh	46.19	1,555.00	49,14,67,514.67	1.06
Delhi	117.70	5,817.00	97,92,82,850.11	0.83
Goa	11.12	7,029.00	10,12,78,662.06	0.91
Gujarat	228.29	3,283.00	3,11,35,44,660.29	1.36
Haryana	111.52	3,840.00	1,21,10,67,944.46	1.09
Himachal Pradesh	23.37	3,118.00	30,29,22,914.59	1.30
J&K and Ladakh	23.69	1,636.00	22,76,54,229.70	0.96
Jharkhand	45.15	1,179.00	28,75,15,096.75	0.64
Karnataka	226.81	3,359.00	2,94,34,23,946.74	1.30
Kerala	118.73	3,327.00	1,32,26,54,242.24	1.11
Madhya Pradesh	122.98	1,461.00	1,31,90,90,710.29	1.07
Maharashtra	399.92	3,193.00	4,32,97,32,365.86	1.08
Manipur	4.23	1,222.00	3,04,67,388.69	0.72
Meghalaya	5.09	1,417.00	2,75,22,222.68	0.54
Mizoram	3.39	2,773.00	2,40,68,151.78	0.71
Nagaland	4.14	1,918.00	2,06,03,694.63	0.50
Odisha	74.10	1,651.00	57,41,91,067.59	0.78
Punjab	79.96	2,536.00	1,03,80,31,495.66	1.30
Rajasthan	143.18	1,820.00	1,75,14,42,702.50	1.22
Sikkim	4.36	6,421.00	3,16,94,626.30	0.73

Tamil Nadu	247.63	3,184.00	3,33,36,04,827.75	1.35
Telangana	130.79	3,321.00	1,14,77,86,930.59	0.88
Tripura	7.57	1,851.00	6,33,49,354.03	0.84
Uttar Pradesh	240.73	1,043.00	2,99,03,73,496.98	1.24
Uttarakhand	37.35	3,250.00	53,50,62,619.65	1.43
West Bengal	165.56	1,634.00	1,34,95,18,298.59	0.82

DISCUSSION AND CONCLUSION

Quantification of health burden from the previous available literature suggest an overall 13.5 lakh deaths annually due to all forms of tobacco (WHO, 2022; Gupta et al, 2005; and Gajalakshami et al, 2003).¹²⁻¹⁴ The findings from this report correlate with the previous work estimating over 5.5 lakhs deaths annually due to bidi smoking alone and provide quantification in form of disease specific mortality figures. The findings are derived using the Global Burden of Disease⁹ database which was not available during the previous studies and provide a novel insight to the current health burden in the country. Further estimates to assess the economic implications from all cause mortality by meticulously calculating the present value of lifetime earnings project an economic burden of USD 805 billion to the national exchequer (John, 2019).¹⁵ Our findings compliment the existing work by quantifying the economic ramifications specifically due to lost productivity, from a parallel lens of potential GDP loss amounting to USD 30.44 billion to the country or 1.08% of the annual national GDP. Moreover, our report provides state specific sub-national estimates that may be utilized by tobacco control advocates around the country for regional as well as country specific policy reforms. To conclude, our findings suggest that bidis are carcinogenic and harmful to cardiorespiratory health and mortality with an huge economic ramifications, making a strong evidence for regulation of bidi trade to be incorporated as an integral part of India's tobacco control framework.

RECOMMENDATIONS

- Looking into the staggering health and economic burden to the country due to bidi consumption, reconsideration of the status of bidi industry from a cottage industry along with the numerous levied tax and regulatory exemptions.
- Reduce supply and demand through stricter regulations on bidi production, distribution, sale and marketing while ensuring improved compliance of taxation policies and tobacco control act, especially on graphic health warning on bidi packages.
- Establish an improved surveillance system at national, sub national and medical college level, to monitor bidi-related diseases along with intensive and targeted public awareness campaigns for health risks associated with bidi smoking.
- Considering increased taxes on bidis to reduce affordability and discourage consumption and allocation of revenue generated from increased taxes to fund tobacco control programs and public health initiatives.
- Strengthening and expansion of the tobacco cessation programs to provide accessible resources and support tailored for bidi smokers willing to quit.
- Vocational rehabilitation to non-tobacco related livelihoods for assisting the workers employed by the bidi industry in transitioning to alternative products or diversifying into other sectors, within the existing skill development initiatives.

List of Tables and Figures	Page No.
Table 1: Pooled odds ratio and population attributable fraction for bidi smoking obtained by meta-analysis	12
Table 2: Disease burden directly attributable to bidi consumption in India	13
Table 3: State-wise annual deaths due to bidi consumption	14
Table 4: State-wise annual DALYs due to bidi consumption	15
Table 5: State-wise annual YLLs due to bidi consumption	16
Table 6: State-wise annual YLDs due to bidi consumption	17
Table 7: State-wise annual economic losses through potential GDP losses due to bidi consumption	19
Annexure A: Descriptions of the studies included in the metanalysis	24
Annexure B: Forest plot of pooled odds ratio (From top to bottom: oral cancer attributable to bidi smoking and lung cancer attributable to bidi smoking)	25

References

1. World Health Organization (WHO) [Internet]. Tobacco; 2022 May [cited 2023 Nov 9]. Available from: <https://www.who.int/news-room/fact-sheets/detail/tobacco#:~:text=The%20tobacco%20epidemic%20is%20one,level%20of%20exposure%20to%20tobacco>
2. Centers for Disease Control and Prevention [Internet]. Tobacco-Related Mortality; 2020 [cited 2023 Nov 9]. Available from: https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality/index.htm
3. Siddiqi K, Husain S, Vidyasagaran A, Readshaw A, Mishu MP, Sheikh A. Global burden of disease due to smokeless tobacco consumption in adults: an updated analysis of data from 127 countries. *BMC Med.* 2020 Aug 12;18(1):222
4. Jha P, MacLennan M, Chaloupka FJ, et al. Global Hazards of Tobacco and the Benefits of Smoking Cessation and Tobacco Taxes. In: Gelband H, Jha P, Sankaranarayanan R, et al., editors. *Cancer: Disease Control Priorities, Third Edition (Volume 3)*. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2015 Nov 1. Chapter 10. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK343639/> doi: 10.1596/978-1-4648-0349-9_ch10
5. Tata Institute of Social Sciences (TISS), Mumbai and Ministry of Health and Family Welfare, Government of India. *Global Adult Tobacco Survey GATS 2 India 2016-17*
6. National Center for Biotechnology Information [Internet]. The Effects of Tobacco Use on Health - Public Health Implications of Raising the Minimum Age of Legal Access to Tobacco Products - NCBI Bookshelf; [cited 2023 Nov 9]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK310413/>
7. Mansournia M A, Altman D G. Population attributable fraction *BMJ* 2018; 360 :k757 doi:10.1136/bmj.k757
8. Measuring Association in Case-Control Studies [Internet]; 2018 [cited 2023 Nov 9]. Available from: https://sphweb.bumc.bu.edu/otlt/mph-modules/ep/ep713_association/EP713_Association8.html
9. Indian Council of Medical Research, Public Health Foundation of India, and Institute for Health Metrics and Evaluation. *GBD India Compare Data Visualization*. New Delhi: ICMR, PHFI, and IHME; 2017. Available from <http://vizhub.healthdata.org/gbd-compare/india> [cited 2023 Nov 9]
10. Centers for Disease Control and Prevention [Internet]. Health Effects of Smoking and Tobacco Use; 2020 [cited 2023 Nov 9]. Available from: https://www.cdc.gov/tobacco/basic_information/health_effects/index.htm#:~:text=Smoking%20causes%20cancer,%20heart%20disease,immune%20system,%20including%20rheumatoid%20arthritis
11. Centers for Disease Control and Prevention [Internet]. Smokeless Tobacco: Health Effects; 2020 [cited 2023 Nov 9]. Available from: https://www.cdc.gov/tobacco/data_statistics/fact_sheets/smokeless/health_effects/index.htm
12. World Health Organisation [Internet]. Bidi rolling is an occupational health hazard: WHO study; 2022 [cited 2024 Jan 19]. Available from: <https://www.who.int/india/news/feature-stories/detail/bidi-rolling-is-an-occupational-health-hazard--who-study>
13. Gajalakshmi V, Peto R, Kanaka TS, Jha P. Smoking and mortality from tuberculosis and other diseases in India: retrospective study of 43000 adult male deaths and 35000 controls. *Lancet* 2003;362:507–15
14. Prakash C Gupta, Mangesh S Pednekar, DM Parkin, R Sankaranarayanan, Tobacco associated mortality in Mumbai (Bombay) India. Results of the Bombay Cohort Study, *International Journal of Epidemiology*, Volume 34, Issue 6, December 2005, Pages 1395–1402
15. John RM. Economic costs of diseases and deaths attributable to bidi smoking in India, 2017. *Tob Control.* 2019 Sep;28(5):513–518. doi: 10.1136/tobaccocontrol-2018-054493. Epub 2018 Oct 18

ANNEXURES

A. Descriptions of the studies included in the metanalysis

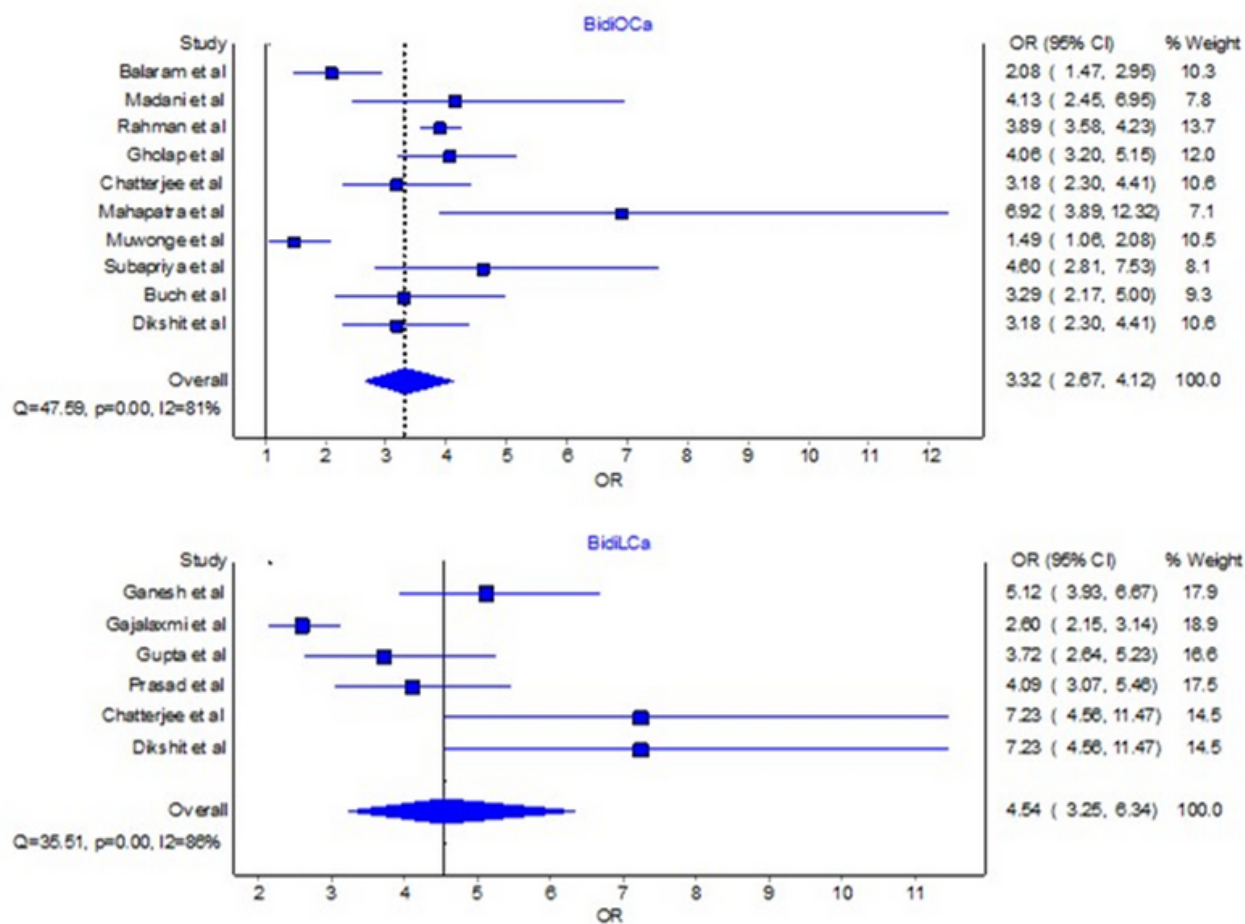
Study	Exposed Cases	Unexposed Cases	Exposed Controls	Unexposed Controls	OR (LCI, UCI)	Pooled OR (LCI, UCI); I ²	PAF
<i>Tobacco Product Type: Bidi</i>							
<i>Disease: Oral Cancer</i>							
Balaram et al (2002)	128	181	74	218	2.08 (1.47, 2.95)	3.32 (2.67, 4.12) I² = 81.09	0.32
Madani et al (2014)	70	280	20	330	4.13 (2.45, 6.95)		
Rahman et al (2005)	2347	2431	1247	5024	3.89 (3.58, 4.23)		
Gholap et al (2022)	318	409	129	673	4.06 (3.20, 5.15)		
Chatterjee et al (2021)	254	141	94	166	3.18 (2.30, 4.41)		
Mahapatra et al (2015)	48	86	20	248	6.92 (3.89, 12.32)		
Muwonge et al (2008)	84	79	340	475	1.49 (1.06, 2.08)		
Subapriya et al (2007)	84	304	22	366	4.60 (2.81, 7.53)		
Buch et al (2002)	74	211	41	385	3.29 (2.17, 5.00)		
Dikshit et al (2000)	254	141	94	166	3.18 (2.30, 4.41)		
<i>Tobacco Product Type: Bidi</i>							
<i>Disease: Lung Cancer</i>							
Ganesh et al (2011)	153	255	145	1238	5.12 (3.93, 6.67)	4.54 (3.25, 6.34) I² = 85.92	0.39
Gajalaxmi et al (2003)	204	574	413	3017	2.60 (2.15, 3.14)		
Gupta et al (2001)	209	56	263	262	3.72 (2.64, 5.23)		
Prasad et al (2010)	195	89	297	555	4.09 (3.07, 5.46)		
Chatterjee et al (2021)	131	32	94	166	7.23 (4.56, 11.47)		
Dikshit et al (2000)	131	32	94	166	7.23 (4.56, 11.47)		
<i>Tobacco Product Type: Bidi</i>							
<i>Disease: Ischemic Heart Disease</i>							
Rastogi et al (2005)	87	222	78	540	2.71 (1.92, 3.82)	2.68 (2.11, 3.40)	0.17
Rastogi et al (2004)	89	261	80	620	2.65 (1.89, 3.70)		
<i>Tobacco Product Type: Bidi</i>							
<i>Disease: Tuberculosis</i>							
Gajalakshmi et al (2003)	295	725	23116	206021	3.63 (3.17, 4.15)	-	0.21
<i>Tobacco Product Type: Bidi</i>							
<i>Disease: Chronic Obstructive Pulmonary Disease*</i>							
Duong et al (2017)	82	187	1843	11152	2.58 (2.00, 3.33)**	-	0.19

Abbreviations: OR: Odds Ratio, LCI: 95% Lower Class Interval, UCI 95% Upper Class Interval, I²: statistic representing heterogeneity of studies included, PAF: Population Attributable Fraction

*For Chronic Obstructive Pulmonary Disease, cohort study was considered as per the study methodology. In the table, exposed cases may be referred to as event occurrence amongst exposed, unexposed cases as event occurrence amongst unexposed, exposed controls as event not occurred amongst exposed, and unexposed controls as event not occurred amongst unexposed.

**Relative Risk value with 95% Confidence Interval was calculated for the cohort study

B. Forest plot of pooled odds ratio (From top to bottom: oral cancer attributable to bidi smoking and lung cancer attributable to bidi smoking)





School of Public Health AIIMS Jodhpur



School of Public Health
AIIMS Jodhpur

