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Patterns of tobacco use in low and middle income countries by tobacco product and sociodemographic characteristics: nationally representative survey data from 82 countries

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ABSTRACT

OBJECTIVES

To determine the prevalence and frequency of using any tobacco product and each of a detailed set of tobacco products, how tobacco use and frequency of use vary across countries, world regions, and World Bank country income groups, and the socioeconomic and demographic gradients of tobacco use and use frequency within countries.

DESIGN

Secondary analysis of nationally representative, cross-sectional, household survey data from 82 low and middle income countries collected between 1 January 2015 and 31 December 2020.

SETTING

Population based survey data.

PARTICIPANTS

1 231 068 individuals aged 15 years and older.

MAIN OUTCOME MEASURES

Self-reported current smoking, current daily smoking, current smokeless tobacco use, current daily smokeless tobacco use, pack years, and current use and use frequencies of each tobacco product. Products were any type of cigarette, manufactured cigarette, hand rolled cigarette, water pipe, cigar, oral snuff, nasal snuff, chewing tobacco, and betel nut (with and without tobacco).

RESULTS

The smoking prevalence in the study sample was 16.5% (95% confidence interval 16.1% to 16.9%) and ranged from 1.1% (0.9% to 1.3%) in Ghana to 50.6% (45.2% to 56.1%) in Kiribati. The user prevalence of smokeless tobacco was 7.7% (7.5% to 8.0%) and prevalence was highest in Papua New Guinea (daily user prevalence of 65.4% (63.3% to 67.5%)). Although variation was wide between countries and by tobacco product, for many low and middle income countries, the highest prevalence and cigarette smoking frequency was reported in men, those with lower education, less household wealth, living in rural areas, and higher age.

CONCLUSIONS

Both smoked and smokeless tobacco use and frequency of use vary widely across tobacco products in low and middle income countries. This study can inform the design and targeting of efforts to reduce tobacco use in low and middle income countries and serve as a benchmark for monitoring progress towards national and international goals.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Of several multicountry studies on tobacco user prevalence identified, most have not examined variation in use by sociodemographic and economic characteristics

No multicountry study analysed product specific tobacco user prevalence along with its variation by sociodemographic and economic characteristics

Only one multicountry study examined smoking frequency but did not disaggregate by tobacco product, nor estimated associations of tobacco user prevalence and frequency with sociodemographic characteristics

WHAT THIS STUDY ADDS

Analysis of smoked or smokeless tobacco use as overall categories (rather than separately for each tobacco product) masks large differences in use across tobacco products both between and within countries

The common focus of studies on cigarettes or manufactured cigarettes ignores the widespread use of other tobacco products, particularly by individuals with lower education and less household wealth

Introduction

The Global Burden of Disease study estimates that tobacco smoking caused 7.7 million deaths globally in 2019 and that smoking is the leading risk factor for disability adjusted life years among men.[1] Smokeless tobacco use, such as chewing tobacco, snuff, or tobacco chewed with betel nut, are estimated to have caused an additional 349 000 deaths in 2017.[2] As of 2020, almost one billion people worldwide were estimated to smoke tobacco and 336 million were estimated to use smokeless tobacco, predominantly living in low and middle income countries.[3] Although the prevalence of tobacco use (both smoked and smokeless) in low and middle income countries has decreased over the past 20 years, the prevalence is projected to be more than 20% in middle income countries and 12% in low income countries in the coming years.[3] The tobacco associated health consequences can pose a risk to the health systems of these countries because many of them are not well prepared to cope with the increased need for care of related diseases, such as cancers and cardiovascular diseases.

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The key tobacco indicator that countries have agreed to monitor as part of both the World Health Organization's (WHO's) Global Action Plan on Non-Communicable Diseases[4] and the Sustainable Development Goals[5] is current tobacco use, which was defined as use of any tobacco product. Yet, to date, most studies on tobacco use in low and middle income countries have focused on smoking tobacco use in general or on manufactured cigarettes only. Furthermore, most monitoring efforts and policies target smokers of cigarettes, because this market is well regulated, but do not cover smokers of less well regulated products, including pipe, cigarillos, water pipe, and locally grown tobacco, or smokeless tobacco product users.[6] In addition to highlighting the importance of research into a broad set of tobacco products, the 2017 WHO report on monitoring tobacco use emphasised the urgent need to assess tobacco use gradients by socioeconomic and demographic characteristics to enable policy makers to "tailor interventions to best meet the needs of different population subgroups."[7] Our study complements the Global Burden of Disease studies on smoked and smokeless tobacco use. Our detailed participant level data allow us to provide a more granular assessment, both in terms of tobacco products and variation in use by individuals' socioeconomic characteristics, of tobacco use in our study countries.[8 9] Specifically, our study provides prevalence and frequency of use for a large number of common smoked and smokeless tobacco products. Furthermore, we analyse not only how tobacco use overall varies by age and sex within these countries but also how the use of each product varies by sociodemographic and economic variables, including education, household wealth, and rural versus urban residency.

This study can inform the monitoring of international goals on tobacco use reduction as well as the targeting and health system planning of efforts to reduce tobacco use and effectively deal with its sequelae. Specifically, we pooled data from 1 231 068 individuals across 82 low and middle income countries that represent about 90% of people living in low and middle income countries globally. With this information, we aimed to determine the prevalence of any tobacco use overall and by tobacco product as well as the product specific frequency of use; how they vary across countries, world regions, and World Bank income groups; and how they differ with socioeconomic and demographic characteristics of individuals within countries.

Methods

Data sources

A survey was considered eligible for inclusion in this study if it met the following criteria: (1) the date of study initiation was 1 January 2015 until the screen date of 4 October 2021; (2) the country was classified as a low or middle income country by the World Bank[10] at the time of survey data collection; (3) the survey was nationally representative for at least three 10 year age groups in individuals 15 years and older; (4) data were available at the individual level; (5) the response rate was ≥50%; and (6) the survey collected information on current smoking for women and men. Firstly, all publicly available Global Adult Tobacco Surveys,[11] WHO-STEPwise Approach to Surveillance surveys,[12] Demographic and Health Surveys,[13] and Multiple Indicator Cluster Surveys[14] were screened. Secondly, we screened surveys used in the WHO report on the global tobacco epidemic 2021[15] and surveys indexed on the Global Health Data Exchange[16] and the Gateway to Global Ageing platform.[17] If publicly available, the data were downloaded from the respective repository. Otherwise, the survey team was contacted and access to the data was requested. If several surveys were eligible for one country, we included the survey with the most complete information (supplementary table S1).

We ensured the following quality measures were met for all included surveys: (1) a survey should have a response rate of at least 50%, (2) the share of missing values in the outcome variables should be low (<10%), (3) information on the sampling strategy should be available showing that the produced data are nationally representative, (4) questions on tobacco use distinguished between smoked and smokeless tobacco, and (5) our estimated prevalences were plausible and consistent with previously published survey reports and other literature (supplementary table S6).

Definition of tobacco use

The outcome variables for this study were current smoking, current daily smoking, current smokeless tobacco use, current daily smokeless tobacco use, and daily use frequencies of each tobacco product. The tobacco products were manufactured cigarette; hand rolled cigarette; cigarette (which encompasses both manufactured and hand rolled cigarettes); pipe; cigar, cheroot, and cigarillo (henceforth referred to as cigar); water pipe; oral snuff; nasal snuff; chewing tobacco; and betel nut (with or without tobacco). For each survey, supplementary tables S4 and S5, and supplementary text S2 detail the relevant survey instrument questions, data availability, data cleaning procedure, and how the survey responses were used in the analyses. Survey questions were largely standardised and thus consistent across surveys. In some Demographic and Health Surveys (18 for women and four for men), participants were not asked about current tobacco use. In these cases, current smoking and current smokeless tobacco use were derived from the product-specific current use variables. In all 17 Multiple Indicator Cluster Surveys and in three Demographic and Health Surveys, participants were asked about the number of cigarettes smoked in the past 24 h, whereas the other surveys asked about the average daily number smoked. As a measure of smoking history, we calculated pack years for people who self-reported to be smoking cigarettes (manufactured or hand rolled). One pack was defined as containing 20 cigarettes. Pack years were calculated by multiplying the number of packs smoked per day with the number

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of years since smoking initiation. Instead of asking about age at smoking initiation, the Multiple Indicator Cluster Surveys asked about participants' age at which they first smoked a whole cigarette. Current smoking and smokeless tobacco use prevalences were estimated among all eligible survey participants. Use prevalences of product specific tobacco, such as current cigarette smoking or oral snuff use, were estimated among all current smokers or smokeless tobacco users. Use frequencies of specific tobacco products were estimated among current users of the respective product.

Socioeconomic and demographic characteristics

Socioeconomic and demographic variables used in this analysis were sex, age groups of 10 years (15-24, 25-34, 35-44, 45-54, 55-64, ≥65), education, household wealth (divided by quintile), and household residency (rural *v* urban). We used the following categories of educational attainment: no formal education, some primary school, primary school completed, some high school, and high school or higher. Household wealth groups were calculated separately for each country based on household asset ownership or income. Supplementary text S3 details the information used to calculate household wealth in each country.

Statistical analysis

We applied sampling weights in all analyses to account for the survey specific sampling designs. We scaled these survey weights such that each country was weighted proportional to its total population size in 2015.[18] Supplementary text S4 provides more detail on the calculation of the sampling weights. Prevalence and frequency of tobacco use were disaggregated by country, world region, World Bank income group, and sex, overall (prevalence) and separately for each tobacco product (prevalence and frequency). World regions were defined according to the WHO's regional classification (Africa, the Americas, Eastern Mediterranean, Europe, South East Asia, and Western Pacific).[19] World Bank income groups were determined by the World Bank based on gross domestic product per capita in the country in the survey year.[10] Surveys were excluded from analyses that were not specific by sex if information on the respective outcome was only available for men. Supplementary tables S7 and S8 detail which countries were included in the samples for each of the global, region, and World Bank group level analyses. We focus on crude tobacco use prevalence but also show age standardized estimates using the WHO World Standard Population[20] in the appendix. Additionally, because the sampled age range varied between surveys, the appendix shows all global and country level estimates of tobacco use prevalence and frequency when restricting the sample to the age range of 18-49 years, which was covered by all surveys.

We estimated weighted logistic regression models for binary and ordinary least squares regression models for continuous outcomes to determine the association between both tobacco product use and use frequency, and participants' socioeconomic and demographic characteristics. Regression models with household residency, education, or household wealth as exposures were adjusted for sex and age. Models with sex as exposure were adjusted for age. Age groups were included as continuous variables using restricted cubic splines with five knots at the 5th, 27.5th, 50th, 72.5th, and 95th percentile. If age was the exposure, age was included as a categorical variable and the model adjusted for sex. As a secondary analysis, we included age splines when age was the variable of interest in regression models at the global level. As a final step, we included all five covariates (household residency, sex, age categories, education, and wealth) in the regression models. We assessed potential multicollinearity through the variation inflation factor, which was below three across all model specifications. To ease interpretation of the regression outputs, we show average adjusted predictions, which can be interpreted as the tobacco use prevalence or mean tobacco use frequency. The average adjusted predictions were obtained through the Stata margins command based on the results of the respective estimated regression models. All regressions included robust standard errors adjusting for clustering at the level of the primary sampling unit.[21] When no primary sampling unit indicator was available (ie, Marshall Islands), standard errors were adjusted for clustering at the country level instead. As secondary analyses, we clustered standard errors at the country level. This approach requires clusters to be of comparable size. Because India and China together represent a population of over two billion, and are therefore manifold larger than the other countries, they had to be excluded from this analysis. In addition to this secondary analysis, we weighted each country equally instead of proportionate to its population size. These results, thus, include India and China and allow for a clustering of standard errors at the country level. We included country dummies in regressions at the global, world region, and World Bank income group levels. By doing so, we accounted for heterogeneity by country without making assumptions on the distribution of prevalence across countries. All analyses were complete case analyses because the missingness in the outcome variables was low, ranging from 0.01% to 0.03% in the pooled sample.

We used Stata 15 for statistical analyses and R's ggplot2 package for all figures.

Patient and public involvement

As this study did not receive any funding, patient or public involvement was unfortunately not possible.

Results

Sample characteristics

The study sample from the surveys in 82 low and middle income countries comprised 1 231 791 eligible participants aged 15 years or older (table 1). Of these participants, 723 were excluded from the analysis because information was missing for all four overall tobacco use outcomes (current smoking, current daily

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smoking, current smokeless tobacco use, and current daily smokeless tobacco use). We thus included 1 231 068 participants in our analysis. Supplementary table S9 displays the percentage of missing observations for each outcome and sociodemographic characteristic by country. The survey level median age was 35 years (interquartile range 28-39) and mean percentage of female respondents was 63% (table 1). Of the 1 078 781 observations with information on both current smoked and smokeless tobacco use, 114 321 (10.6%) smoked and 42 830 (4.0%) used smokeless tobacco.

All 82 surveys asked about current smoking (supplementary table S5). For women, 64 surveys had information on current daily smoking and 80 on cigarette use frequency. Seventy seven surveys had information on current use of other smoked tobacco products and 43 specified their use frequencies. Seventy two surveys had information on current smokeless tobacco use and 55 on current daily smokeless tobacco use. Sixty five surveys asked about current use of smokeless tobacco separately for different smokeless tobacco products. Thirty five surveys additionally asked about the use frequency of these products.

For men, 78 surveys asked about current daily smoking. As for women, 80 surveys had information on cigarette use frequency. Seventy seven surveys asked about current use of other smoked products and 56 surveys collected information on the use frequency of these products. Seventy two surveys had information on current smokeless tobacco use and 68 on current daily smokeless tobacco use. Sixty six surveys asked about current use of specific smokeless tobacco products and 46 about the use frequency of these products.

Weighted sociodemographic characteristics of participants by survey are shown in supplementary tables S10-S14. Of the 82 surveys, nine (Ecuador, Kiribati, Lebanon, Marshall Islands, Nauru, Solomon Islands, Tajikistan, Tonga, and Tuvalu) did not collect information on rural versus urban household residency, and six (Bangladesh, Belarus, Iraq, Nepal, Tonga, and Turkmenistan) did not collect information on household wealth.

Prevalence and frequency of tobacco smoking

Across all 82 low and middle income countries, the weighted mean current smoking prevalence was 16.5% (95% confidence interval 16.1% to 16.9%; survey level median 12.4%; interquartile range 5.3-22.5%; range 1.1-50.6%; supplementary table S15). Smoking prevalence was higher among men than women (33.2% (32.5% to 33.8%; 23.9%; 13.4-44.1%; range 3.5-72.2%) *v* 3.3% (3.1% to 3.4%; 2.0%; 0.6-5.7%; 0.1-45.3); supplementary tables S16 and S17). Among both male and female smokers, cigarettes were the most commonly used tobacco product, smoked by 95.6% of men (95.3% to 96.0%; 94.6%; 89.8-98.2%; range 50.0-100.0%) and 85.2% of women (83.1% to 87.3%; 85.4%; 63.4-97.3%; 17.6-100.0%).

In all countries, where data were available, more male and female smokers reported to be smoking manufactured (men 73.5% (95% confidence interval 72.3% to 74.6%, survey level median 88.4%, interquartile range 79.4-94.9%, range 28.3-100.0%); women 55.8% (52.2% to 59.5%, 81.1%, 56.2-95.1%, 5.5-100.0%)) than hand rolled (men 30.7% (29.4% to 31.9%, 16.2%, 7.9-31.0%, 0.0-97.9%); women 38.7% (35.6% to 41.7%, 12.0%, 5.5-30.5%, 0.0-89.8%)) cigarettes. The mean frequency of cigarette smoking among male smokers was 12.0 cigarettes per day (11.8 to 12.3; 8.7; 6.1-14.2; 2.1-29.4) and among female smokers was 8.5 (7.9 to 9.2; 6.1; 4.8-10.7; 2.0-21.2). The mean number of pack years was also higher among men (17.2 (16.6 to 17.8; 9.3; 5.3-17.2; 2.8-33.2)) than among women (12.5 (11.0 to 14.1; 6.6; 3.7-11.7; 0.9-26.4)).

At the country level, smoking prevalence ranged from 1.1% (95% confidence interval 0.9% to 1.3%) in Ghana to 50.6% (45.2% to 56.1%) in Kiribati (fig 1, supplementary figure S1). Four of the 10 countries with the highest smoking prevalence were small pacific islands (supplementary table S18), with high prevalence both among men and women. In other cases, the country level prevalence hides notable sex disparities. Indonesia or Armenia, for example, have an exceptionally high smoking prevalence among men but smoking is uncommon among women resulting in a below average country level smoking prevalence. Across all countries, cigarettes were the most commonly used product by smokers. The only two exceptions were Papua New Guinea, where a comparably large share of smokers smoked brus (a local tobacco), and Lesotho, where smoking of cigarillos (BB, which is rolled tobacco) was comparably common.

The mean number of pack years among cigarette smokers was 17.1 (95% confidence interval 16.5 to 17.7; survey level median 8.9; interquartile range 5.2-16.5) across the 59 countries with information on pack years, ranging from 2.8 (2.1 to 3.4) in Ecuador to 31.5 (25.8 to 37.2) in Albania (fig 1, supplementary figure S2). At the WHO regional level, the smoking prevalence was highest in Europe (28.0% (27.3% to 28.8%)) and in Western Pacific, both with China (26.1% (25.1% to 27.2%)) and without (23.1% (22.3% to 23.8%)); supplementary table S19). Africa had by far the lowest smoking prevalence of 5.9% (5.7% to 6.1%). The smoking prevalence was highest in upper middle income countries both including (24.2% (23.5% to 25.0%)) and excluding (20.4% (20.1% to 20.7%)) China and lowest in low income countries (4.9% (4.5% to 5.2%); supplementary table S20). Figure S3 shows that the smoking prevalence was lower in more recent surveys. Smoking prevalence and frequencies at the global level with sampling weights that weigh each country equally (supplementary table S21) and with standard errors clustered at the country level (supplementary table S22) are displayed in the appendix. Age standardised smoking prevalence estimates are shown in supplementary tables S23-S27. Smoking frequencies and pack years among

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daily smokers (as opposed to all current smokers) are presented in supplementary tables S28-S32. Supplementary figures S1 and S4 show the prevalence of daily smoking and mean number of pack years among daily smokers. Supplementary tables S33 and S34 show the sociodemographic characteristics and crude smoking prevalence, product use prevalence, and use frequencies at the global and country levels for adults aged 18-49 years.

Prevalence and frequency of smokeless tobacco use

In the 72 study countries that collected information on current smokeless tobacco use, the smokeless tobacco use prevalence was 7.7% (95% confidence interval 7.5% to 8.0%; survey level median 1.1%; interquartile range 0.4-4.0%; range 0.0-29.3%; supplementary table S35). Use of smokeless tobacco was reported in 11.1% (10.7% to 11.5%; 1.8%; 0.4-4.3%; 0.0-59.4%) of men and 4.8% (4.6% to 5.0%; 0.6%; 0.1-2.5%; 0.0-28.1%) of women (supplementary tables S36 and S37). Among male smokeless tobacco users, chewing tobacco was the most commonly used smokeless tobacco product, used by 49.5% (47.5% to 51.4%; 13.8%; 3.2-46.8%; 0.0-100.0%) and on average 5.0 (4.7 to 5.3; 3.6; 2.1-5.6; 0.1-8.6) times a day. Among female smokeless tobacco users, betel nut with or without tobacco (40.8% (38.4% to 43.3%; 3.5%; 0.5-50.5%; 0.0-99.9%)) and oral snuff (40.0% (34.1% to 46.0%; 33.6%; 13.7-55.8%; 0.0-100.0%)) were comparably common and were used on average 4.5 times a day (4.2 to 4.8; 4.2; 1.4-7.0; 1.1-11.0) and 3.2 times a day (2.8 to 3.5; 3.8; 2.3-4.5; 0.1-8.3), respectively.

Myanmar had the highest prevalence of smokeless tobacco use of 29.3% (95% confidence interval 28.0% to 30.6%; supplementary table S35). Of the 72 countries for which data for current smokeless tobacco use were available, 32 had a smokeless tobacco use prevalence of less than 1% (supplementary figure S1). Papua New Guinea did not have information on current smokeless tobacco use; however, the survey collected information on daily betel nut chewing, which was estimated to be 65.4% (63.3% to 67.5%). Despite insufficient data, current smokeless tobacco use prevalence, which includes betel nut use, can be inferred to be at least twice as high as in Myanmar. Supplementary table S18 shows that five (Myanmar, Bangladesh, India, Nepal, and Bhutan) of the 10 countries with the highest smokeless tobacco use prevalence also were among the 10 countries with the highest prevalence among men and women, respectively and three (Afghanistan, Tajikistan, and Algeria) had high prevalence among men but not among women. Smokeless tobacco use was substantially higher in South East Asia than in the other regions, where prevalences ranged from 0.5% to 6.0% (supplementary table S38). Prevalence was highest in low and lower middle income countries (eg, India) and low in upper middle income countries (supplementary table S39). Figure S5 shows that the smokeless tobacco use prevalence was slightly higher in more recent surveys. Smokeless tobacco use prevalence and frequency at the global level with sampling weights that weigh each country equally (supplementary table S21) and with standard errors clustered at the country level are displayed in the appendix (supplementary table S22). Age standardised smokeless tobacco use prevalence estimates are shown in supplementary tables S23-S27. Daily smokeless tobacco use prevalence and use frequencies among daily smokeless tobacco users are presented in supplementary tables S40-S44, supplementary figures S1 and S4 and supplementary table S45 show the crude smokeless tobacco use prevalences, product use, and use frequencies at the global and country levels for adults aged 18-49 years.

Variation in tobacco use by socioeconomic and demographic characteristics

Prevalence of current smoking

When pooling data across all study countries, residing in a rural area was associated with a higher smoking prevalence than residing in an urban area (supplementary table S46). This pattern could also be observed in South East Asia and Western Pacific (while both including and excluding India and China), whereas the reverse was true for the Americas (supplementary table S47). In Africa, South East Asia, and Western Pacific, a clear negative association was noted between education or household income and smoking. These associations can largely also be observed across World Bank income groups (supplementary table S48). When the regression was run separately for each country, we found a higher prevalence of smoking in rural than urban areas in 15 countries while the reverse was true in 11 countries (fig 2, supplementary figure S6, supplementary table S49). Men were more likely to smoke than women in all countries but Nauru (fig 3, supplementary figure S7). In most countries, people in the lowest education and household wealth category had a higher smoking prevalence than those in the highest category (fig 2, fig 3). However, both the direction and magnitude of this association varied greatly across countries (supplementary figures S8 and S9). The association between the prevalence of smoking and age group was highly heterogeneous across countries (supplementary figure S10).

Among current smokers in our sample, cigarette smoking was more common in urban than rural areas (95.7% (95% confidence interval 95.2% to 96.1%) *v* 93.5% (92.7% to 94.2%)) and among men than women (95.6% (95.3% to 96.0%) *v* 86.1% (84.2% to 87.9%); fig 4, supplementary table S50). The current cigarette smoking prevalence increased with education and household wealth. In countries that distinguished between manufactured and hand rolled cigarettes, the same associations were observed for manufactured cigarettes. Furthermore, the manufactured cigarette smoking prevalence also decreased with age. However, the reverse was true for smoking of hand rolled cigarettes. Prevalence of hand rolled cigarette smoking was higher in rural than urban areas, increased

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Table 1 | Survey and sample characteristics

Country	ISO-3 code	Survey	Year	Sample size	No of women (%)*	Median age (IQR)*
Afghanistan	AFG	STEPS	2018	3891	48.8	35 (25-48)
Albania	ALB	DHS	2017-18	20916	70.8	39 (26-50)
Algeria	DZA	STEPS	2016	6989	55.9	40 (31-51)
Angola	AGO	DHS	2015-16	19528	72.7	26 (20-35)
Armenia	ARM	DHS	2015-16	8834	68.9	31 (24-39)
Azerbaijan	AZE	STEPS	2017	2801	59.4	47 (34-57)
Bangladesh	BGD	STEPS	2018	8185	53.5	38 (30-48)
Belarus	BLR	STEPS	2016	5010	58.3	48 (36-58)
Belize	BLZ	MICS	2015-16	8272	56.8	28 (21-36)
Benin	BEN	STEPS	2015	5126	54.6	35 (27-46)
Bhutan	BTN	STEPS	2019	5575	61.3	38 (30-50)
Bolivia	BOL	EH	2019	27757	52.0	36 (24-52)
Botswana	BWA	GATS	2017	4643	58.8	37 (28-51)
Brazil	BRA	PNS	2019	90849	52.9	45 (32-60)
Burundi	BDI	DHS	2016-17	23761	72.1	27 (20-35)
Central African Republic	CMR	MICS	2018-19	13082	70.3	27 (20-35)
Cameroon	CAF	DHS	2018	19261	65.7	27 (20-37)
China	CHN	GATS	2018	19376	53.0	53 (41-65)
Costa Rica	CRI	GATS	2015	8607	58.8	43 (29-59)
Côte d'Ivoire	CIV	MICS	2016-17	17185	68.5	28 (21-36)
Cuba	CUB	MICS	2019	12549	70.5	31 (25-40)
Democratic Republic of the Congo	COD	MICS	2017-18	27869	78.1	27 (20-35)
Ecuador	ECU	STEPS	2018	4638	58.1	40 (29-52)
Egypt	EGY	DHS	2015	15943	54.4	32 (23-44)
Ethiopia	ETH	GATS	2016	10150	54.4	30 (24-40)
Gambia	GMB	MICS	2018	18162	75.1	27 (20-35)
Georgia	GEO	STEPS	2016	4204	69.8	50 (36-59)
Ghana	GHA	MICS	2017-18	19697	73.0	27 (20-38)
Guinea	GIN	DHS	2018	14289	75.1	28 (20-36)
Guinea-Bissau	GNB	MICS	2018-19	13750	79.6	27 (20-35)
Guyana	GUY	STEPS	2016	2651	59.9	40 (29-53)
Haiti	HTI	DHS	2016-17	24756	61.2	29 (20-41)
India	IND	GATS	2016	74037	54.4	37 (27-50)
Indonesia	IDN	DHS	2017	56288	85.3	34 (25-42)
Iran	IRN	STEPS	2016	30541	52.3	42 (31-56)
Iraq	IRQ	STEPS	2015	4060	60.4	40 (29-52)
Jordan	JOR	STEPS	2019	5713	61.4	38 (28-50)
Kenya	KEN	STEPS	2015	4472	60.1	35 (27-47)
Kiribati	KIR	STEPS	2015	2156	54.3	37 (27-48)
Laos	LAO	MICS	2017	37322	67.8	29 (21-38)
Lebanon	LBN	STEPS	2017	1899	58.1	47 (36-56)
Lesotho	LSO	MICS	2018	9326	69.2	28 (20-37)
Liberia	LBR	DHS	2019-20	11607	67.9	28 (20-38)
Madagascar	MDG	MICS	2018	24784	69.2	27 (20-36)
Malawi	MWI	DHS	2015-16	31336	77.6	26 (20-35)
Maldives	MDV	DHS	2016-17	11897	64.1	30 (23-38)
Mali	MLI	DHS	2018	14420	72.3	28 (20-36)
Marshall Islands	MHL	Hybrid Survey	2017	3005	52.4	37 (28-49)
Mauritania	MRT	MICS	2015	19029	75.3	27 (20-36)
Mexico	MEX	ENCODAT	2016-17	50511	59.2	36 (24-48)
Mongolia	MNG	STEPS	2019	6647	55.4	40 (31-52)
Morocco	MAR	STEPS	2017	5429	65.2	44 (32-57)
Myanmar	MMR	DHS	2015-16	17070	73.2	32 (23-40)
Nauru	NRU	STEPS	2015-16	1387	53.0	33 (26-44)
Nepal	NPL	STEPS	2019	5593	64.3	38 (29-51)
Nigeria	NGA	MICS	2016-17	49559	69.4	28 (20-36)
Pakistan	PAK	DHS	2017-18	15146	79.6	32 (26-39)
Papua New Guinea	PNG	DHS	2016-18	21970	67.2	28 (21-37)
Philippines	PHL	GATS	2015	11644	50.4	38 (27-52)
Romania	ROU	GATS	2018	4571	53.8	53 (38-67)
Russia	RUS	GATS	2016	11458	58.2	50 (35-62)
Rwanda	RWA	DHS	2019-20	20145	71.4	28 (20-37)
São Tomé and Principe	STP	MICS	2019	4510	69.1	28 (20-37)

(*Continued*)

with age, and decreased with higher education and household wealth. No difference was reported in the prevalence of smoking hand rolled cigarettes between male and female current smokers. Water pipe smoking was more prevalent among female than in male smokers (10.5% (8.8% to 12.3%) *v* 4.1% (3.6% to 4.6%)) and slightly more common among smokers in rural than in urban areas (5.5% (4.7% to 6.3%) *v* 4.1% (3.5% to 4.7%)). Pipe smoking was also slightly more prevalent among female than male smokers (3.1% (2.4% to 3.8%) *v* 1.9% (1.6% to 2.2%)) and increased with age.

The direction and magnitude of the associations of product specific tobacco use with socioeconomic and demographic characteristics varied widely across countries (supplementary tables S51-S56). Supplementary tables S57 and S58 show regression results when weighting each country equally, supplementary tables S59 and S60 show regression when clustering standard errors at the country level, and supplementary table S61 shows the regression coefficient for age cubic splines. Supplementary tables S62-S71 and supplementary figures S11-S16 show all results for adults aged 18-49 years. Supplementary tables S72-S83 show prevalence regression results that are specific to products at the region and World Bank income group levels. Supplementary tables S84-S105 and supplementary figures S6-S10, S17, and S18 display regression results at all levels for daily smokers.

Prevalence of current smokeless tobacco use

In the 72 countries with information on current smokeless tobacco use, prevalence of use was higher in rural versus urban areas (8.8% (95% confidence interval 8.5% to 9.1%) *v* 5.9% (5.5% to 6.3%)) and among men versus women (11.0% (10.6% to 11.4%) *v* 4.8% (4.6% to 5.1%); supplementary table S46). Smokeless tobacco use prevalence increased with age and was negatively associated with education and household wealth. These associations were largely also observed across the world regions, except for Western Pacific including China, and the World Bank income groups (supplementary tables S106 and S107). Smokeless tobacco use was significantly more common in rural than urban areas in 24 countries (fig 5, supplementary table S108). Although men were significantly more likely to report using smokeless tobacco than women in 31 countries, the opposite was true in 10 countries (fig 6). People in the lowest education category and household wealth group were more likely to use smokeless tobacco than those in the highest category in 32 countries each (fig 5, fig 6). Older age groups were more likely to report using smokeless tobacco than younger age groups in 35 countries. However, a large degree of variation was noted in both the direction and magnitude of the associations between the five socioeconomic and demographic characteristics and smokeless tobacco use across countries (supplementary figures S19-S23).

Among smokeless tobacco users in our sample, the use prevalence of all smokeless tobacco products

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Table 1 | Continued

Country	ISO-3 code	Survey	Year	Sample size	No of women (%)*	Median age (IQR)*
Senegal	SEN	GATS	2015	4347	54.8	33 (23-46)
Sierra Leone	SLE	MICS	2017	25 288	70.7	27 (20-36)
Solomon Islands	SLB	STEPS	2015	2525	55.4	38 (29-48)
South Africa	ZAF	DHS	2016	10 116	58.9	36 (24-53)
Sudan	SDN	STEPS	2016	7722	64.9	36 (27-48)
Tajikistan	TJK	STEPS	2016	2717	59.6	39 (29-50)
Tanzania	TZA	GATS	2018	4797	56.5	35 (25-48)
Timor-Leste	TLS	DHS	2016	16 454	75.7	27 (19-37)
Togo	TGO	MICS	2018	9612	76.2	29 (21-37)
Tonga	TON	STEPS	2017	3858	64.5	40 (30-51)
Tunisia	TUN	MICS	2018	13 004	81.2	32 (24-40)
Turkey	TUR	GATS	2016	8760	49.3	39 (29-51)
Turkmenistan	TKM	STEPS	2018	4053	57.7	39 (29-50)
Tuvalu	TUV	STEPS	2015	1155	54.4	41 (29-54)
Uganda	UGA	DHS	2016	22 774	78.4	26 (20-35)
Ukraine	UKR	GATS	2017	8298	54.6	54 (38-67)
Vietnam	VNM	GATS	2015	8996	55.7	44 (32-56)
Zambia	ZMB	STEPS	2017	4302	62.5	34 (25-46)
Zimbabwe	ZWE	DHS	2015	17 175	55.2	27 (20-36)
Sample	–	–	–	1 231 791	63.4†	35 (28-39)‡

DHS=Demographic and Health Survey; EH=Encuesta de Hogares; ENCODAT=Encuesta Nacional del Consumo de Drogas; Alcohol, y Tobacco; GATS=Global Adult Tobacco Survey; ISO=International Organization for Standardization; IQR=interquartile range; MICS=Multiple Indicator Cluster Surveys; PNS=Pesquisa Nacional de Saúde; STEPS=WHO-STEPwise Approach to Surveillance.
*Median age and mean percentage of female respondents are unweighted.
†Unweighted country-level mean percentage of female respondents.
‡Unweighted country-level median age and interquartile range.

did not differ between rural and urban users (supplementary table S50, fig 4). Oral snuff and betel nut use were more prevalent among female smokeless tobacco users and chewing tobacco was more commonly used by males. The chewing tobacco use prevalence decreased with household wealth and the betel nut chewing prevalence increased with both education and household wealth. The direction and magnitude of the associations of tobacco product use with socioeconomic and demographic characteristics varied widely across countries (supplementary tables S109-S112). Supplementary tables S57 and S58 show regression results when weighting each country equally, supplementary tables S59 and S60 when clustering standard errors at the country level, and supplementary table S61 regression coefficients for age cubic splines. Supplementary tables S62, S113-S118, and supplementary figures S24-S29 show the smokeless tobacco use regression results for adults aged 18-49 years. Supplementary tables S119-S126 show product-specific prevalence regression results at the region and World Bank income group levels. Supplementary tables S127-S141 and supplementary figures S19-S23 and S30 display regression results at all levels for daily smokers.

Pack years among current cigarette smokers

Across study countries, male smokers smoking cigarette had a more intense smoking history than female smokers (17.8 pack years (95% confidence interval 17.2 to 18.4) *v* 9.6 (8.8 to 10.5; fig 7, supplementary table S142). The number of pack years was negatively associated with education and household wealth. Associations between pack years and socioeconomic and demographic variables are shown separately for each region, World Bank income group, and country, as well as among current cigarette smokers aged 18-49 years and all daily smokers smoking cigarettes in supplementary tables S143-S151 and supplementary figures S31-S42. Supplementary table S152 shows results when weighting each country equally, supplementary table S153 when clustering standard errors at the country level, and supplementary table S154 regression coefficient for age cubic splines.

Frequency of tobacco use by product among current smokers and users

The self-reported mean daily number of cigarettes smoked was higher in rural areas and among men, increased with age and decreased with education (fig 7, supplementary table S155). Data from countries with information separated by cigarette type showed that smoking frequency of manufactured cigarettes was similar to that of hand rolled cigarettes. No notable differences were reported for the associations between use frequencies of each cigarette type with sociodemographic characteristics mirroring what was observed for cigarettes in general. The frequency of all other smoked and smokeless tobacco products was low and did not vary significantly across socioeconomic and demographic groups. Supplementary tables S156-S185 show the associations separately for each region, World Bank income group, and country. Supplementary table S186 shows results when weighting each country equally, supplementary table S187 when clustering standard errors at the country level, supplementary table S188 regression coefficient for age cubic splines, and supplementary tables S189-S199 for the sample aged 18-49 years. Supplementary tables S200-S230 and supplementary figure S43 show the results for daily users using the respective products.

Fully adjusted regressions

Adjusting for education and household wealth in addition to sex and age in the regression models yielded similar results. One notable difference is that adjustment for education and household wealth reduced the magnitude of the differences in tobacco use prevalence between rural and urban areas. In addition, when running the regressions separately by country, the differences in current smokeless tobacco use prevalence by sex became more pronounced. Results of the fully adjusted regression models are shown in supplementary tables S231-S308 and supplementary figures S44-S65.

Discussion

Main findings

Pooling nationally representative individual level data from 82 countries that represent roughly 90% of the population living in low and middle income countries,[18] we found that about one in five individuals aged 15 years and older in these countries used tobacco. Although smoking tobacco

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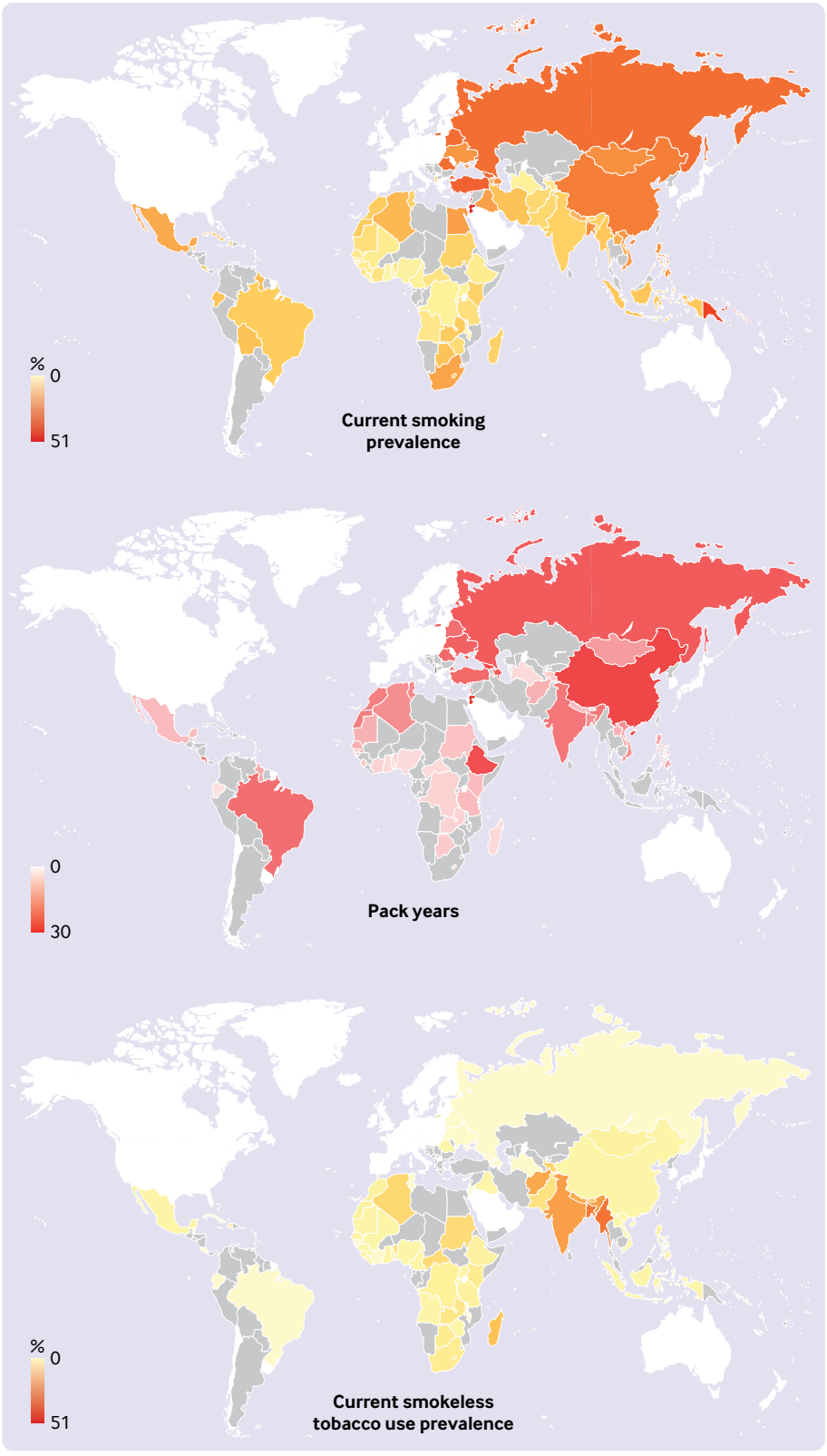


Fig 1 | Smoking prevalence, mean pack years among current smokers, and smokeless tobacco user prevalence in low and middle income countries. Panels display the crude (ie, not age standardised) prevalences and mean pack years among adults in the sampled age range. Mean pack years were calculated among current smokers who reported to smoke cigarettes. Sampling weights were used in all estimations to account for the complex survey design. Grey indicates low and middle income countries for which no data were available. White indicates high income countries

was the most common form of tobacco use, smokeless tobacco use also had a substantial prevalence with 7.7%. Individuals with less education and household wealth were most likely to use tobacco and cigarette smokers in these population groups were more likely to smoke more frequently. However,

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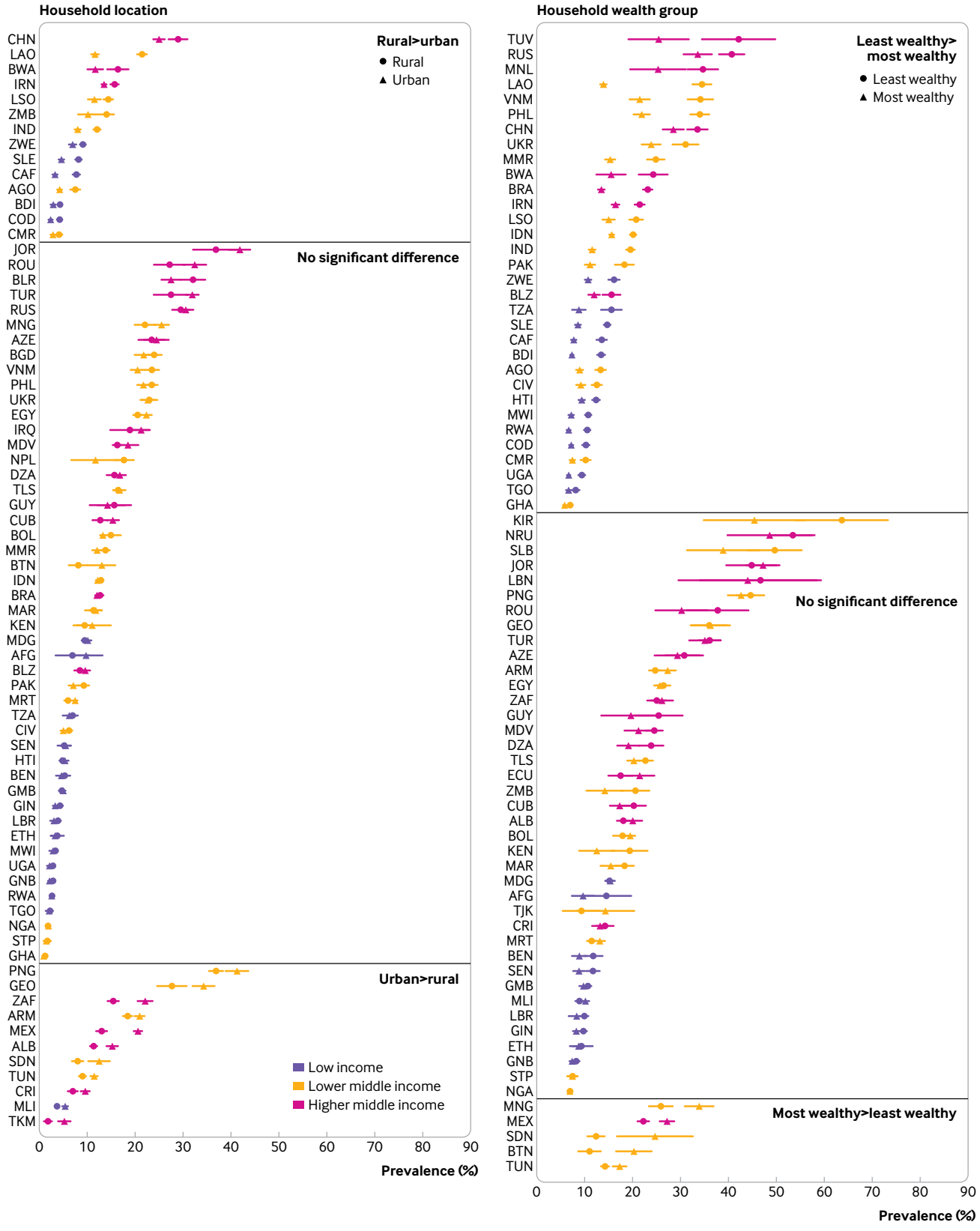


Fig 2 | Country level prevalence of smoking by household residency and household wealth. Estimates were obtained from logistic regression models adjusting for sex and age. Horizontal bars represent 95% confidence intervals. Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. Country names are abbreviated using the relevant International Organization for Standardization-3 code (table 1). Horizontal black lines group countries according to significant differences (top and bottom panels) and no significant difference (middle panel) between the categories. For example, in the countries in the top left panel, smoking prevalence was larger in rural than in urban areas, whereas the reverse was true in the bottom left panel. Household wealth was divided into five equal groups (ie, by quintiles)

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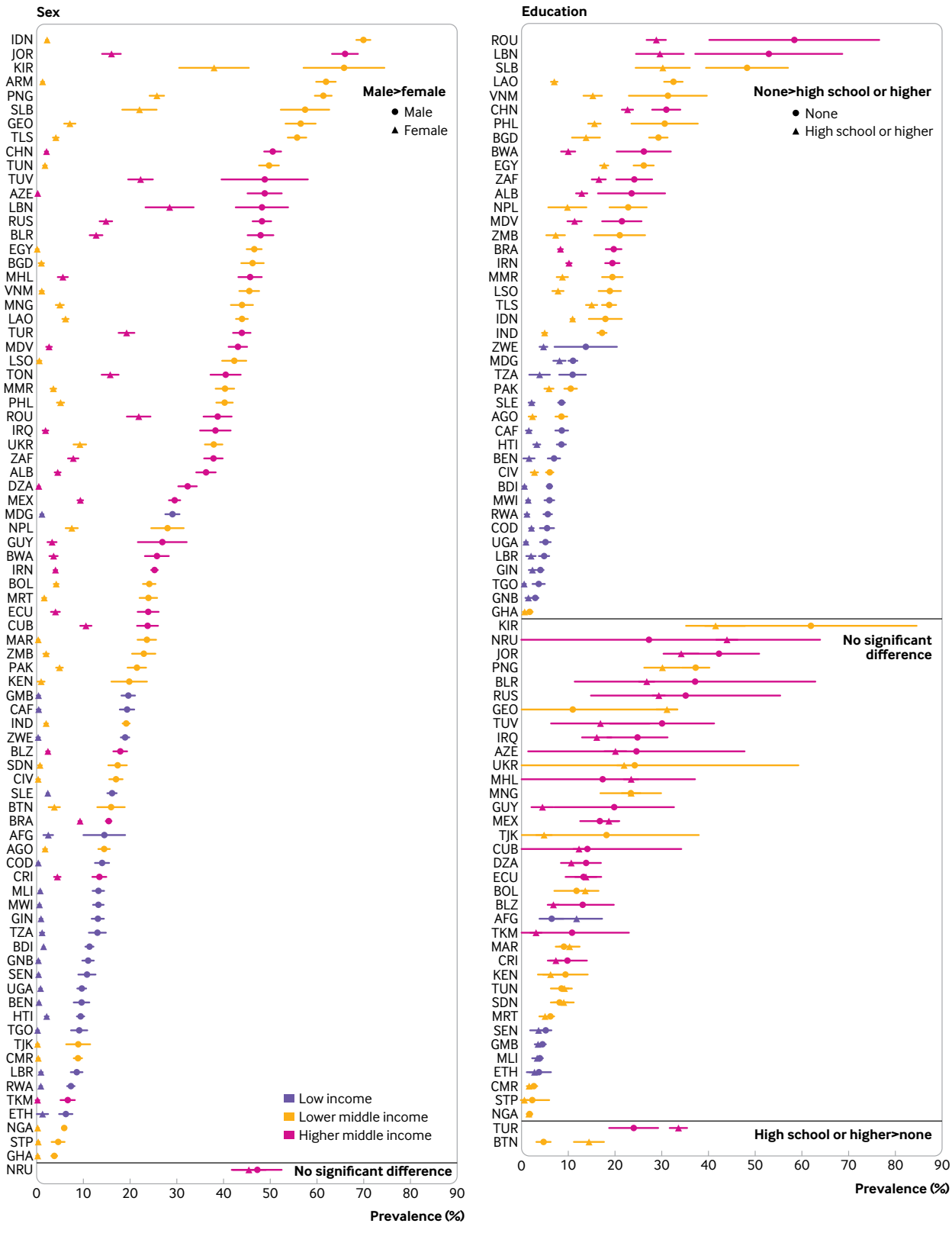


Fig 3 | Country level prevalence of smoking by sex and education. Estimates were obtained from logistic regression models adjusting for sex and age (education) or age only (sex). Horizontal bars represent 95% confidence intervals. Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. Country names are abbreviated using the relevant International Organization for Standardization-3 code (table 1). Horizontal black lines group countries according to significant differences (top and bottom panels) and no significant difference (middle panel) between the categories. For example, in the countries in the top right panel, smoking prevalence was larger among those with no education than among those with education to high school or higher level, whereas the reverse was true in the bottom panel. In all countries, the smoking prevalence was either higher among men (top left panel) or confidence intervals overlapped (bottom left panel)

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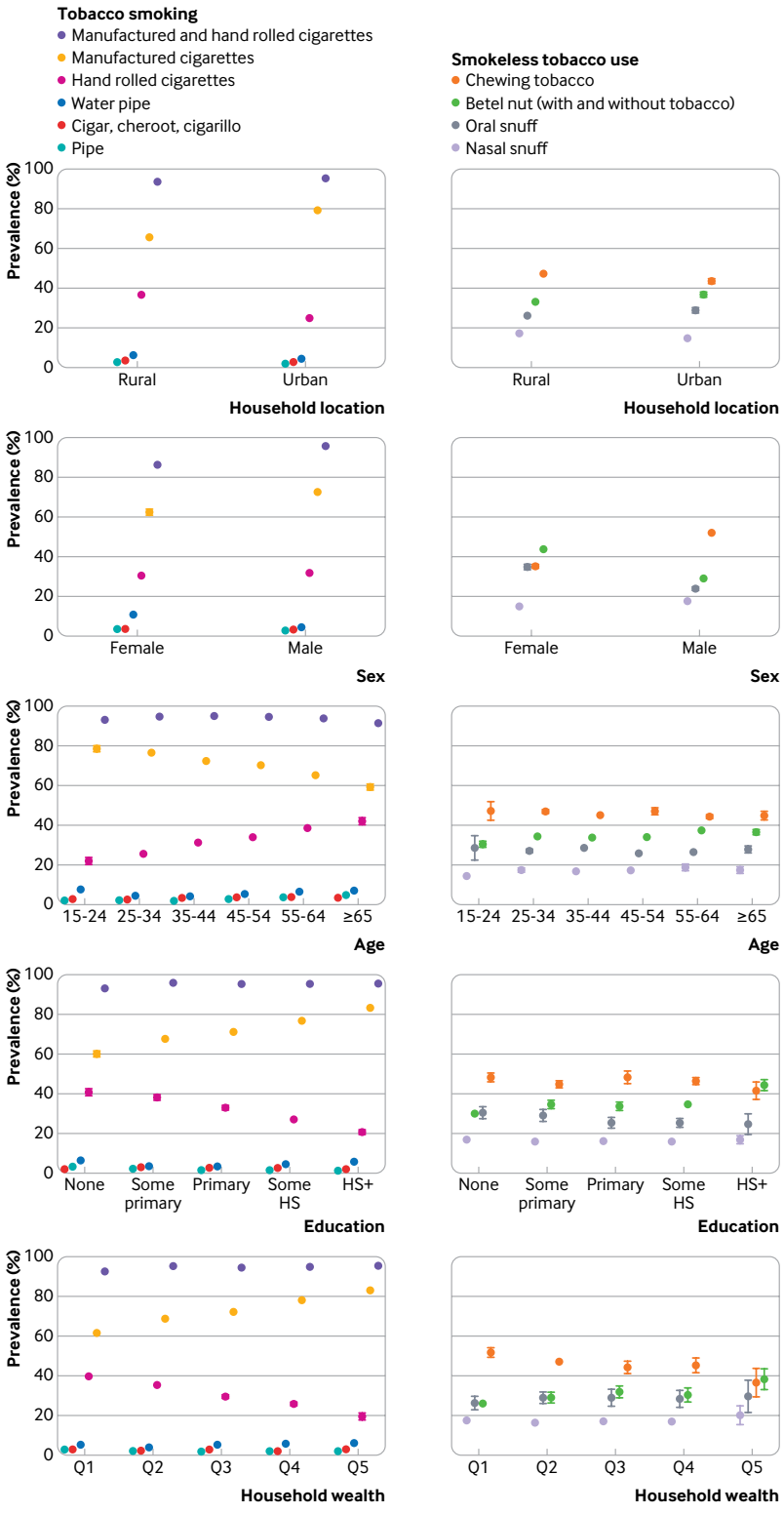


Fig 4 | Tobacco product user prevalence among current smokers or users. Adjusted user prevalences among current smokers or smokeless tobacco users are displayed. Estimates were obtained from logistic regression models with country dummies and adjusting for sex and age (household residency, education, household wealth), sex (age), or age (sex). Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. 95% confidence intervals are shown as vertical lines; however, confidence intervals are generally very narrow and therefore some are not displayed. HS=high school; Q=household wealth group, divided by quintile (the least wealthy group is denoted as Q1 and the wealthiest as Q5)

we observed large variation in the direction and magnitude of these associations across countries and by tobacco product. Variation was less in the use frequency of smokeless tobacco products across sociodemographic characteristics, which might, in part, be caused by the generally low daily use frequency of these products.

Implications

This study makes several key contributions to the existing body of evidence on tobacco use in low and middle income countries. Firstly, this is, to our knowledge, the largest study of tobacco use in low and middle income countries to date. As such, our estimates of tobacco use in each of 82 low and middle income countries can serve as an important benchmark for monitoring progress on reducing tobacco use in low and middle income countries as part of national and international goals. Secondly, this study is the only one to comprehensively examine use of each of a detailed set of tobacco products and how such use varies across a large set of low and middle income countries. This evidence is essential for setting priorities in tobacco control policies. Although we found cigarettes (in particular manufactured ones), which have been studied most extensively thus far, to be the most commonly used tobacco product in low and middle income countries, about a third of current smokers in our study smoked hand rolled cigarettes. In addition, smokeless tobacco use was common, particularly in South-East Asian countries.

Thirdly, unlike most studies to date,[22-31] we assessed not only use prevalence but also use frequency of each tobacco product. We showed that wide variation exists between countries in the use frequency of each tobacco product. Given the strong dose-response relation between tobacco use and adverse health outcomes,[32-35] this evidence is important for the design and targeting of relevant tobacco control policies in low and middle income countries. Finally, we examine in detail socioeconomic and demographic patterns of use and use frequency for each tobacco product. Our findings show that the existing literature's focus on smoking of (manufactured) cigarettes or tobacco use overall masks important variation in the patterns of tobacco use between socioeconomic groups in low and middle income countries.

One important finding of our analysis is that, across our study countries, men consistently smoke more tobacco than women. In most (60 (73%) of 82) of the low and middle income countries in our study, smoking prevalence among women was less than 5%. The key drivers of the tobacco epidemic, such as increasing cigarette purchasing power and rising educational attainment in low and middle income countries, have been argued to impact women differently than men, with their effect being mediated by gendered social, cultural, and economic factors.[36 37] Specifically, in line with the finding that higher female empowerment was found to be associated with lower female to male smoking prevalence ratios,[38] rising

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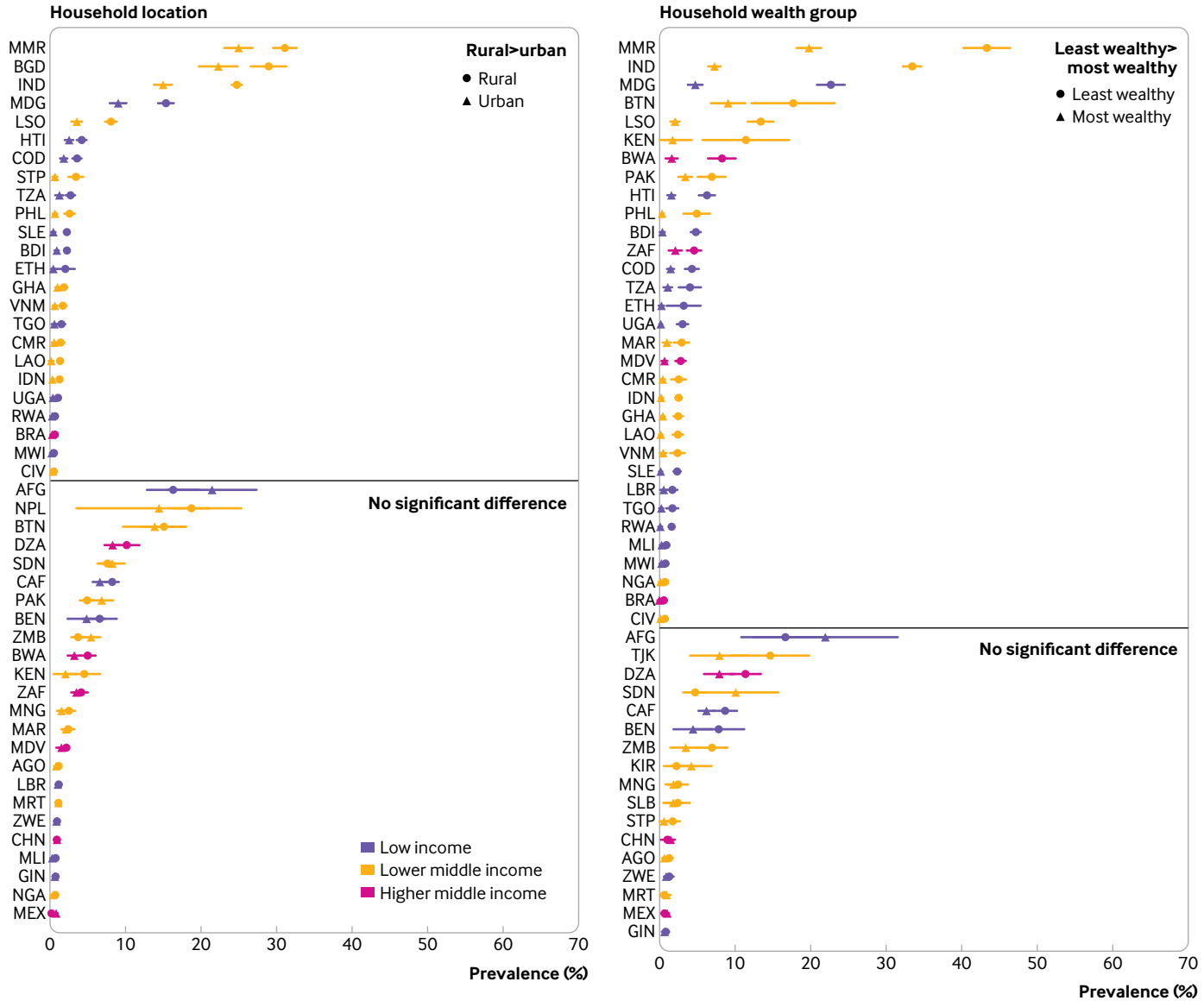


Fig 5 | Country level prevalence of smokeless tobacco use by household residency and household wealth . Estimates were obtained from logistic regression models adjusting for sex and age. Horizontal bars represent 95% confidence intervals. Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. Country names are abbreviated using their ISO-3 code (table 1). Horizontal black lines group countries according to significant differences (top panel) and no significant difference (bottom panel) between the categories. For example, in the countries in the top left panel, smokeless tobacco user prevalence was larger in rural than in urban areas, whereas the confidence intervals overlapped in the bottom panel. Household wealth was divided into five equal groups (ie, by quintiles)

economic and educational standards could drive an increase in the smoking prevalence among men but not among women because of persisting social norms and restrictions on women's smoking. Although the differences in smoking prevalence between men and women have been described previously,[39] an additional contribution of our analysis is the finding that smokeless tobacco use among women is similar to, or even greater than, that among men in some low and middle income countries. Therefore, particularly in these countries, tobacco control efforts are important to not exclusively focus on men.

Importantly, whereas manufactured cigarettes were more likely to be smoked by wealthier and more educated individuals, the opposite was true for hand rolled cigarettes and for the use of smokeless tobacco. Focusing on manufactured cigarettes or cigarettes in general, thus, overlooks the degree to which tobacco use in low and middle income countries impacts health among more socioeconomically disadvantaged groups and contributes to inequalities in health by socioeconomic status. The socioeconomic gradients observed in our study were generally less pronounced and showed larger within and between country

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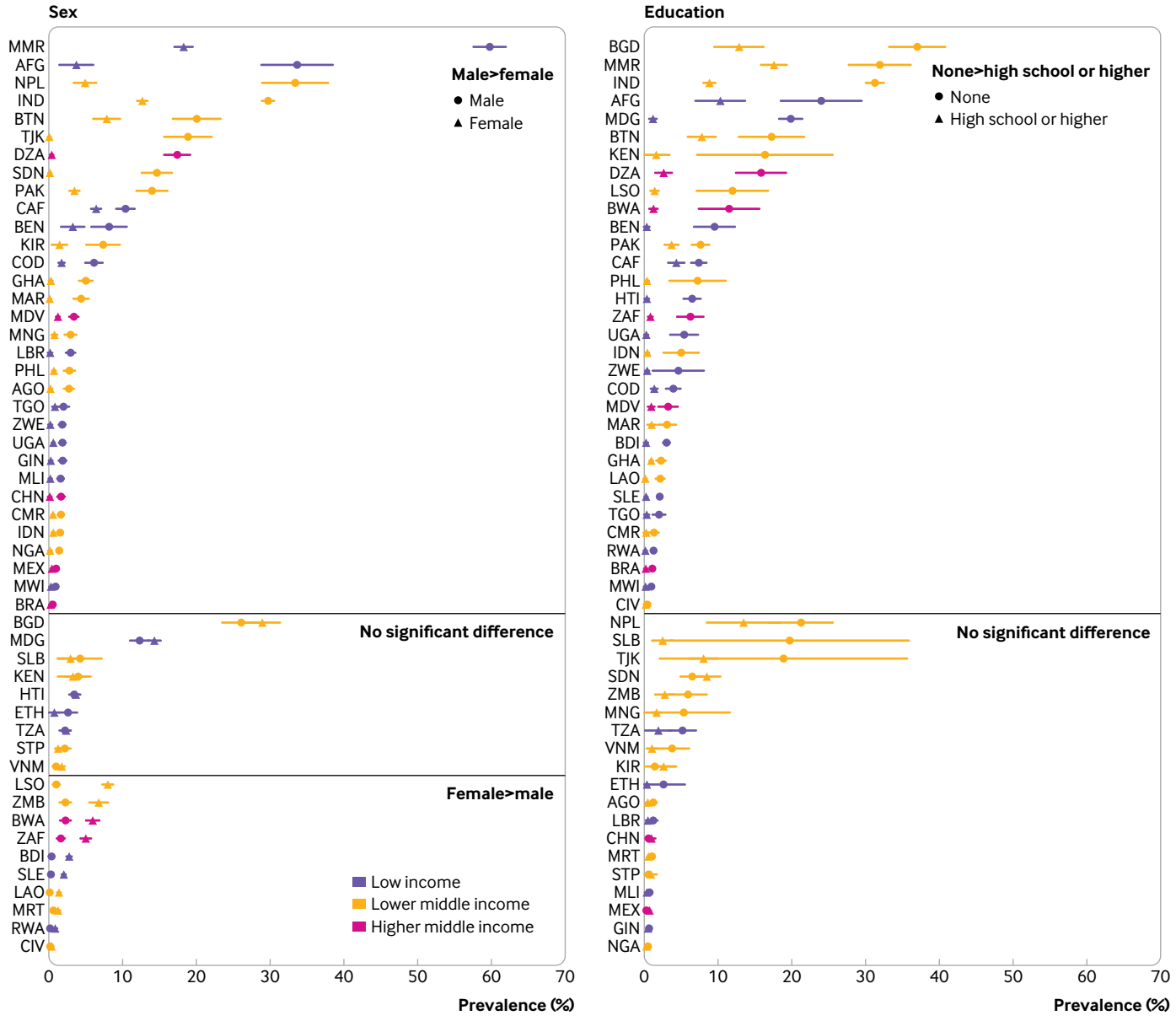


Fig 6 | Country level prevalence of smokeless tobacco use by sex and education. Estimates were obtained from logistic regression models adjusting for sex and age (education) or age only (sex). Horizontal bars represent 95% confidence intervals. Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. Country names are abbreviated using their ISO-3 code International Organization for Standardization-3 (table 1). Horizontal black lines group countries according to significant differences (top and bottom panels) and no significant difference (middle panel) between the categories. For example, in the countries in the top left panel, smokeless tobacco user prevalence was larger among men than women, whereas the reverse was true in the bottom left panel. In all countries, smokeless tobacco use was either larger among those without formal education (top right panel) or the confidence intervals overlapped (bottom right panel)

heterogeneity compared with studies from high-income countries.[40 41] However, our results show that people in most low and middle income countries tend to use more tobacco with decreasing formal education and decreasing wealth. This finding raises the question as to what explains these socioeconomic differences in tobacco use. Although evidence, albeit mostly limited to settings in high income countries, suggests that individual material (eg, financial problems), cultural (eg, norms regarding smoking), and psychosocial factors (eg, perceived social support, psychosocial working conditions) contribute to the socioeconomic gradient in tobacco use, these factors often do not fully account for the gradient.[42-44] Ecological models of health behaviour emphasise the environmental and policy contexts of behaviour, suggesting that the characteristics of the physical and social environment, such as the home, school, workplace, or neighbourhood, are also an important contributor to socioeconomic patterns of tobacco use.

Heterogeneity in socioeconomic gradients between countries might also be partially explained by country level factors such as implemented tobacco control policies.[45] However, whereas price increases and

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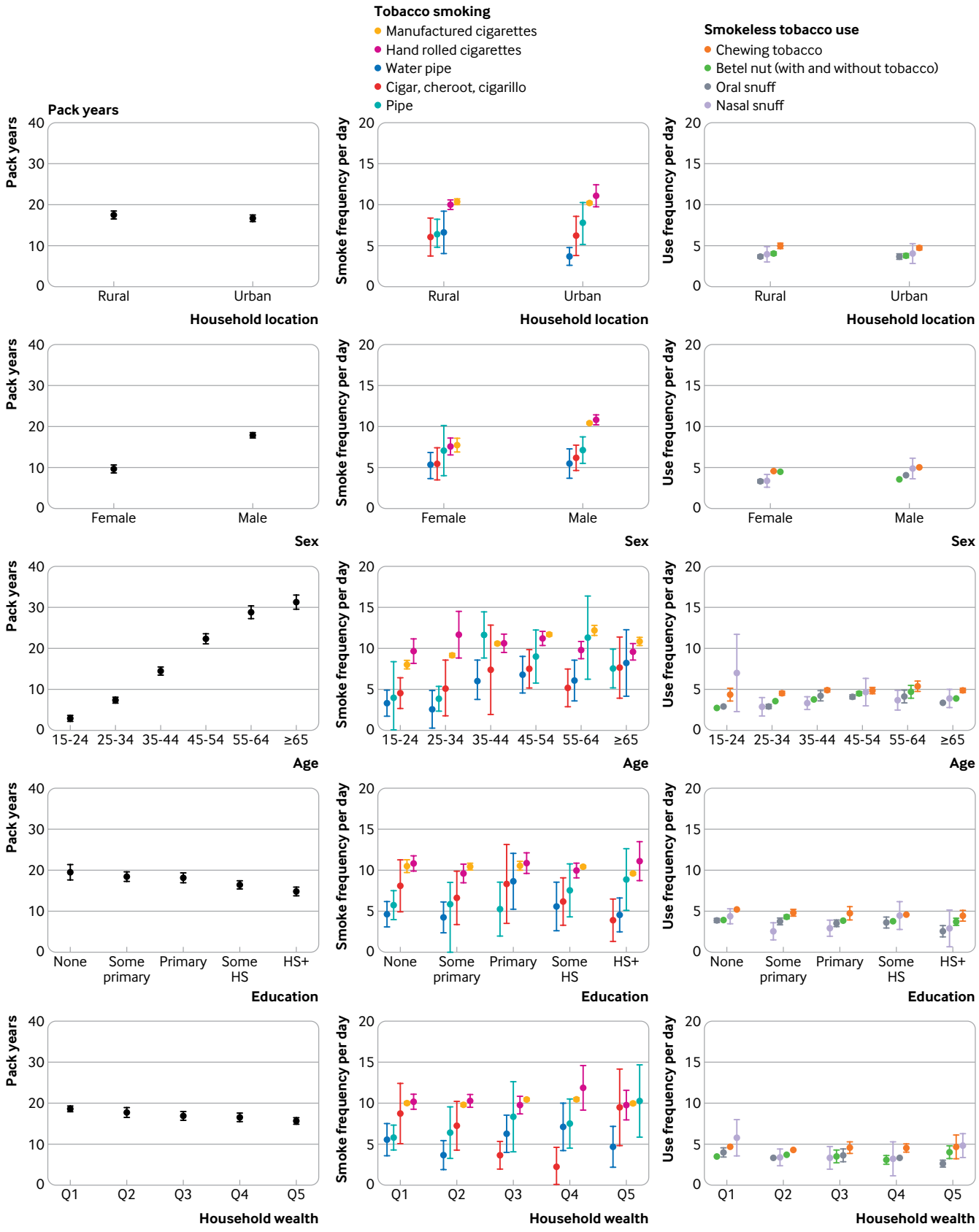


Fig 7 | Tobacco use frequencies among current smokers or users of the respective product. Pack years were estimated among current smokers who reported smoking cigarettes. Estimates were obtained from ordinary least squares regression models with country dummies and adjusting for sex and age (household residency, education, household wealth), sex (age), or age (sex). Vertical bars represent 95% confidence intervals. Regressions models were estimated using sampling weights and standard errors were adjusted for clustering at the primary sampling unit level. HS=high school. Q=household wealth group, divided by quintile (the least wealthy household wealth group is denoted as Q1 and the wealthiest as Q5)

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targeted cessation support have been found to reduce inequalities in smoking by socioeconomic status, equity impacts of other tobacco control interventions are less clear.[45] Thus, socioeconomic differences in tobacco use in low and middle income countries might not only warrant the stricter implementation of tobacco control measures to reach disadvantaged individuals, but also the integration of these measures into wider, community-based public health strategies. Finally, our results suggest that socioeconomic gradients are divergent by tobacco products. For example, because hand rolled cigarettes likely act as a substitute in settings where manufactured cigarettes are less affordable,[46] distinct consumption patterns for each tobacco product as displayed in our study should be considered by targeted tobacco control efforts.

Our results raise several additional research questions that could be investigated to further our understanding of tobacco use in low and middle income countries. The reasons for the observed sex differences in product specific tobacco use could be further investigated by linking quantitative and qualitative data. Additionally, research on dual and poly tobacco use (that is, the use of more than one tobacco product) could yield insights on how the use of different tobacco products interacts. Finally, for countries with more than one survey wave available, use patterns over time specific to products could be linked to country level indicators of economic development, which could elucidate whether, and to what degree, individuals switch tobacco products as a country develops economically.

Limitations

This study has several limitations. Tobacco use was self-reported. Thus, in countries where using tobacco is viewed as being socially undesirable, tobacco use prevalence and frequency are likely to be underestimated. Similarly, because tobacco use is often viewed as being more undesirable for women than for men,[47] sex differences in tobacco use might be overestimated. Additionally, our 82 study countries account for 90% of the global population living in low and middle income countries,[18] however, the countries included in this analysis are not a random sample of all low and middle income countries and might not be representative of countries for which we did not have data. Although all surveys were conducted between 2015 and 2020, they were not all conducted at the same time. Our results should, thus, be interpreted as applying to the country in the year of the survey. Furthermore, the surveys differed in the age range of participants who were sampled, which could introduce bias in the comparison of tobacco use prevalence and frequency between countries. We, therefore, show in the appendix all prevalence and frequency estimates when restricting the analysis to participants aged 18-49 years, which was the overlapping age range for all surveys. 28 surveys potentially censored the maximum daily use frequency of a tobacco product at 50, which could result in an underestimate of the true tobacco use frequency in these countries. Heterogeneity was present in how the information for the calculation of pack years was collected. In Multiple Indicator Cluster Surveys, participants were asked about the age at which the first whole cigarette was smoked, which might have led to overestimate pack years. In Global Adult Tobacco Surveys, current smokers were asked about the age at daily smoking initiation, which might have led to underestimate of pack years. Pack years cannot be accurately estimated unless detailed data for the number of cigarettes smoked at different points in time are available. Although this limitation could affect our point estimates for the number of pack years, the associations of pack years with sociodemographic characteristics within countries are unlikely to be influenced. Information about use of electronic cigarettes was not considered in most surveys. Fourteen surveys (mainly Global Adult Tobacco Surveys) included questions on current use of electronic cigarettes. Seventeen surveys (mainly Multiple Indicator Cluster Surveys) mentioned electronic cigarettes in the survey instrument and included this category under other tobacco products smoked or used. However, other tobacco products are not specified in the data and, therefore, this information could not be extracted.

Conclusion

This study provides a benchmark for the monitoring of tobacco use in low and middle income countries against which future progress can be compared. Within countries, we found that men, older age groups, and those with lower education, less household wealth, and residency in rural areas were more likely to use tobacco, particularly in the form of hand rolled cigarettes and smokeless tobacco. These groups, thus, constitute important target groups for reducing tobacco use. Given the large disease burden caused by tobacco in low and middle income countries,[1] efforts to curb tobacco use should be a major global health priority. The high use of, and expenditure for, tobacco among the most vulnerable population groups in low and middle income countries offers a unique opportunity for such efforts to lift individuals out of poverty, both through improved health status and reduced expenditures on tobacco.

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Contributors: SV and PG share last authorship as senior authors. MT, VW, JM-G, SV, and PG conceived the idea of the study. MT, VW, JM-G, CB, MMat, SV, and PG developed the methodology of the study. MT conducted the formal analysis and JML conducted the validation. MT, JM-G, M-EM, WAL, CE, GA-B, SKB, PB, FF, EG, MTM, SSM, KJM, SN, LS, SV, and PG curated the data. MT wrote the original draft and all other authors critically revised the manuscript and approved its final version. MT, JM-G, M-EM, RA, JID, TB, SV, and PG are the project administrators, and MT, SV, and PG are the guarantors of the work. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Ethical approval: The HPACC dataset was designated as Non-Human Subjects Research by the Harvard T H Chan School of Public Health in 2018 under protocol #IRB16-1915.

Data sharing: All data cleaning and analysis code will be made publicly available on the Harvard Dataverse repository on publication of the paper. A description of each included survey's sampling design is provided in the supplementary text S1 and response rates and sampled age ranges in supplementary table S2. Supplementary table S3 displays low and middle income countries for which no eligible survey data were available. De-identified data from the Global Adult Tobacco Surveys are publicly available on the Centers for Disease Control and Prevention's Global Tobacco Surveillance System (https://nccd.cdc.gov/GTSSDataSurveyResources/Ancillary/Documentation.aspx?SUID=4&DOCT=1). Data from all WHO-STEPwise Approach to Surveillance surveys but Iran are available on the WHO NCD Micro Data Repository (https://extranet.who.int/ncdsmicrodata/index.php/catalog). All Demographic and Health Survey data are publicly available at https://dhsprogram.com/data/ and all Multiple Indicator Cluster Surveys data at https://mics.unicef.org/. Data from the Bolivian Encuesta de Hogares are available at http://anda.ine.gob.bo/index.php/catalog/84, from the Brazilian Pesquisa Nacional de Saúde at https://www.ibge.gov.br/en/statistics/social/health/16840-national-survey-of-health.html?=&t=downloads. from the Mexican Encuesta Nacional de Consumo de Drogas, Alcohol y Tabaco at https://datos.gob.mx/busca/dataset/base-de-datos-encodat-2016-2017. Data from the Iranian WHO-STEPwise Approach to Surveillance have been shared upon request by the national data owner and are not publicly accessible. Data are, however, available from the authors on reasonable request and with permission of the data owners.

The manuscript's guarantors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported and that no important aspects of the study have been omitted.

Dissemination to participants and related patient and public communities: We are planning to issue press releases by several of the authors' institutions and to disseminate the results through social media.

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Web appendix 1: Supplementary tables and text
Web appendix 2: Supplementary figures

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