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Prevalence of smoking and smokeless tobacco use during breastfeeding: A cross-sectional secondary data analysis based on 0.32 million sample women in 78 low-income and middle-income countries

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Summary

Background Smoking and smokeless tobacco use during the postpartum period is well studied in high-income countries, whereas low-income and middle-income countries (LMICs) lack evidence.

Methods In this cross-sectional study we used data from the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) conducted in 78 LMICs between January 2010 and December 2019 to study tobacco use among 0.32 million sample lactating women. Age-standardized prevalence of smoking and smokeless tobacco use was estimated and presented with a 95% Confidence Interval (CI) for 78 LMICs. Pooled estimates overall and by WHO regions were obtained using random-effects meta-analyses. Country-level and community-level variance to understand contextual factors was also quantified using multilevel modelling.

Findings Pooled prevalence of any tobacco use among breastfeeding women in LMICs was 3.61% (95% CI 3.53–3.70); with the lowest prevalence in regions of the Americas (1.44%, 1.26–1.63) and the highest in the Southeast Asia region (6.13%, 6.0–6.27). The pooled prevalence of tobacco smoking was reported to be 1.16% (1.11–1.21), with the highest prevalence in the Eastern Mediterranean region (4.27%, 3.88–4.67) and the lowest in the African region (0.81%, 0.76–0.86). The pooled prevalence of smokeless tobacco use was reported to be 2.56% (2.49–2.63), with the highest prevalence in the Southeast Asia region (4.92%, 4.80–5.04). Illiterate and poor women in LMICs bore the enormous burden of tobacco use.

Interpretation The prevalence of smoking and smokeless tobacco use among lactating women in LMICs varied considerably across different WHO regions. Considering the cross-sectional design of the study, caution is required while interpreting the results. To improve mothers' and children's health and nutrition outcomes and reduce health inequalities in LMICs, reducing tobacco use through evidence-based interventions is critical.

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Research in context

Evidence before this study

In order to identify articles aiming to report estimates on the prevalence and determinants of tobacco use among breastfeeding women from low-income and middle-income countries (LMICs), we conducted a systematic review. We searched PubMed for articles published between January 1, 2000, and May 15, 2022, with no language restrictions. Our search words included the terms “smoking” or “cigarette” or “*bidi*” or “*beedi*” or “pipe” or “*hookah*” or “cigar” or “smokeless” or “tobacco” or “*khaini*” or “*gutkha*” or “*mawa*” or “*naswar*” or “snus” or “snuff” or “*gul*” AND “breastfeeding women” or “lactating women” or “postpartum women”. Three original articles based on LMICs were identified that investigated tobacco use among women during the lactation period based on national-level data from India, Ethiopia, and Jordan. While these studies provide the prevalence of tobacco use among mothers, they neither examined smoking and smokeless tobacco use separately nor explored socioeconomic determinants of tobacco use among lactating women.

Added value of this study

This study is the first to report on the prevalence of tobacco smoking and smokeless tobacco use among approximately 0.32 million sample breastfeeding women from 78 countries, representing nearly half of the LMICs. During 2010–2020, about one in every 28 breastfeeding women consumed tobacco, with considerable variations across regions and countries. The prevalence of smokeless tobacco use was double that of smoking in Southeast Asia, Africa and Eastern Mediterranean regions. Poor and illiterate women share the profound burden of tobacco use during the lactation period in LMICs. Unexplained community-level variations in tobacco use suggest that socio-contextual factors play a pivotal role in determining tobacco use among breastfeeding women.

Implications of all the available evidence

Postpartum relapse is an emerging public health issue globally as women may initiate tobacco use post-delivery. Possible interaction of postpartum women with health personnel while accessing postnatal care services may serve as an opportunity to integrate tobacco prevention and cessation programmes into reproductive, maternal, newborn and child healthcare services in LMICs. The WHO Framework Convention on Tobacco Control (FCTC) recommends preventing and managing tobacco use and exposure to second-hand smoke during pregnancy, and calls for monitoring tobacco use among different sections of society. This study advocates continuous monitoring of different forms of tobacco use during breastfeeding and community-centric health promotion and tobacco control initiatives.

Introduction

Globally, tobacco is a leading avertible risk factor for non-communicable diseases. In 2017, tobacco use was attributable to 8.1 million deaths and 213 million disability-adjusted-life-years (DALYs) worldwide.¹ Tobacco use during lactation has severe adverse impacts such as changes in the breast milk composition, affecting regular sucking activity of infants and reducing protective properties of breast milk against various infections.² Although low-income and middle-income countries (LMICs) contribute to over 80% of global tobacco users, population-based data for the prevalence of tobacco use among breastfeeding women in these countries is inadequate.

Based on the data from 54 LMICs, Caleyachetty et al. (2014) reported the overall prevalence of tobacco use during pregnancy among pregnant women aged 15–49 as 2.6% (95% CI 1.8–3.6) for the period 2001–2012; with an equal proportion of women consuming both smoked and smokeless forms of tobacco (1.3%; 95% CI 0.9–1.8).³ In a recent study using Demographic and Health Survey (DHS) data for the period 2010–2018, the prevalence of tobacco use was estimated to be lower among pregnant women (2.1%) than non-pregnant women (3.3%); however, the prevalence of daily second-hand smoking (SHS) exposure at home (24.4% vs 22.8%) and household solid fuel use (69.1% vs 65.3%) was higher among pregnant women than non-pregnant women.⁴ This study did not explicitly examine tobacco use among lactating women and the extent of smokeless tobacco use among women. In another study using DHS data for 42 LMICs for 2010–2016, the prevalence of smoking and smokeless tobacco use among non-pregnant women was estimated at 1.1% (95% CI 0.8–1.4) and 0.8% (0.4–1.4), respectively.⁵ Studies report that many women quit tobacco during pregnancy, but a large proportion resume during the postpartum period, often to the level of their preconception tobacco use,⁶ however stoppage of tobacco use during pregnancy in LMICs is not universal.

The adverse impact of tobacco use on women and foetus has been well established and disseminated worldwide, resulting in increasing quitting tobacco use during pregnancy. According to the American College of Obstetricians and Gynecologists (ACOG), approximately 54% of women who smoke before pregnancy quit smoking directly before or during pregnancy.⁷ However, the impact of tobacco use in the postpartum period has not been well disseminated.² Tobacco use by lactating women during the postpartum period poses a higher risk of colic, allergies and respiratory disorders in the child.⁸ Tobacco products contain carcinogens, including nicotine-derived nitrosamines (like NNN and NNK), which have been found in breast milk leading to early-age leukaemia.⁹ Besides, maternal tobacco smoking alters infant sleep,¹⁰ affects cardiac rhythm and is

linked with higher sudden infant death syndrome causing mortality.¹¹ The consumption of different forms of smokeless tobacco (e.g., chewing tobacco or snus) during breastfeeding has been associated with higher levels and prolonged presence of nicotine in breast milk,¹² leading to an adverse nicotinic effect on infants (i.e., deficiency of iodine and thyroid stimulating hormone, damage to the liver and lung, higher levels of superoxide dismutase, minor catalase and malondialdehyde, decrease in glucose tolerance; high body weight after weaning; hyperleptinemia; and, a lower amount of type-1 deiodinase in the liver).¹³ Studies also suggest that smokers are less intended to breastfeed compared to non-smokers.¹⁴

In order to plan effective health promotion and to provide tobacco cessation support to women who consume tobacco during lactation, identification of the current tobacco burden and socioeconomic inequalities is essential. In this study, we aimed to estimate the prevalence of current tobacco smoking and smokeless tobacco use among breastfeeding women across 78 LMICs using nationally representative household surveys and examine their socioeconomic determinants.

Methods

Data source

We analysed the most recent Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) carried out in 50 and 28 low-and-middle-income countries, respectively, between January 2010 and December 2019, for which data is available in the public domain. DHS and MICS are nationally representative cross-sectional household surveys, primarily conducted in low-and-middle-income countries. They have earned a global reputation for collecting and disseminating robust data on various indicators related to the health and welfare of reproductive-age women and their children (supplementary p 1). Both surveys follow the standard and comparable procedures across the countries. A detailed description of DHS and MICS sampling, questionnaires, data collection methods and validation procedures are published elsewhere.¹⁵ Over the years, both DHS and MICS surveys have played a significant role in shaping national and global policies and intervention strategies to advocate for programmes to improve women's and children's health.¹⁵ This study is adhered with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.

The DHS and MICS were approved centrally by ICF International institutional and UNICEF review boards, respectively, and by nodal agency review boards in every participating country. Both DHS and MICS obtained informed consent from all eligible lactating women aged 15-49 years before the survey in their local language.

Outcomes

Both surveys collected information on the breastfeeding status of children born in the last five years preceding the survey. The women (mothers of these children) respondents reported the breastfeeding status of their children at the time of the survey in response to the question, "Are you currently breastfeeding [Name of the child]?" in DHS and "Is the [Name of the child] still breastfeeding?" in MICS, with the 'yes' and 'no' response options. To ascertain current tobacco use, questions are included in both surveys. Participants were asked whether they currently smoke cigarettes, pipes, or other country-specific tobacco smoking products with the response option 'yes' or 'no'. Similarly, they were asked whether they were current users of smokeless tobacco, which includes snuff, chewing tobacco or other country-specific products. We classified currently breastfeeding women as 'current tobacco smoker' if their response was 'yes' to cigarettes, pipes, and any other country-specific smoking products. Breastfeeding women were categorized as 'smokeless tobacco users' if the response was 'yes' to the use of chewing tobacco, snuff, or other country-specific smokeless tobacco products. We further classified breastfeeding women who smoked any form of tobacco or consumed any form of smokeless tobacco as 'any tobacco user'. The survey contains no information related to age at initiation, past tobacco use, age at cessation or intention to quit tobacco.

Socioeconomic and demographic covariates

We considered selected demographic and socioeconomic characteristics as socioeconomic determinants. Women's age was determined based on reporting year of birth of the last child and the current age of women and grouped as follows: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49. The marital status of women was categorised as: single, married and widowed/divorced/separated. The sex of the child (male or female) was considered based on the mother's reporting. Place of delivery of last birth was assessed based on the mother's response to the question asked, "where did you give birth to [name of the child]?". Responses were organised under two categories: institutional (government/private hospital, health centre, health post/clinic) and non-institutional (home, relatives or other places). The mother's completed education level (no education, primary, secondary and higher) was assessed based on their self-reported responses. A composite measure of household wealth was constructed based on the availability of household assets (e.g., mobile, car, television, radio) and characteristics (e.g. type of cooking fuel, source of drinking water, type of flooring and toilet facility) using factor analysis. Household wealth was grouped into five quintiles: poorest, poor, middle, rich and richest (supplementary p 2).

Statistical analysis

We estimated the age-standardized prevalence of current tobacco smoking, smokeless tobacco use, and any tobacco use among currently breastfeeding women for 78 LMICs using the individual recode files. We used the survey analysis procedure to account for cluster sampling design and sampling weights while deriving these prevalence estimates and corresponding 95% Confidence Intervals (CIs). We calculated pooled estimates based on the World Health Organization's (WHO) regional classifications of countries. I^2 statistics were used to estimate the proportion of the variance in tobacco use estimates due to heterogeneity at the regional level.¹⁶ I^2 values of 25% or less connoted low heterogeneity, values around 50% corresponded to moderate heterogeneity and value around 75% or above indicated high heterogeneity.¹⁶

Socioeconomic determinants of tobacco smoking, smokeless tobacco use, and any tobacco use were examined using three-level random intercept binary regression models with the individual at level 1, nested within a community (PSU) at level 2, and country at level 3. We calculated variance partition coefficients (VPC) of tobacco use attributable to each level (supplementary p 3). We used the penalized quasi-likelihood (PQL) approximation procedure, which is considered the least biased in the case of binary response data. DHS and MICS adopt a hierarchical structure in their sample design. The multilevel method recognises the existence of such data hierarchies by allowing for residual components at each level in the hierarchy. We did not find any missing data for the outcomes under study. We performed all analyses using Meta-XL version 5.3 and Stata 14.¹⁷

Role of the funding source

There was no funding source for this study.

Results

We included 78 LMICs in our analysis with the recent data available for the year between 2010 and 2020. Table 1 presents the country-level characteristics of study participants. The individual response rate ranged from 70.6% in Peru to 100% in Burundi among 326,902 sample currently breastfeeding women across 66,707 Primary Sampling Units (PSUs) in 78 LMICs (Figure 1). The mean age of currently breastfeeding women ranged from 25.5 in Afghanistan to 32.3 years in Tunisia. The proportion of breastfeeding women with no formal education ranged from 0.0% (Armenia and Kyrgyzstan) to 85.7% (Niger); 32 countries had more than 25% of women without formal education. The proportion of breastfeeding women with institutional delivery ranged from the lowest at 26.7% in Chad to 100% in Barbados, Belarus and Bosnia. In 54 countries, over

half of the women were residing in rural areas (Supplementary Table S1).

The prevalence of tobacco smoking among breastfeeding women from LMICs was reported to be 1.16% (1.11–1.21) (Table 2). The pooled regional prevalence of tobacco smoking ranged from 4.27% (3.80–4.67; I^2 -squared=94.5%) in the Eastern Mediterranean region, followed by 3.72% (3.28–4.16; I^2 -squared=98.2%) in the Western Pacific region, to 0.81% (0.76–0.86; I^2 -squared=95.7%) in the African region. This prevalence varied considerably across countries from 0.04% in Togo and Ghana to over 20% in Montenegro (Figure 2 & Supplementary Table S1). In 24 countries, the prevalence of smoking among breastfeeding women was over 5%. The percentage of countries with prevalence above the global pooled estimate for tobacco smoking among breastfeeding women across WHO regions were 100% (6 of 6) in the Western Pacific region, followed by 83% in the Americas (10 of 12) and Southeast Asia (5 of 6), 80% (3 of 5) in Eastern Mediterranean region, 75% (9 of 12) in Europe and 21% (8 of 37) in Africa.

Fifty-two countries collected data on smokeless tobacco use among breastfeeding women. Nearly 2.56% (2.49–2.63) of breastfeeding women from LMICs consumed some form of smokeless tobacco (Table 2). The pooled regional prevalence of current smokeless tobacco use among breastfeeding women was the lowest in the region of the Americas (0.33% [95% CI 0.24–0.42; I^2 -squared=94.6%]) and the highest in the Southeast Asia region (4.92% [95% CI 4.80–5.04; I^2 -squared=99.8%]). We observed considerable variations in the prevalence of smokeless tobacco use among breastfeeding women ranging from 0.01% (95% CI 0.00–0.07) in Honduras to 16.57% (15.37–17.84) in Madagascar and 19.09% (16.37–22.13) in Kiribati (Figure 2 & Supplementary Table S1). In 4 countries, smokeless tobacco use among breastfeeding women was over 5% – Kiribati, Madagascar, Lesotho, and India. The proportion of countries higher than the global average pooled estimates for smokeless tobacco consumption among breastfeeding women was 33% in Southeast Asia Region (2 of 6) and Western Pacific region (2 of 6), followed by 20% in the Eastern Mediterranean Region (1 of 5) and 19% in African Region (7 of 37).

Nearly 3.61% (3.53–3.70) of breastfeeding women from LMICs used any form of tobacco, i.e., either smoking or smokeless tobacco (Table 2). The pooled regional prevalence of any tobacco use among breastfeeding women ranged from the highest in the Southeast Asia region (6.13% [95% CI 6.00–6.27; I^2 -squared=99.6%]), followed by the Eastern Mediterranean Region (5.63% [95% CI 5.18–6.08; I^2 -squared=93.9%]), Western Pacific Region (4.53% [95% CI 4.05–5.01; I^2 -squared=99.3%]), to the lowest in Region of America (1.44% [95% CI 1.26–1.63; I^2 -squared=90.12%]). The prevalence of any form of tobacco use among breastfeeding women varied from 0.12% (0.02–0.82) in Kyrgyzstan to 39.34% (36.86

WHO regions	Survey	Year	Response Rate	Urban dwellers (%)	Lowest wealth quintile (%)	No Education (%)	Institutional delivery of last birth (%)	Mean age	n
African Region (37 countries)									
Angola	DHS	2015–16	98	59.1	22.8	28.1	46.4	26.9	4,615
Benin	DHS	2017–18	98.1	36.6	22	64.8	83.8	26.9	4,638
Burundi	DHS	2016–17	100	7.7	23.5	46	82.3	27	5,721
Cameroon	DHS	2011	97.3	53.9	16.1	20	31.9	27.1	15,426
Comoros	DHS	2012	93.2	26.9	24	45.8	79.6	27.2	1,003
CDR	DHS	2013–14	98.6	28.3	23.6	19.7	73.7	27.3	6,925
Congo	DHS	2011–12	98	56.2	25.9	8.1	90.7	27.4	2,839
Cote D'Ivoire	DHS	2011–12	92.7	34.9	27.3	65.8	55.9	27.4	2,597
Ethiopia	DHS	2016	94.6	11.1	22.8	62.7	33.1	27.5	4,252
Gabon	DHS	2012	98.2	80.6	25.8	7.3	64.3	27.5	1,438
Gambia	DHS	2013	90.7	45.1	20.9	58.9	62.4	27.5	3,146
Ghana	DHS	2014	97.3	42.2	26.1	29.4	70.8	27.6	2,161
Guinea	DHS	2018	99	26.6	24	76.3	53.6	27.6	2,725
Kenya	DHS	2014	96.6	33.8	25.4	12.3	64.5	27.8	3,519
Lesotho	DHS	2014	97.1	18.5	28.4	1	64.4	27.8	1,008
Liberia	DHS	2013	97.6	47.9	26.1	39.8	60.4	27.8	2,633
Malawi	DHS	2015–16	97.7	12.7	26.6	12.9	93	27.9	6,189
Mali	DHS	2018	97.6	20.4	20.6	71.5	69.4	28	3,481
Namibia	DHS	2013	92.3	39.5	25.5	6.5	85.3	28	1,353
Niger	DHS	2012	95.4	12.8	20.5	85.8	33.5	28.1	4,293
Nigeria	DHS	2018	99.3	34.8	24.3	50.3	36.2	28.1	9,971
Rwanda	DHS	2014–15	99.5	15.1	24.9	14.4	91	28.2	3,836
Senegal	DHS	2017	95.5	34.9	25.8	61	79.6	28.3	4,095
Sierra Leone	DHS	2013	97.2	22.4	23.7	66.9	56.3	28.3	3,891
South Africa	DHS	2016	88.2	64.8	25	1.9	95.5	28.4	729
Tanzania	DHS	2015–16	97.3	26.1	25.7	19.7	59.1	28.4	3,581
Togo	DHS	2013–14	97.8	32.9	23.9	42.4	72.6	28.4	2,686
Uganda	DHS	2016	97	19	24.5	10.7	75.7	28.5	5,018
Zambia	DHS	2013–14	96.2	29.6	27.4	11.6	71	28.6	4,357
Zimbabwe	DHS	2015	96.2	25.9	25.6	1.4	74.2	28.8	1,725
CAR	MICS	2018	94.1	27.5	23.4	0.9	57	27.2	2,882
Chad	MICS	2019	99	14.4	20.2	0.8	26.7	27.8	6,717
Eswatini	MICS	2014	95.2	23.8	24.8	28.9	87.1	26.4	549
Guinea-Bissau	MICS	2018	97.8	24.1	22.7	0.6	48	28.2	2,506
Madagascar	MICS	2018	91.2	19.9	24.8	1.7	38.6	26.8	4,943
Mauritania	MICS	2015	94.1	43.2	22.2	2.1	67.3	29.3	3,393
STP	MICS	2019	84	65.8	26.8	3.6	94.8	27.8	481
Region of the Americas (12 countries)									
Haiti	DHS	2016–17	98.9	29.6	27.8	17.6	37.1	29.7	1,860
DR	DHS	2013	94.1	71.7	31.2	3.8	98.2	29.8	691
Honduras	DHS	2011–12	93.2	41.2	28.9	5.5	83.1	29.9	3,712
Peru	DHS	2012	70.6	64.4	24.9	3.3	86.2	29.9	3,338
Guatemala	DHS	2014–15	96.8	32.2	30.3	19	57.3	30.1	4,734
Barbados	MICS	2012	80.5	57.4	25.9	39.1	100	28.3	90
Belize	MICS	2015	92.2	36.7	27	14.1	97.9	27.1	674
Costa Rica	MICS	2018	91.3	72.6	29.5	25.6	96.8	28.1	967
Cuba	MICS	2019	99.8	64.1	23.9	18.6	99.6	27.7	865
El Salvador	MICS	2014	89.8	56.7	27.2	8	97.4	26.6	2,486
Guyana	MICS	2014	87.4	24	36.8	6.6	90.5	27.2	965

Table 1 (Continued)

WHO regions	Survey	Year	Response Rate	Urban dwellers (%)	Lowest wealth quintile (%)	No Education (%)	Institutional delivery of last birth (%)	Mean age	n
Paraguay	MICS	2016	93.1	55.7	28.5	21.2	92.4	27.6	1,114
South-East Asian Region (6 countries)									
India	DHS	2019–20	97	25.2	26.9	29.2	80.5	25.7	1,14,922
Indonesia	DHS	2017	97.8	44.8	23	1.2	55.9	26.5	5,897
Myanmar	DHS	2015–16	95.8	21.7	30.3	16.6	41.3	26.5	2,042
Maldives	DHS	2016–17	84	33.4	20.8	1	94.9	26.6	1,253
Nepal	DHS	2016	98.3	53.8	22.4	31.1	57.4	26.7	2,953
Timor L	DHS	2016	97	26.4	21.1	24.6	49.2	26.8	2,310
European Region (12 countries)									
Albania	DHS	2017–18	93	58.3	21.2	0.5	98.6	29.2	744
Armenia	DHS	2015–16	97.8	59.9	16.3	0	93.8	29.4	400
Kyrgyzstan	DHS	2012	99.1	29.2	18.6	0	99.5	29.4	1,428
Tajikistan	DHS	2017	99.2	19.5	19.5	2.1	88.9	29.5	1,803
Belarus	MICS	2012	97.2	73.1	13.7	51.2	100	28.7	452
BH	MICS	2011	96	23	18.4	11.8	100	28.5	237
Kazakhstan	MICS	2015	98.1	48.1	20.5	42.4	99.7	28.6	1,437
Kosovo	MICS	2013	81.4	36.6	26.4	16.6	99.9	29.2	407
Moldova	MICS	2012	89	33.1	18.4	27.1	99.7	27.5	387
Montenegro	MICS	2013	77.7	64.2	20.2	30.3	99.5	29.7	172
North Macedonia	MICS	2011	93.5	49.9	24.5	28.2	99.7	28.2	253
Ukraine	MICS	2012	97.2	67.5	16	41.8	99.4	27.6	786
Eastern Mediterranean Region (5 countries)									
Afghanistan	DHS	2015	96.8	27.8	19.7	77.3	52.3	25.5	3,188
Pakistan	DHS	2017–18	94	31	24.8	51.6	67.9	25.8	3,925
Jordan	DHS	2017–18	97.1	88.4	25.2	1.4	99.1	29.2	2,103
Iraq	MICS	2018	98.2	65.3	25	9.8	84.6	28.5	3,617
Tunisia	MICS	2018	95.8	61.4	22.2	26.9	99.7	32.3	658
Western Pacific Region (6 countries)									
Cambodia	DHS	2014	97.6	10.2	25.1	13.4	86.5	26.8	2,312
Philippines	DHS	2017	97.6	41.6	28.8	1.1	79.8	25.8	3,873
Kiribati	MICS	2018	98	52.3	23.6	3.9	85.6	29	820
Lao	MICS	2017	96.9	20.7	33.3	5.9	60.3	26.4	3,284
Mongolia	MICS	2018	92	65.9	20.6	51.3	98.4	29.7	2,135
Tonga	MICS	2019	92	19.7	29.6	15.1	97	30	286

Table 1: Characteristics of currently breastfeeding women covered across 78 Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) countries.
DHS = Demographic and Health Survey; MICS = Multiple Indicator Cluster Surveys; CDR = Congo Democratic Republic; CAR = Central African Republic; STP = São Tomé and Príncipe; DR = Dominican Republic; BH = Bosnia and Herzegovina

–42.92) in Kiribati. In 21 countries, over 5% of women consumed some form of tobacco during breastfeeding; it was over 10% in seven countries – Kiribati, Montenegro, Bosnia and Herzegovina, Tonga, Madagascar, North Macedonia and Kosovo (Figure 2 & Supplementary Table S1). The proportion of countries higher than the global average pooled estimates for any tobacco use among breastfeeding women was 100% (6 of 6) in the Western Pacific region, 60% (3 of 6) in the Eastern Mediterranean region, 58% (7 of 12) in Europe, 33% (2 of 6) in Southeast Asia, 25% (3 of 12) in Americas and 19% (7 of 37) in Africa.

The multilevel binomial logistic regression models showed that the likelihood of smoking and smokeless tobacco use among breastfeeding women increased with age (Supplementary Table S2-S4). Women living with a partner and widowed/ divorced/ separated (compared to never in the union) had higher odds of tobacco use; the extent of tobacco use was much greater in the case of smokeless tobacco. Women who delivered their last birth at health facilities were less likely to use both forms of tobacco compared to those women who had elsewhere. The lower level of education among breastfeeding women was associated with higher use of

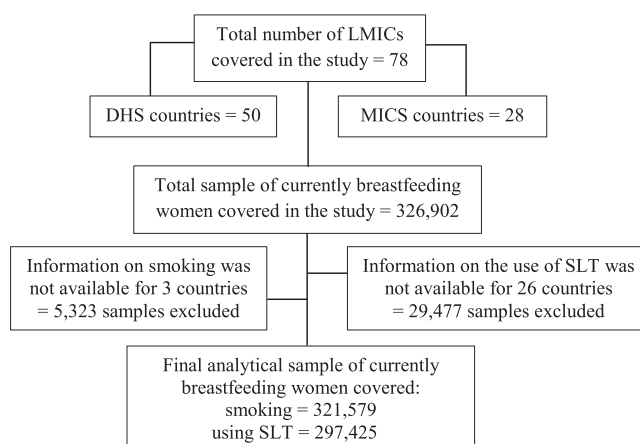


Figure 1. Flowchart of samples included in this study.

LMIC = Low-income and middle-income countries; DHS = Demographic and Health Survey; MICS = Multiple Indicator Cluster Survey; SLT = smokeless tobacco.

smoking and smokeless tobacco. Poor women had higher odds of using tobacco compared to women from rich households. Women residing in urban areas (compared to rural) had higher odds of smoking; no difference was found in the case of smokeless tobacco use, though.

The random effect parameters suggest that nearly 26.4% variance in smoking among breastfeeding women was attributed to between-individual differences, while the remaining attributed to between-population differences (19.9% between-country and 53.8% within country between-community). In the case of smokeless tobacco use among breastfeeding women, 12.0% variance was attributed to between-individual differences, whereas the rest was attributed to between-country (24.0%) and within-country between-community (64.0%) differences (Table 3).

Discussion

To the best of our knowledge, this is the first and most extensive multi-country study with 326,902 samples of lactating women to provide estimates on tobacco smoking and smokeless tobacco consumption using representative surveys from 78 LMICs. During 2010–2020, about one in every 28 breastfeeding women consumed tobacco, with considerable variations across regions and countries. It suggests that tobacco use among women during postpartum is higher than during pregnancy in LMICs.^{3,5} Much higher prevalence estimates of tobacco during pregnancy have been reported from population-based studies in high-income countries, including the USA (6.7%)¹⁸ and the UK (10.6%).¹⁹ The highest prevalence of tobacco use among breastfeeding women was in the Southeast Asia region, while the lowest was in the European region. Moreover, we found that the prevalence of smokeless tobacco use was double that of

smoking among breastfeeding women at the global level as well as in Southeast Asia. For instance, in the Southeast Asia region for every single woman smoker during the lactation period, five women consumed smokeless tobacco, while the opposite pattern was evident in Eastern Mediterranean and Western Pacific regions. Our findings are consistent with other studies which also reported a higher prevalence of tobacco use in women from the Southeast Asia region compared to women elsewhere.⁵

Relapse of tobacco use after delivery is reportedly a common phenomenon.²⁰ Approximately half of UK women who smoke attempt cessation after conception but up to 75% return to smoking within 12 months postpartum and interventions for preventing the postpartum return to smoking (PPRS) have not been found to be effective.²¹ Studies from high-income countries find that some women resume smoking postpartum to help them lose weight or to manage stress.²¹

We found that smokeless tobacco was the main form of tobacco use among breastfeeding women in 25 countries. Smokeless tobacco is often less expensive than cigarettes and a more culturally acceptable form of substance use among women in many LMICs due to its (mis)belief of being a safe alternative to smoking and often used in the form of medicine to treat common illnesses such as influenza, nausea, cold by women. Very limited studies on smokeless tobacco use among lactating women are available; with the majority of them being conducted in high-income countries primarily focusing on smoking and limited to a certain section of the population.^{22,23} This indicates the need to formulate policies and strategies to address these forms of tobacco use in prevention-based programmes in LMICs.

We also examined the demographic and socioeconomic factors that influence tobacco use among lactating women. Age, low education and belonging to a poor

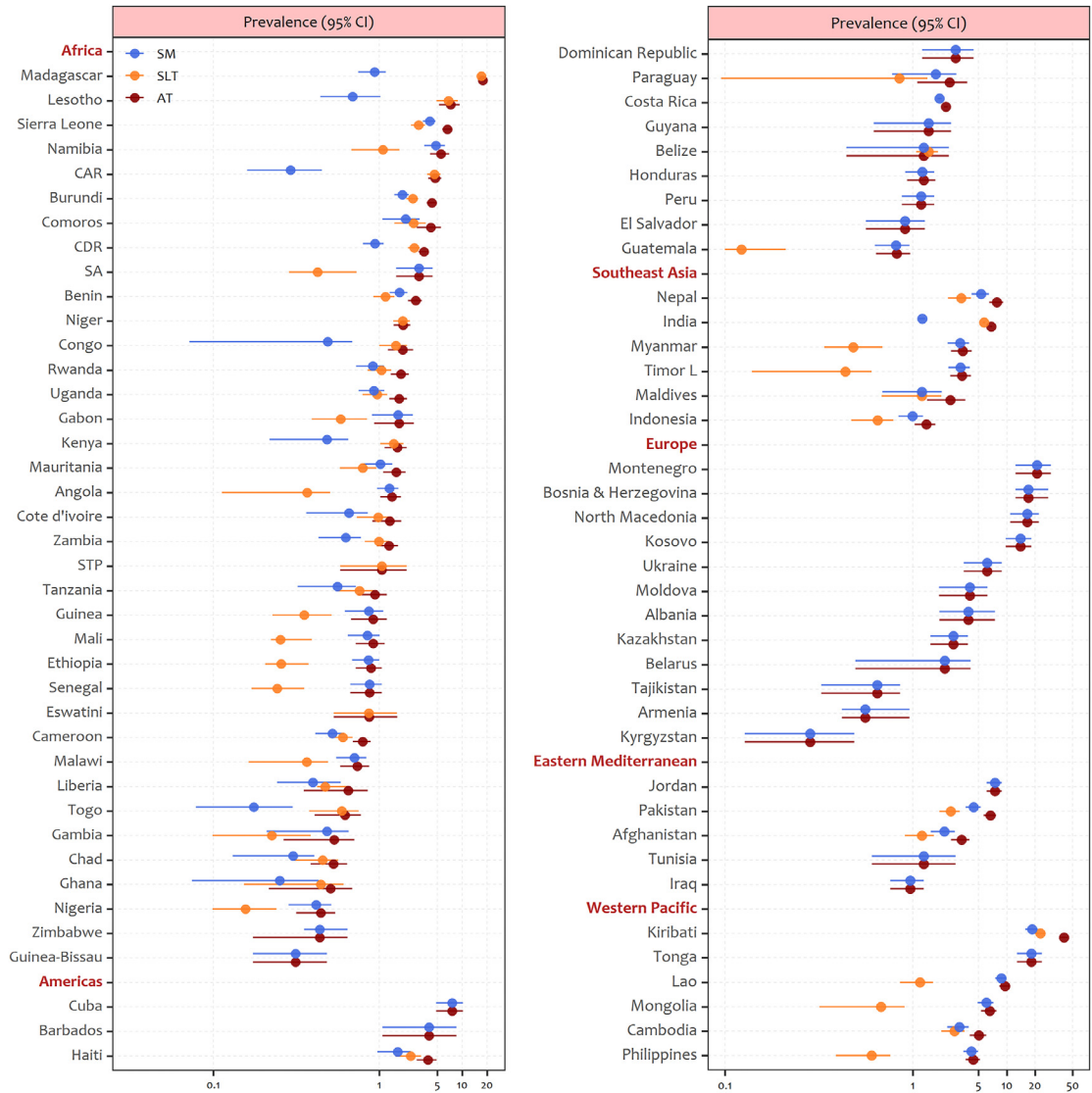


Figure 2. Prevalence (%) of tobacco use among breastfeeding women in 78 countries.

Circles are the prevalence estimates and the horizontal bars show 95% CIs. The prevalence of smoking is shown in blue colour, the prevalence of smokeless tobacco use is shown in orange colour and the prevalence of any form of tobacco is shown in brown colour.

SM = smoking; SLT = smokeless tobacco use; AT = any tobacco use; CAR = Central African Republic; CDR = Congo Democratic Republic; SA = South Africa; STP = São Tomé and Príncipe.

wealth quintile were found to be associated with increased tobacco use during breastfeeding. These findings are consistent with extant literature.^{3,5,24} However, while being in urban residence significantly increased the odds of smoking among breastfeeding women, we did not find any difference in smokeless tobacco; consistent with other studies.⁵ Further, we explored the country- and community-level variations in determining tobacco use among lactating women. Even after adjusting for individual-level factors, unexplained country and community-level variations suggest that socio-

contextual factors play a pivotal role in determining tobacco use among breastfeeding women. This is particularly significant at the community level wherein only a marginal decline in smoking and an increase in the case of smokeless tobacco at community-level variance was observed after accounting for individual-level factors. This implies that local contextual factors may be crucial in determining the variations in tobacco use among breastfeeding women between nations than the individual-level characteristics of their populations. Perhaps, it may include the local tobacco marketing and

WHO regions	Smoking	Smokeless tobacco	Any tobacco use
	Prevalence (95%CI)	Prevalence (95%CI)	Prevalence (95%CI)
African Region (AFR)	0.81 (0.76–0.86) $I^2 = 95.7 (94.70–96.44)$	0.92 (0.87–0.96) $I^2 = 98.93 (98.79–99.06)$	1.66 (1.60–1.73) $I^2 = 98.9 (98.74–99.01)$
Region of the Americas (AMR)	1.12 (0.95–1.29) $I^2 = 87.7 (80.33–92.28)$	0.33 (0.24–0.42) $I^2 = 94.60 (89.26–97.29)$	1.44 (1.26–1.63) $I^2 = 90.12 (84.68–93.63)$
South-East Asian Region (SEAR)	1.40 (1.33–1.47) $I^2 = 98.2 (97.38–98.78)$	4.92 (4.80–5.04) $I^2 = 99.8 (99.74–99.82)$	6.13 (6.00–6.27) $I^2 = 99.6 (99.43–99.65)$
European Region (EUR)	0.89 (0.65–1.13) $I^2 = 95.89 (94.24–97.06)$	na	0.98 (0.65–1.13) $I^2 = 95.89 (94.24–97.06)$
Eastern Mediterranean Region (EMR)	4.27 (3.88–4.67) $I^2 = 94.58 (89.99–97.00)$	1.52 (1.27–1.76) $I^2 = 80.7 (87.74–95.49)$	5.63 (5.18–6.08) $I^2 = 93.9 (88.69–96.73)$
Western Pacific Region (WPR)	3.72 (3.28–4.16) $I^2 = 98.20 (97.36–98.77)$	1.18 (0.94–1.43) $I^2 = 99.12 (98.77–99.37)$	4.53 (4.05–5.01) $I^2 = 99.33 (99.12–99.49)$
Overall	1.16 (1.11–1.21)	2.56 (2.49–2.63)	3.61 (3.53–3.70)

Table 2: Prevalence (%) of smoking, smokeless tobacco and any tobacco use in breastfeeding women by WHO regional classification.

I^2 = the percentage of variation across countries within a region that is due to heterogeneity in the prevalence; na = data not collected.

distribution strategies, sociocultural history of tobacco use, and availability of different kinds of branded and indigenous tobacco products. The finding underscores the need to understand the sources of heterogeneity across countries. Differences in implementation of the WHO Frameworks Convention on Tobacco Control (FCTC) Articles at the national and sub-national level, perhaps, also explains country- and community-level variance in tobacco use among women.²⁵

Our study has several limitations. First, information on tobacco use was self-reported and was not biochemically verified, hence it may be subject to recall bias. In addition, role of social desirability bias in tobacco use reporting could also influence the responses. This may be particularly important as disclosing use of tobacco may carry social taboos and cultural pressures, especially among women in many LMICs. Second, since the DHS and MICS do not collect information on the frequency of tobacco use, we cannot ascertain the level of addiction among the population. Third, since the data is cross-sectional in nature, due to lack of temporality we cannot assign causations and only possible associations can be inferred. However, given the descriptive objective of this study future longitudinal studies should examine the causal effects of socioeconomic exposures on tobacco use in lactating women. Fourth, we do not know any information related to the switching of tobacco products during pregnancy and lactation period by women. Fifth, due to the very limited sample size across many countries, we could not estimate dual tobacco use in this study. Sixth, the MICS does not collect any information related to second-hand smoking exposure to currently pregnant or lactating mothers, restricting the scope to study in this dimension. Seventh, the impact of the COVID-19 pandemic on tobacco use behaviour is beyond the scope of this study. Existing

studies have shown the mixed impact of the COVID-19 pandemic on tobacco use, but these studies are largely confined to smoking and mainly to a small section of the population.

Tobacco-related maternal and newborn health concerns are numerous,^{2,13} and possibly also include high body weight and related metabolic complications.¹² As maternal, newborn and child health outcomes have been remained poor in many LMICs despite improvements in the last few years,²⁶ use of tobacco during the lactation period in these settings could significantly worsen outcomes, and therefore could sluggish the progress to achieve the Sustainable Development Goal 3 (Ensuring Healthy Lives and Promote Well-being for all at all ages). The American College of Obstetricians and Gynecologists recognizes pregnancy and lactation as two ideal times to promote tobacco cessation and recommends getting the greatest benefit with cessation before 15 weeks of gestation.²⁷ The WHO FCTC recommends prevention and management of tobacco use and exposure to second-hand smoke during pregnancy and calls for the implementation of different articles of the WHO FCTC including monitoring of tobacco use among adults, youth and different sections of the society; offering assistance to quit; warning users of the health effects of tobacco; enforcing advertising bans; and raising taxes on tobacco products.²⁸ Although, many LMICs have ratified the FCTC, the implementation of all provisions remains a great challenge for many LMICs.²⁸ For instance, in many African and Eastern Mediterranean countries, despite the increasing prevalence of smokeless tobacco interventions and regulatory policies such as pictorial health warnings are not well structured. Moreover, in many LMICs either tobacco products have become more affordable or no attempts have been made to raise the taxes.²⁸ In 2013, WHO released

	Smoking						Smokeless tobacco					
	Null Model			Full Model			Null Model			Full Model		
	Estimates	(95% CI)	SE	Estimates	(95% CI)	SE	Estimates	(95% CI)	SE	Estimates	(95% CI)	SE
Random-effects parameters												
Country level variance	1.434	(1.01, 2.04)	0.260	1.413	(0.99, 2.02)	0.258	0.736	(0.47, 1.15)	0.168	2.194	(1.37, 3.52)	0.530
PSU variance	2.39	(2.22, 2.57)	0.090	2.415	(2.23, 2.61)	0.097	3.407	(3.23, 3.59)	0.091	3.652	(3.46, 3.85)	0.098
Variance partition coefficient												
Countries	0.202	(0.15, 0.27)	0.030	0.199	(0.15, 0.26)	0.030	0.099	(0.07, 0.15)	0.021	0.24	(0.16, 0.34)	0.045
PSU	0.538	(0.50, 0.57)	0.017	0.538	(0.50, 0.57)	0.017	0.557	(0.54, 0.58)	0.010	0.64	(0.60, 0.68)	0.021
VPC (at countries level) in%	20.16%			19.86%			9.90%			24.02%		
VPC (at PSU level) in%	53.75%			53.78%			55.74%			63.99%		
Model parameters												
AIC	46379.37			43659.59			83808.63			78831.3		
BIC	46411.41			43883.34			83840.44			79055.1		
Df	3			21			3			21		
Number of breastfeeding women	3,16,256			3,16,256			2,92,102			2,92,102		
Number of countries	75			75			52			52		
Number of communities (PSU)	65,855			65,855			56,161			56,161		

Table 3: Multilevel regression for socioeconomic and demographic determinants of smoking among breastfeeding women.

SE = standard error; CI = Confidence Interval; PSU = Primary Sampling Unit; VPC = variance partition coefficient; AIC = Akaike information criterion; BIC = Bayesian information criterion; df = degree of freedom. *Full models are adjusted for age, marital status, education, sex of the child, place of delivery of the last child, household wealth index and urban-rural residence.

guidelines for prevention and management of tobacco use from the first antenatal care contact up to six weeks postpartum with a focus on assessment of tobacco use and providing psychosocial and pharmacological intervention for tobacco cessation.²⁹ Tobacco cessation during pregnancy remains a challenge not only in developing countries but in high-income countries like the United States with limited access to counselling services.³⁰ While the overall quality of evidence of tobacco cessation in LMICs is weak, few studies have shown that medication may be effective in tobacco cessation besides educating pregnant women about the adverse health impact of smoking in improving the cessation rates.³¹ However, it can be very challenging to translate tobacco control into routine care considering various limitations being faced by healthcare systems in LMICs. Moreover, no intervention on smokeless tobacco has been tested among pregnant or lactating women in LMICs; hence the importance of our study lies in presenting the magnitude of smokeless tobacco use in countries and the lack of evidence on tobacco cessation.

Tobacco use during the postpartum period in LMICs was low as compared with the USA and the UK. However, with the expansion of the tobacco industry's marketing strategies to influence women of LMICs and the promotion of newer tobacco products such as smokeless tobacco, full implementation of WHO FCTC Articles are crucial. Also, urgent attention is needed to prevent and manage tobacco use and second-hand smoke exposure during postpartum with the combination of appropriate tobacco cessation strategies and community-led tobacco control initiatives to improve the health and wellbeing of women and children in LMICs.

Contributors

PKS contributed to the conceptualisation, study design, analysis, interpretation, writing of the manuscript, and revisions. LS, FCW and NS contributed to the study design, analysis, data extraction and survey data preparation. CK and AS contributed to the study design, analysis, interpretation, and revisions of the manuscript. CK contributed to data assembly and preparation. DNS, ZAB and SS contributed to conceptualisation, interpretation and revisions. PKS, FCW and NS had access to, and verified, the data. All authors read and approved the final version and had final responsibility for the decision to submit for publication.

Data sharing statement

This study used publicly available datasets for all 78 LMICs. The DHS datasets can be availed from the DHS website (<https://dhsprogram.com/data/>) and the MICS datasets are available on the UNICEF website (mics.unicef.org/surveys) at the request of the registered users.

users.

Declaration of interests

We declare no competing interests.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.eclinm.2022.101660](https://doi.org/10.1016/j.eclinm.2022.101660).

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