

# Tobacco use in pregnant women: analysis of data from Demographic and Health Surveys from 54 low-income and middle-income countries

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## Summary

**Background** Worldwide, use of tobacco is viewed as an important threat to the health of pregnant women and their children. However, the extent of tobacco use in pregnant women in low-income and middle-income countries (LMICs) remains unclear. We assessed the magnitude of tobacco use in pregnant women in LMICs.

**Methods** We used data from Demographic and Health Surveys (DHS) done in 54 LMICs between Jan 1, 2001, and Dec 1, 2012, comprising 58 922 pregnant women (aged 15–49 years), which were grouped by WHO region. Prevalence of current tobacco use (smoked and smokeless) was estimated for every country. Pooled estimates by regions and overall were obtained from random-effects meta-analysis.

**Findings** Pooled prevalence of any tobacco use in pregnant women in LMICs was 2·6% (95% CI 1·8–3·6); the lowest prevalence was in the African region (2·0%, 1·2–2·9) and the highest was in the Southeast Asian region (5·1%, 1·3–10·9). The pooled prevalence of current tobacco smoking in pregnant women ranged from 0·6% (0·3–0·8) in the African region to 3·5% (1·5–12·1) in the Western Pacific region. The pooled prevalence of current smokeless tobacco use in pregnant women was lowest in the European region (0·1%, 0·0–0·3) and highest in the Southeast Asian region (2·6%, 0·0–7·6).

**Interpretation** Overall, tobacco use in pregnant women in LMICs was low; however high prevalence estimates were noted in some LMICs. Prevention and management of tobacco use and exposure to second-hand smoke in pregnancy is crucial to protect maternal and child health in LMICs.

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## Introduction

Tobacco is a leading global disease risk factor.<sup>1</sup> Although more than 80% of the world's smokers live in low-income and middle-income countries (LMICs),<sup>2</sup> population-based data for prevalence of tobacco use in pregnant women in these countries is insufficient. The 2008–10 Global Adult Tobacco Survey of 14 LMICs showed that in women of reproductive age, prevalence of current tobacco smoking ranged from 0·4% in Egypt to 30·8% in Russia, and current smokeless tobacco use was less than 1% in most countries, but was common in Bangladesh (20%) and India (15%).<sup>3</sup>

The risks associated with tobacco smoking during pregnancy for both mother and child have been established,<sup>4</sup> and include pregnancy complications (ie, placenta praevia, placental abruption, and pre-eclampsia) and poor fetal outcomes (ie, low birthweight, premature birth, and overall perinatal mortality).<sup>5,6</sup> The use of several forms of smokeless tobacco (eg, snuff or chewing tobacco) during pregnancy is less studied but has also been associated with stillbirth, preterm birth, and reduced birthweight.<sup>7</sup>

Identification of where smoking cessation interventions for pregnant women are most needed in LMICs is

particularly important in view of the insufficient antenatal care capacities and poor pregnancy outcomes in many LMICs.<sup>8</sup> However, there are no population-based estimates of tobacco use during pregnancy in LMICs.

We aimed to estimate the prevalence of current tobacco use in pregnant women in LMICs using data from 54 nationally representative household surveys, and investigate potential sources of heterogeneity in the estimates across countries and geographic regions.

## Methods

### Data sources and procedures

We searched for data from the most recent Demographic and Health Survey (DHS) in every country, which were done between Jan 1, 2000, and Jan 1, 2014, with data available for pregnancy status and tobacco use. The DHS are nationally representative cross-sectional household surveys done at about 5-year intervals across LMICs. DHS are designed to collect data on health and welfare from women of reproductive age, their children, and their households. In all countries, these surveys followed the same standardised procedures. Complete descriptions of country DHS sampling, questionnaire validation, data collection methods, and data validation procedures are

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	Pregnant (n)	Response rate*	Age (years)	Urban dwellers (%)	Lowest house- hold wealth quintile (%)	Not working (%)	No education (%)
Albania, 2008–09	136	100.0%	26.3	39.2%	16.4%	80.9%	0.7%
Armenia, 2010	174	99.4%	24.5	64.0%	16.9%	81.9%	0.0%
Benin, 2006	1946	100.0%	26.9	33.8%	21.3%	17.3%	74.6%
Bolivia, 2008	926	99.8%	26.8	58.3%	23.4%	35.7%	4.2%
Burkina Faso, 2010	1687	99.8%	27.0	18.0%	18.8%	22.9%	81.9%
Burundi, 2010	928	100.0%	27.8	9.1%	19.8%	9.2%	50.1%
Cambodia, 2010	929	100.0%	25.9	16.0%	23.0%	18.2%	16.5%
Cameroon, 2011	1492	99.8%	26.4	43.7%	22.5%	32.6%	27.5%
Congo (Brazzaville), 2011–12	1114	99.8%	26.6	64.6%	20.1%	32.9%	7.0%
DR Congo, 2007	1100	100.0%	26.3	37.8%	20.0%	24.4%	22.4%
Côte d'Ivoire, 2011–12	1016	99.8%	26.6	41.7%	21.6%	33.4%	59.3%
Dominican Republic, 2007	1279	99.6%	24.0	67.7%	26.4%	60.3%	3.9%
Egypt, 2005	1869	99.9%	25.4	36.6%	18.4%	86.0%	25.4%
Ethiopia, 2011	1277	99.9%	27.5	12.5%	24.4%	45.0%	61.4%
Gabon, 2012	873	99.3%	26.3	87.4%	18.3%	55.4%	5.4%
Ghana, 2008	365	100.0%	27.8	41.5%	18.8%	17.0%	25.9%
Guinea, 2005	767	100.0%	27.5	23.6%	23.7%	16.6%	85.0%
Guyana, 2009	233	99.1%	25.1	20.6%	28.0%	70.7%	3.9%
Haiti, 2012	872	100.0%	26.6	37.6%	18.7%	41.3%	17.5%
Honduras, 2012	1276	99.9%	24.6	52.3%	21.4%	50.8%	4.2%
India, 2006	5911	99.9%	23.6	24.7%	24.4%	67.4%	46.4%
Indonesia, 2012	2060	99.9%	27.9	50.3%	20.8%	40.1%	1.0%
Jordan, 2012	1132	100.0%	27.6	82.8%	18.2%	87.0%	1.3%
Kenya, 2008	622	99.8%	26.4	24.4%	23.4%	39.6%	12.5%
Kyrgyzstan, 2012	588	99.8%	25.8	33.8%	18.1%	76.7%	0.0%
Lesotho, 2009	336	100.0%	24.5	25.7%	18.0%	NA	1.2%
Liberia, 2007	741	100.0%	27.3	30.5%	24.8%	29.3%	47.1%
Madagascar, 2008–09	1449	99.9%	25.3	11.2%	24.6%	10.3%	23.4%
Malawi, 2010	2162	99.9%	26.0	12.1%	19.9%	28.3%	14.7%
Maldives, 2009	558	100.0%	26.8	26.4%	18.7%	53.8%	8.3%
Mali, 2006	1795	99.7%	26.7	26.4%	20.7%	57.0%	85.0%
Moldova, 2005	179	100.0%	25.4	40.6%	15.0%	55.1%	0.0%
Mozambique, 2011	1409	100.0%	26.0	25.8%	25.6%	56.7%	35.5%
Namibia, 2006–07	579	100.0%	27.1	41.7%	21.3%	48.2%	8.9%
Nepal, 2011	614	100.0%	23.6	11.8%	20.9%	34.6%	36.9%
Nicaragua, 2001	667	100.0%	24.3	53.1%	NA	64.6%	19.1%
Niger, 2006	1210	99.8%	27.0	13.6%	17.7%	52.7%	86.0%
Nigeria, 2008	3547	99.7%	27.1	30.9%	23.6%	34.4%	43.0%
Pakistan, 2012–13	1495	99.9%	26.7	26.9%	24.9%	73.4%	54.7%
Peru, 2007–08	1860	86.2%	27.4	60.2%	15.0%	25.3%	3.2%
Philippines, 2008	729	100.0%	27.2	46.3%	26.5%	50.9%	1.4%
Rwanda, 2010	937	99.9%	27.7	15.7%	20.7%	12.0%	16.4%
São Tomé and Príncipe, 2008–09	225	100.0%	26.2	53.2%	20.1%	53.9%	5.2%
Senegal, 2010–11	1297	100.0%	27.1	37.9%	26.0%	58.6%	68.6%
Sierra Leone, 2008	571	99.6%	26.0	28.7%	21.1%	20.1%	72.3%
Swaziland, 2006–07	273	100.0%	24.7	26.6%	20.7%	58.7%	7.9%
Tajikistan, 2012	700	99.9%	24.6	20.6%	16.5%	73.9%	2.1%
Tanzania, 2010	945	100.0%	26.1	18.9%	18.5%	15.1%	25.5%
Timor Leste, 2009–10	902	100.0%	28.2	27.4%	17.8%	67.3%	28.9%
Turkey, 2003	524	99.6%	25.6	63.4%	24.1%	NA	17.7%
Uganda, 2011	963	99.8%	26.3	13.9%	22.8%	23.7%	13.2%

(Table 1 continues on next page)

	Pregnant (n)	Response rate*	Mean age (years)	Urban dwellers (%)	Lowest household wealth quintile (%)	Not working (%)	No education (%)
(Continued from previous page)							
Ukraine, 2007	190	99.5%	26.2	76.7%	12.1%	29.8%	0.0%
Zambia, 2007	770	100.0%	26.6	30.6%	22.0%	48.8%	10.5%
Zimbabwe, 2010–11	723	100.0%	26.1	34.0%	20.2%	61.5%	1.7%

Means and percentages for variables are calculated with appropriate sampling weight. \*The response rate for pregnant women who completed the Demographic and Health Surveys questions on tobacco use. NA=not measured in survey.

**Table 1: Characteristics of pregnant women in the Demographic Health Surveys across countries by year of survey**

For more on the **Macro International. Demographic and Health Surveys (DHS)** see <http://www.measuredhs.com>

published elsewhere.<sup>9</sup> Briefly, the DHS use a stratified two-stage random sampling approach, consisting of a selection of census enumeration areas based on a probability (proportional to area size), followed by a random selection of households from a complete listing of households within the selected enumeration areas. For every sampled household, one member answers general questions about the household and provides a list of household residents. Then, all consenting women aged 15–49 years in the household are interviewed. The response rates for pregnant women for the available eligible DHS ranged from 86.2% to 100.0% (mean 99.6%, SD 1.9; table 1). The DHS was approved centrally by ICF International (Calverton, MD, USA) institutional review board and by individual review boards within every participating country.

## Outcomes

The current pregnancy status of women was self-reported and ascertained from the question, “Are you pregnant now?”, with the response options “yes” or “no or unsure”.

In the DHS, tobacco use is ascertained by questionnaire. Participants were asked four questions to be answered by “yes” or “no” about whether, at current, they use cigarettes, pipes, or other country-specific tobacco smoking products or nothing. The DHS contains no information about age at initiation, former smoking status, or age at cessation. Pregnant women were classified as a “tobacco smoker” if the response was “yes” to smoking cigarettes, pipes, or other country-specific smoking products. Pregnant women were classified as “smokeless tobacco users” if the response was “yes” to the use of chew, snuff, or other country-specific smokeless tobacco products. Pregnant women who smoke tobacco or use smokeless tobacco were classified as “any tobacco users”.

The participants’ place of residence was categorised as rural versus urban. Maternal education was assessed by self-report of the completed educational level (no education, primary, secondary, or higher). Maternal occupation was measured through the question, “What is your primary occupation, or class of work?” Responses were organised under three categories: professional, technical, or service; agriculture or manual; and not working, and responses were categorised as not working,

	Prevalence of tobacco smoking (95% CI)	Prevalence of smokeless tobacco use (95% CI)	Prevalence of any tobacco use (95% CI)
<b>Eastern Mediterranean</b>			
Egypt, 2005	0.4% (0.1–0.9)	0.1% (0.0–0.5)	0.4% (0.2–1.0)
Jordan, 2012	9.6% (6.8–13.4)	ND	9.6% (6.8–13.4)
Pakistan, 2012–13	3.8% (2.6–5.5)	1.9% (1.0–3.5)	5.4% (3.9–7.5)
Pooled region estimate	2.6% (0.7–9.5)	0.6% (0.0–2.5)	3.1% (0.9–10.0)
Statistical heterogeneity, I <sup>2</sup>	99.0 (98.4–99.4)	96.9 (91.7–98.8)	99.1 (98.6–99.4)
<b>Europe</b>			
Albania, 2008–09	3.2% (1.0–9.2)	ND	3.2% (1.0–9.2)
Armenia, 2010	0.3% (0.04–2.2)	0.0%	0.3% (0.04–2.2)
Kyrgyzstan, 2012	0.8% (0.3–2.4)	0.3% (0.0–1.8)	0.8% (0.3–2.4)
Moldova, 2005	0.8% (0.2–3.3)	0.0%	0.8% (0.2–3.3)
Tajikistan, 2012	0.1% (0.0–0.8)	0.0%	0.1% (0.0–0.8)
Turkey, 2003	15.0% (11.8–18.9)	ND	15.0% (11.8–18.9)
Ukraine, 2007	3.9% (1.4–10.8)	0.0%	3.9% (1.4–10.8)
Pooled region estimate	2.5% (0.0–6.4)	0.1% (0.0–0.3)	2.5% (0.0–6.4)
Statistical heterogeneity, I <sup>2</sup>	96.5 (94.6–97.7)	0.0 (0.0–33.2)	96.5 (94.6–97.7)
<b>African</b>			
Benin, 2006	0.0% (0.0–0.3)	ND	0.0% (0.0–0.3)
Burkina Faso, 2010	0.0%	2.8% (2.0–3.8)	2.8% (2.0–3.8)
Burundi, 2010	0.2% (0.1–0.7)	3.7% (2.4–5.6)	8.2% (6.3–10.5)
Cameroon, 2011	0.2% (0.0–1.1)	0.1% (0.0–0.4)	0.2% (0.1–0.6)
Congo (Brazzaville), 2011–12	0.5% (0.2–1.3)	0.8% (0.4–1.5)	1.3% (0.7–2.2)
DR Congo, 2007	0.1% (0.0–0.4)	1.3% (0.6–2.7)	1.4% (0.7–2.8)
Côte d'Ivoire, 2011–12	0.5% (0.1–2.2)	1.0% (0.5–2.0)	1.5% (0.8–3.0)
Ethiopia, 2011	0.8% (0.4–1.9)	0.2% (0.0–0.9)	1.0% (0.5–2.1)
Gabon, 2012	2.3% (0.2–5.0)	0.2% (0.1–0.5)	2.4% (0.1–5.0)
Ghana, 2008	0.3% (0.0–2.1)	0.2% (0.0–1.6)	0.5% (0.1–2.1)
Guinea, 2005	1.4% (0.6–3.4)	ND	2.0% (1.0–4.1)
Kenya, 2008	0.3% (0.1–1.1)	2.6% (0.9–5.6)	2.4% (1.0–5.7)
Lesotho, 2009	0.0%	5.1% (3.2–8.0)	5.1% (3.2–8.0)
Liberia, 2007	1.6% (0.8–3.2)	2.0% (0.9–4.3)	5.1% (3.2–8.0)
Madagascar, 2008–09	0.4% (0.2–0.9)	11.8% (9.6–14.3)	11.9% (9.8–14.4)
Malawi, 2010	0.2% (0.0–0.9)	0.4% (0.2–1.0)	0.6% (0.3–1.3)
Mali, 2006	0.0 (0.0–0.3)	ND	0.0 (0.0–0.3)
Mozambique, 2011	0.8% (0.4–1.6)	0.4% (0.2–1.1)	0.8% (0.4–1.6)
Namibia, 2006–07	5.4% (3.4–8.6)	2.2% (1.2–4.0)	7.6% (5.3–11.0)
Niger, 2006	0.0%	ND	0.0%
Nigeria, 2008	0.1% (0.0–0.3)	0.5% (0.2–0.9)	0.6% (0.3–1.0)
Rwanda, 2010	0.3% (0.1–0.9)	2.0% (1.2–3.2)	2.2% (1.4–3.5)

(Table 2 continues on next page)

	Prevalence of tobacco smoking (95% CI)	Prevalence of smokeless tobacco use (95% CI)	Prevalence of any tobacco use (95% CI)
(Continued from previous page)			
São Tomé and Príncipe, 2008–09	0.2% (0.0–1.0)	0.2% (0.0–1.4)	0.4% (0.1–1.3)
Senegal, 2010–11	0.2% (0.0–0.8)	0.3% (0.1–0.8)	0.5% (0.2–1.1)
Sierra Leone, 2008	4.5% (2.9–6.9)	4.6% (3.0–6.9)	8.3% (6.1–11.3)
Swaziland, 2006–07	1.3% (0.5–3.6)	0.6% (0.2–2.4)	2.0% (0.9–4.4)
Tanzania, 2010	0.2% (0.0–0.7)	0.9% (0.4–2.0)	1.1% (0.5–2.1)
Uganda, 2011	0.3% (0.1–0.8)	1.9% (1.2–3.1)	2.2% (1.4–3.3)
Zambia, 2007	0.5% (0.2–1.3)	1.1% (0.6–2.1)	1.4% (0.8–2.5)
Zimbabwe, 2010–11	0.0%	0.4% (0.1–1.4)	0.4% (0.1–1.4)
Pooled region estimate	0.6% (0.3–0.8)	1.7% (1.0–2.6)	2.0% (1.2–2.9)
Statistical heterogeneity, $I^2$	89.6 (86.5–92.2)	96.2 (95.3–97.0)	96.9 (96.3–97.4)
<b>Americas</b>			
Bolivia, 2008	4.1% (2.6–6.4)	ND	4.1% (2.6–6.4)
Dominican Republic, 2007	2.4% (1.4–4.1)	0.1% (0.0–0.4)	2.7% (1.7–4.4)
Guyana, 2009	3.5% (1.3–9.1)	0.0%	3.5% (1.3–9.1)
Haiti, 2012	1.0% (0.5–2.2)	2.7% (1.6–4.7)	3.6% (2.3–5.7)
Honduras, 2012	0.7% (0.3–1.8)	0.0%	0.7% (0.3–1.8)
Nicaragua, 2001	1.3% (0.5–3.3)	0.0%	1.3% (0.5–3.3)
Peru, 2007–08	1.3% (0.7–2.2)	ND	1.3% (0.7–2.2)
Pooled region estimate	1.8% (1.1–2.6)	0.3% (0.0–1.1)	2.1% (1.2–3.2)
Statistical heterogeneity, $I^2$	82.8 (65.8–91.3)	91.4 (82.9–95.7)	90.0 (81.9–94.4)
<b>Southeast Asia</b>			
India, 2006	1.0% (0.7–1.5)	7.2% (6.3–8.1)	8.0% (7.1–9.0)
Indonesia, 2012	0.7% (0.4–1.4)	0.3% (0.1–0.7)	1.0% (0.6–1.7)
Maldives, 2009	1.8% (0.9–3.4)	1.6% (0.7–3.5)	3.3% (2.0–5.5)
Nepal, 2011	5.9% (4.1–8.4)	2.8% (1.6–4.9)	8.4% (6.0–11.5)
Timor Leste, 2009–10	3.4% (2.3–4.8)	1.2% (0.6–2.1)	3.7% (2.6–5.2)
Pooled region estimate	2.7% (1.1–4.8)	2.6% (0.0–7.6)	5.1% (1.3–10.9)
Statistical heterogeneity, $I^2$	95.9 (92.9–97.7)	99.2 (99.0–99.5)	98.8 (98.3–99.2)
<b>Western Pacific</b>			
Cambodia, 2010	3.4% (1.8–6.4)	3.5% (2.4–5.2)	6.7% (4.6–9.7)
Philippines, 2008	2.4% (1.5–3.9)	0.1% (0.0–0.4)	2.5% (1.6–3.9)
Pooled region estimate	3.5% (1.5–12.1)	1.6% (0.0–7.1)	4.5% (0.3–12.1)
Statistical heterogeneity, $I^2$	84.7 (37.4–96.2)	97.8 (94.6–99.0)	96.7 (91.2–98.8)
<b>Overall</b>			
Overall pooled estimate	1.3 (0.9–1.8)	1.3 (0.7–2.0)	2.6 (1.8–3.6)

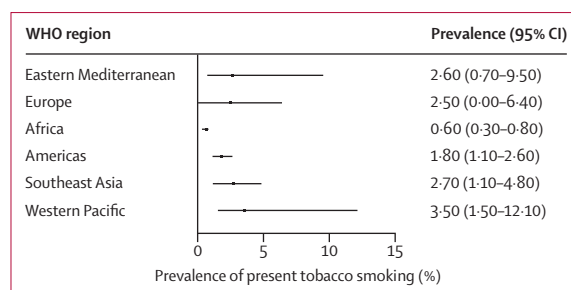
ND=no data collected.

**Table 2: Prevalence of tobacco use in pregnant women by WHO region**

non-manual, manual, and agricultural. Household wealth was measured as a composite measure of household assets (eg, bicycles, cars, or radios) and characteristics (eg, flooring material, drinking water source, or type of toilet facility). Household wealth was further divided into five quintiles (poorest, poor, middle, rich, or richest).

### Statistical analysis

The DHS used complex sample designs that involved clustering of households. We therefore calculated sampling weights to account for differential probabilities of selection and participation, and estimated proportions



**Figure 1: Pooled prevalence of current smoking in pregnant women by WHO region**

Black squares are the effect estimates (pooled prevalence) and the horizontal bars show 95% CIs. Pooled estimates were derived from double arc-sine transformed prevalence and back-transformed for reporting.

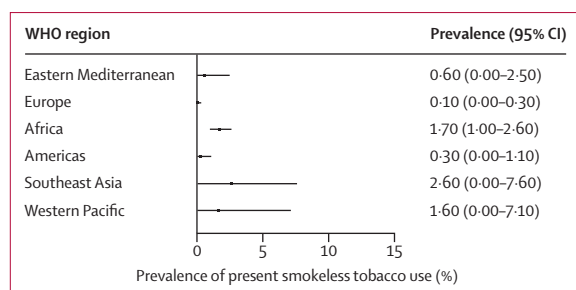
and 95% CIs for current tobacco smoking, smokeless tobacco use, and any tobacco use in pregnant women from every country, accounting for stratification and clustering in the sample design. Pooled regional estimates were computed by first stabilisation of the variances of the raw proportions with a double arc-sine transformation and then application of a DerSimonian-Laird random-effects model. Heterogeneity between study-specific estimates was assessed with the  $I^2$  statistic; values of 25% or less indicated low heterogeneity, values near 50% corresponded to moderate heterogeneity, and values near 75% or greater indicated high heterogeneity. We further explored potential sources of heterogeneity for any tobacco use through meta-regression analysis. We did univariable analyses to test the individual association of several a priori country-level covariates with pooled estimates: year of survey ( $\leq 2009$  vs  $> 2009$ , for which 2009 is the median year of the 11-year period covered by the various country-specific DHS surveys), percentage of people living in urban areas (below median value vs at and above median value), or gross national income based on purchasing power parity (below median value vs at and above median value). No more than one covariate was significantly associated with the outcome in region-specific univariable meta-regression models. Accordingly, we therefore did not develop multiple meta-regression models. The p value was obtained from random-effects meta-regression. Weighted proportions and 95% CIs were calculated with STATA version 11.2 (Stata, College Station, TX, USA). Meta-XL version 1.3 was applied to stabilise the variances of the raw proportions and pool proportions with a random-effects model.

### Role of the funding source

There was no funding source for this study. RC had access to the full data set and final responsibility to submit the report.

### Results

54 countries with valid DHS data were included in our analyses. By WHO region per total number of LMICs, seven (35%) of 20 countries in Europe, three (20%) of



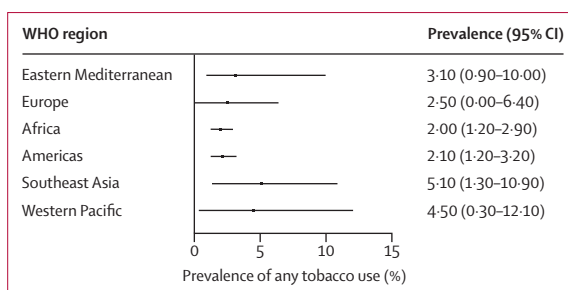
**Figure 2: Pooled prevalence of current smokeless tobacco use by pregnant women by WHO region**

Black squares are the effect estimates (pooled prevalence) and the horizontal bars show 95% CIs. Pooled estimates were derived from double arc-sine transformed prevalence, and back-transformed for reporting.

15 in the Eastern Mediterranean, 30 (65%) of 46 in Africa, seven of (27%) 26 in the Americas, five (45%) of 11 in Southeast Asia, and two (11%) of 18 in the Western Pacific had DHS data. Table 1 shows the country-level characteristics of participants. The mean age of pregnant women ranged from 23.6 to 28.2 years. The proportion of pregnant women who had no formal education ranged from 0.0% (Armenia, Kyrgyzstan, Moldova, Ukraine) to 86.0% (Niger), and 23 (42.6%) of 54 surveys had more than 20% of pregnant women with no formal education. The proportion of households classified in the lowest household wealth quintile ranged from 12.1% (Ukraine) to 28.0% (Guyana), whereas the proportion of pregnant women who were not in work ranged from 9.2% (Burundi) to 87.0% (Jordan).

1.3% (95% CI 0.9–1.8) of pregnant women from LMICs reported smoking tobacco (table 2). The prevalence of current tobacco smoking varied substantially across countries, ranging from 0.0% (in Benin, Burkina Faso, Lesotho, Mali, Niger, and Zimbabwe) to 15.0% (in Turkey). Figure 1 shows the pooled prevalence of current tobacco smoking in pregnant women by WHO region. The pooled regional prevalence of current tobacco smoking ranged from 0.6% (95% CI 0.3–0.8) in the African region to 3.5% (1.5–12.1) in the Western Pacific region. The percentage of countries with a prevalence above the overall pooled estimate for tobacco smoking in pregnant women was 100% (two of two) in the West Pacific region, 60% (three of five) in the Southeast Asia region, 67% (two of three) in the Eastern Mediterranean region, 43% (three of seven) in the Americas region, 43% (three of seven) in European region, and 17% (five of 30) in the African region.

45 countries had data for use of smokeless tobacco in pregnant women. 1.3% (95% CI 0.7–2.0) of pregnant women from LMICs reported use of smokeless tobacco (table 2). We noted substantial variation in the prevalence of current smokeless tobacco use from 0.0% (in Armenia, Moldova, Tajikistan, Ukraine, Guyana, Honduras, and Nicaragua) to 11.8% (in Madagascar). Figure 2 shows the pooled prevalence of current smokeless tobacco use in pregnant women by WHO



**Figure 3: Pooled prevalence of any tobacco use by pregnant women by WHO region**

Black squares are the effect estimates (pooled prevalence) and the horizontal bars show 95% CIs. Pooled estimates were derived from double arc-sine transformed prevalence, and back-transformed for reporting.

region. The pooled regional prevalence of current smokeless tobacco use in pregnant women was lowest in Europe (0.1%, 95% CI 0.0–0.3) and highest in Southeast Asia (2.6%, 0.0–7.6). The proportion of countries with a prevalence greater than the overall pooled estimate for smokeless tobacco use in pregnant women was 60% (three of five) in the Southeast Asian region, 50% (one of two) in the West Pacific region, 38% (10 of 26) in the African region, 50% (one of two) in the Eastern Mediterranean region, and 20% (one of five) in the Americas region. No country in the Europe region had a prevalence greater than the overall pooled estimate for smokeless tobacco use in pregnant women.

2.6% (95% CI 1.8–3.6) of pregnant women from LMICs reported any tobacco use (table 2). The prevalence of any current tobacco use in pregnant women ranged from 0.0% (Benin, Mali, Niger) to 15.0% (Turkey). Figure 3 shows the pooled prevalence of any tobacco use in pregnant women by WHO region. The pooled prevalence of any tobacco use in pregnant women was lowest in the African region (2.0%, 95% CI 1.2–2.9) and highest in Southeast Asia (5.1%, 1.3–10.9). The proportion of countries with a prevalence above the overall pooled estimate for any tobacco use in pregnant women was 80% (four of five) in the Southeast Asian region, 67% (two of three) in the Eastern Mediterranean region, 57% (four of seven) in the Americas region, 50% (one of two) in the West Pacific region, 43% (three of seven) in the European region, and 23% (seven of 30) in the African region.

Table 2 shows substantial heterogeneity in prevalence estimates of tobacco use between countries in every region and across regions.

In univariable meta-regression analysis, we noted a higher prevalence of any tobacco use in pregnant women for countries with surveys done after 2009 in the Eastern Mediterranean region ( $p=0.019$ ) and in countries with a higher proportion of people living in urban areas in the Americas region ( $p=0.012$  table 3). We also noted a lower prevalence of any tobacco use in pregnant women for countries with a higher gross national income per head in the Southeast Asian region (table 3).

	Eastern Mediterranean			Europe			Africa			Americas			Southeast Asia			Western Pacific		
	N*	Prevalence (95% CI)	p value	N*	Prevalence (95% CI)	p value	N*	Prevalence (95% CI)	p value	N*	Prevalence (95% CI)	p value	N*	Prevalence (95% CI)	p value	N*	Prevalence (95% CI)	p value
<b>Year</b>																		
≤2009	1	0.4% (0.2–1.0)		4	4.1% (0.0–12.0)		16	2.1% (0.8–4.0)		5	2.3% (1.4–3.3)		3	5.5% (1.5–11.6)		1	2.5% (1.6–3.9)	
>2009	2	8.8% (7.6–10.5)	0.019	3	0.4% (0.1–0.8)	0.085	14	1.7% (0.9–2.7)	0.635	2	1.8% (0.0–5.3)	0.671	2	5.0% (0.0–16.3)	0.846	1	6.7% (4.6–9.7)	NA
<b>People living in urban areas</b>																		
Below median	1	5.4% (3.9–7.5)		3	5.1% (0.0–15.2)		14	2.5% (1.1–4.4)		2	1.8% (0.3–5.1)		2	6.4% (1.4–14.1)		1	6.7% (4.6–9.7)	
Above median	2	3.4% (0.0–10.3)	0.647	4	0.8% (0.1–1.9)	0.136	16	1.5% (0.8–2.5)	0.233	5	2.3% (1.5–3.4)	0.012	3	4.7% (0.0–12.7)	0.636	1	2.5% (1.6–3.9)	NA
<b>Gross national income per head based on purchasing power parity (current international \$)</b>																		
Below median	1	9.6% (6.8–13.4)		3	0.4% (0.1–1.1)		14	2.3% (0.9–4.4)		3	2.3% (0.6–4.8)		2	11.0% (10.3–11.8)		1	6.7% (4.6–9.7)	
Above median	2	3.6% (0.0–14.6)	0.647	4	3.7% (0.0–12.0)	0.136	15	1.7% (0.9–2.6)	0.341	4	1.9% (0.9–3.3)	0.640	3	2.8% (1.1–5.2)	0.019	1	2.5% (1.6–3.9)	NA

\*Number of countries. NA=not applicable, p value not calculated because of small number of countries.

Table 3: Pooled prevalence of any tobacco use in pregnant women by WHO region and by subgroups

## Discussion

To our knowledge, this study is the largest to provide contemporary evidence on tobacco use during pregnancy using nationally representative samples from 54 LMICs. During 2001–12, about one in every 30 pregnant women used tobacco, with wide variations in prevalence within and between world regions (panel). The highest regional prevalence of any tobacco use was in the Southeast Asian region and the lowest was in the African region. Additionally, we noted that in 21 countries, smokeless tobacco was the primary form of tobacco use in pregnant women, thus showing the need to account for these forms of tobacco use in prevention programmes. Both smoked and smokeless forms of tobacco encompass a very diverse group of products.<sup>10</sup> Smokeless tobacco is often less expensive than manufactured cigarettes and is sometimes viewed by pregnant women as a form of medicine to treat influenza, colds, and other common ailments,<sup>11</sup> as a safer alternative to tobacco smoking,<sup>12</sup> or in some countries is more socially acceptable than tobacco smoking in women.<sup>7</sup>

Although the prevalence of tobacco use by women during pregnancy is low at current, evidence suggests that it might rise during the coming decades.<sup>13</sup> Data from the Global Youth Tobacco Survey 2006 showed that the difference in current cigarette smoking between boys and girls is narrower than expected in many regions of the world, suggesting substantial future increases in tobacco use.<sup>13</sup> Moreover, as long as tobacco use remains much lower in women than in men, women will constitute an obvious target for multinational tobacco companies.

Bhatti and colleagues<sup>14</sup> previously reported that the prevalence of tobacco use in pregnant women in LMICs ranged between 0.1% and 11.9%; however, these data were estimated from selected DHS data (42 countries). Our study is more comprehensive because it includes all

available DHS data, and we show that the prevalence of tobacco use in pregnant women ranges from 0% to 15%. Other studies on the prevalence of tobacco use in pregnant women in LMICs<sup>15–21</sup> have typically used convenience samples<sup>22</sup> or have been hospital-based studies limited to certain regions,<sup>15,16,18,19,21</sup> and thus are more prone to selection bias. For example, in a multicentre, cross-sectional survey<sup>17</sup> with a convenience sample of pregnant women from several LMICs (at the time of survey), including those from Latin America (Argentina, Brazil, Ecuador, Guatemala, and Uruguay), Africa (DR Congo and Zambia), and Asia (Pakistan and two states in India), the prevalence of current tobacco smoking was 18.3% in Uruguay, 10.3% in Argentina, 6.1% in Brazil, 6.4% in Guatemala, and 3.0% in Pakistan; prevalences were not calculated at all other sites because there were fewer than five current smokers. The prevalence of ever having used non-cigarette tobacco products in all other countries surveyed was less than 5%. Much higher prevalence estimates of tobacco smoking in pregnant women have been reported from population-based studies in high-income countries, including the USA (12.3%)<sup>23</sup> and the UK (36.0%).<sup>24</sup>

The DHS data we present could be the basis for surveillance of tobacco use in pregnant women in LMICs, and might be the best available surveillance data in countries where there are no existing surveillance systems or regular surveys that collect tobacco use information in pregnant women. Reliance of LMICs on the DHS programme to obtain surveillance data for tobacco use in pregnant women is restricted, in that the surveys are initiated by the United States Agency for International Development (USAID) and do not cover countries where the USAID is not established.

We detected a high level of heterogeneity in prevalence of any tobacco use across countries and regions.

However, few covariates sufficiently explained the heterogeneity, suggesting that the source of variation lies elsewhere. Sociocultural histories of tobacco use, the local economy of tobacco including marketing, and possibly the extent of the implementation of the WHO Framework Convention on Tobacco Control (FCTC) Articles might be more important to explain national differences within the LMICs. Understanding the sources of heterogeneity will be crucial to predict future trends and target strategies of control, particularly in countries already facing worrying rates of tobacco use.

Our study has some limitations that need to be considered. First, tobacco smoking status was self-reported; hence, misclassification of smoking status is possible.<sup>25</sup> Evidence from high-income countries suggests that up to a quarter of pregnant tobacco smokers could be missed when self-reporting is relied upon.<sup>25,26</sup> Although under-reporting of smoking status by pregnant women is unknown in LMICs, smoking status could be much higher in LMICs with strong social and cultural pressures against tobacco smoking in women. Future studies could overcome this limitation by use of biomarkers of tobacco exposure such as urinary cotinine, at least in a subsample of their population for validation of self-report. Second, in the DHS, pregnancy status was ascertained by self-report. Misclassification of pregnant women as non-pregnant will potentially have an effect on our estimates if this occurred in a different way between tobacco users and non-users. Such a hypothesis is difficult to ascertain, but is unlikely in the context of multicountry surveys. Third, the study was constrained by the scarce availability of country data from every WHO region. Fourth, country-specific prevalence of tobacco use reflected estimates during an 11-year period. Given that prevalence of tobacco smoking in females in LMICs could be growing,<sup>27</sup> the prevalence estimates of tobacco use in our study might be smaller than those in contemporary studies. However, we only showed that prevalence estimates for any tobacco use in pregnant women for countries with surveys done after 2009 in the Eastern Mediterranean region were significantly higher than those before 2009. Finally, our study did not include other ways in which tobacco use might harm pregnant women and children. For example, second-hand smoke exposure has been reported to be highly prevalent in women of reproductive age in some LMICs,<sup>28</sup> including during pregnancy.<sup>17</sup> Additionally, tobacco use by family members might divert household income from food to tobacco, putting infants at increased risk of chronic malnutrition and mortality.<sup>29</sup>

Maternal and fetal complications related to tobacco use in pregnant women are numerous,<sup>5,6</sup> and possibly also include obesity and obesity-related metabolic complications.<sup>30</sup> Because maternal and child health outcomes are often poor in many LMICs,<sup>8</sup> use of tobacco by pregnant women in these settings could substantially

### Panel: Research in context

#### Systematic review

We searched PubMed for articles published in English, Spanish, and French between Jan 1, 2000, to Jan 1, 2014, that included the search terms “smoking” or “tobacco use” or “smokeless” or “cigarette” AND “maternal” or “pregnancy” or “pregnant women” in the title and were from low-income and middle-income countries. We identified only 16 primary research articles, of which three were based on national data.

#### Interpretation

Our study is the first study to report estimates of the prevalence of tobacco smoking and smokeless tobacco use in pregnant women in all 54 low-income and middle-income countries for which nationally representative data are available and comparable across countries. During 2001–12, about one in every 30 pregnant women from LMICs used tobacco, with wide variations in prevalence within and between world regions. Tobacco use in pregnant women in low-income and middle-income countries is low; however, in Turkey prevalence reaches as high as 15%.

worsen outcomes, and therefore slow progress to achieve the Millennium Development Goals 4 (Reduce Child Mortality) and 5 (Improve Maternal Health).<sup>22</sup> The main recommendations of the WHO FCTC on the prevention and management of tobacco use and exposure to second-hand smoke in pregnancy<sup>31</sup> include screening for tobacco use and second-hand smoke exposure, advice and psychosocial interventions for tobacco cessation to those who are current tobacco users, and protection from second-hand smoke. Although many LMICs have ratified the FCTC, the implementation of the provisions are still a challenge.<sup>32</sup> For example, although most African countries require tobacco health warning messages (WHO FCTC Article 11), at current only three countries (Mauritius, Djibouti, and Madagascar) require picture-based warnings. Furthermore, a few studies in LMICs have incorporated cigarette smoking cessation interventions (WHO FCTC Article 14) into existing health-care services for pregnant women.<sup>33,34</sup> However, no interventions on other forms of smoked or smokeless tobacco have been tested;<sup>29</sup> hence the importance of our study in showing the magnitude of the use of smokeless tobacco in specific countries. These data could aid in the cultural adaptation of tobacco control interventions to make these more acceptable and feasible, and integrated into existing health-care delivery systems.

Tobacco use in pregnant women in low-income and middle-income countries was low; however, in Turkey it reached levels as high as 15%. The expansion of the tobacco industry’s marketing efforts to women of reproductive age in low-income and middle-income countries suggests that the prevalence of tobacco use might increase if the WHO FCTC Articles are not

implemented. Urgent action is needed to prevent and manage tobacco use and second-hand smoke exposure in pregnancy to improve the health of women and children in LMICs at present.

#### Contributors

RC conceptualised the study, developed the analytical strategy, did the statistical analysis, interpreted the results, and wrote the first draft of the report. CAT contributed to the statistical analysis and to the interpretation of the results. APK and JBE contributed to the analytical strategy, to the interpretation of the results, and did the critical revisions. CC and RU contributed to the interpretation of the results and did the critical revisions.

#### Declaration of interests

We declare no competing interests.

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