International Health 2020; **12**: 388–394
doi:10.1093/inthealth/ihz113 Advance Access publication 24 January 2020

ORIGINAL ARTICLE

Medical injection and access to sterile injection equipment in low- and middle-income countries: a meta-analysis of Demographic and Health Surveys (2010–2017)

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Received 23 April 2019; revised 22 July 2019; editorial decision 5 October 2019; accepted 5 October 2019

Background: Unsafe injection practices contribute to increased risks of blood-borne infections, including human immunodeficiency virus, hepatitis B and hepatitis C viruses. The aim of this study was to estimate the prevalence of medical injections as well as assess the level of access to sterile injection equipment by demographic factors in low- and middle-income countries (LMICs).

Methods: We carried out a meta-analysis of nationally representative Demographic and Health Surveys (DHSs) conducted between 2010 and 2017 in 39 LMICs. Random effects meta-analysis was used in estimating pooled and disaggregated prevalence. All analyses were conducted using Stata version 14 and Microsoft Excel 2016.

Results: The pooled 12-month prevalence estimate of medical injection was 32.4% (95% confidence interval 29.3–35.6). Pakistan, Rwanda and Myanmar had the highest prevalence of medical injection: 59.1%, 56.4% and 53.0%, respectively. Regionally, the prevalence of medical injection ranged from 13.5% in west Asia to 42.7% in south and southeast Asia. The pooled prevalence of access to sterile injection equipment was 96.5%, with Pakistan, Comoros and Afghanistan having comparatively less prevalence: 86.0%, 90.3% and 90.9%, respectively.

Conclusions: Overuse of medical injection and potentially unsafe injection practices remain a considerable challenge in LMICs. To stem the tides of these challenges, national governments of LMICs need to initiate appropriate interventions, including education of stakeholders, and equity in access to quality healthcare services.

Keywords: blood-borne infections, low- and middle-income countries, medical injection, sterile injection equipment

Introduction

Injections are one of the most common medical procedures performed in healthcare settings worldwide.[1] About 16 billion injections are administered annually.[1] The majority of these injections, approximately 90%, are given to administer medicines for therapeutic purposes, while injections for vaccination and other procedures such as blood transfusions and injectable contraceptives account for the remaining 10%.[1] In many instances where injections are administered for therapeutic purposes, they are usually unnecessary or could be replaced by oral medications.[1,2] A number of factors contribute to this overuse, including the misconception that injections are more effective than oral medications and the financial gains associated with the use of injections, as they increase the fees healthcare providers charge for their services.[3]

A safe injection is one that does not harm the patient receiving it, does not expose the healthcare provider to any preventable risk and does not result in waste that is dangerous for the community.[1] Unsafe injection practices such as reusing needles and syringes and poor handling and disposal of used injection equipment are related to overuse of or unnecessary injections.[4–6] These practices portend great health risks for patients, healthcare workers and the community at large.[7] The health risks include direct exposure to blood-borne diseases and/or increased chances of needlestick injury and subsequent exposure to blood-borne infections,[2,8,9] all contributing to the global burden of diseases.[10] For instance, available data show that injection medication is a major contributor to the increasing trends of new human immunodeficiency virus (HIV) infections in many countries around the world.[11,12] Other blood-borne infections, particularly, hepatitis B virus, hepatitis C virus and viral haemorrhagic fever viruses, are similarly and commonly transmitted through unsafe injections.[1,2,6,13]

In several low- and middle-income countries (LMICs), especially the Eastern Mediterranean and Southeast Asia regions, evidence confirms both unnecessary and unsafe use of injections.[2,3,14] However, little is known about the prevalence of medical injections and access to sterile injection equipment in LMICs. Worldwide, the prevalence of unsafe injections was estimated to have decreased from 39% in 2000 to 5% in 2010.[2,5] Conversely, in 2010, up to 1.7 million hepatitis B virus infections, 315 000 hepatitis C virus infections and 33 800 HIV infections were estimated to have occurred due to unsafe injections.[5] The World Health Organization's (WHO) report on global hepatitis identified the need for more recent data to monitor progress towards injection safety since 2010.[2] Accordingly, we utilized data from nationally representative household surveys (2010–2017) to provide an up-to-date estimate of the prevalence of medical injections and access to sterile injection equipment in LMICs by demographic factors.

Methods

Data source

This study utilized data from the Demographic and Health Survey (DHS) reports of LMICs. The DHSs are nationally representative household surveys conducted by ICF Macro/MEASURE DHS on behalf of national ministries of health of the respective countries. The data and reports are freely available and accessible from the DHS website (https://dhsprogram.com/data/data-collection.cfm). Many international partners, including the US Agency for International Development, provide financial support for the surveys.[15] The standard DHS uses identical methodology including the probability sampling strategy and survey instrument to collect data that are comparable across countries.[15] Our study included reports of countries whose surveys were conducted from 2010 to 2017 and contained data on the prevalence of medical injections among adults 15–49 y of age and access to syringes and needles taken from new, unopened packages. This study was based on a secondary analysis of data extracted from DHS reports in LMICs. The variables from the DHS reports, extracted and included in our analysis, were the prevalence of medical injection by demographic category, including sex (male, female), age group (15–24, 25–29, 30–39, 40–49 y), place of residence (rural, urban), education level (no education, primary, secondary/higher) and wealth index (lowest, second, middle, fourth, highest). The data in the reports were completely anonymized. No additional ethical clearance was required for the conduct of the present study.

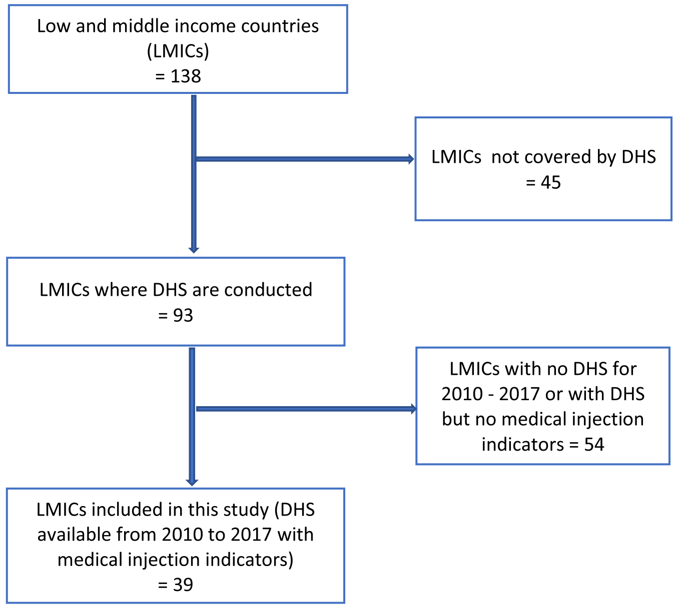

Figure 1. PRISMA flow chart for country selection.

Definition of outcome variables

In the DHS, a medical injection was considered to be an injection given by a healthcare worker, which can be a doctor, nurse, pharmacist, dentist or other healthcare professionals. The prevalence of medical injections was estimated as the proportion of adults who received an injection from a healthcare worker in the 12 months preceding the survey. Participants in the surveys were asked if their last injection was given with a new, unopened syringe package, and responses to this question were used in estimating access to sterile injection equipment.

Selection of countries and inclusion criteria

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[16] were followed in selecting the countries included in this study (Figure 1). Countries were included if they are classified as an LMIC by the World Bank (https://data.worldbank.org/income-level/low-and-middle-income) and had a DHS conducted from 2010 to 2017 with medical injection indicators.[15] This study period was selected to provide the most recent update on the subject using available nationally representative data. We excluded from our study countries without DHS data or whose DHS data did not measure the prevalence of medical injection.

Data analysis

Data were analysed using Stata version 14 (StataCorp, College Station, TX, USA) and Excel 2016 (Microsoft, Redmond, WA, USA). The proportions of participants whose last injection was administered using a syringe from a new, unopened package were also extracted by demographic category. Countries whose reports were extracted were classified by geographic region according to the DHS regional classification (Table 1). Furthermore, we

Table 1. Prevalence of medical injection and access to sterile injection equipment by country

Countries	Study period	No. of participants	Average injections/ person/year	Prevalence of medical injection, % (95% CI)	Access to new syringe and needle, % (95% CI)
Sub-Saharan Africa					
Benin	2011–2012	21 032	0.5	15.8 (15.3–16.3)	95.0 (94.3–95.8)
Burkina Faso	2010	23 587	0.6	31.6 (31.0–32.2)	99.0 (98.8–99.3)
Burundi	2010	13 149	0.9	33.9 (33.1–34.7)	98.7 (98.3–99.0)
Cameroun	2011	13 912	1.8	40.3 (39.5–41.1)	97.7 (97.4–98.1)
Chad	2014–2015	10 900	1.9	36.0 (35.1–36.9)	93.9 (93.1–94.7)
Comoros	2012	7328	0.6	20.0 (19.1–20.9)	90.3 (88.8–91.8)
Congo	2011–2012	15 542	1.8	25.5 (24.8–26.1)	98.1 (97.7–98.5)
Cote d'Ivoire	2011–2012	14 696	1.2	38.1 (37.3–38.9)	96.9 (96.5–97.4)
Democratic Republic of the Congo	2013–2014	26 582	3.3	32.8 (32.3–33.4)	92.8 (92.2–93.3)
Equatorial Guinea	2011	5132	2.7	38.2 (36.8–39.5)	96.0 (95.1–96.9)
Ethiopia	2011	29 349	1.4	32.7 (32.1–33.2)	97.5 (97.2–97.8)
Gabon	2012	13 530	1.2	32.8 (32.0–33.6)	97.3 (96.8–97.7)
Gambia	2013	13 810	0.8	31.6 (30.8–32.4)	97.1 (96.6–97.6)
Ghana	2014	13 265	0.7	29.4 (28.6–30.2)	97.8 (97.3–98.2)
Kenya	2014	26 688	1.4	40.0 (39.4–40.6)	98.5 (98.3–98.7)
Lesotho	2014	9281	0.9	29.2 (28.3–30.1)	96.9 (96.3–97.6)
Liberia	2013	13 357	1.6	40.2 (39.4–41.1)	98.2 (97.8–98.5)
Mali	2012–2013	14 220	0.7	21.9 (21.3–22.6)	97.5 (96.9–98.0)
Mozambique	2011	17 257	0.5	18.1 (17.5–18.6)	94.2 (93.4–95.0)
Namibia	2013	13 197	1.0	30.5 (29.7–31.3)	97.5 (97.0–98.0)
Niger	2012	14 549	0.8	37.1 (36.3–37.9)	96.4 (95.9–96.9)
Nigeria	2013	56 307	1.1	25.0 (24.7–25.4)	97.1 (96.8–97.3)
Rwanda	2014–2015	19 074	1.4	56.4 (55.7–57.1)	99.2 (99.0–99.4)
Sierra Leone	2013	23 240	1.9	40.0 (39.4–40.6)	97.2 (96.8−–97.5)
Tanzania	2015–2016	16 780	1.0	28.5 (27.8–29.2)	98.3 (98.0–98.7)
Togo	2013–2014	13 498	1.2	30.1 (29.4–30.9)	95.9 (95.3–96.5)
Uganda	2011	10 847	1.7	39.5 (38.5–40.4)	96.5 (96.0–97.1)
Zambia	2013–2014	29 972	0.7	22.7 (22.2–23.1)	97.2 (96.9–97.6)
Zimbabwe	2015	17 996	0.5	23.3 (22.7–23.9)	97.8 (97.3–98.2)
South and Southeast Asia					
Afghanistan	2015	40 221	2.9	33.8 (33.4–34.3)	90.9 (90.4–91.4)
Cambodia	2014	22 768	1.9	35.0 (34.4–35.6)	98.6 (98.3–98.9)
Indonesia	2012	54 913	1.6	42.9 (42.5–43.3)	93.0 (92.6–93.2)
Myanmar	2015–2016	17 622	2.3	53.0 (52.3–53.8)	98.8 (98.6–99.1)
Nepal	2011	16 795	1.1	32.3 (31.6–33.0)	98.0 (97.6–98.4)
Pakistan	2012–2013	16 692	5.3	59.1 (58.4–60.0)	86.0 (85.3–86.7)
West Asia					
Armenia	2015–2016	8871	1.2	13.5 (12.8–14.2)	97.3 (96.4–98.2)
Central Asia					
Kyrgyz Republic	2012	10 621	3.0	25.6 (24.8–26.4)	96.5 (95.8–97.2)
Latin America and the Caribbean					
Dominican Republic	2013	3543	1.2	23.1 (21.7–24.5)	99.5 (99.0–100)
Haiti	2012	22 721	0.7	24.5 (23.9–25.0)	98.6 (98.3–98.9)
Overall		732 844	1.5	32.4 (29.3–35.6)	96.5 (95.9–97.2)

classified countries into low income or middle income using the World Bank income classification system.

We employed a random effects meta-analysis to calculate the pooled prevalence estimates of medical injection and access to sterile injection equipment. We used a random effects meta-analysis because it allows for heterogeneity across studies. Our study population differs along geographic, regional and socio-economic divides. Hence, even though the DHS used a similar study design across countries, we expected heterogeneity. Our choice of a random effects model was equally supported by a test of heterogeneity of the DHS data obtained for the different countries, which showed a high level of inconsistency ($I^2>50\%$). Furthermore, we used sensitivity analysis to assess the effects of outliers as well as test the robustness of our findings. We performed a sensitivity analysis by excluding from our analysis data from one country at a time, and the impact of excluding the data was evaluated on the summary results.

We performed subgroup analyses to estimate the prevalence of medical injection and access to sterile injection equipment by some sociodemographic factors, including sex, age, type of residence, wealth index, education, geographic region and income classification.

Results

The DHS reports for 39 countries met the inclusion criteria for this study and were meta-analysed (see Table 1). The pooled 12-month prevalence estimate of medical injection among adults 15–49 y of age in LMICs was 32.4% (95% confidence interval [CI] 29.3–35.6) (see Figure 2). Medical injections were more common in Pakistan, Rwanda and Myanmar, with prevalence estimates of 59.1% (95% CI 58.4–60.0), 56.4% (95% CI 55.7–57.1) and 53.0% (95% CI 52.3–53.8), respectively (Table 1). The sensitivity analysis performed by excluding data from Pakistan yielded a prevalence estimate of 31.7% (95% CI 28.8–34.7). This estimate was comparable to the overall pooled estimate. There were substantial regional variations in the 12-month prevalence of medical injection, ranging from 13.5 (95% CI 12.8–14.2) in West Asia to 42.7% (95% CI 35.0–50.4) in the South and Southeast Asia.

Overall, 96.5% (95% CI 95.9–97.2) of individuals reported having an injection with a syringe and needle taken from a new, unopened package. Access to new syringes and needles was comparatively less common in Pakistan, Comoros and Afghanistan, with estimates of 86.0% (95% CI 85.3–86.7), 90.3% (95% CI 88.8–91.8) and 90.9% (95% CI 90.4–91.4), respectively (Table 1). There were also regional differences in access to sterile injection devices (Table 2), with Latin America and the Caribbean having the highest regional estimate of 99.0% (95% CI 98.2–99.9) and South and Southeast Asia having the lowest estimate (94.2% [95% CI 91.1–97.3]).

Based on age categorization (Table 2), we found the highest prevalence of injection medication use among adults aged 25–29 y (37.0% [95% CI 33.4–40.5]) and the lowest among adults aged 40–49 y (30.4% [95% CI 27.0–33.8]). Adults in the highest wealth index category had a higher prevalence of injection medication use (35.3% [95% CI 32.1–38.4]) than their counterparts in the lowest wealth index category (28.5% [95% CI 25.1–31.9]). This pattern of results for the wealth index was similarly observed for education level, where adults with at least a secondary education had a higher prevalence of injection use (35.1% [95% CI 31.9–38.2]) than those without education (29.1% [95% CI 25.8–32.3]). Interestingly, the highest prevalence of access to sterile injection equipment was also recorded for adults in the highest wealth index category (97.4% [95% CI 96.9–97.8]) compared with those in the lowest wealth index category (95.2% [95% CI 94.2–96.3]), as well as adults with secondary/higher education level (97.4% [95% CI 96.9–97.9]) compared with those with no education (94.7% [95% CI 93.6–95.9]).

Discussion

In this study we estimated the prevalence of medical injections and assessed the level of access to sterile injection equipment in LMICs (potentially safe injections). The pooled prevalence of medical injections was 32.4%. Higher prevalences were recorded in South/Southeast Asia and sub-Saharan Africa regions. Pakistan, Rwanda and Myanmar were the countries with the highest prevalence of medical injection use. The pooled and disaggregated prevalence found in our study indicates that medical injections were considerably common in LMICs—suggesting varying degrees of overuse of this mode of drug administration in the countries assessed. Overall, 96.5% of adults in LMICs had access to new, unopened syringes and needles. Thus 3.5%, approximately 1 in 29, medical injections were potentially unsafe in LMICs.

The global prevalence of unsafe injection was estimated in the year 2010 to be 5%.[2,5] Our estimated pooled prevalence is lower than this global prevalence—probably suggesting some progress over time. However, given the risk associated (morbidity and mortality) with unsafe injections,[1,2,6–8,11,12] our estimated pooled prevalence is considerable and calls for urgent actions/interventions. This position becomes even more important in countries such as Pakistan, Comoros and Afghanistan, where we found 14.0%, 9.7% and 9.1% prevalence of potentially unsafe medical injections, respectively.

Generally, both patient- and provider-related factors are known to drive overuse and subsequently unsafe medical injections.[3,17,18] For example, injection medications are often thought (by patients and healthcare providers alike) to be better, more effective or stronger than oral medicines.[3,18] This observation, coupled with the profiteering tendencies of some healthcare providers, may be relevant in explaining the considerably high prevalence of medical injection found in the present study. Poor knowledge of the risks associated with the overuse of injections, sociocultural beliefs, financial constraints, poor consumer protection, low awareness in the population and poor regulation of medical practices have equally been noted to contribute to the overuse of injection medications.[3,17,18]

The finding of a high prevalence of medical injections in South/Southeast Asian countries is probably not surprising. Available data have shown that injections are commonly used in countries in these regions.[17] For instance, in Pakistan (where we found the highest prevalence of medical injections and unsafe injections), and indeed in other countries in the South/Southeast Asia region, economic incentives, patient preference (due to misconceptions about injections), private practice (in particular)

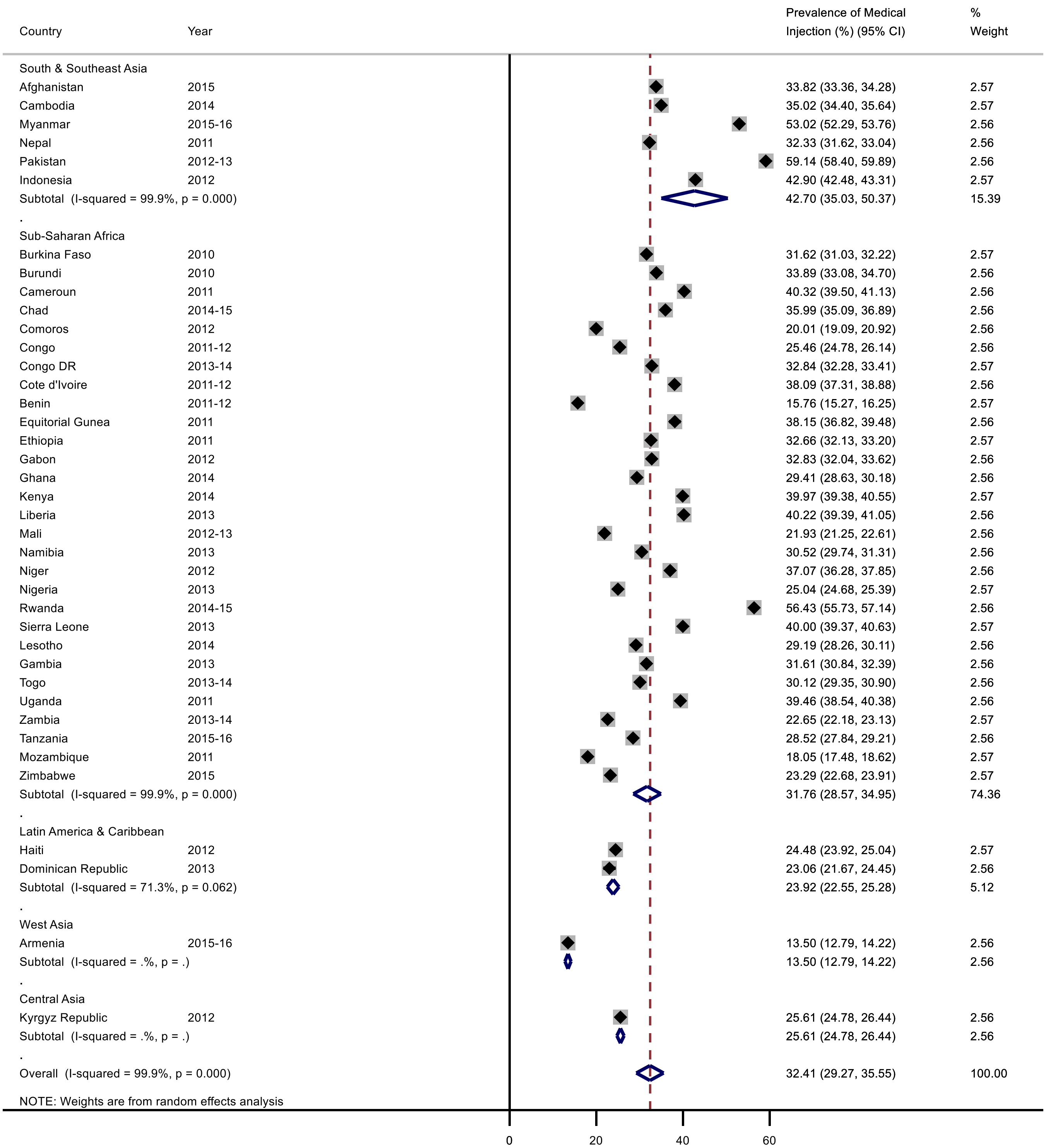

Figure 2. Meta-analysis for the prevalence of medical injection in low- and middle-income countries.

and prescribing by unqualified practitioners are among the major factors contributing to the overuse of medical injections.[17,19] Interventions, including regulatory and policy measures, directed at these factors may contribute to reducing the overuse of medical injections in this region and, by extension, other LMICs.

Our study reveals the place of the wealth index and education level in medical injection medication use as well as in the level of access to sterile injection equipment (potentially safe injection). Rich respondents had a higher prevalence of medical injections compared with the poor. Given that injections generally tend to

Table 2. Prevalence of medical injection and access to new syringes and needles by demographic category

Category	Number of participants (N=732 844)	Prevalence of medical injection, % (95% CI)	Access to sterile syringes and needles, % (95% CI)
Sex			
Male	218 991	27.1 (24.3–29.9)	96.4 (95.8–97.0)
Female	513 853	35.3 (31.8–38.7)	96.6 (95.9–97.2)
Age (y)[a]			
15–24	267 732	30.7 (27.8–33.7)	96.5 (95.9–97.1)
25–29	125 606	37.0 (33.4–40.5)	96.9 (96.3–97.5)
30–39	199 956	34.3 (30.9–37.7)	96.7 (96.0–97.3)
40–49	138 252	30.4 (27.0–33.8)	96.2 (95.4–97.0)
Type of residence[a]			
Urban	286 943	34.2 (31.2–37.2)	97.1 (96.6–97.6)
Rural	444 367	31.8 (28.4–35.2)	96.0 (95.3–96.8)
Education level[a]			
No education	202 271	29.1 (25.8–32.3)	94.7 (93.6–95.9)
Primary	216 224	33.0 (29.5–36.4)	96.5 (95.9–97.1)
Secondary or higher	303 658	35.1 (31.9–38.2)	97.4 (96.9–97.9)
Wealth index			
Lowest	125 962	28.5 (25.1–31.9)	95.2 (94.2–96.3)
Second	135 289	31.2 (27.8–34.6)	96.2 (95.4–97.0)
Middle	141 767	32.6 (29.2–36.0)	96.4 (95.7–97.1)
Fourth	155 385	34.2 (31.1–37.4)	97.0 (96.5–97.6)
Highest	174 441	35.3 (32.1–38.4)	97.4 (96.9–97.8)
Geographic region			
Sub-Saharan Africa	518 077	31.8 (28.6–34.9)	96.9 (96.4–97.3)
Latin America and Caribbean	26 264	23.9 (22.5–25.3)	99.0 (98.2–99.9)
West Asia	8871	13.5 (12.8–14.2)	97.3 (96.4–98.2)
Central Asia	10 621	25.6 (24.8–26.4)	96.5 (95.8–97.2)
South and Southeast Asia	169 011	42.7 (35.0–50.4)	94.2 (91.1–97.3)
Country income level			
Low income	386 292	31.4 (27.5–35.4)	96.4 (95.6–97.2)
Middle income	346 552	33.6 (28.4–38.7)	96.7 (95.7–97.8)
Overall	732 844	32.4 (29.3–35.6)	96.5 (95.9–97.2)

[a]Category with some missing data.

be more expensive than oral medicines, this finding may well be explained by the differences in financial capabilities, as in many LMIC settings, healthcare services are paid for out of pocket.[20,21] Not surprisingly, the rich also had greater access to sterile injection equipment compared with their poor counterparts, highlighting the possible disparity in access to quality healthcare that is commonly reported between the rich and the poor.[22–24] These findings coupled with those in respect of education level suggest that quality healthcare in many developing countries continues to be associated with socio-economic level. A holistic approach to safer injection thus needs to address socio-economic disparities in access to quality healthcare services.

The use of nationally representative DHS data is the major strength of this study; thus our findings are generalizable to the adult population ages 15–49 y in the LMICs assessed in this study. The application of a meta-analysis in providing pooled and disaggregated estimates remains another important strength. However, non-availability of relevant DHS data for our study period (2010–2017) limited the number of LMICs considered in the present study. Also, given that the DHS data largely captured adults 15–49 y of age (an age group with lesser healthcare needs compared with older adults), medical injection use may have been underestimated. The data analysed were self-reported and collected retrospectively, hence recall and social desirability biases are likely. Nonetheless, restricting our analysis to information provided for the period within 1 y preceding the surveys may reduce the chances of recall bias.

Conclusions

Our study reveals a substantially high prevalence of medical injection in LMICs, indicating that overuse of medical injection remains a considerable public health challenge in these countries. This overuse varies from region to region and from one country to another, with Pakistan, Rwanda and Myanmar ranking as countries where this was most commonly practised. About 1 in 29 injections in LMICs is potentially unsafe. Urgent, comprehensive and multisectoral interventions, including regulation of medical practices and policy measures aimed at addressing socio-economic disparities in access to healthcare services, are needed to stem the tide of unnecessary and unsafe medical injection use in LMICs. In addition, there is a need to educate both healthcare workers and patients on the dangers of unsafe injection and the need for medical injection to be given only when absolutely necessary. This is particularly critical in countries/regions with a high prevalence of unsafe injection use as found in the present study.

Authors' contributions: AA conceived and designed the study, carried out the analysis and contributed to writing of the manuscript. EOA contributed to study design, interpretation of results and writing and editing the manuscript. Both authors critically revised, read and approved the final version of the manuscript for submission.

Acknowledgments: We thank ICF International, USA for providing the DHS data analysed in this study.

Funding: None.

Competing interests: None declared.

Ethical approval: This study was based on a secondary analysis of data extracted from DHS reports in LMICs. The data in the reports were completely anonymized. No additional ethical clearance was required for the conduct of the present study.

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