Intimate Partner Violence Against Women Estimates 2000-2018

Summary of statistical methodology

WHO for the Violence Against Women Inter-Agency Group on Estimation and Data (VAW-IAGED)

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Acronyms and abbreviations

CEDAW	Committee on the Elimination of all Forms of Discrimination against Women
DHS	Demographic and Health Survey
GBD	Global Burden of Disease
IPV	Intimate Partner Violence
SDG	Sustainable Development Goals
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNODC	United Nations Office for Drugs and Crime
UNSD	United Nations Statistics Division
UN Women	United Nations Entity for Gender Equality and the Empowerment of women
VAW	Violence Against Women
WHO	World Health Organization
WPP	World Population Prospect

Instructions

- ✓ Please review this methodological note.
- ✓ Please review the intimate partner violence estimates for your country and identified data sources used in your country profile (attached pdf).
- ✓ Please identify any potentially eligible national- or sub-national level intimate partner violence data that is not already included. Note that only population-based studies –representative at either the national or sub-national level conducted between 2000 and 2018 and that used act-specific questions (See 'Concepts and Definitions) – can be included
- ✓ You are welcome to share observations, queries and data by writing to: **vawestimates@who.int.** by **May 30th, 2020**.
- ✓ Any submissions made after this date may not be considered in the final publication of country estimates.

Introduction

The World Health Organization (WHO), the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the United Nations Office on Drugs and Crime (UNODC) and the United Nations Statistics Division (UNSD) comprise the Inter-Agency Working Group on Violence Against Women Estimation and Data (VAW-IAWGED) which was established for strengthening the monitoring and reporting of the violence against women (VAW) Sustainable Development Goal (SDG) indicators 5.2.1 and 5.2.2 the and for the broader purpose of improving measurement of violence against women.

The IAWG-ED have collaborated on the first round of country, -level estimates on of intimate partner violence and updated regional and global estimates of intimate partner violence and non-partner sexual violence against women (2000-2018). This round of consultations focuses on estimates of physical and sexual violence against women by a husband/intimate partner (henceforth referred to as 'intimate partner violence' or IPV). These have been summarized for your country in the accompanying "country profile" (PDF document).

The purpose of this technical document is to support the country consultation process with Member States by providing a detailed description of the processes and methods for estimating levels of intimate partner violence globally. During the consultation, Member States have an opportunity to review the draft estimates and their methods, to provide advice on primary data sources for respective countries that may not have been previously reported or used, and to build mutual understanding of the strengths and weaknesses of available data and estimation process.

The following sections of this document provide a rationale for the importance of generating robust prevalence estimates on violence against women, and explanatory notes on data sources and methods used for constructing these estimates. As explained in more details in the 'Methods' section, the updated estimates draw on an extensive global violence against women database created by the WHO. For most countries, the information comes from population-based surveys such as the Demographic and Health Surveys, reproductive health surveys, studies using the WHO multi-country study questionnaire or others carried out by national statistics offices, academics or other research institutions.

Concepts and Definitions

Violence against women (VAW) is a human rights violation and a global health, and development concern with serious short- and long-term effects on women, children, families and society. Violence against women takes many different forms including physical, sexual and psychological by different perpetrators. Violence by an intimate partner or other family member is among the most pervasive. Women also experience sexual violence by perpetrators other than a partner, including friends, acquaintances or strangers (non-partner sexual violence or NPSV). Violence against women also includes trafficking and other forms of violence.

Violence against women has been recognized as a factor affecting women's lives and health for over 2 decades, and calls for its elimination date back to the UN Declaration on the elimination of violence against women in 1993, the Beijing Platform for Action in 1995, CEDAW General recommendation 35, Commission on the Status of Women (CSW) 57 agreed conclusions, and regional conventions like Belem do Para, the Maputo protocol and the Istanbul convention.[1] More recently, recognizing its pervasiveness and significant impact on individuals and communities, countries agreed in 2015 to eliminate all forms of VAW as part of Goal 5 of the *Sustainable Development Goals* (SDG) (See Box 1) .

BOX 1 SDG Target 5.2: "Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation," which includes the following indicators

- 5.2.1: Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age
- 5.2.2: Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence

In 2016 Member States endorsed the Global Plan of Action on strengthening the role of the health system in addressing violence against women and girls, which includes improving the collection and use of robust data as one of its four strategic directions. Accurate and reliable VAW statistics are crucial for improving our understanding of the prevalence, nature and impact of VAW, how these may differ across settings, age cohorts

[1] https://apps.who.int/iris/bitstream/handle/10665/251664/WHO-RHR-16.13-eng.pdf?sequence=1

and over time. The collection, analyses and reporting of these data play an important role in informing targeted investments into the development of effective and sustainable intersectoral prevention interventions, policies and programs aimed at reducing VAW [1-5].

Among the most prevalent forms of violence experienced by women are physical, sexual and psychological violent or abusive behaviours perpetrated by a current or former husband/intimate partner, in the context of marriage, cohabitation or any other formal or informal union, referred to as intimate partner violence (IPV).[2] [5-7]

The SDG indicator 5.2.1 calls for global reporting on: The proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age. Currently however, for several reasons relating to comparability and highly non-standardized measurement of psychological/emotional intimate partner violence, SDG reports include only the percentage of ever-partnered women and girls aged 15 to 49 who have experienced physical and/or sexual partner violence. While there is global consensus on how physical and, to a lesser degree, sexual intimate partner violence is generally defined and measured, psychological partner violence—which may be conceptualised differently across cultures and in different contexts—is still a Tier III sub-indicator. Efforts led by the WHO along with the other co-custodian agencies are underway to develop a global standard for measuring and reporting on psychological intimate partner violence. This will enable reporting on the three stipulated types of partner violence in the future.

Research has shown that questions that inquire about behaviourally specific acts have several advantages and yield higher levels of disclosure about experiences of intimate partner violence compared to a single question threshold like ‘have you ever experienced violence or abuse’. Women may have differing interpretations of violence and by asking about specific acts, the violence measure is not affected by different understandings of what constitutes violence. A woman would be asked whether she has, for example, ever been “slapped,” not whether she has ever experienced “violence” or even “beatings”. Hence acts-based questions are considered the gold-standard in surveys as they are most likely to yield the best estimates of the prevalence of the intimate partner violence. Furthermore, for cross-national comparisons, it is important that the questions have similar meanings in all cultural contexts. Single over-arching questions also impact disclosure; some women may not be immediately willing to disclose their experience of violence the first time they are asked,and asking about a list of discrete

[2] This ‘intimate partner violence’ is used globally and in this Technical Note and related documents to capture all forms of partnerships where women are exposed to violence. In some settings however, ‘spousal violence’ or ‘domestic violence’ is preferred.

acts (for example, if she was punched, kicked, physically forced to have sex when she did not want to) gives women more opportunities to disclose their experiences. For these reasons, only surveys/studies using acts-based measures were included for prevalence estimation.

Challenges and considerations with survey measurement and data reporting

Generating comparable estimates of the prevalence of intimate partner violence is challenging and they often exhibit large heterogeneity [8, 9, 10]. Reasons for this include differences in survey instruments and methods, survey sampling designs, geographical coverage, and implementation issues that often result in under-reporting of the 'true' prevalence of intimate partner violence. Heterogeneity in instruments, measurement and reporting include: a) Variations in case definition (e.g., the specific items used to measure physical or sexual intimate partner violence might vary between surveys or studies, or some surveys or studies measure only severe forms of violence) and variations in recall periods (e.g., lifetime versus past year experience); b)lack of measurement disaggregation between different forms of violence (physical, sexual, emotional/psychological); c)whether the perpetrator of violence is the current or most recent partner (versus any previous partners), and d)reported survey estimates are often not age-disaggregated and, when available, heterogeneous age-group definitions are often encountered.

Reported prevalence rates are also significantly impacted by survey design and sampling, for example, differences in surveyed populations (i.e., the denominator) - all women, ever partnered, or currently partnered women. Survey implementation issues such as comprehensive vs limited interviewer training on administering intimate partner violence questions, adherence (or not) to ethical and safety protocols including respondent privacy, hinder disclosure and therefore result in an underestimation of prevalence. Dedicated violence against women surveys, if well implemented, tend to encourage higher disclosure compared to embedding a brief question set within broader, more generic surveys.

Lastly, violence against women data are sparse geographically (some countries do not have any estimate) and temporally (most countries with data have only one or two estimates). They also do not cover all age groups, with fewer observations for women aged 50 years and above. Taken together, these considerations affect comparability and require statistical models to adjust, compare, and monitor VAW data within and across countries.

The objective of this document is to present a sound and flexible statistical modeling framework for global, regional, and national intimate partner violence

prevalence statistics which can inform the development of effective policies and programs to address VAW and that are in line with SDG monitoring. We first present a brief overview of the global VAW database, and go on to provide details on the chosen modeling framework, including covariate adjustments, age modeling, and time trends.

Methods

Global Violence Against Women database

The WHO global VAW database includes prevalence surveys/studies of intimate partner violence and non-partner sexual violence. This database builds on an earlier database and systematic reviews that *World Health Organization* (WHO) curated [6, 7]. Briefly, all population-based surveys/studies conducted between 2000 and 2018, either representative at national or sub-national level, were eligible for inclusion. As stated earlier, surveys that used questions that did not refer to specific acts of violence were excluded. For each eligible study, age-specific prevalence estimates and their denominators (design-adjusted), preferably by 5-year age groups, were extracted for the different types of intimate partner violence (namely, *physical and/or sexual, physical*, *sexual*, and *psychological*). For each observation, the following characteristics were extracted: country, author of publication/report, publication year, start and end years of data collection, the type of violence against women, the surveyed population (all women, currently-partnered/married, ever-partnered/married women), age-group for the estimate, the recall period for prevalence (lifetime, past year, past two years), whether the survey questions referred to specific acts of violence (a requirement for inclusion), and whether the study is nationally representative (if not, whether it was conducted in an urban, rural, or mixed urban/rural region). Intimate partner violence estimates were further characterized according to whether the perpetrator included only the spouse (versus all types of intimate partners) and whether the experience of violence referred to the current or most recent husband/partner (versus any husband/intimate partner).

Pre-processing of data

A conceptual overview of methods used for data analysis is provided in Figure 1. This overview describes data inputs, data pre-processing, data analyses, and post-processing to obtain national, regional, and global estimates of intimate partner violence.

The first step of the data pre-processing involves the imputation of missing survey sample sizes. If the overall survey sample size of a specific study was available but the age-specific denominators of the prevalence estimates were missing, we imputed them by distributing this overall sample size proportionally to the age-specific size of the female

population reported in the *United Nations World Population Prospect* (WPP), 2017[3] [11]. In cases where design-adjusted standard errors or confidence intervals were available, the effective sample size was derived from these quantities. If only a confidence interval was available, we used Wilson's formula and applied it to the upper limit of the confidence interval to obtain standard errors [11]. Population-based surveys included in the VAW database often use complex sampling schemes, for example, using stratification and/or clustered sampling– that needs to be accounted for in the analyses. For surveys where the effective sample size could not be numerically derived, we used a design effect of 2.5. This design effect corresponds to the median design effect obtained from standardized analyses of individual-level data from 89 *Demographic and Health Surveys* (DHS). Surveys for which the end date of data collection was not available the date of publication was used as a proxy. Finally, where the upper age of the survey sample was missing or not reported, we assumed an open-ended age category.

The final pre-processing step was to create two datasets (Figure 1). The first one is to calculate adjustment factors to enable the combination of different types of estimates (for example, estimates for urban or rural only versus those for national, or severe violence versus all severity levels). In this case, we only kept the prevalence estimates from the broadest age-group (i.e., 15-49 years). The second dataset is the one used to model global, regional, and national estimates of IPV statistics. In this case, only the finest levels of age-stratification were retained. This was done to avoid double-counting women and artificially increasing the precision of the estimates. This process was repeated and, if more than one prevalence estimates remained for each age group, we selected the ones from the "*optimal set*" of observations that used gold-standard methods and survey instruments. Specifically, we applied the following rules for each survey:

- If a study has estimates from both "*severe violence only*" and "*severe and non-severe violence*", we only keep the latter;
- Keep those from "*physical and/or sexual intimate partner violence*" (if unavailable, "*physical intimate partner violence only*"; and if not recorded, "*sexual intimate partner violence only*");
- Retain observations when the surveyed population is composed of "*ever-partnered/married women*" (if not available, "*all women*"; otherwise, we retain "*currently-partnered/married women*");

[3] We are aware of the release of the WPP 2019, however, age-standardization is done for surveys conducted over the 2000-2018 period; therefore WPP 2019 is outside of that window. As the age distribution and total population of each country does not change significantly over a 2-year interval this would likely not impact the prevalence estimates.

- Preserve observations reflecting intimate partner violence perpetrated by "*any current/previous intimate partners/husbands*" (if unavailable, violence experienced from the "*current or most recent intimate partner/husband*").

Multilevel modeling framework

Multilevel modeling is the best suited statistical approach used with hierarchical data and to pool together observations from different sources. An advantage of the proposed multilevel approach relies on the use of random effects that enable the model to "*borrow strength*" across units. Another appealing characteristic of such Bayesian multilevel models is that the degree of pooling –in other words, how much information is shared between observations– is determined empirically by the data and not arbitrarily by the user [12].

The chosen model structure is based on similar meta-regressions of health indicators [6, 7, 9, 10, 13-18] and has five nested levels: 1) individual studies, 2) countries, 3) regions, 4) super regions, and 5) the world. Here, regions correspond to the classification used by the *Global Burden of Disease* (GBD) study that groups countries in 21 mutually exclusive regions (Figure 2), themselves grouped into 7 super regions (Figure 3), based on the similarities of their epidemiological profiles. The regression model uses a binomial likelihood where y_{it} is the survey-adjusted number of women reporting violence for observation *i* at calendar year *t* and N_{it} is the effective sample size for that observation.

$$y_{it} \sim Binomial(p_{it}, N_{it})$$

Further, the logit-transformed prevalence estimate p_{it} is equal to the sum of the study specific intercepts (i.e., the random effects; denoted $\alpha_{s[i]}$), the country-specific age adjustments ($\gamma_{c[i]}$), the country-level time trend ($\delta_{c[i],t}$), and the sum of the log-odds ratios of the adjustment factors (i.e., the crosswalk covariate modeling; $X_{s[i]}$). In its simplest form, the model takes the following form:

$$logit(p_{it}) = \alpha_{s[i]} + u_{c[i]} + \delta_{c[i],t} + X_{s[i]}$$

The four terms on the right-hand-side of this equation are detailed in the next sections.

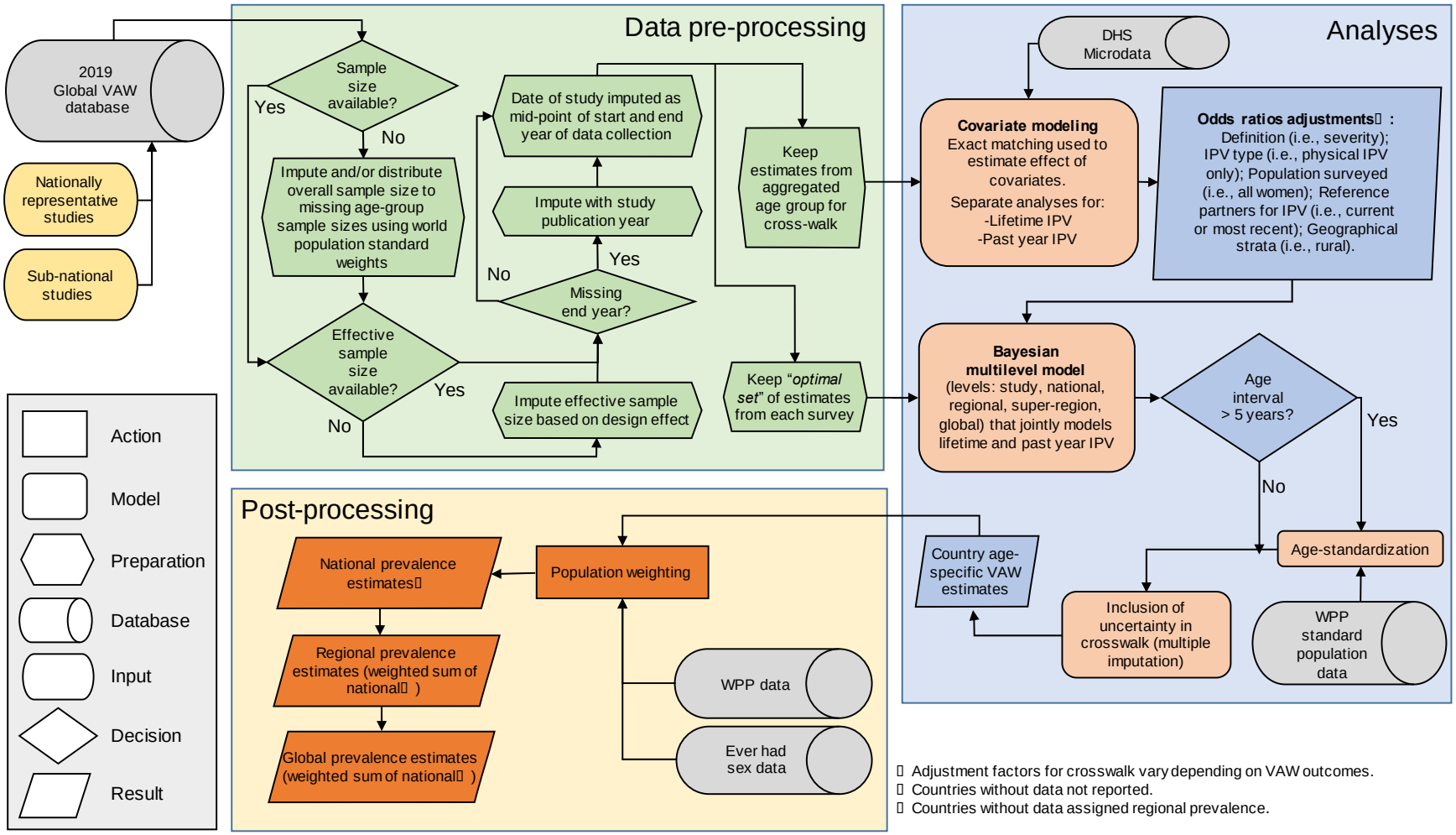


Figure 1. Conceptual overview of data inputs, data pre-processing, data analysis, and post-processing steps required to produce global, regional, and national intimate partner violence statistics. (DHS: Demographic and Health Surveys; IPV: intimate partner violence; VAW: violence against women; WPP: world population prospect.)

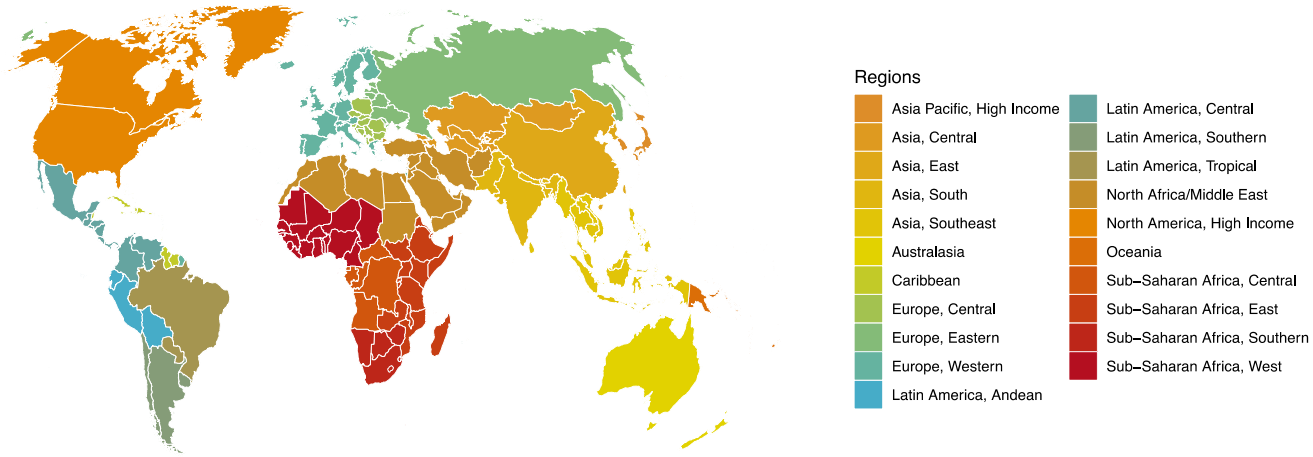


Figure 2. Classification of countries into twenty-one *Global Burden of Disease* "regions".[4]

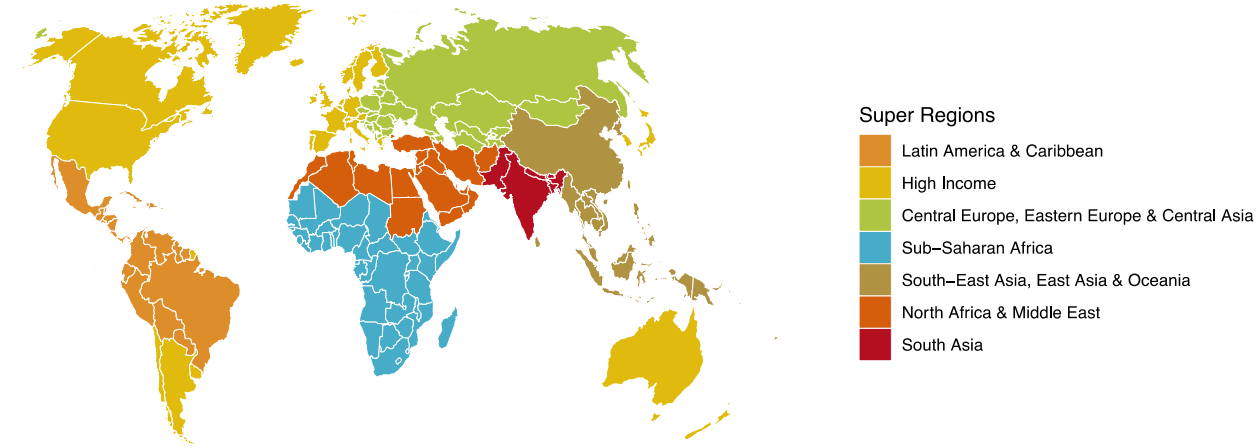


Figure 3. Classification of countries into seven *Global Burden of Disease* "super regions".

[4] http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf

Random effects to account for study variability

Random effects are useful to account for unobserved heterogeneity and each study is assumed to have its own random intercept. We can further impose a hierarchy on these intercepts. This means that we can assume that each study, conducted within a selected country, should yield a prevalence estimate closer to the average prevalence of that country as opposed to that of other ones. We further posit that the average prevalence in a country should be closer to its regional prevalence than to that of other regions of the world. Nesting these effects within clear geographical units is statistically advantageous because it enables us to borrow strength from other geographical units to improve estimate of prevalence in data sparse settings. To model this hierarchy, we have the following equation for the intercept ($\alpha_{s[i]}$) of observation *i*:

$$\alpha_{s[i]} = u_g + u_{z[i]} + u_{r[i]} + u_{c[i]} + u_{s[i]}$$

where u_g is the overall global intercept, u_z is the super-region effect, u_r is the regional effect, u_c is the country effect, and u_s is the study effect. It is assumed that these effects are normally distributed on the logit scale and are given non-informative prior distributions. We also consider that sub-national studies, such as the ones conducted in only one administrative region of a country, are inherently more variable than if they had been nationally representative. As such, they should potentially be given less weight than nationally representative surveys. To do so, we modeled the standard deviation of the study-level random effect depending on its representativeness at the national level [10]. This effectively means that sub-national studies have equal or more variability than those representative at the national level.

Age modeling

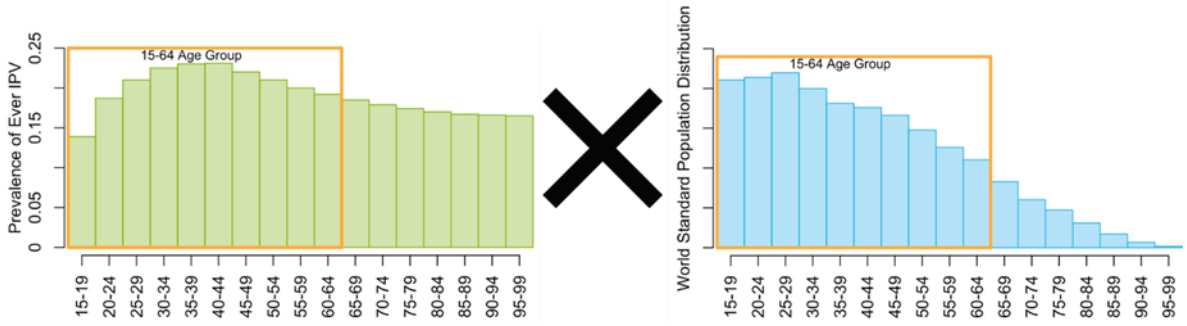
Previous studies suggested that the relationship between age and intimate partner violence is not linear [19, 20]. Splines are a simple and effective way to model non-linear relationships using piecewise polynomials [21]. Because the data in the age groups above 65 years old are very sparse, we modified the splines so that prevalence among the ≥65 years age group remains constant.

An additional complexity to consider is that of heterogeneous age groups. Some prevalence observations refer to 5-year age groups (at best), others to much wider ones (i.e., 15+ years old). To enable inclusion of all observations and consider these age-heterogeneous categories, an age-standardizing approach was adopted [9]. The rationale for age-standardization is depicted in Figure 4 where it is shown that the prevalence in a wide age group is a function of both the age-specific prevalence and the underlying age distribution of the sampled population.

For age-standardization, we use demographic data from the *UN World Population Prospect* [22] and aggregated the 2017 country-level female age distributions for the 21 GBD regions. Age-standardization is applied to all age groups for which the width of the age interval was larger than five years. Our model assumes that each country has its own age pattern but that this pattern is more similar across regions, and super-regions. In practice, this means that we have included country-specific coefficients (random slopes) for the natural cubic spline, denoted $\lambda_{c[i],k}$:

$$\lambda_{c[i],k} = \eta_{g,k} + \eta_{z[i],k} + \eta_{r[i],k} + \eta_{c[i],k}$$

where $\eta_{g,k}$ is a vector that contains the coefficients for the global age-prevalence pattern common to all studies, and $\eta_{z[i],k}$, $\eta_{r[i],k}$, and $\eta_{c[i],k}$ contains the super-region, region, and country-specific deviations from this overall pattern, respectively. The model specification is completed using non-informative normal prior distributions.



$$Prevalence_{15-64} = \frac{\sum_{a=15}^{64} Prevalence_a * W_a}{\sum_{a=15}^{64} W_a}$$

Figure 4. Visual representation of an age-standardizing model when age groups are heterogeneous. The left graph corresponds to the age pattern for lifetime prevalence of intimate partner violence (IPV). The right graph shows that the underlying population distribution is not uniform. If IPV prevalence is estimated for the 15-64 age group, the resulting prevalence will be a function of the specific age pattern of IPV (left) and underlying age distribution (right). Hence, the equation below the graphs says that the prevalence in the 15-64 age group is a weighted average of the age-specific prevalence estimates where the weights correspond to the relative size of the age groups.

Time trends

Prevalence of intimate partner violence could exhibit secular changes over the near 20-year study period. To allow for potential non-linear changes in prevalence, natural cubic splines with one knot placed at the median year of data collection were used (i.e., 2011). Here again, we modeled the country-specific time trend ($\delta_{c[i],t}$) hierarchically:

$$\delta_{c[i],t} = \sum_{k=1}^{K} (\phi_{gk} + \phi_{z[i],k} + \phi_{r[i],k} + \phi_{c[i],k}) \times T_{tk}$$

where ϕ_{gk}, $\phi_{z[i],k}$, $\phi_{r[i],k}$, and $\phi_{c[i],k}$ contain the spline's *K* coefficients for the global, super-region, region, and country-specific time trends. T_{tk} contains the basis matrix for the natural cubic splines for calendar year *t*. Again, this specification is complemented with non-informative prior distributions.

Covariate modeling

To compare and combine prevalence estimates from different surveys, adjustments are required if those surveys used different outcome definitions and/or eligibility criteria. Covariate modeling could be conducted by including indicator variables in the regression model, assuming that these fixed effects are constant across all studies and multiplicatively related [9]. Preliminary models using this approach suggested that the resulting adjustment factors could be affected by compositional bias. This type of bias could occur, for example, if studies that required a specific adjustment are more common in countries/regions with lower or higher VAW prevalence, potentially resulting in biased adjustment factors. To circumvent this issue, we chose a robust exact matching identification strategy [23] where the adjustment factors are calculated outside of the main meta-regression models.

Matching methods enable robust estimation by ensuring that observations, with and without the factor to be adjusted for, have the same distribution of other study characteristics (i.e., population surveyed, country, time of data collection, etc.). This is operationalized by matching on the survey's identifier and this procedure provides us with the ideal comparison group to obtain unbiased adjustment factors. For all adjustment factors except geographical strata, the specific methodology was employed in the following stages:

1. Performed exact matching for each adjustment factor separately Table 1).
2. Calculated the odds ratio comparing prevalence in the observation with the adjustment factor as compared to the reference group within each matched set.
3. Pooled those odds ratios using meta-analytic approaches. Specifically, we used random-effect meta-analysis [24] and, to account for potential variability of the adjustment between regions, stratified results by the seven GBD super regions.

For geographical strata, we used a similar exact matching approach but, since the adjustment factor is not binary (i.e., "rural", "urban", "national"), we only used surveys that

had information on all three categories. We then pooled the matched surveys using random effect logistic regressions with one random intercept per survey and random slopes that vary by the seven GBD super-regions for the "rural" and "urban" areas (referent was "national").

Once the adjustment factors were estimated, we created a vector $X_{s[i]}$ summarizing adjustments required for each observation. The approach outlined above does not consider the uncertainty in the meta-analyzed odds ratios. To address this, we independently sample values of those odds ratios from their distributions. The procedure by which we propagate the uncertainty of these adjustments to final results is described in the section titled *"Computations"*.

Please refer to *Appendix A* for the specific adjustment factors used for lifetime and past year intimate partner violence.

Table 1. List of covariates for which adjustments were estimated and characteristics used for exact matching.

Covariates to adjust	Exact matching on
IPV*	
IPV definition: "*severe violence*" (ref.: "all severity")	Survey, population surveyed, violence type, age, geographical strata, reference partners.
IPV type: "*physical only*" (ref.: "*physical and/or sexual*")	Survey, population surveyed, age, geographical strata, severity, reference partners.
IPV type: "*sexual only*" (ref.: "*physical and/or sexual*")	Survey, population surveyed, age, geographical strata, severity, reference partners.
Population surveyed: "*all women*" (ref.: "*ever-partnered*")	Survey, violence type, age, geographical strata, severity, reference partners.
Population surveyed: "*currently partnered*" (ref.: "*ever-partnered*")	Survey, violence type, age, geographical strata, severity, reference partners.
Reference partners: "*current/most recent*" (ref.: "*any partners*")	Survey, population surveyed, violence type, age, geographical strata, severity.
Geographical strata: "*urban*" or "*rural*" (ref.: "*national*")	Survey, population surveyed, violence type, age, severity, reference partners.

IPV=intimate partner violence.

*Separate adjustments estimated for lifetime and past year IPV.

Constraints

Past year intimate partner violence should be lower or equal to lifetime intimate partner violence. Hence, these two outcomes are modelled together to ensure that this constraint is respected. This is achieved by jointly performing the meta-regression described above and forcing model predictions for past year intimate partner violence to

be equal or lower to those of their corresponding prediction for lifetime intimate partner violence.

The difference between lifetime and past year intimate partner violence should also be relatively small for the youngest age-group of 15-19 years old as these girls and young women have been exposed to the risk of IPV for time periods that are more similar than those of older age groups. Preliminary analyses suggested that including a constraint such that the prevalence ratio of predicted lifetime versus past year intimate partner violence among this youngest age group is equal or smaller than 3 improved out-of-sample predictions. This conservative value was chosen based on the empirical observation that prevalence ratio of lifetime to past year intimate partner violence among 15-19 years old are always less than 3.

Computations

The posterior distributions of the parameters of interests were obtained using Markov chain Monte Carlo simulations implemented through the JAGS software [25]. Inferences are based on 4 chains of 50,000 iterations (with an adaptation phase of 10,000 iterations and an additional 5,000 used as warm up), thinned at every 20^{th} iteration.

Uncertainty in the estimated log-odds ratios of the adjustment factors are considered by sampling a total of 10 vectors from their estimated distributions using Latin hypercube sampling. For each set, we fitted the Bayesian model using the procedure outlined above. We then mixed all draws from the posterior distributions of the 10 sampled vectors and used these mixed draws to summarize the overall posterior distributions of parameter of interests [26, 27]. Convergence was examined using trace plots and we ensured that the potential scale reduction factor for all parameters and hyperparameters remained close to one [28]. All parameters are estimated based on a minimum of roughly 1,000 independent samples from the posterior distributions [29]. All analyses are carried in the R statistical software [30] and selected packages [29, 31-33].

Model validation

The performance of our models is assessed using posterior predictive checks, and both in-sample and out-of-sample comparisons. Graphical posterior predictive checks enable one to visually assess how well simulations from the fitted model compare to the observed data [26]. This procedure is especially useful to understand the ways in which our multilevel model does not fit the observed intimate partner violence statistics. By systematically identifying where model predictions are not congruent with the observed data, we were able to improve estimates, through the iterative process of model building and refinement. In addition to this visual inspection, we computed selected summary

statistics for in-sample comparisons, such as the median error, absolute error, and the proportion of empirical observations outside the lower and upper credible intervals. We also quantified model performance through out-of-sample comparisons by randomly excluding 20% of countries and 20% of studies from the datasets and comparing their model-predicted age-specific prevalence with the known-but-excluded empirical observations.

Post-processing

The model described above provides us with estimated parameters for the global, regional, and country-level intercepts that, when combined with the spline's coefficients and the time trend, produces estimates of intimate partner violence by age and time for all countries with available data.

To estimate the prevalence for broader age groups (i.e., 15-49 years), at higher level of aggregation (i.e., regional and global), and for countries without data we first weighted the age-specific prevalence estimates by the age structure of their respective country considering the proportion of women who ever had sex. This is required because our denominator of interest for IPV is not all women but those ever-partnered. The definition of a partnership being variable around the world, the proportion of women who have entered the sexually active population is believed to be a better proxy of partnership formation than marriage.

Also, for these countries that did not have any empirical observations informing intimate partner violence statistics, they were statistically imputed based on the regional average. We then aggregate country-specific prevalence estimates at the regional level –either using the GBD, WHO (Figure 5), or United Nations Statistics Division (Figure 6) classification– by summing the number of women having experienced intimate partner violence in each region. The same approach was used to obtain global prevalence estimates.

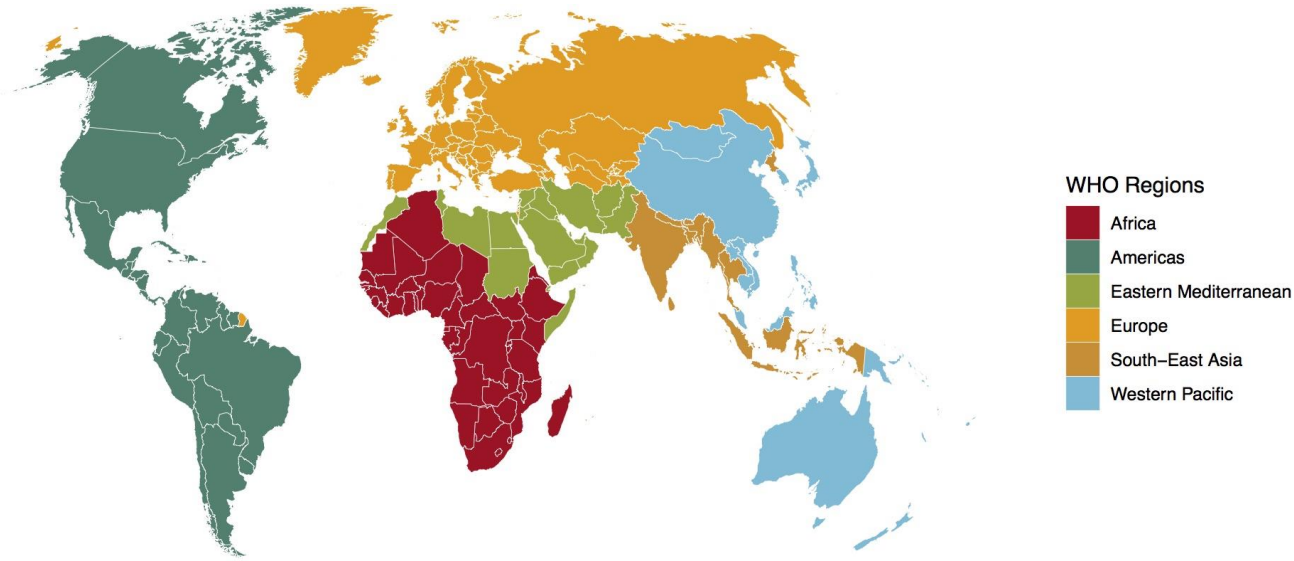


Figure 5. Classification of countries into the six *Word Health Organization* (WHO) regions.[5]

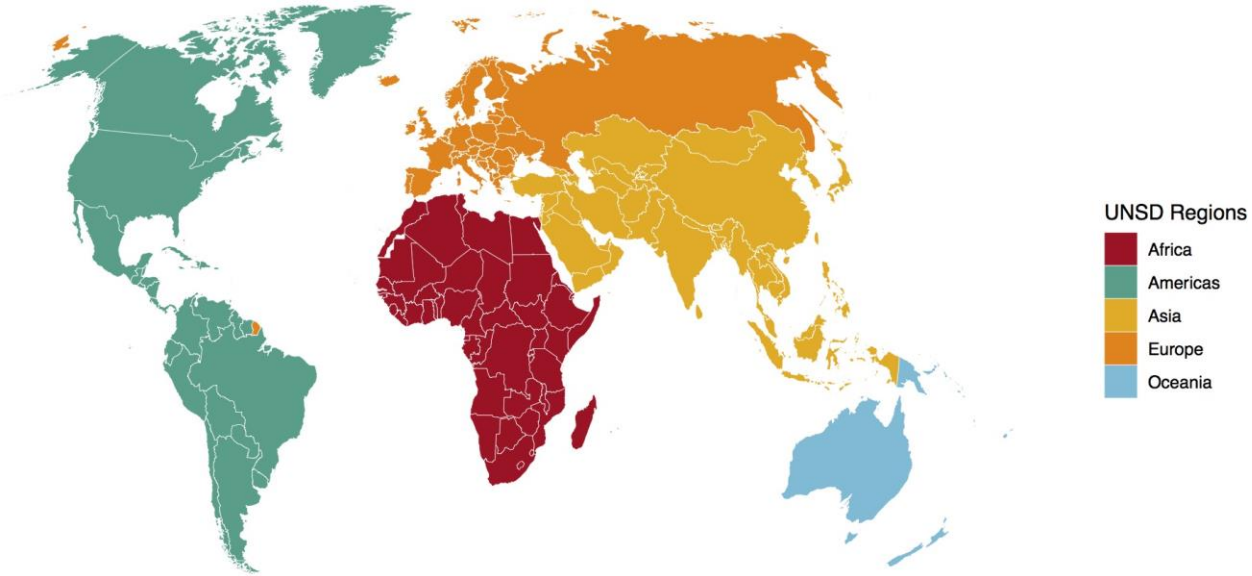


Figure 6. Classification of countries into five *United Nations Statistics Division* (UNSD) regions.[6]

[5] https://www.who.int/healthinfo/global_burden_disease/definition_regions/en/

[6] Based on M49 classification https://unstats.un.org/unsd/methodology/m49/

Presentation of estimates

For each country, a profile is provided that contains the following information:

- The national estimate of lifetime and past year prevalence of intimate partner violence for the 2018 calendar year overall (15+ years of age) and stratified by different age groups.
- The survey observations that were included to inform estimates and the adjustment factors (i.e., odds ratio) that were used to make the survey observations comparable where required.
- A table that indicates if any surveys were excluded and the reason justifying exclusion.
- Plots comparing the statistical model's estimates of lifetime and past year intimate partner violence among ever-partnered/married women aged 15-49 years with the available survey observations. In general, model predictions are in good concordance with the survey estimates. Most differences can be explained considering the representativeness of the survey, its denominator (i.e., all women vs ever partnered/married, or different age groups), and definition of intimate partner violence (i.e., physical intimate partner violence only).

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Appendix A - Adjustment factors

Table A. Results of random effects meta-analysis for different adjustment factors, stratified by super regions, for lifetime intimate partner violence (IPV) and past year IPV.

Adjustment factors by super regions (and overall)	Lifetime IPV OR (95%CI)	Past year IPV OR (95%CI)
Severe violence (ref. all severity levels) §		
Central Europe, Eastern Europe & Central Asia	0.35 (0.27-0.46)	0.39 (0.34-0.45)
High Income	*NA*	*NA*
Latin America & Caribbean	0.57 (0.45-0.73)	0.62 (0.56-0.69)
North Africa & Middle East	0.35 (0.29-0.42)	0.47 (0.34-0.64)
South Asia	0.24 (0.14-0.39)	0.52 (0.44-0.61)
South-East Asia, East Asia & Oceania	0.36 (0.25-0.50)	0.57 (0.48-0.67)
Sub-Saharan Africa	0.37 (0.33-0.42)	0.61 (0.58-0.64)
Overall	0.39 (0.33-0.46)	0.57 (0.55-0.60)
Physical IPV (ref. physical and/or sexual IPV)		
Central Europe, Eastern Europe & Central Asia	0.94 (0.92-0.96)	0.95 (0.92-0.97)
High Income	0.84 (0.81-0.87)	0.72 (0.62-0.84)
Latin America & Caribbean	0.90 (0.87-0.93)	0.84 (0.80-0.88)
North Africa & Middle East	0.94 (0.90-0.97)	0.86 (0.79-0.94)
South Asia	0.82 (0.73-0.93)	0.79 (0.70-0.90)
South-East Asia, East Asia & Oceania	0.79 (0.73-0.84)	0.78 (0.73-0.83)
Sub-Saharan Africa	0.82 (0.78-0.86)	0.79 (0.76-0.82)
Overall	0.85 (0.83-0.87)	0.81 (0.79-0.83
Sexual IPV (ref. physical and/or sexual IPV)		
Central Europe, Eastern Europe & Central Asia	0.20 (0.17-0.24)	0.18 (0.15-0.23)
High Income	0.30 (0.19-0.46)	0.24 (0.18-0.30)
Latin America & Caribbean	0.26 (0.23-0.30)	0.32 (0.28-0.36)
North Africa & Middle East	0.19 (0.14-0.26)	0.26 (0.16-0.41)
South Asia	0.28 (0.21-0.37)	0.34 (0.27-0.44)
South-East Asia, East Asia & Oceania	0.31 (0.26-0.36)	0.35 (0.28-0.44)
Sub-Saharan Africa	0.26 (0.24-0.29)	0.31 (0.28-0.35)
Overall	0.26 (0.24-0.28)	0.30 (0.28-0.33)
All women surveyed (ref. ever-partnered)		
Central Europe, Eastern Europe & Central Asia	*NA*	*
High Income	0.95 (0.94-0.97)	*
Latin America & Caribbean	0.77 (0.76-0.78)	*
North Africa & Middle East	*NA*	*
South Asia	0.83 (0.82-0.85)	*
South-East Asia, East Asia & Oceania	0.69 (0.63-0.76)	*
Sub-Saharan Africa	0.77 (0.68-0.88)	*
Overall	0.79 (0.74-0.84)	*

95%CI: 95% confidence interval; IPV: intimate partner violence; OR: odds ratio; VAW: violence against women.
§The adjustment factors for past year severe IPV is based on the analyses of microdata of *Demographic and Health Surveys* (DHS) where the definition of severe physical and/or sexual violence includes punching, kicking/dragging, trying to strangle/burn, threatening with a weapon, attacking with weapon, and any type of sexual violence.
*Matching for past year IPV for the population surveyed (all women) did not result in any match. The OR for lifetime IPV are used instead as adjustment factors in the regression.

Table A (con't). Results of random effects meta-analysis for different adjustment factors, stratified by super region, for lifetime intimate partner violence (IPV) and past year IPV.

Adjustment factors by super regions (and overall)	Lifetime IPV OR (95%CI)	Past year IPV OR (95%CI)
Currently partnered women surveyed (ref. ever-partnered)		
Central Europe, Eastern Europe & Central Asia	0.81 (0.71-0.92)	0.88 (0.80-0.98)
High Income	*NA*	*NA*
Latin America & Caribbean	0.85 (0.80-0.90)	0.89 (0.82-0.96)
North Africa & Middle East	0.94 (0.91-0.99)	1.00 (0.99-1.02)
South Asia	0.98 (0.97-0.98)	1.06 (1.04-1.07)
South-East Asia, East Asia & Oceania	0.92 (0.89-0.96)	1.00 (0.98-1.02)
Sub-Saharan Africa	0.93 (0.92-0.94)	1.02 (1.00-1.04)
Overall	0.91 (0.90-0.93)	0.99 (0.97-1.01)
Partner is current or most recent (ref. any current or previous partners)		
Central Europe, Eastern Europe & Central Asia	0.94 (0.94-0.95)	0.93 (0.82-1.06)
High Income	*NA*	0.69 (0.55-0.85)
Latin America & Caribbean	0.82 (0.71-0.95)	0.99 (0.98-1.00)
North Africa & Middle East	0.99 (0.97-1.01)	*NA*
South Asia	0.96 (0.95-0.97)	*NA*
South-East Asia, East Asia & Oceania	0.88 (0.82-0.95)	0.99 (0.99-1.00)
Sub-Saharan Africa	0.89 (0.86-0.92)	0.98 (0.95-1.01)
Overall	0.88 (0.83-0.93)	0.97 (0.95-1.00)
Geographical urban strata (ref. nationally representative)		
Central Europe, Eastern Europe & Central Asia	0.97 (0.88-1.07)	0.92 (0.84-1.02)
High Income	*NA*	*NA*
Latin America & Caribbean	1.06 (0.97-1.16)	1.05 (0.96-1.14)
North Africa & Middle East	0.85 (0.77-0.93)	0.86 (0.79-0.94)
South Asia	0.76 (0.70-0.84)	0.77 (0.71-0.84)
South-East Asia, East Asia & Oceania	0.91 (0.83-1.00)	0.92 (0.84-1.01)
Sub-Saharan Africa	0.99 (0.91-1.08)	0.98 (0.90-1.07)
Overall	0.92 (0.84-1.00)	0.91 (0.84-0.99)
Geographical rural strata (ref. nationally representative)		
Central Europe, Eastern Europe & Central Asia	1.01 (0.93-1.09)	1.03 (0.97-1.10)
High Income	*NA*	*NA*
Latin America & Caribbean	0.89 (0.83-0.96)	0.93 (0.88-0.98)
North Africa & Middle East	1.13 (1.06-1.22)	1.09 (1.03-1.15)
South Asia	1.14 (1.06-1.22)	1.13 (1.07-1.20)
South-East Asia, East Asia & Oceania	1.04 (0.96-1.12)	1.03 (0.97-1.09)
Sub-Saharan Africa	1.00 (0.94-1.07)	1.01 (0.95-1.06)
Overall	1.03 (0.96-1.10)	1.03 (0.98-1.09)

95%CI: 95% confidence interval; IPV: intimate partner violence; OR: odds ratio; VAW: violence against women.