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Methodology Report

World Contraceptive Use 2024

Estimates and Projections of Family Planning Indicators 2024

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United Nations Department of Economic and Social Affairs, Population Division

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PREFACE

The United Nations Population Division has published comprehensive global data compilations and estimates of family planning indicators since 2003. The work forms part of monitoring the progress of the international community in advancing sexual and reproductive health and reproductive rights, which was emphasised as key to ensure the well-being of individuals and their families by the International Conference on Population and Development in 1994 in Cairo and its Programme of Action.

This report provides a detailed overview of the methodology used to produce the *2024 Revision of World Contraceptive Use and Estimates and Projections of Family Planning Indicators*. It summarizes the approach used by the United Nations Population Division to compile survey-based estimates and produce model-based estimates and projections. After a brief overview of the strategy describing the process of the biennial revisions, chapter 2 presents the data set of survey-based estimates and chapter 3 presents the methodology of the statistical model that is used to produce the data set of model-based annual estimates and projections.

The compilation of survey observations and the estimates and projections of family planning indicators were prepared by a team led by Vladimíra Kantorová, including Joseph Molitoris, María del Rocío Peinador Roldán and Mark Wheldon of the Population Division, building on earlier revisions. Input on data was provided by Yumiko Kamiya and Guangyu Zhang of the Population Division. Assistance on programming was provided by Kyaw Kyaw Lay.

The Population Division is grateful for the data and comments on the World Contraceptive Use 2024 revision provided by the following individuals (in alphabetical order): María José Benegas Mateo (Universidad Nacional de Educación a Distancia, Spain), Mariana Cruz Carrillo (Universidad de Costa Rica), Tina Fetner (McMaster University, Canada), Reiko Hayashi and Mio Iwasawa (National Institute of Population and Social Security Research, Japan), Eun Jung Kim (Korea Institute for Health and Social Affairs, Republic of Korea), Lucia Ratih Kusumadewi (Universitas Indonesia, Indonesia), Angela Isabel Peña Farias (UNICEF, Cuba) and Evelyn Ramirez Hernandez (Oficina Nacional de Estadísticas, Cuba).

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EXPLANATORY NOTES

The following symbols have been used in the tables throughout this report:

A full stop (.) is used to indicate decimals.
Years given refer to July 1 or the civil calendar year by default.

References to countries, territories and areas:

The designations employed in this publication and the material presented in it do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The term "country" as used in this publication also refers, as appropriate, to territories or areas.

In this table, data for countries or areas have been aggregated in six continental regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. Further information on continental regions is available from https://unstats.un.org/unsd/methodology/m49/. Countries or areas are also grouped into geographic regions based on the classification being used to track progress towards the Sustainable Development Goals of the United Nations (see: https://unstats.un.org/sdgs/indicators/regional-groups/).

The designation of "more developed" and "less developed" regions is intended for statistical purposes and does not express a judgment about the stage reached by a particular country or area in the development process. More developed regions comprise all regions of Europe plus Northern America, Australia and New Zealand and Japan. Less developed regions comprise all regions of Africa, Asia (excluding Japan), and Latin America and the Caribbean as well as Oceania (excluding Australia and New Zealand).

The group of Least Developed Countries (LDCs) includes 45 countries: 32 in Sub-Saharan Africa, 2 in Northern Africa and Western Asia, 4 in Central and Southern Asia, 3 in Eastern and South-Eastern Asia, 1 in Latin America and the Caribbean, 3 in Oceania (as accessed on 8 May 2024). Further information is available from https://www.un.org/ohrlls/content/least-developed-countries.

The group of Landlocked Developing Countries (LLDCs) is composed of 32 countries or territories: 16 in Sub-Saharan Africa, 2 in Northern Africa and Western Asia, 8 in Central and Southern Asia, 2 in Eastern and South-Eastern Asia, 2 in Latin America and the Caribbean, and 2 in Europe and Northern America (as accessed on 8 May 2024). Further information is available from https://www.un.org/ohrlls/content/landlocked-developing-countries.

The group of Small Island Developing States (SIDS) is composed of 57 countries or territories: 29 in the Caribbean, 20 in the Pacific and 8 in the Atlantic, Indian Ocean and South China Sea (AIS) (as accessed on 8 May 2024). Further information is available from https://www.un.org/ohrlls/content/small-island-developing-states.

The country classification by income level is based on the GNI per capita from the World Bank (as accessed on 8 May 2024). Further information is available from https://datahelpdesk.worldbank.org/knowledgebase/articles/906519.

The following abbreviations have been used:

COVID-19	Coronavirus Disease 2019
CP	Contraceptive Prevalence
CPS	Contraceptive Prevalence Survey
DHS	Demographic and Health Surveys
FFS	Fertility and Family Survey
GGS	Generations and Gender Survey
GNI	Gross National Income
IUD	Intra-Uterine Device
LAM	Lactational Amenorrhea Method
LDCs	Least Developed Countries
LLDCs	Landlocked Developing Countries
LOWESS	Locally Weighted Regression
MCMC	Markov chain Monte Carlo
MICS	Multiple Indicator Cluster Survey
PMA	Performance Monitoring and Accountability Survey
RHS	Reproductive Health Survey
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
UMN	Unmet Need for Family Planning
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNICEF	United Nations Children's Fund
WFS	World Fertility Survey

INTRODUCTION

The United Nations Population Division has published comprehensive global data compilations and estimates of family planning indicators since 2003. The work forms part of monitoring the progress of the international community in advancing sexual and reproductive health and reproductive rights which was emphasised as key to ensure the well-being of individuals and their families by the International Conference on Population and Development in 1994 in Cairo and its Programme of Action (United Nations 1994) that was adopted by the United Nations General Assembly in 1995 (United Nations 1995).

In 2005, the Millennium Development Goals (United Nations, n.d. [a]) added under Goal 5 (improve maternal health) the Target 5.B which called for achieving universal access to reproductive health by 2015. Progress towards this target was assessed by two additional indicators: Indicator 5.3 *Contraceptive Prevalence* and Indicator 5.6 *Unmet Need for Family Planning*. The Population Division was the custodian agency for monitoring of these two indicators, in partnership with the United Nations Population Fund (UNFPA).

In 2015, the 2030 Agenda for Sustainable Development (United Nations, 2015) included under Goal 3, (Health) Target 3.7, which calls for the universal access to reproductive health-care services, including family planning, and the integration of reproductive health into national strategies and programmes. The Population Division is the custodian agency for the global monitoring of Sustainable Development Goal (SDG) Indicator 3.7.1: *Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods* that is used to monitor progress towards this target.

For the purpose of monitoring internationally agreed development goals and analysing the progress made towards these goals, the Population Division produces two data sets on family planning indicators. The 2024 revision was released in July 2024. The data set *World Contraceptive Use* is a comprehensive compilation of available survey-based family planning estimates on the country level. The data set *Estimates and Projections of Family Planning Indicators* provides model-based estimates and projections on the national, regional and global level. Originally, these data sets were available for women of reproductive age who were married or in a union. Since the 2017 revision, survey-estimates and model-based estimates of family planning indicators are provided as well for all women and unmarried women of reproductive age.

For the purpose of global monitoring of SDG Indicator 3.7.1, the Population Division provides for each country, a compilation of survey-based estimates from 2000 to the most recent survey available, and for regional and global aggregates model-basedestimates from 2000 to the current year. These data, including respective metadata information, are accessible from the dissemination platform of the Global Sustainable Development Goal Indicators Database (United Nations, n.d [b]).

This methodology report summarizes the methods used by the United Nations Population Division to compile survey-based estimates and produce model-based estimates and projections. After a brief overview of the strategy describing the process of the biennial revisions, chapter 2 presents the data set of survey-based estimates,*World Contraceptive Use,* and chapter 3 presents the methodology of the statistical model that is used to produce the data set of model-based estimates, *Estimates and Projections of Family Planning Indicators*.

I. GENERAL ANALYTICAL STRATEGY AND MAJOR STEPS FOR PRODUCING THE DATA SETS

The strategy of the United Nations Population Division to arrive at the biennial publication of survey observations as well as model-based estimates and projections of family planning indicators, can be categorised broadly into five steps (figure I.1):

1. Compile and asses the quality of all available data on relevant family planning indicators from nationally representative surveys. Where possible, survey observations are derived from primary data either by directly working with microdata (information at the individual respondent level), or by consulting with the institutions responsible for data collection to receive bespoke tabulations. Prepare standard errors for family planning indicators from microdata.

2. Where necessary, make adjustments to standardize family planning indicators across surveys. If adjustment is not possible, document deviations from standard definitions and assign biases.

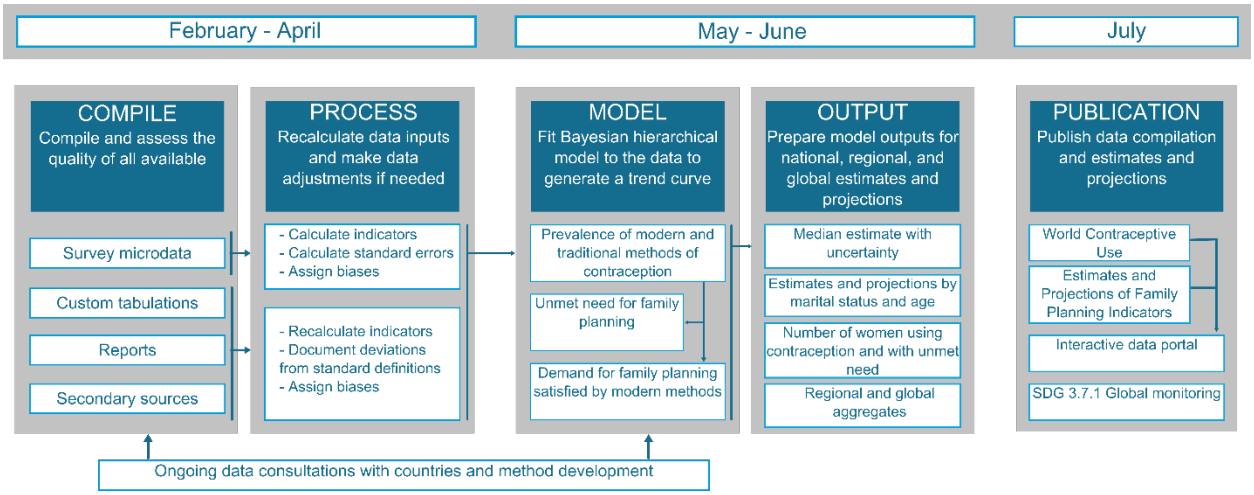
3. Fit a Bayesian hierarchical model to the standardized data to generate estimates of contraceptive prevalence (of modern and traditional methods) and unmet need for family planning.

4. Prepare model outputs for national, regional and global estimates and projections, including annual median estimates by marital status from 1990 to 2030 with 95 per cent and 80 per cent uncertainty intervals for publication. Regional and global estimates are aggregated from country level model estimates.

5. Publish the biennial revisions of *World Contraceptive Use* and the *Estimates and Projections of Family Planning Indicators*. Both publications are available in excel format from on the Population Division website (https://www.un.org/development/desa/pd/content/family-planning-0 and in database format through the Population Division's interactive data portal (https://population.un.org/dataportal/home). Prepare the data set for the global monitoring of Sustainable Development Goal indicator 3.7.1, with survey-based estimates at the country level and model-based estimates at the regional and global level.

The process, from the start of data compilation to the publication of data sets, usually takes place between February and July.

Figure I.1 Strategy for the biennial publications of World Contraceptive Use and Estimates and Projections of Family Planning Indicators



II. COMPILATION OF WORLD CONTRACEPTIVE USE DATA SET

A. INDICATOR DEFINITIONS

World Contraceptive Use contains estimates calculated from nationally representative household surveys for the following indicators: contraceptive prevalence (total, modern and traditional), the unmet need for family planning (total) and the demand for family planning that was satisfied by using modern methods of contraception. Whenever possible, the indicators are disaggregated by marital status and age. Information on contraceptive prevalence by method and unmet need for spacing and for limiting, is presented for women who were married or in a union at the time the information was collected.

The family planning indicators of contraceptive prevalence (modern/traditional), unmet need for family planning and need for family planning met by modern methods are compiled for several categories of marital status and by five-year age groups. The *All women* category pertains to all women of reproductive age (from 15 to 49 years). The *Married/In-union* category pertains to women who are married (defined in relation to the marriage laws or customs of a country) and to women in a union, which refers to women living with their partner in the same household (also referred to as cohabiting unions, consensual unions, unmarried unions, or "living together"). The *Unmarried/Not-in-union* category pertains to women who are not married and not in a union and is a complement to the *Married/In-union* category. Notes on the survey population included in the data set indicate when estimates refer to a non-standard category.

1. Contraceptive prevalence

Contraceptive prevalence (CP_{any}) is the proportion of women who are currently using, or whose sexual partner is currently using, at least one method of contraception, regardless of the method being used. It is reported as a percentage of the women of the respective marital status and age group and is calculated as:

$$CP_{any} = \frac{U_m + U_t}{P} \times 100 \quad (1)$$

where U = Number of women of a given marital status and age-group using a modern method of contraception (m) or a traditional method of contraception (t) and P = Number of women of a given marital status and age-group.

For analytical purposes, contraceptive methods are often classified as either modern or traditional. Modern methods of contraception include female and male sterilization, intra-uterine devices (IUD), implants, injectables, oral contraceptive pills, male and female condoms, vaginal barrier methods (including the diaphragm, cervical cap and spermicidal foam, jelly, cream and sponge), the lactational amenorrhea method (LAM), emergency contraception and other modern methods not reported separately (e.g., the contraceptive patch or vaginal ring). Traditional methods of contraception include rhythm (e.g., fertility awareness-based methods, periodic abstinence), withdrawal and other traditional methods not reported separately. A detailed explanation of these methods is provided in the World Health Organization Department of Reproductive Health and Research and the Johns Hopkins Bloomberg School of Public Health/Center for Communication Programs (2018).

Among women who are married/in-union, this data set presents levels of contraceptive prevalence for individual methods, any modern method, any traditional method, and any method (modern or traditional). In some cases, data for specific methods are not available, and the corresponding missing values are designated in the database by two dots (..). Notes on data in "Contraceptive use: residuals" indicate if the method is included in the respective residual category.

2. Unmet need for family planning

Unmet need for family planning (*UMN*) measures the gap between women's reproductive intentions and their contraceptive behaviour. It is defined as the proportion of women who want to stop or delay childbearing but are not using any method of contraception. In this data set, it is reported as a percentage of the women of the respective marital status and age group, and is calculated using the following formula:

$$UMN = \frac{P_u}{P} \times 100 \quad (2)$$

where P_u = Number of women of a given marital status and age-group who have a need for family planning, but are not using any form of contraception and P = Number of women of a given marital status and age-group.

The standard definition of unmet need for family planning includes in the numerator women who are fecund and sexually active, and who report not wanting any (more) children, or who report wanting to delay the

birth of their next child for at least two years or are undecided about the timing of the next birth, but who are not using any method of contraception. The numerator also includes:

- Pregnant women whose pregnancies were unwanted or mistimed at the time of conception; and
- Postpartum amenorrheic women who are not using family planning and whose last birth was unwanted or mistimed.

Infecund women are excluded from the numerator. Women are assumed to be infecund if:

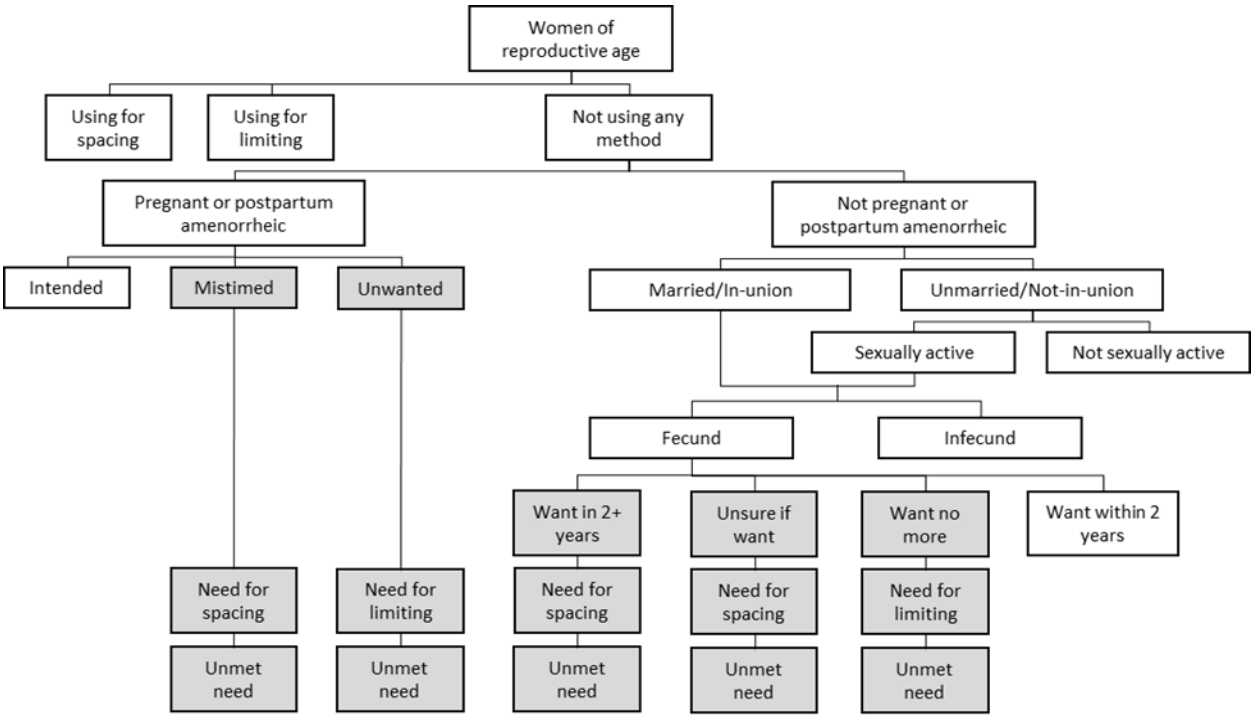
- They were married for more than five years ago, have not had a birth in the past five years, are not currently pregnant, and have never used any kind of contraceptive method; or
- They report being infecund or menopausal, having had a hysterectomy, never having menstruated, or being postpartum amenorrheic for five years or longer; or
- For women who are not pregnant or in postpartum amenorrhea, they report that their last menstrual period occurred six months or more prior to the survey.

Postpartum amenorrheic women are women who have not had a menstrual period since the birth of their last child, if the birth occurred in the period 0-23 months prior to the survey interview. If their period has not returned 24 months or more after the previous birth, women are considered fecund, unless they fall into one of the infecund categories above.

Women who are married or in a union are assumed to be sexually active. For unmarried women, it is necessary to determine the timing of their most recent sexual activity. Unmarried women who are not pregnant or postpartum amenorrheic are considered currently at risk for pregnancy (and thus could be potentially included in the numerator as having unmet need) if they have had intercourse in the four weeks prior to the survey interview. Unmet need for unmarried women who are pregnant or postpartum amenorrheic is determined in the same way as for married women and regardless of their most recent sexual activity. Unmarried pregnant women whose pregnancies were unwanted or mistimed at the time of conception; and unmarried postpartum amenorrheic women who are not using family planning and whose last birth was unwanted or mistimed are assumed to have an unmet need.

The diagram below indicates the procedure set out by the Demographic and Health Survey (DHS) programme (figure II.1) for computing the number of women of reproductive age who have an unmet need for family planning (referred to as the 2012 DHS definition). These data are available for Demographic and Health Surveys from Round 2 and for Multiple Indicator Cluster Surveys from Round 4 for married/in-union women and from Round 5 also for unmarried/not-in-union women of reproductive age.

Figure II.1 2012 DHS revised definition of the unmet need for family planning indicator



***Source*: Based on Bradley and others (2012). Revising Unmet Need for Family Planning. DHS Analytical Studies No. 25, Calverton, Maryland: ICF International.**

When the unmet need for family planning is measured in a comparable way at different dates, the trend indicates whether there has been progress towards meeting women's needs for family planning. Nevertheless, even when contraceptive prevalence is rising, the unmet need for family planning may not decline, and it may even increase. This happens because in many populations the need for family planning increases with a decline in the number of children desired (National Research Council, 2001). Changes in the desired spacing of births or in the percentage of women who are at risk of pregnancy also influence the trend in the need for family planning, independently of trends in contraceptive prevalence.

Further information on the history of refinements in the operational definition of the unmet need for family planning, as well as survey questions and statistical programmmes needed to derive the indicator, can be found on the Demographic and Health Survey Program website: https://dhsprogram.com/topics/Family-Planning.cfm.

3. Demand for family planning satisfied by modern methods

The demand for family planning that is satisfied by using modern methods of contraception (NS_m) is defined as the number of women who are currently using, or whose sexual partner is currently using, at least one modern contraceptive method as a proportion of the number of women of reproductive age who have a demand for family planning, either by using any method of contraception or by having an unmet need for family planning, as defined above.

$$UMN = \frac{P_u}{P} \times 100 \quad (3)$$

This is the SDG Indicator 3.7.1. *Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods.*

B. DATA AVAILABILITY

The data presented in the 2024 revision pertain to 1,464 observations from 200 countries or areas of the world for the period from 1950 to 2023 and were updated as of 30 June 2024. This dataset supersedes previously published versions. Data availability varies across the different marital status categories.

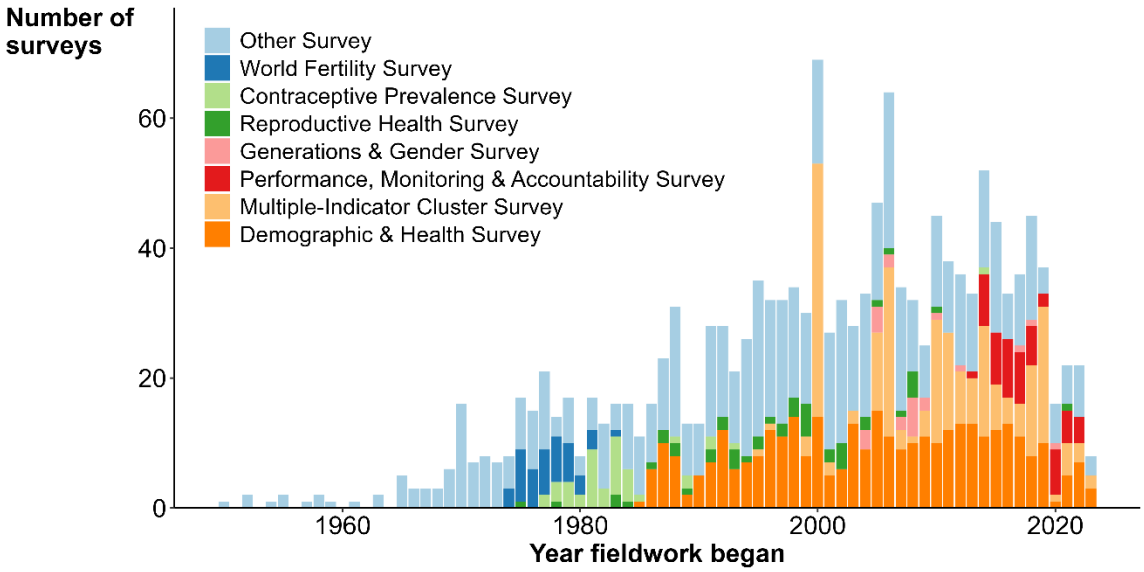
Table II.1 Number of data points on contraceptive prevalence and unmet need for family planning and number of countries covered.

Marital Status	*Contraceptive use*		*Unmet need for family planning*	
	Number of data points	*Number of countries*	*Number of data points*	*Number of countries*
All women	739	157	352	95
Married/In-union	1346	187	669	153
Unmarried/Not-in-union	657	140	349	95

C. DATA SOURCES

The indicators presented in the *World Contraceptive Use* data set have been obtained from nationally representative household surveys. Much of the information was obtained from multi-country survey programmes that routinely collect the necessary data, including the Contraceptive Prevalence Surveys (CPS), the Demographic and Health Surveys (DHS), the Fertility and Family Surveys (FFS), the Generations and Gender Survey (GGS), the Reproductive Health Surveys (RHS), the Multiple Indicator Cluster Surveys (MICS), the Performance Monitoring and Accountability surveys (PMA), and the World Fertility Surveys (WFS). Additional information was provided by other international survey programmes and national surveys (see figure II.2).

Figure II.2 Sources of survey observations in *World Contraceptive Use,* 2024



D. DATA LIMITATIONS AND COMPARABILITY OVER TIME AND ACROSS COUNTRIES

Differences in survey design and implementation, and in the representativeness of the samples, can affect the comparability of survey-based estimates over time and between countries. The survey-based estimates of family planning indicators can also, in some cases, be affected by rounding and small sample population size of the surveys.

Generally, there is no discrepancy between the survey-based estimates presented in *World Contraceptive Use* and those published in national survey reports. However, in some cases, the estimates published by the United Nations have been adjusted to improve comparability. Notes included in the dataset indicate when adjustments were made and where the survey data differed from standard definitions.

Where available, microdata for the DHS, MICS, PMA and GGS surveys and some national surveys, were used to calculate family planning indicators. Survey variables related to family planning indicators for DHS and MICS surveys were harmonised over time and across countries. Estimates produced from microdata are not presented in the data set when the number of events and the sample population size of specific age and marital status combinations are too small to yield reliable estimates. First, family planning indicators are not presented for any combination of marital status and age group that has fewer than 50 cases. Second, the estimates of demand for family planning satisfied by modern methods are presented only for the combination of age group and marital status for which the total demand for family planning (contraceptive prevalence of any method plus unmet need for family planning) is greater than 5 per cent. Furthermore, in cases where the total number of contraceptive users of any marital status and age category is less than 10 women, the estimates of family planning indicators are not published.

Where no microdata was available, family planning indicators were obtained from survey reports, secondary sources or externally provided custom tabulations. Family planning indicators are often not reported for unmarried women separately. In these cases, estimates were calculated indirectly based on the published tabulations of the contraceptive prevalence among all women and married/in-union women, weighted by the numbers of women of respective marital status and age. Notes included in the data set indicate when estimates were produced using this approach.

One of the most common differences in the measurement of contraceptive prevalence relates to the range of contraceptive methods included and the existence of questions to probe the types of methods used. The lack of probing questions, which are asked to ensure that the respondent understands the meaning of the different contraceptive methods, can result in an underestimation of contraceptive prevalence.

The time frame used to assess contraceptive prevalence may also vary. Often times, it is left to the respondent to determine what is meant by "currently using" a method of contraception. Some surveys ask specifically about use within the past month. Occasionally, when information on current use is not collected, data on the use of contraceptive methods at last sexual intercourse or during the previous year are utilized for estimating the prevalence of use at the time of the survey.

Differences in the questions asked may also affect estimates of the unmet need for family planning and make comparability difficult over time or across countries. For example, some surveys do not gather all of the information required to estimate infecundity in the same way. Differences in questions about contraceptive prevalence, fertility desires and assessment of postpartum amenorrhea may also affect the estimated level of unmet need for family planning and, as a consequence, of the demand satisfied by modern methods.

Although the majority of estimates of the unmet need for family planning follow the standard method of calculation, there can be differences in the definition used for calculating this indicator. For instance, some surveys do not include pregnant women with a mistimed or unwanted pregnancy in the count of women with an unmet need for family planning.

The specification of some of the characteristics of the study population (age groups or definitions of marital or union status categories) can also affect the comparability of estimates for these indicators. Alternative reference populations used include all sexually active women (irrespective of marital status), women with a partner (cohabiting or not), and ever-married women. In the *World Contraceptive Use* data set, pertinent notes indicate any deviations from the standard definitions of the indicators or of the populations represented.

E. THE IMPACT OF THE COVID-19 PANDEMIC ON SURVEY ACTIVITIES

The COVID-19 pandemic significantly disrupted survey activities. Many surveys, including those in Cambodia, Côte d'Ivoire, Egypt, Jamaica, Japan, Madagascar, Niger, Peru or the Republic of Moldova, experienced delays of up to two years. These delays sometimes affected the sample representativeness, necessitating adjustments to data weighting (e.g., Guadeloupe, French Guiana, Martinique or Viet Nam). Survey teams adopted various strategies to adapt, such as implementing individual protective measures

(masks, hand sanitizer) or modifying data collection methods (smaller training groups, phone interviews). However, reporting on these adjustments varied, making it challenging to fully assess the pandemic's impact on data quality (Breton and others, 2023; Central Agency for Public Mobilization and Statistics, 2022; General Statistics Office and UNICEF, 2021; Institut National de la Statistique and ICF, 2023; Institut National de la Statistique and ICF, 2022; Institut National de la Statistique and Utica International, 2022; Instituto Nacional de Estadística Informática, 2021; Marie and others, 2023a; Marie and others, 2023b; National Institute of Population and Social Security Research, 2023; National Institute of Statistics, Ministry of Health and ICF, 2023).

The disruption of survey activities is reflected in the data availability for the *World Contraceptive Use 2024*. While the data set contains 37 surveys from year 2019, there are less than a half surveys (16 surveys) for year 2020 and 22 surveys for years 2021 and 2022 each (figure II.2).

III. PREPARATION OF ESTIMATES AND PROJECTIONS OF FAMILY PLANNING INDICATORS DATA SET

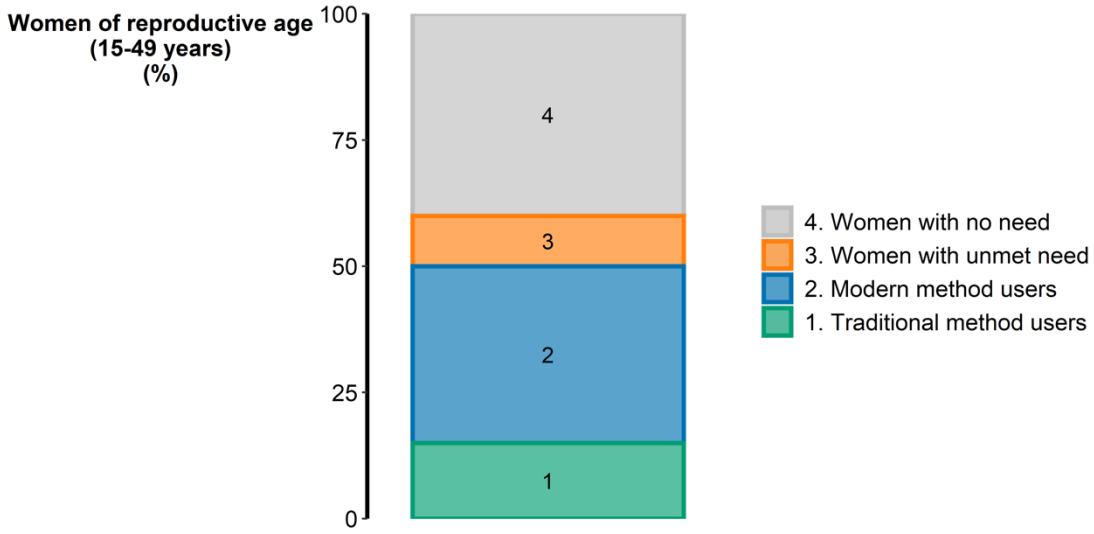
Differences in survey design and implementation, the representativeness of the samples, the methods of calculation, and systematic errors due to misreporting and misclassification, can affect the comparability of survey-based estimates over time and between countries. As a result, different surveys often yield widely different estimates of family planning indicators for a given time period. In order to fill data gaps and to take better account of the systematic biases associated with the various types of data inputs, a Bayesian hierarchical model was used to estimate and project contraceptive prevalence and the unmet need for family planning among women aged 15 to 49 years. The model allows an assessment of uncertainty in the estimates based on the availability and quality of input data: they allow for greater precision in cases where more and better data is available and indicate the degree of uncertainty in situations where the data are insufficient or are from sources more susceptible to systematic differences as captured by the biases assigned to each survey-based data point (Alkema and others, 2013). The estimates for women who are married or in a union were produced using the model described in Alkema and others (2013) and Cahill and others (2017). The estimates for unmarried and not-in-union women were produced using the method described in Kantorová and others (2020). The main features of these models are described below.

A. MODELLING CONTRACEPTIVE USE AND UNMET NEED OVER TIME AND COUNTRIES

1. Time trends in contraceptive use and unmet need for family planning

For each country, the models generated estimates of the following proportions for women aged 15-49: i) the proportion of women aged 15–49 using any method of contraception; ii) the proportion of (i) using any modern method; iii) the proportion of non-users experiencing unmet need for family planning. These are refered to as the *modelled parameters.* Together with a fourth, the proportion with no need for any method of contraception, these categories account for the whole target population. Moreover, in each country in each year and for each marital group, the proportions sum to 100 per cent across the population of women aged 15–49 (figure III.1). Only three categories needed to be modelled because the fourth could be determined from the other three and the constraint that all four sum to 100 per cent.

Figure III.1 The four categories used to model contraceptive use among women aged 15–49.



***Note*: The categories are mutually exclusive and exhaustive; in each country in each year, and for each marital group, the proportions sum to 100 per cent across the population of women aged 15–49.**

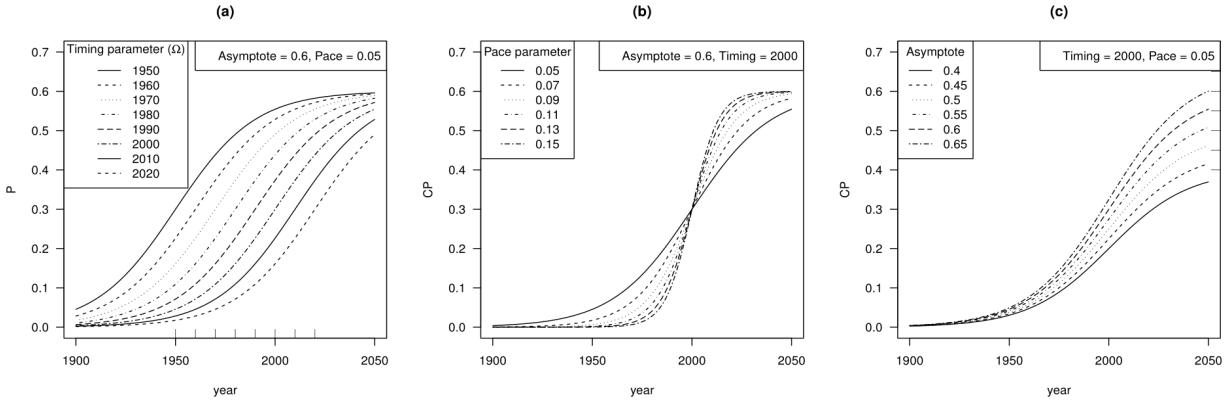
The time trends for (i) and (ii) were modelled using logistic curves. These are "S"-shaped curves that capture the underlying transition from a state of very low contraceptive prevalence, through a period of growth, to an eventual maximum level. A separate pair of curves was estimated for each country allowing the rate of growth, the timing, and the long-run maximum levels to vary as the data indicated.

Logistic curves can be defined by the following mathematical relationship:

$$Y^*_{c,t} = \frac{\tilde{Y}_c}{1 + \exp\left(-\psi_c(t - \Psi_c)\right)} \qquad (4)$$

The three parameters are $\tilde{Y}_c$, the asymptote or long-run stable value, ψ_c, the pace of the transition, and Ψ_c, the timing of the transition. All are subscripted by c to indicate that they are country-specific. $Y^*_{c,t}$ is subscripted by c and t because it is a country-specific time trend. Estimates and projections are produced for all countries so one triplet of parameters for each country was included in the modelled parameter set. The effect each of these parameters has on the logistic curve is illustrated in figure III.2. Each panel illustrates the curves that correspond to different values of one of the parameters, holding the other two constant.

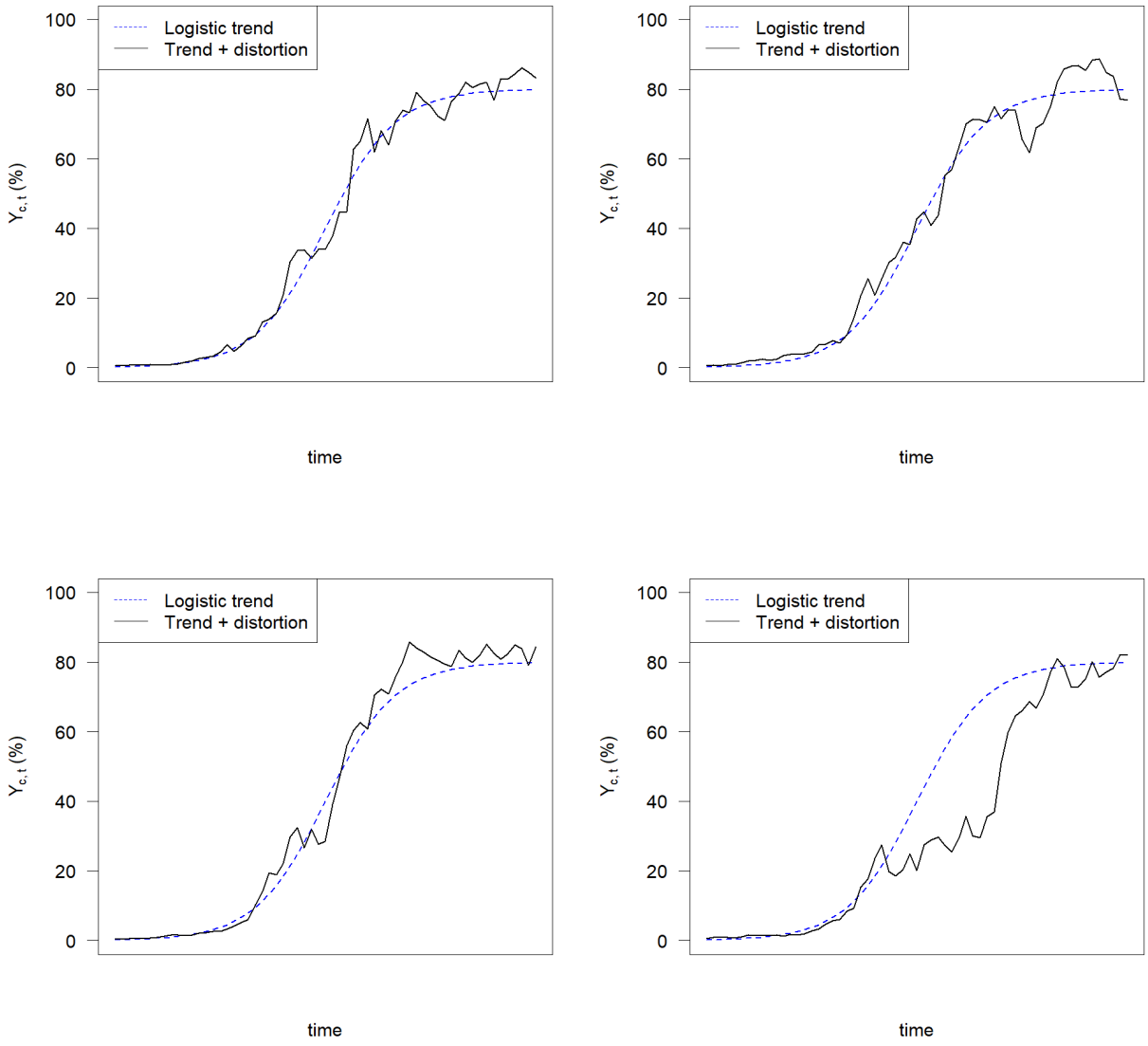
Figure III.2 Stylized logistic curves under different values of each of the three logistic parameters: (a) timing; (b) pace; (c) asymptote. In each panel, one parameter is changed and the other two are held constant at the values specified



The model did not assume, nor impose the condition, that all countries move through the entire curve during the period of interest (1970–2030). Many countries, for example, remained in the state of low prevalence across the whole time period of interest, including to the end of the projection. In these cases, only a portion of the logistic curve was used to model the components. The extent of the curve used was determined by the country-level data through the statistical model.

Deviations from the (partial) logistic trends were accommodated by additional auto-correlated error processes. These allowed the model-based estimates of the proportion of women aged 15–49 using any method of contraception and the proportion of users using any modern method to deviate from the smooth logistic trend where the data indicated this was happening. Stylized examples of possible "trend + error" outputs from the model are shown in figure III.3.

Figure III.3 Stylized example of a logistic trend curve plus several examples of autocorrelated error processes.



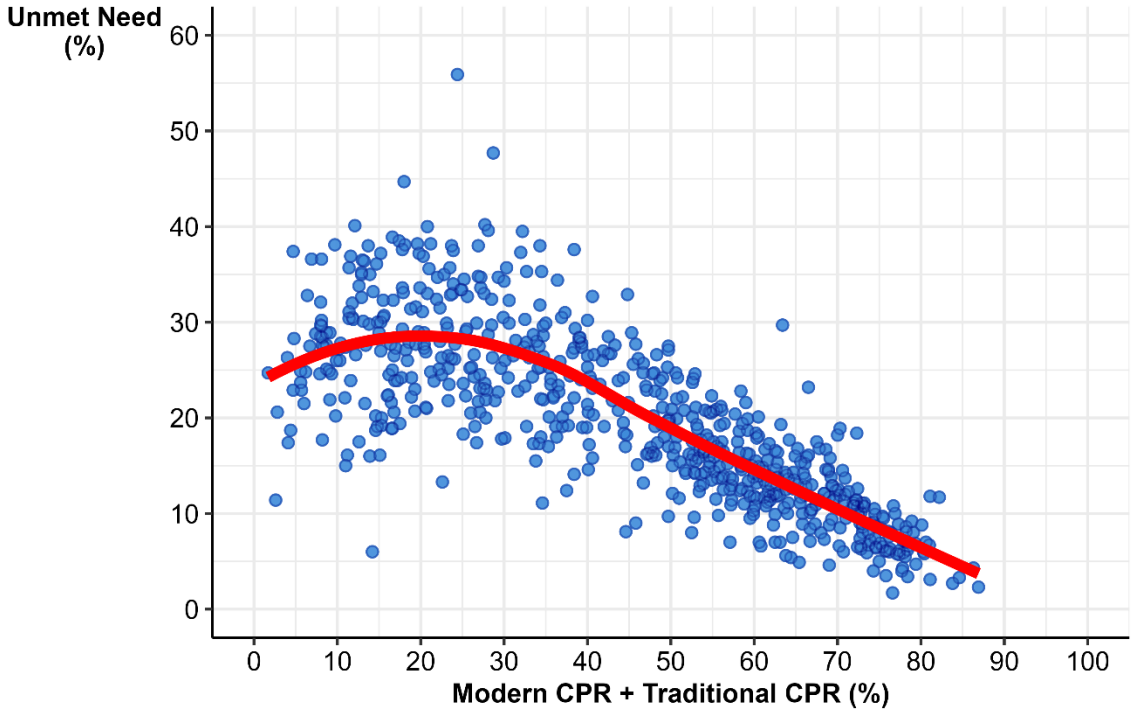
The systematic trend are the blue dashed lines, the 'trend + error' processes are the solid black lines. The systematic time trend for the proportion of non-users experiencing unmet need for family planning, denoted here as $\boldsymbol{Z^*_{c,t}}$, was modelled as a function of contraceptive prevalence, denoted $\boldsymbol{P_{c,t}}$, using the relationship:

$$Z^*_{c,t} = \frac{1}{1 + \exp\left(-z_c - \beta_1\left(P_{c,t} - 0.4\right) - \beta_2\left(P_{c,t} - 0.4\right)^2\right)} \tag{5}$$

This was based on theoretical reasoning about the relationship between these two indicators. The reasoning was that, as prevalence increases, there will be a concomitant increase in unmet need due to an increased

need for, and awareness of, contraception, as it becomes more common in the population. At a certain level of contraceptive prevalence, unmet need reaches a turning point and begins to decline as availability, accessibility, and acceptability of contraception improves and use increases further. This assumption is supported by the empirical data collected in *World Contraceptive Use* (figure III.4). The model used encapsulates this relationship. The parameters β_1 and β_2 were estimated from the data through the statistical model in the same way as all the other model parameters. Like the logistic curve parameters, an auto-correlated error process was added to $Z^*_{c,t}$ to ensure the model could accommodate departures from the smooth trend.

Figure III.4 Empirical relationship between contraceptive prevalence and the percentage of women of reproductive age having unmet need for family planning observed in *World Contraceptive Use*



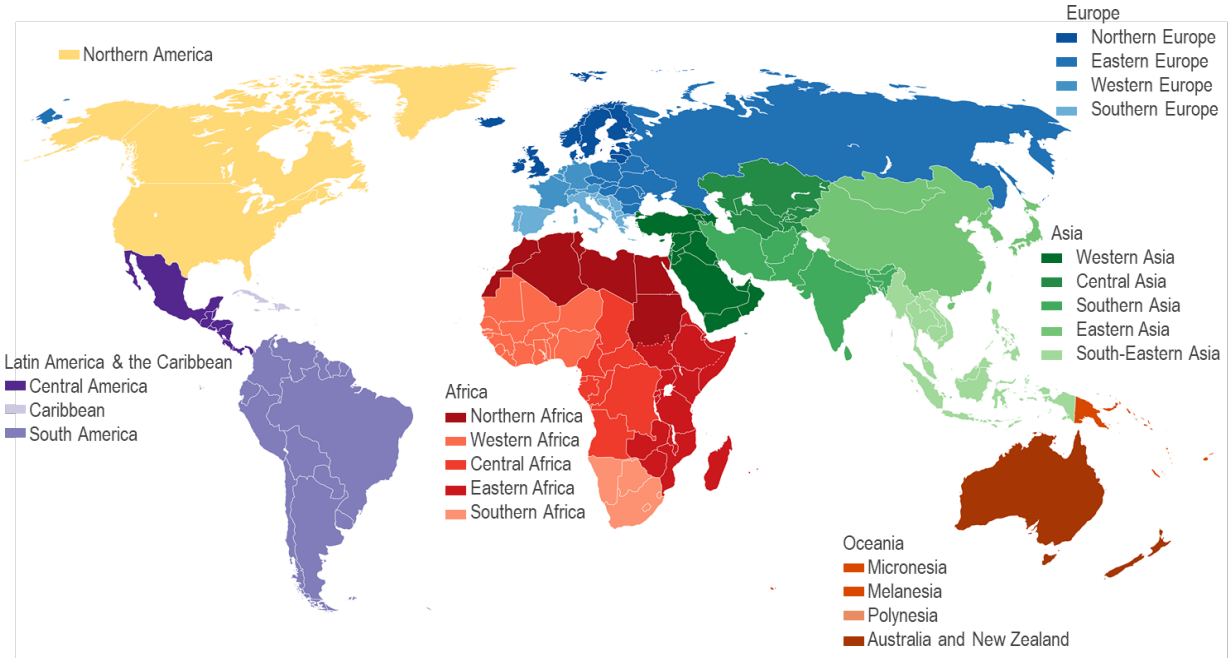
***Note*: Red trendline estimated using a locally weighted regression (LOWESS).**

2. Hierarchical structures

Many countries had few data points, and few countries had no data available. To improve the precision and accuracy of estimations and projections, hierarchical (or multi-level) modelling was used (Gelman and others, 2013) for some of the modelled parameters. Hierarchical models facilitate "borrowing of strength" across data points such that estimates for countries with little or no data were based partly on data for other "similar" countries. What constituted "similar" was specified by the hierarchical structure of the model. Several different structures were applied depending on the subpopulation and parameter.

For married women, many parameters were estimated using the M49 geographic standard (United Nations, 2024b), wherein, countries were clustered into subregions (e.g., Eastern Africa), and subregions into regions (e.g., Africa) was used (Alkema and others, 2013) (see figure III.5). All countries belonged to one, and only one, sub-region and region. All regions together constituted the world. The clustering was based on geographic location, regardless of the availability of data.

Figure III.5 Geographic classification of countries

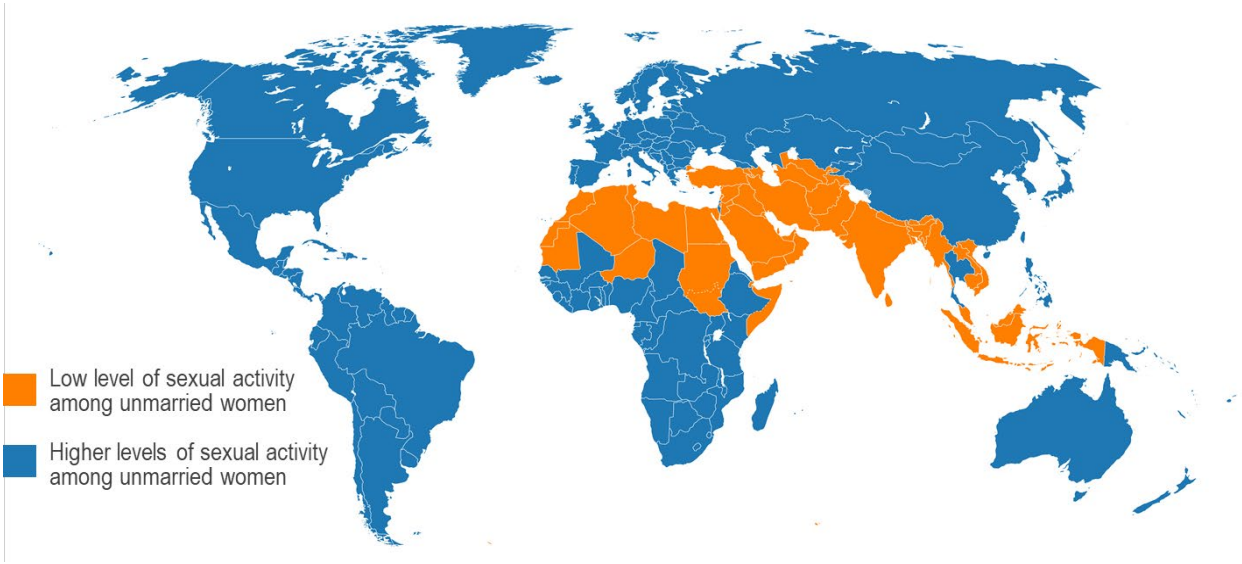


***Note*: Further information on the geographic classification used is available from https://unstats.un.org/unsd/methodology/m49/.**

Among unmarried women (UWRA), use of contraception and need for family planning is closely related to levels of sexual activity, which varies considerably between countries (Ueffing and others, 2020). To account for this, a different hierarchical structure was used for the hierarchically modelled parameters. Countries were first clustered into the geographic sub-regions used in the model for married women. The sub-regions were then clustered into one of two sexual activity groups. Group 0 consisted of countries where sexual activity among unmarried women was estimated to be very low. Group 1 consisted of all other countries (figure III.6). Data from a variety of sources, additional to those used to estimate the family planning indicators, were used to estimate the extent of sexual activity among unmarried women. Eighty-one countries were assigned using information about proportion sexually active from the most recent DHS or MICS; countries with less than 2 per cent sexually active (defined as having a sexual intercourse in past 28 days) among UWRA were assigned to Group 0, the rest to Group 1. An additional 43 countries were classified using information about the acceptance of sex between unmarried adults reported in the Pew 2013 Global Attitudes Survey (29 countries) or the World Values Survey Wave 6 (14 countries) and remaining 71 countries, all in Asia and Northern Africa, were assigned on the basis of the proportion religious in the population (see more information in Appendix of Kantorová and others, 2020).

Estimates for countries and indicators with no data were obtained from weighted averages of parameter estimates for certain sets of countries with data. The sets and weights were determined by the hierarchical structure of the model, such that averages based on countries most proximate in the hierarchy were given higher weights.

Figure III.6 Classification of countries based on information about the level of, acceptance of, or justification for sexual activity among unmarried and not-in-union women aged 15–49 year



Hierarchical models work by introducing additional parameters to the modelled set for each level of the hierarchy. Consider Equation 4, which gives the model for a logistic trend curve with three parameters. These are indexed by c to indicate that one parameter triplet is estimated per country. The country level was the first level. Countries were then collected into successively larger groups at each subsequent level. For example, many of the hierarchically modelled parameters in the married women model were modelled using the M49 standard geographic classification (see above). At the second level, countries are grouped into subregions. A new parameter triplet was therefore introduced for each subregion, say $(\tilde{Y}_s, \psi_s, \Psi_s)$, where s indexes subregion. Sub-regions were then grouped into regions, which meant the addition of additional triplets, one per region. All these additional parameters were added to the modelled parameter set and estimated simultaneously.

B. ACCOUNTING FOR BIAS AND MEASUREMENT ERROR IN AVAILABLE DATA

As discussed in Chapter II, the survey data used to fit the model were from a wide variety of sources and, as such, were subject to systematic biases and non-systematic measurement error. These were accounted for using the various approaches described below.

1. Accounting for bias due to sampling of non-baseline groups and misclassifications

Some surveys targeted groups outside the baseline national populations of women aged 15–49. Examples include the Generations and Gender Surveys (GGSs) that surveyed only women aged 18 and over. Several other surveys excluded some populations, for example, non-nationals or people living in particular provinces or areas. Additional sources of bias were due to misclassification of women as users of modern or traditional methods. These sources of bias were accounted for via the use of misclassification parameters and multiplier parameters that adjusted the estimated proportions to counter the sources of bias. These were estimated from the data through the statistical model in the same way as all the other model parameters. A detailed explanation of these parameters is given in previous work (Kantorová and others, 2020).

2. Accounting for sampling and non-sampling error

Measurement error was decomposed into sampling and non-sampling error. Sampling error arises from the fact that sample surveys cover only a subset of the target population. It can be calculated from survey meta-data such as the survey sampling weights. Non-sampling error consists of all other errors not due to sampling.

Sampling error was calculated for all observations where the requisite meta data were available. These were treated as fixed inputs and included in the model as data along with the survey estimates of the modelled parameters. All other sampling errors were imputed using the scheme described in Cahill and others (2017).

Non-sampling error was accounted for after accounting for biases and misclassifications (described above). Each survey observation modelled by adding a normally distributed random error, with the variance of this error component quantifying the non-sampling error. These variance parameters were estimated by adding them to the modelled parameter set. To ensure they could be estimated with some useful degree of precision, the same parameter was used for all observations of the same survey type. There were five survey types: DHS, MICS, PMA, National Survey and Other International Survey.

C. PRODUCING INDICATOR ESTIMATES AND PROJECTIONS

1. Parameter estimation and summarization

A Bayesian hierarchical model was fitted to obtain country specific estimates of model parameters. This model provides a ‘posterior’ distribution, a high dimensional probability distribution for the parameters of interest, which is the result of combining information about the parameters contained in the data (captured by the likelihood component of the model) and existing prior knowledge (captured by the prior distribution component). Standard practice is to summarise the posterior distribution with quantiles of key parameters that provide point estimates and ranges representing the magnitude of uncertainty (Alkema and others, 2013).

A Markov chain Monte Carlo (MCMC) algorithm (Gelfand and Smith, 1990; Gelman and others, 2013) was used to draw a large sample from the joint posterior distribution of the modelled parameters. Each

element of this sample was then transformed into a set of trajectories for the family planning indicators of interest, including SDG indicator 3.7.1, *the proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods*.

The trajectories were summarized by taking sample quantiles at each year for each country and parameter, such as the 0.025, 0.1, 0.5, 0.9, and 0.975 quantiles. The 0.5 quantile, the median, was used as the measure of central tendency. The other quantiles were used to form 80 per cent and 95 per cent uncertainty intervals.

2. Interpolation and projection

Estimates for years outside the periods of data availability were obtained from the time trends described above (e.g., Equations (4) and (5)) by interpolation and extrapolation of the systematic logistic trends and the auto-correlated error processes. The parameters of the systematic trend component are time-invariant and thus provide estimates of the trend at all years. The result is an estimate, or projection, of each indicator at each year.

3. Aggregates

Estimates and projections for country aggregates, such as regions and subregions, were obtained by computing weighted averages of the constituent country-level estimates, year-by-year, where the weights were the number of women aged 15–49 by marital status (United Nations, 2024a) based on the population of women or reproductive age from *World Population Prospects 2024*.

4. Software and source code

All computation was done using the R Environment for Statistical Computing, version 4.1.2 and JAGS version 4.2.0 (Plummer, 2016, R Core Team, 2018). The source code is available from https://github.com/FPcounts/FPEMglobal.

5. Estimating the impact of the COVID-19 pandemic on family planning indicators

The unprecedented impact of the COVID-19 pandemic is difficult to assess in the statistical model used to produce estimates and projections of family planning indicators based on historical data. No short-term disruptions accounting for the COVID-19 pandemic's effects on family planning were included in the model.

IV. COUNTRY EXAMPLES AND RESULTS INTERPRETATION

Country examples in this section present survey-based observations together with the results from a Bayesian hierarchical model. Results for all countries are available from: https://www.un.org/development/desa/pd/data/family-planning-indicators and through the interactive data portal at: https://population.un.org/dataportal/home.

The indicators presented in the country profiles are:

1. CP (any) - Contraceptive prevalence
2. CP (modern) - Contraceptive prevalence of modern methods
3. CP (traditional) - Contraceptive prevalence of traditional methods
4. Unmet need – Unmet need for family planning
5. Total demand – Total demand for family planning, calculated as sum of contraceptive prevalence and unmet need for family planning
6. Demand satisfied (any method) – demand for family planning satisfied by any contraceptive method, calculated as contraceptive prevalence divided by total demand
7. Demand satisfied (modern methods) - demand for family planning satisfied by modern contraceptive method, calculated as contraceptive prevalence of modern methods divided by total demand; Sustainable Development Goals Indicator 3.7.1. *Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods*

The survey-based observations from the *World Contraceptive Use* data set are characterised by data source, the differences in the sample and the existence of biases due to misclassification. The results for model-based estimates and projections are presented as the median (black line), 10^{th} and 90^{th} percentiles of 80 per cent uncertainty intervals (dashed lines) and 2.5^{th} and 97.5^{th} percentiles of 95 per cent uncertainty intervals (grey area).

In Chad (figure IV.1), there are only six survey-based observations for married/in-union women and four observations for unmarried women. For unmet need for family planning, the values are inconsistent between two survey programmes (DHS and MICS). Therefore, the estimates have larger uncertainty intervals.

In China (figure IV.2), there are 27 observations for contraceptive prevalence of modern methods. Estimates from 1970 to 1988 are based on China 1988 National Two-per-Thousand-Population Sample Survey and administrative data for the period from 1970. Only eight surveys provide estimate of prevalence of traditional contraceptive methods. Four surveys are for the sample of ever-married women (illustrated by a triangle in the figure). Unmet need for family planning is available from three surveys. There are no survey-based observations for family planning indicators among unmarried women that are nationally-representative. For that reason, the uncertainty ranges around estimates of all family planning indicators among unmarried women are large.

In Colombia (figure IV.3) there are 11 survey-based observations for contraceptive prevalence (any, modern, traditional) in the period from 1969 to 2015 for women who are married or in a union. Of these, seven surveys have an estimate of unmet need for family planning. The survey Colombia 1978 Encuesta Nacional de Prevalencia de Uso de Anticoncepción has an estimate for all women (illustrated by a triangle in the figure). For unmarried women, seven surveys provide estimates of family planning indicators. The

uncertainty ranges around estimates are relatively narrow but widen in the projection period and in the periods before the first survey-based observation.

In Malaysia (figure IV.4), there are seven surveys, including five national surveys with a subnational bias "Data pertain to Peninsular Malaysia." Only one of these surveys have estimates of unmet need for family planning available. The estimates of unmet need family planning for the other surveys are derived from the relationship between the indicators of contraceptive prevalence and unmet need for family planning from the countries within the hierarchical cluster that have similar level of contraceptive prevalence. There are no data available for unmarried women. The demand for family planning satisfied by modern contraceptive methods (SDG 3.7.1.) is estimated to be low because of higher levels of traditional method use and unmet need for family planning. In the model for unmarried women, Malaysia is classified as having low levels of sexual activity among unmarried persons. Therefore, the estimates of contraceptive prevalence are very low.

These cases illustrate how the model-based estimates relate to the available data and respond to various biases and inconsistencies. They also demonstrate that estimates and projections are produced for all years in the period of interest, not just those in which data were available.

Figure IV.1 Estimates and projections of family planning indicators with underlying survey-based observations, among married/in-union women and unmarried women, 1970 to 2030, Chad

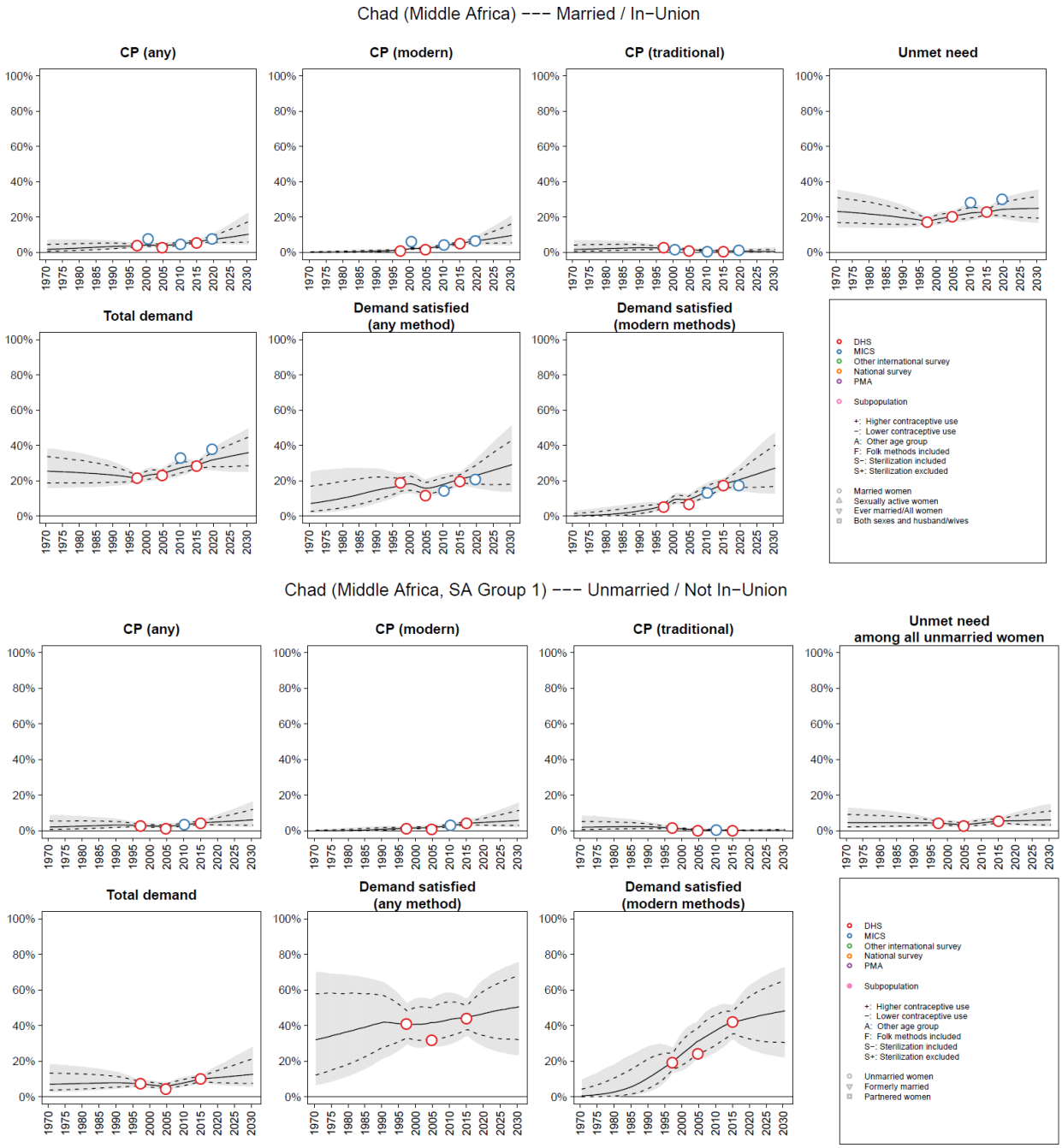


Figure IV.2 Estimates and projections of family planning indicators with underlying survey-based observations, among married/in-union women and unmarried women, 1970 to 2030, China

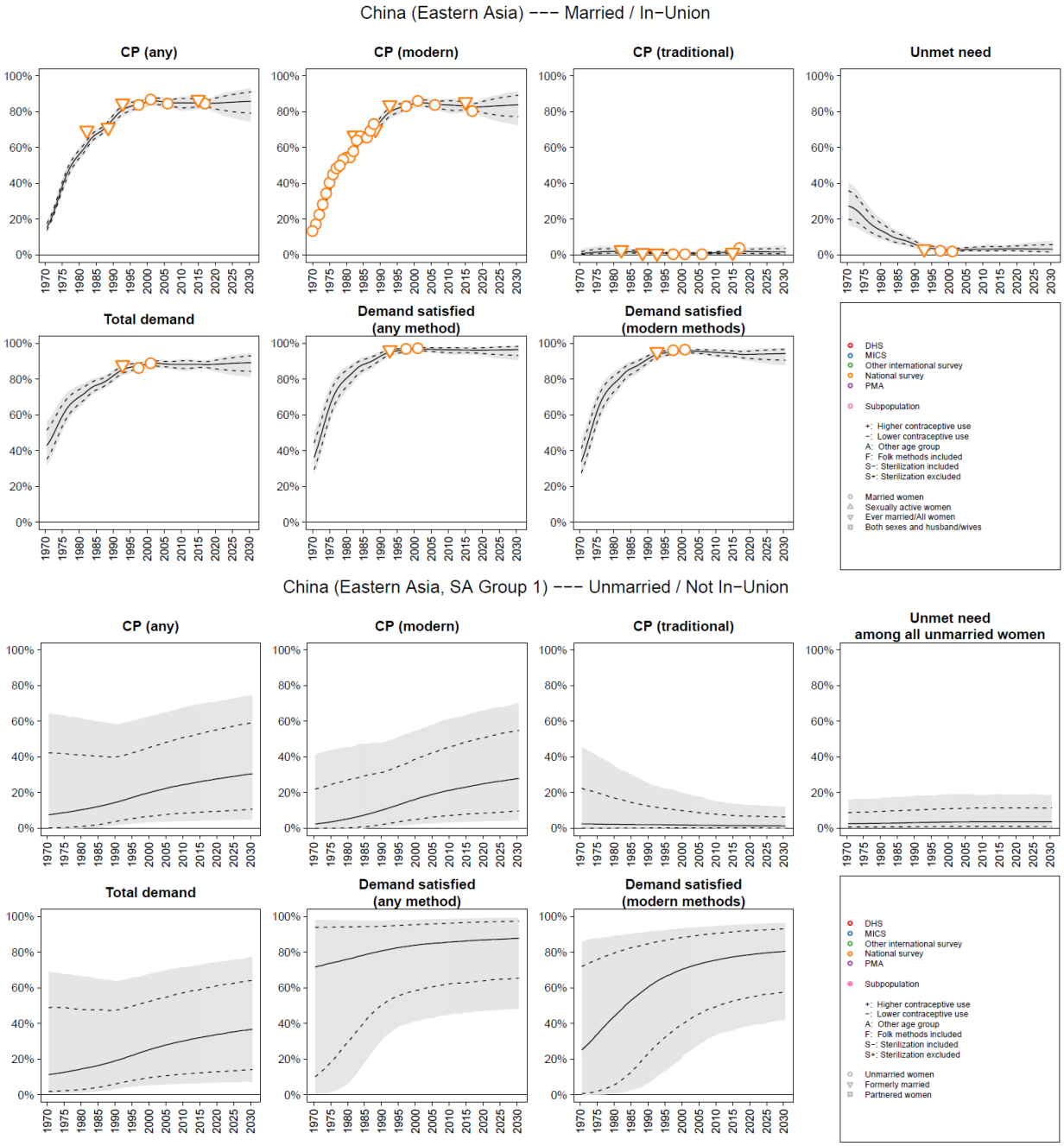


Figure IV.3 Estimates and projections of family planning indicators with underlying survey-based observations, among married/in-union women and unmarried women, 1970 to 2030, Colombia

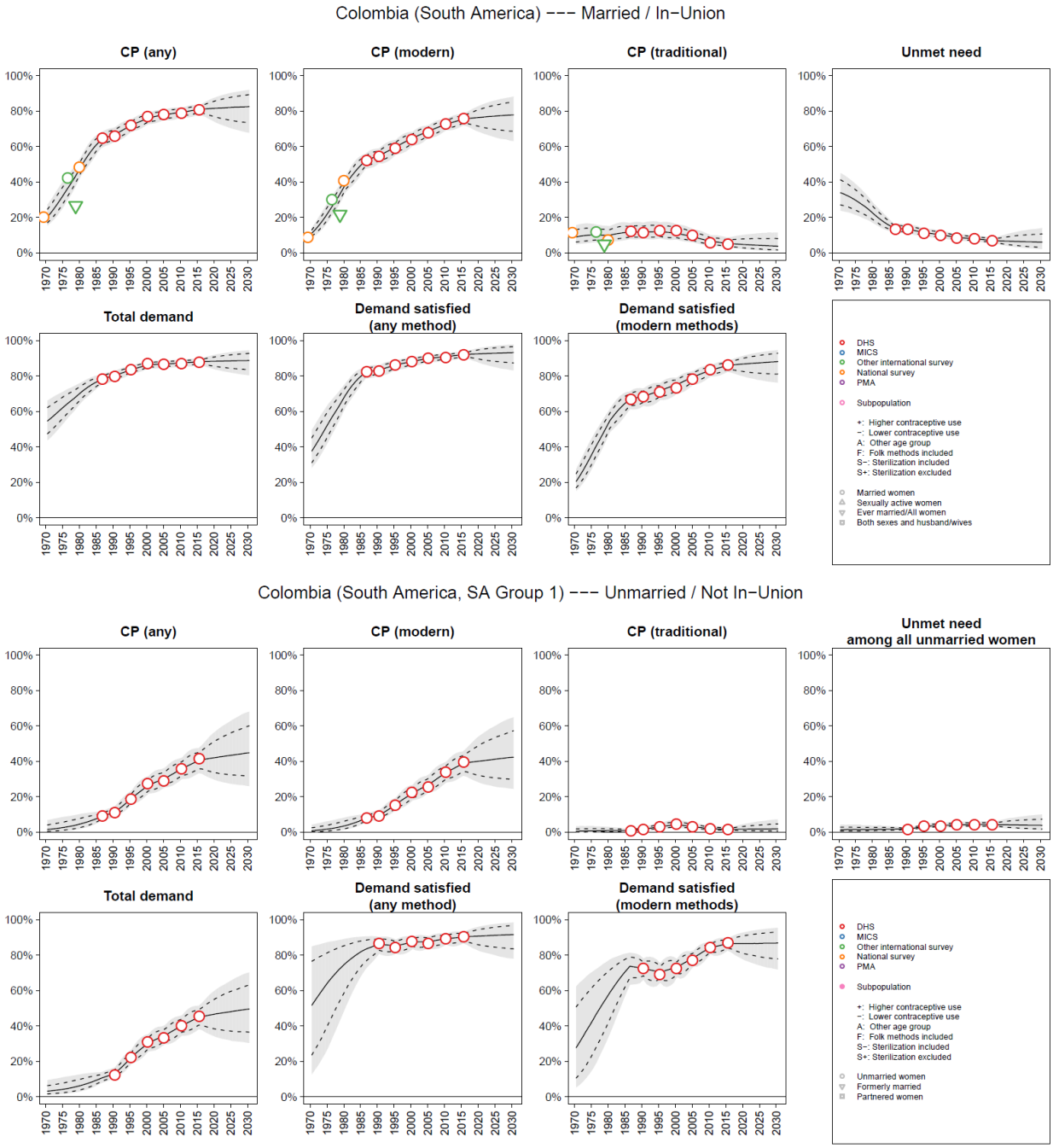
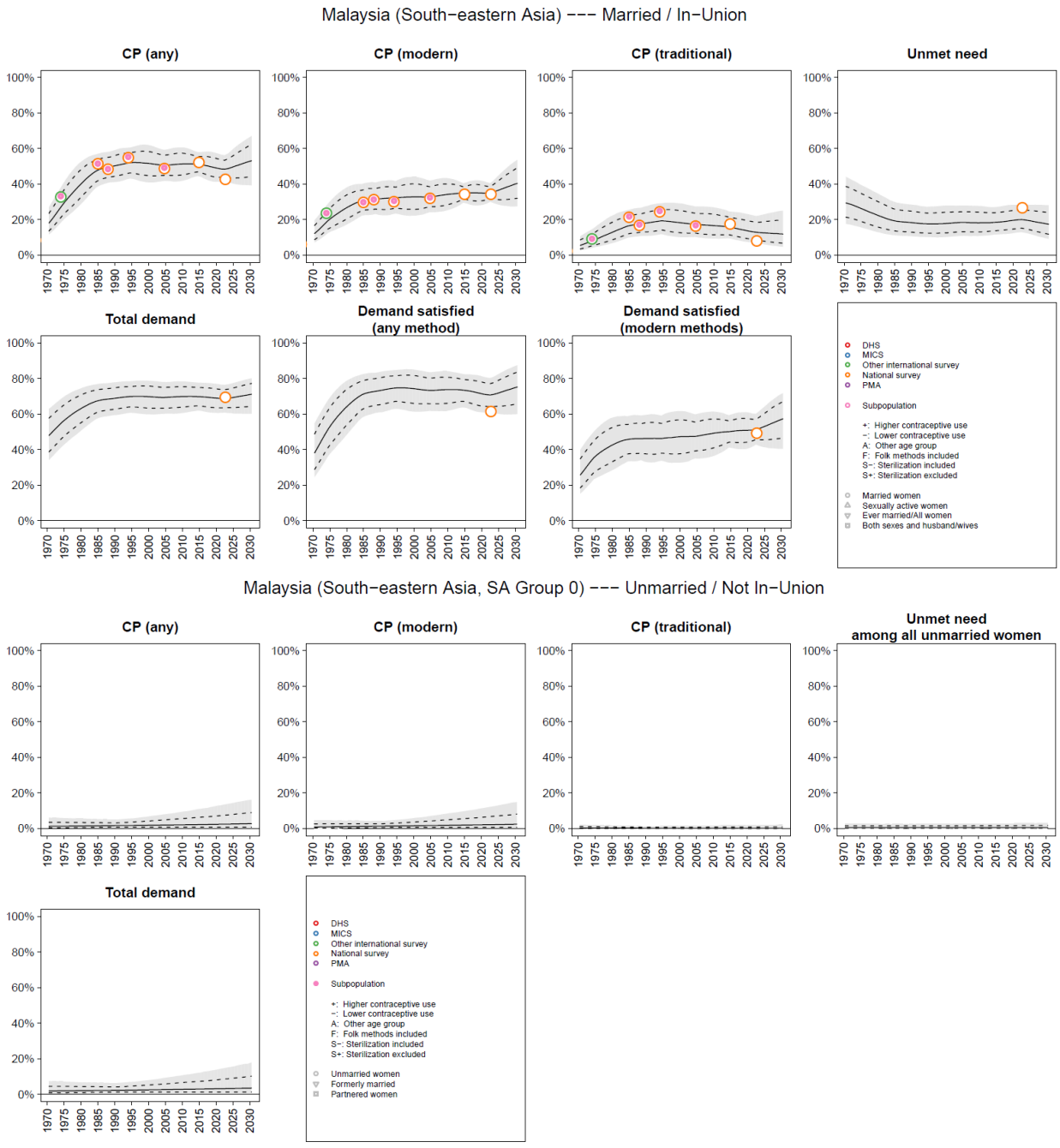


Figure IV.4 Estimates and projections of family planning indicators with underlying survey-based observations, among married/in-union women and unmarried women, 1970 to 2030, Malaysia



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