GUTTMACHER INSTITUTE

ADDING IT UP:
Investing in Contraception and Maternal and Newborn Health, 2017
Estimation Methodology

By Jacqueline E. Darroch

Acknowledgments

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SECTION 1: Introduction to Adding It Up 2017

This report provides methodological details on the estimates presented in Adding It Up: Investing in Contraception and Maternal and Newborn Health, 2017[1] and related publications.[2–7] Adding It Up is an ongoing Guttmacher Institute project in which researchers estimate the need for and the use, costs and impacts of various sexual and reproductive health services in developing countries. The years for which estimates have thus far been produced are 2003, 2008, 2012, 2014, 2016 (contraceptive services for adolescents only) and 2017. While the basic approach remains unchanged, there have been changes in scope and in some of the methodological details across these projects.[8–13]

Adding It Up Reports

The first Adding It Up project (AIU-2003) estimated the costs of meeting all women's needs for modern contraceptives in developing countries in 2003 and the benefits of investing in contraceptive services. Benefits were measured in terms of the number of pregnancies, births, abortions, and maternal and infant deaths averted and disability-adjusted life years (DALYs) saved, as well as the reduction in the number of children losing their mother from maternal mortality.[8,14,15] Costing data for this project came from a small number of country-level studies then available in the literature.

The next Adding It Up project (AIU-2008) expanded the scope to estimate the costs and impacts in 2008 of increasing maternal and newborn health care in addition to family planning.[14,16] AIU-2008 covered the impacts and costs of meeting all women's needs for modern contraception and all needs for maternal and newborn health care, as well as a synergistic scenario in which both types of needs would be met. Cost estimates were based on a United Nation Population Fund (UNFPA) update of cost estimates for implementing the Programme of Action of the 1994 International Conference on Population and Development (ICPD).[9,17–19]

Adding It Up analyses for 2012 updated estimates separately for contraception[10] and for maternal and newborn health care,[11] but did not investigate the synergistic impacts of fully meeting both types of needs. The contraceptive estimates of need, use and impact helped inform the baseline estimates and projections of the global FP2020 initative.[20,21] Cost estimates for AIU-2012 used updated costs for drugs, supplies and personnel, including information from a new database of contraceptive commodities provided by donors to developing countries.[22]

AIU-2014 further expanded the scope of sexual and reproductive health needs and services to include antiretroviral care for pregnant women living with HIV and their newborns, and treatment for four common STIs, in addition to modern contraceptive services and maternal and newborn health care.[23–27] Cost estimates included updated costs for drugs and supplies and 2014 estimates of personnel costs.

A report focused on adolescents in 2016 (ADOL AIU-2016) used the Adding It Up methodology to estimate the costs and benefits of meeting the contraceptive needs of women aged 15–19.[13,28–31] This report analyzed patterns in young women's sexual behavior and marriage according to residence, education and age. An assessment of research gaps in adolescent sexual and reproductive health accompanied this report.[32] Also, estimates from this project of births to girls under age 15 were included in a report on the sexual and reproductive health of very young adolescents.[33]

The AIU-2017 project estimated contraceptive and maternal and newborn health needs, coverage, impact and costs as of 2017.[1] Supplementary tables[6] present the measures included in the analysis by geographic subregions for all developing countries[34] and by country income level for developing countries classified as low-and middle-income by the World Bank.[35,36]

Trends Over Time

Methods for estimating needs for and use of contraceptive and maternal and newborn health care have been similar across all Adding It Up analyses.[37–39] However, the classification of contraceptive methods as modern or traditional has changed slightly over time; these are described in Section 4.

Sources and estimation methods for some of the costing and impact data have changed over time and therefore do not provide valid time trends. See relevant methodology summaries for details on data sources and methods used for each Adding It Up report.[8–13]

Data Sources

This project did not collect information from individuals; all data used in the analysis came from sources that did not contain individuals' identifying information. Patient consent was therefore not required for these analyses.

Other Recent Estimates

Adding It Up is one of several recent efforts to estimate the resources required to meet the need for sexual and reproductive health services in developing countries. Several high-level global initiatives have published relevant cost estimates in recent years, including Countdown to 2015,[40] the Disease Control Priorities project,[41] Every Woman Every Child's Global Strategy for Women's, Children's and Adolescents' Health,[42,43] the FP2020 initiative,[20,21] the Global Financing Facility,[44] the Reproductive Health Supplies Coalition[45] and the World Health Organization's cost estimates of achieving the health-related Sustainable Development Goals in 67 low- and middle-income countries by 2030.[46]

The United Nations Population Division (UNPD) publishes annual, country-level estimates and projections of contraceptive need and use,[47,48] and the Track 20 project of Avenir Health

monitors contraceptive use and related measures for the 69 FP2020 countries.[49] Also, a number of researchers and organizations are working to track resources committed annually for population and reproductive health activities.[50–65] The Adding It Up project has benefited from these efforts and from prior estimation work carried out by UNFPA,[18] Women Deliver,[66] the High-Level Taskforce on Innovative International Financing for Health Systems[67] and Norway's Global Campaign for the Health MDGs,[67] as well as other cost and impact analyses.[68–70]

The global estimates published by these organizations and initiatives differ from each other because each includes a different subset of sexual, reproductive and child health services. Estimates may also differ in terms of geographic coverage—for example, focusing on countries with the lowest income or with the highest burden of disease. FP2020 focuses on 69 countries with 2010 per capita incomes of $2,500 or less,[71] while the Countdown to 2030 collaboration focuses on the 81 countries where 95% of maternal and child deaths occur.[72] Many other analyses focus on countries identified by the World Bank as low- and middle-income countries.[7,35] Adding It Up estimates include all 148 countries in developing regions, as classified by the UNPD.[34]

Other examples of differences among estimates include

- covering only direct service costs versus covering total costs, which include indirect costs such as infrastructure, management and training of health personnel;
- covering the total costs associated with services versus covering only the additional funds needed to expand services from their current level;
- using a one-year time frame versus showing cumulative costs over several years;
- using the average cost per case for each health intervention versus the costs of inputs across a group of interventions; and
- estimating the fulfillment of all need for services versus fulfillment of only a certain proportion of need.

Under the aegis of the Step Up project,[73] Guttmacher Institute researchers have worked with other colleagues involved in estimating impacts of contraceptive use to identify similarities and differences in various models' inputs and assumptions.[74] Data from Adding It Up analyses have been adopted for harmonizing the estimates of unintended pregnancy, abortion and maternal death across the different models.[75]

Organization of this Report

In this report, we describe the analytic framework, sources and calculations behind the AIU-2017 estimates. Our objective is to enable users to better understand the results, as well as the assumptions and limitations, of the estimates presented in Adding It Up publications.

The Adding It Up approach starts with estimating the need, current use (or coverage), and the unmet need for care for components of sexual and reproductive health care: Need – Coverage =

Unmet Need. Section 2 of this report describes the Adding It Up scenario-based approach to estimating sexual and reproductive health service needs, coverage, costs and impacts. Section 3 describes the methodology and data sources for the demographic measures used in the project, including numbers of women by marital status, pregnancies by intention status and outcome, and maternal deaths. Estimates of need and coverage for sexual and reproductive health care in this project were built from individual interventions (components of care). In Sections 4 and 5, we describe each intervention and the bases for estimating the need for and coverage of each intervention. Section 4 describes how we estimated contraceptive need and method use, and Section 5 provides similar information for maternal and newborn health care. We provide detail on the treatment requirements for commodities and supplies, personnel and hospitalization for each intervention. In Section 6, we estimate the impacts of sexual and reproductive health services based on estimates for each component intervention. Impacts are presented for each of the service-coverage scenarios, including the impacts resulting from separate and combined services on pregnancies, health status and costs. We discuss available information for estimating service costs in Section 7, along with the details of how we made costing estimates. Section 8 presents selected results from revised 2017 estimates incorporating data for India that were not available for the AIU-2017 analysis. Data and estimates used in AIU-2017 are presented in tables.[*]

In this project, we estimated many measures using a large number of different data sources, including census information, survey tabulations, modeled estimates and existing literature. Confidence intervals are therefore not available for estimates. Numbers presented in the tables are unrounded to facilitate their use in further calculations, but this does not indicate precision. Calculations of distributions, rates and numbers for AIU-2017 were made from unrounded data.

[*]The tables are published online at https://www.guttmacher.org/report/adding-it-up-investing-in-contraception-maternal-newborn-health-2017-methodology.

SECTION 2: Adding It Up Approach

Adding It Up covers all developing regions, as defined by the UNPD.[34] It assesses the numbers of women needing and receiving contraceptive, maternal and newborn health services recommended by WHO, and it provides estimates of the total costs of current services and of services that would fully satisfy needs—both direct costs and the indirect program and systems costs that support service provision. Further, it estimates the health benefits of meeting these needs, allowing comparisons between the impact of current services and the impact that would be made by fully meeting service needs.

The estimates in this report assume that the necessary investments and accompanying changes will occur in the short-term, and that all unmet needs will be fulfilled in the near future. If all needs are not met, the costs will be correspondingly lower, but so will the benefits of the investments. Similarly, if needs are met over a longer time horizon, cost increases and benefits will be spread out as well. In addition to population growth in most developing regions, the growing preference for smaller families will result in a greater number of women needing services (all other things being equal). Therefore, additional resources will be required to maintain the gains in service provision that have been achieved.

Adding It Up synthesizes information from a wide range of sources to present a coherent and comprehensive set of estimates covering all developing regions; identify synergies between sexual and reproductive health focus areas; illustrate the need for addressing sexual and reproductive health needs in integrated ways; and put disparate research findings into the fuller context of women's lives. To accomplish these goals, estimates must be set in a common context. We adjusted all estimates to 2017 and 2017 U.S. dollars and used a common demographic framework across all service areas. Some data were available for countries and others were for various geographic groupings. We transformed data for geographic regions to country levels for our calculations and estimated the missing values; see the following sections for details relevant to each intervention.

Scenarios

In AIU-2017, we estimated impacts, costs and benefits for three basic scenarios: one representing current use of sexual and reproductive health care; one in which no women needing sexual and reproductive health care receive it; and one in which all women receive all the sexual and reproductive health services they need. We used a combination of scenarios for contraceptive services and maternal and newborn health services, to estimate the synergistic effects of meeting needs for both types of services compared with each on its own.

Current-use scenario

For each type of sexual and reproductive health care, we first estimated current levels of

coverage or service use, impacts and costs in 2017. Section 3 provides information on the sources and assumptions used for establishing the demographic framework behind all the need and coverage measures, specifically population numbers and characteristics, numbers and outcomes of pregnancies and numbers and causes of deaths.

No-needs-met scenario

To estimate the impacts of current coverage levels, we estimated comparison scenarios in which no women or newborns would use each intervention.

Contraception. We assumed that no women wanting to avoid a pregnancy would use modern methods and that there would be no change in the proportions of women wanting to avoid a pregnancy currently using traditional methods or no method, or in the level of unintended pregnancies among women in these groups. We assumed no change in the factors affecting the proportions of women wanting to avoid a pregnancy, such as marital status, sexual activity, fecundity and childbearing intention, and that intended pregnancies would continue to occur at 2017 levels.

Maternal and newborn care. We assumed that pregnant women and newborns would receive no maternal or newborn health care, but that their needs for care would remain unchanged.

Full-needs-met scenario

Contraception. We assumed that women currently wanting to avoid a pregnancy and using either traditional methods or no method would all become users of modern methods—and that those already using modern methods would continue to do so. We included women relying on traditional methods as needing modern contraceptives because the failure rates of traditional methods are typically much higher than those of modern methods.[76–82]

We assumed that new contraceptive users would adopt the same mix (i.e., percentage distribution) of modern methods as current modern-method users in their country with the same characteristics—age (in five-year age groups), marital status (currently, formerly or never-married) and childbearing intentions (spacing vs. limiting future births). We assumed no change in the proportions of women wanting to avoid a pregnancy or in numbers of intended pregnancies.

Maternal and newborn health care. We assumed that all women and newborns would receive the maternal and newborn health care services covered in this project, including general care at recommended levels and, when needed, treatment for special conditions and complications (See Table 39).

Synergistic scenarios

Because contraceptive use affects the numbers of pregnancies, births, miscarriages and

abortions that occur through its impact on levels of unintended pregnancy, we estimated several combinations of scenarios in which the numbers of pregnancies and births differed according to contraceptive-use scenarios. For example, we estimated the number of women and newborns who would need maternal and newborn health care if women wanting to avoid a pregnancy used no contraceptives versus if they all used modern contraceptives, along with various scenarios of maternal and newborn health care coverage.

Time Period of Estimates

The estimates for the AIU-2017 analysis draw from the most recently available data, adjusted to 2017, and demonstrate the gains from immediately fulfilling all unmet needs. Costs are expressed in 2017 U.S. dollars, and all scenarios are calculated as of 2017. We recognize that the necessary increases in service coverage cannot be achieved immediately, especially because many of them depend on improvements in health service infrastructure. However, we use the same year for all scenarios to demonstrate the magnitude of changes needed compared with the current situation.

Another way to interpret the differences between the full-needs-met and current scenario estimates for 2017 is that they reflect the effects of lack of progress in terms of unintended pregnancies, maternal and newborn deaths and the costs of maternal and newborn care resulting from current unmet needs.

Geographic Coverage and Country Groupings

Countries included

The 2017 estimates include all countries classified as "developing" by the UNPD.[34] Under this definition, developing countries include all countries in Africa, Asia (including Central Asia, but excluding Japan), Latin America and the Caribbean, and Oceania (except Australia and New Zealand). Table 1 shows the countries in each of the groupings used in this report.

Estimates for all developing regions and for country groupings are based on numbers of women in each country, i.e., weighted estimates based on the relevant numbers of women, pregnancies, etc., rather than the unweighted average or median using countries as the unit of analysis.

In addition to providing summary estimates for all developing regions, data are presented for developing regions minus Eastern Asia. Limited information is available for the Eastern Asia subregion. Ninety-five percent of women aged 15–49 in this subregion live in China, where patterns of sexual and reproductive behavior are somewhat different from other parts of Asia.

The United Nations designates as "least developed" a special group of developing countries characterized by long-term structural impediments to sustainable development, based on low gross national income per capita, low levels of human assets in terms of health and education

and high vulnerability to economic and environmental shocks.[83] Summary measures for this group of countries are also shown in the tables.

Country income groupings

We used World Bank FY2016 country income classifications, which are based on gross national income (GNI) per capita in 2015, to group countries into four income categories: low, lower-middle, upper-middle and high.[35,36] Table 2 presents the distribution of women aged 15–49 in each income category across developing regions and other country groupings, as well as the distribution of women within each region or grouping who live in each of the three country-income categories (low, lower-middle, and upper-middle).

Low-income countries are those with a 2015 GNI per capita of $1,025 or less; lower-middle-income countries have a GNI per capita of $1,026–4,035; upper-middle-income countries have a GNI per capita of $4,036–$12,475 and high–income countries have a GNI per capita of $12,476 or more. Some developing countries are not covered by the World Bank classifications, namely Réunion and other small countries in Eastern Africa, Guadeloupe, Martinique, and French Guiana and other small countries in South America, as well as Western Sahara. These account for less than 0.1% of the population of all developing regions in 2017.[84,85] For completeness, we assumed Western Sahara would have the same lower-middle-income classification as Morocco; that Réunion and other small countries in Eastern Africa, Guadeloupe, French Guiana and other small countries in South America would be classified as upper-middle-income; and that Martinique would be in the high–income category.

The UNPD definition of developing regions does not include some countries in Eastern and Southern Europe that the World Bank classifies as lower-middle-income countries (Moldova and Ukraine) or as upper-middle-income countries (Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Macedonia, Montenegro, Romania, Russia and Serbia). The low- and middle-income countries included in the developing regions covered in the AIU analysis account for 96% of the population of countries classified as low- and middle-income countries by the World Bank: 100% of people living in low-income countries, 98% of those living in lower-middle-income countries and 93% of those living in the upper-middle-income category. The high-income countries included in AIU-2017 (because they are located in UNPD's developing regions) account for only 15% of the total population of high-income countries.

Geographic groupings

In many tabulations, we grouped countries by geographic region and subregion, according to UNPD's classifications. In the regional groupings shown in the tables, Oceania is included in Asia.

Other common geographic regions are also presented in the tables, namely the regions used by the Sustainable Development Goals (SDG) initiative,[86] the United Nations Population Fund (UNFPA)[87] and the World Health Organization (WHO).[88] Because AIU focuses on the UNPD-

defined developing regions, there is not complete coverage or overlap with these regional classifications.

Other country groupings

In many of the tables in this report, we present measures for country groupings that are the focus of various international efforts to improve health. Countries in these groupings are all categorized as "developing" by the UNPD and include the 81 Countdown to 2030 countries,[72] 32 DFID focus countries,[89] 69 FP2020 focus countries[90] 42 countries with generalized HIV epidemics, defined here as greater than 1% of adults aged 15-49 living with HIV,[91,92] 26 countries currently part of the Global Financing Facility in Support of Every Woman Every Child,[93] nine countries in the Ouagadougou Partnership,[94] and 24 countries that are the focus of family planning programming by the United States Agency for International Development (USAID).[95] Table 1 identifies the countries in each of these groupings.

SECTION 3: Demographic Estimates

All estimates in AIU-2017 draw from common estimates of key demographic measures of population size and composition, pregnancy levels and outcomes, and maternal and newborn mortality and morbidity. This section provides information on the data sources and assumptions used for these measures.

Population Size and Composition

Total population and number of women aged 15–49

We obtained the total population and the number of women aged 15–49 by five-year age groups for each country in 2017 from the UN's *World Population Prospects*, 2015 revision, medium fertility variant.[84,96] We used these figures for all scenarios in the AIU-2017 estimates. Table 2 shows numbers of women aged 15–49 in 2017 in developing regions and for selected country groupings.

In *World Population Prospects,* some small countries are included in the regional totals but not in the detailed country listing. To avoid omitting these countries and so that country estimates would sum to subregional totals, we included the combined populations of these small countries in the calculations. We estimated their combined populations to be the difference between the subregional totals and the populations of the countries for which population was reported; these countries are identified in the notes to Table 1.

Women aged 15–49 by marital status

In this analysis, we consider women who are legally married, cohabiting or in a consensual union to be married. "Formerly married" refers to women who have previously been in a union and were not in union at the time of interview, and "never married" refers to women who have never been in union.

Currently married women. We took the 2017 proportion of 15–49-year-old women in each country who are currently married from the UNPD 2016 revision of marital status estimates and projections.[97] To the extent allowed by the source data, this category includes women who are formally married, women living with a partner in a cohabiting or consensual union, and, in the Caribbean, women in visiting partnerships.[98] The proportions were applied to the number of women aged 15–49 in 2017 in each country to estimate the number of currently married women aged 15–49 in each country.

To estimate numbers of currently married women in 2017 by age, we took the most recent age-specific data on the proportion married from the UNPD marriage database[99] or from a more recent national survey. We then calculated the ratio of the total number of women aged 15–49 in each country to the sum of the age-specific numbers of married women aged 15–49 in each

country. We multiplied the initial estimate of the number of married women in each age group by this country-specific ratio so that the sum of the age-specific numbers of married women would equal the UNPD total.

Formerly married and never-married women. Since the UNPD estimates and projections available at the time of the AIU-2017 analyses did not differentiate formerly married and never-married women, we followed the approach used in prior AIU projects to distribute unmarried women: We estimated the number of unmarried women for each age group in each country in 2017 as the difference between the total number of women and the estimated number who were currently married. We estimated the distribution of unmarried women according to whether they were formerly married or never married from the UNPD marriage database[99] or tabulations from a more recent national survey. Specific sources used for each country are shown in Table 3.

Table 3 shows the marital status distribution for all women aged 15–49 by country, and the specific sources used to estimate age-specific marital status distributions. Table 4 presents the resulting distributions of women aged 15–49 by marital status for age groups 15–19, 20–24, 25–34 and 35–49 for selected country groupings. As shown in Table 4, 66% of women aged 15–49 in developing countries are currently married, a proportion that ranged from 34% in Southern Africa to 70% or more in Eastern Asia and Southern Asia.

Wealth, residence and parity subgroups

We tabulated country-level proportions of women aged 15–49 by marital status and according to household wealth quintile, rural or urban residence and parity (no live births or one or more live births) from available country survey data files and reports. When no information was available on marital-status distribution by wealth quintile, residence or parity, we used the distribution from a similar nearby country, subregion or region. The resulting distributions of women aged 15–49 by marital status and by wealth, residence and parity are shown in Table 5.

Pregnancies by Outcome and Intention

Current scenario numbers of pregnancies by outcome

Births. We estimated the total number of births in each country in 2017 from the UN *World Population Prospects*, 2015 revision, medium fertility variant.[84,100] We took country-level proportions of births that were unplanned or planned from a recent Bayesian analysis.[101] We assumed that the distribution of births by intention status estimated for 2010–2014 applied to live births as well as stillbirths in 2017.

Induced abortions. Survey reports on induced abortion are generally inaccurate, and national abortion statistics are often unavailable or suffer from underreporting, especially in developing countries with restrictive abortion laws.[102,103] Bayesian model-based estimates of the annual number of abortions in developing regions are 47.3 million in 2010–2014, of which 0.8 million

occurred to married women who had not been trying to avoid a pregnancy, i.e., whose pregnancies had been intended.[104] The remainder (46.5 million) occurred to women whose pregnancies were classified as unintended—i.e., married women who had been using contraception, or not using with unmet need for contraception, and unmarried women. To estimate the numbers of induced abortions in developing regions in 2017, we applied the 2010–2014 country-level ratios of induced abortions to live births to the 2017 numbers of live births. We did this separately for births and abortions from intended and unintended conceptions.

We used recent Bayesian model-based estimates of the conditions under which induced abortions occur to segment induced abortions in 2017 into those that were safe, less safe and least safe.[105] (See classification definitions in Section 7.) We assumed that the 2010–2014 subregional-level distribution of abortions by safety applied to abortions in all countries of each subregion in 2017.

Miscarriages and stillbirths. Pregnancies ending in miscarriage—i.e., pregnancies that end in spontaneous abortion or stillbirth after lasting long enough to be noted by the woman (6–7 weeks or more after the last menstrual period)—were estimated to be equivalent to 20% of pregnancies ending in birth and 10% of those ending in induced abortion. These proportions are based on studies estimating that for every 100 pregnancies at six weeks since ovulation, roughly eight will result in miscarriage by week 10, another eight will end in miscarriage or stillbirth in the remaining weeks of pregnancy, and 84 will result in live births.[106] Thus, the ratio of miscarriages (at 6 or more weeks after ovulation) to live births is 16%/84%, or roughly 20%. Since induced abortions typically occur early in pregnancy, we assumed that induced abortions occur less than 10 weeks after ovulation and that they include unintended pregnancies that would have ended as miscarriages during this period. Miscarriage estimation relative to pregnancies ending in induced abortions is based on the ratio of miscarriages to the pregnancies ending 10 or more weeks after ovulation, 8%÷92%, or roughly 10%.

Stillbirth is defined as the death of a fetus weighing at least 1,000g (2.2 lbs) or one that occurs at 28 weeks' gestation or later.[107] Blencowe et al. estimated stillbirth rates (stillbirths per 1,000 total live births and stillbirths) in 2015, defining stillbirths as a baby born with no signs of life at 28 or more weeks of gestation.[108] The country-level rates are available from the Healthy Newborn Network.[109] From these, we calculated stillbirth ratios (stillbirths per 1,000 live births) and estimated the number of stillbirths in each country by applying the ratio for each country to the total number of live births in 2017. For the few countries without available stillbirth rates in 2015, we used an unweighted average of rates for the subregion, with the following exceptions: We used the rate for Morocco for Western Sahara, and China for Hong Kong and Macao. Lacking other information, we assumed that the ratios of stillbirths to live births were the same for births resulting from intended and unintended pregnancies.

We estimated the number of miscarriages at less than 28 weeks' gestation by subtracting the number of stillbirths from the total number of miscarriages. In AIU-2017, we use the general term, miscarriage, to refer to the miscarriages before 28 weeks' gestation.

Ectopic pregnancies. We assumed that ectopic pregnancies equal 2% of live births plus induced abortions based on an analysis of data from the early 1990s by researchers at the Centers for Disease Control.[110]

Current scenario intention status of pregnancies

We estimated intended pregnancies by adding all planned births, plus induced abortions, miscarriages and stillbirths resulting from intended pregnancies. Unintended pregnancies are the sum of all unplanned births, induced abortions among women wanting to avoid a pregnancy (married women using contraception or not using but with unmet need, and unmarried women), and the miscarriages and stillbirths resulting from unintended pregnancies.

The separation of abortions by intention status recognizes that some women with induced abortions likely had intended to become pregnant, but they ended their pregnancies because of health complications for themselves or the fetus, or because their personal situation changed in a way that made them feel they could not give birth.[111,112] In prior AIU analyses, we assumed that all induced abortions follow unintended conceptions because we lacked adequate data for estimating how many intended conceptions end in induced abortion. Only 2% of abortions in developing countries are estimated to have followed intended conceptions, ranging from 1% in Southern Africa, Eastern Asia and all subregions of Latin America and the Caribbean to 5% in Western Africa. Abortions are estimated to account for only 1% of intended pregnancies across all regions and subregions. Thus, AIU-2017 estimates of levels and patterns of intended and unintended pregnancies are affected only slightly by taking account of the intention status of pregnancies ending in induced abortion.

Levels of estimation

Data for the AIU-2017 estimates were available for various geographic levels and groupings. When data were not available at the country level, we made country estimates from higher-level, usually subregional, data to facilitate country-level calculations and to regroup findings into categories of interest. We used unpublished, country-level, Bayesian model-based estimates of the intention status of births and numbers and intention status of abortions that had been used to construct the published estimates aggregated at the regional and subregional levels.[101,113] We used the published subregional estimates of abortion safety.[105] While we made pregnancy calculations at the country level, AIU-2017 estimates in this report and other publications using these data are limited to geographic and other multi-country groupings.

Pregnancy estimates

Table 6 shows the estimated annual numbers of pregnancies by outcome and intention status,

according to region, subregion, country income group and other country groupings. Table 7 shows the proportions of all pregnancies and births resulting from unintended pregnancies, and the distribution of unintended pregnancies by outcome. It also shows the estimated proportions of induced abortions in each region or country grouping that occurred under safe and unsafe (less safe or least safe) conditions.

Pregnancy intention and outcomes across other scenarios

AIU scenarios in which no women or all women wanting to avoid a pregnancy were estimated to use modern contraceptive methods result in different numbers of unintended pregnancies from the current scenario. In each scenario, we distributed unintended pregnancies by outcome (unplanned birth, induced abortion, miscarriage or stillbirth), based on the country's estimated 2017 distribution of unintended pregnancies.

Pregnancy-Related Mortality and Morbidity

A benefit of increased attention in recent years to improvements needed for health, together with the development of new tools for data management and estimation, is that there are now multiple sources of mortality estimates covering countries in all regions of the world. While general patterns in the levels and trends in mortality and morbidity are similar across international sources, differences between them require decisions about which sources to use.[114]

Maternal mortality

Selection of data sources. Estimates of the numbers of maternal deaths and their causes are available from WHO and the Institute for Health Metrics and Evaluation (IHME). The results of these projects have differed, however, reflecting a variety of factors, including that country-level data sources are often incomplete or nonexistent, especially in developing countries;[115–118] international coding of causes of death has changed over time and countries have adopted new versions at different times;[119] estimation methodologies have changed in recent years;[120] and differences in definitions and assumptions exist between and within organizations.[116,120–128]

At the time of our analyses, the most recent estimates of maternal mortality were available for 2015 from IHME[129] and WHO.[124] IHME estimated a total of 275,288 maternal deaths worldwide in 2015; 272,983 maternal deaths occurred in developing regions[127] at a maternal mortality ratio of 216 per 100,000 live births. Some 30,786 of the maternal deaths worldwide, and 30,418 in developing regions, were late maternal deaths, i.e., they occurred 43 days to one year after delivery. Excluding late maternal deaths, IHME researchers estimated 268,576 maternal deaths in 2015 worldwide and 266,480 in developing regions, representing a maternal mortality ratio in developing regions of 211 deaths per 100,000 live births. In contrast, the WHO estimated for 2017 a worldwide total of 303,000 maternal deaths through 42 days after delivery, i.e., excluding late maternal deaths. Some 302,000 maternal deaths were estimated for developing regions, resulting in a maternal mortality ratio of 238 deaths per 100,000 live births.

There is a 0.89 correlation between the IHME and WHO maternal mortality ratio estimates for the period 2005 to 2015.[129] Further, the general pattern of maternal mortality in the two sources is similar across countries in developing regions—i.e., maternal mortality ratios are highest in Africa and lowest in Latin America and the Caribbean. However, the WHO estimate of the number of maternal deaths through 42 days after delivery is 15% more than the comparable number from IHME, with most of the difference in developing regions. This wide discrepancy stems from a number of methodological differences between the two sources.[128–130] We decided to use the estimates from WHO as the basis for the numbers of maternal deaths in AIU-2017.[124] We made this choice primarily for consistency with past estimates and with other international organizations, and we will make a new assessment of the two sources in the next AIU project. In deciding to use WHO maternal mortality estimates, we adopted the WHO definition of maternal deaths: "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes."[124]

The most recent estimates of causes of maternal deaths from WHO is based on literature published between 2003 and 2012, with most of the deaths having occurred in 2003–2009.[116] More recent estimates, based on more recent data and more countries with data, are available from IHME.[127] As shown in Table 8, there is little consistency over time in the cause-of-death estimates. Differences in information sources and estimation methodology obscure possible changes over time in the levels or distribution of causes of maternal death. All sources agree in identifying hemorrhage, hypertension, sepsis and abortion as common causes of maternal mortality. However, the ranges of estimates for some causes are quite wide. The differences may reflect actual changes over time, differences in the number and quality of data sources available for estimating all causes of death or different estimation methodologies used by WHO and IHME.

We decided to use the 2015 IHME cause-of-death estimates, excluding those from late maternal death. The IHME estimates are based on a greater number of data sources extending to more recent years than were available at the time of the earlier WHO estimates.[130]

Total number of maternal deaths. For each country, we took the ratio of maternal deaths per 100,000 live births from WHO estimates for 2015.[124,131] For the few countries with no WHO estimates, we used the maternal mortality ratio from the unweighted average of countries with data in the subregion or from a similar country nearby (i.e., Morocco for Western Sahara and China for Hong Kong and Macao). Including deaths for these countries had little impact on the total number of maternal deaths estimated in developing regions for 2015; it increased the maternal mortality ratio slightly from 238 to 239 per 100,000 live births. We estimated the total number of maternal deaths in each country in developing regions in 2017 to be the product of the country's 2015 maternal mortality ratio and the total number of live births in 2017. We

made no adjustments to the maternal mortality ratios to account for trends over time. The total number of maternal deaths estimated for 2017 in developing regions was 307,553, for a maternal mortality ratio of 242 per 100,000 live births (Table 9).

The estimated increase in both maternal deaths and the maternal mortality ratio in developing regions between 2015 and 2017 reflects that, while the total number of births rose only 0.35% over this period, they increased by 2.62% in Africa, the region with the highest maternal mortality ratios (498 per 100,000 live births in Africa in 2015 vs. 121 in Asia and 68 in Latin America and the Caribbean). Births fell by 0.72% in Asia and 0.86% in Latin America and the Caribbean over this period.

Abortion-related mortality

As shown in Table 8 and described in the AIU-2014 Methodology Report,[12] estimates of abortion-related mortality have differed widely over time and across studies. We based AIU-2017 estimates of abortion-related and other causes of maternal death on the 2015 IHME Global Burden of Disease Study because, as described above, the study included more countries and more recent data than did others.

We estimated the distribution of maternal deaths by cause of death by applying the country-level IHME 2015 distribution of maternal deaths (excluding late maternal deaths) to the estimated number of maternal deaths in each country in 2017. For the few countries with no IHME estimate, we used the cause-of death-distribution from the unweighted average of countries with data in the subregion or for a similar country nearby (i.e., Morocco for Western Sahara and China for Hong Kong and Macao).

Applying the 2015 IHME cause-of-death distribution to births in 2017 yielded an estimated 32,394 maternal deaths categorized as related to "maternal abortion, miscarriage, and ectopic pregnancy." These deaths accounted for 10.5% of maternal deaths, ranging from 8.0–8.7% in Eastern, Middle, Western and Northern Africa to 21.3% in South-Eastern Asia and 28.0% in the Caribbean. We relied on several studies to separate mortality related to induced abortions (safe or unsafe) from miscarriages and ectopic pregnancies in the IHME cause-of-death estimates. From Kahn et al.,[123] we estimated that 7.7% of deaths in this broad category were from ectopic pregnancy, for a total of 2,479 deaths, a rate of 70 per 100,000 ectopic pregnancies. Based on mortality from miscarriages cited by Åhman and Shah,[122] we estimated a mortality rate of one per 100,000 miscarriages at weeks 14–27. Applying this rate to the 2017 estimate of miscarriages resulted in a total of 59 deaths. By subtracting deaths from ectopic pregnancies and miscarriages from the broader category, we estimated 29,855 maternal deaths in 2017 were related to induced abortion. The resulting percentage of maternal deaths due to induced abortion was 9.7%, ranging from 6.9–7.9% in African regions outside Southern Africa to 21.2% in South-Eastern Asia and 27.9% in the Caribbean.

Estimation of mortality from safe and from unsafe abortions.
We assumed that the mortality rate was two deaths per 100,000 safe abortions. This is at least double the reported rates for women having safe abortions in developed countries[132] and is based on the assumption that differences in health status and health care access would contribute to higher mortality in developing countries. We assumed this mortality rate applied to all safe abortions in developing regions in 2017, and that other abortion-related deaths were from unsafe procedures. This resulted in an estimated 478 maternal deaths from complications of safe abortions in developing regions in 2017 and 29,377 deaths from unsafe abortions. Lacking information on the relative mortality rates from less safe vs. least safe abortions, we were unable to distribution unsafe abortion deaths into these subcategories. Information on the numbers and distributions of causes of maternal deaths is shown in Tables 9 and 10.

Neonatal (newborn) mortality

The neonatal mortality rate is defined as the number of babies who die within 28 days of birth per 1,000 live births.[133] We estimated the numbers of neonatal deaths in each country in 2017 by multiplying the median country-specific estimates from the UN Interagency Group for Child Mortality Estimation (IGME) of neonatal mortality rates in 2015[109,133] by the number of live births in each country in 2017. We estimated 2017 neonatal mortality rates for countries not included in the IGME estimates from unweighted subregional averages or from nearby countries; these estimated neonatal deaths accounted for only 0.1% of the total estimated number of neonatal deaths in developing countries in 2017 (Table 11).

We limited our estimates of impact to neonatal mortality, rather than including all infant mortality, because the maternal and newborn health interventions we were able to include in our model primarily affect neonatal survival. Neonatal deaths account for 62% of infant deaths in developing regions. This proportion has risen in recent years as mortality rates at ages 1–12 months have declined more steeply than in the neonatal period.[134]

We distributed the total numbers of neonatal deaths in each country in 2017 according to cause of death based on estimates for 2015 from WHO's Department of Evidence, Information and Research and Maternal Child Epidemiology Estimation collaboration.[135,136]

SECTION 4: Need for and Use of Contraception

We classified women aged 15–49 in each country, marital-status category and age group according to their risk for unintended pregnancy and contraceptive method use, and we summed these subgroups to show women not wanting and wanting to avoid a pregnancy and method use distributions for all women aged 15–49 by marital status. We estimated these distributions by marital status for all women aged 15–49 according to their household wealth category, rural or urban residence and their desire to delay the beginning of childbearing, space pregnancies or have no (more) children. Except where noted, these classifications follow revised DHS definitions.[137,138]

Definitions

Pregnancy intentions

Wanting to avoid a pregnancy and in need of modern contraceptives. Women are classified as wanting to avoid a pregnancy and needing modern contraceptives if

- they or their partner are currently using a contraceptive method, either traditional or modern;
- they are currently married or are unmarried and sexually active, and they are able to become pregnant, but want to wait two or more years before having a child; or
- they identify their current pregnancy as unintended or are experiencing postpartum amenorrhea after an unintended pregnancy.

Women who identify their current pregnancy as unintended or are experiencing postpartum amenorrhea after an unintended pregnancy are included (per the DHS approach) because their current or recent experience with unintended pregnancy indicates that they wanted to avoid becoming pregnant at some point in the last year. They are therefore relevant for estimating the total number of women wanting to avoid a pregnancy in any given year.

Not wanting to avoid a pregnancy. Other women are classified as not currently wanting to avoid a pregnancy; these are women not at risk of having an unintended pregnancy and therefore not considered to be in need of contraceptives. Following the DHS methodology, these include unmarried women who are not sexually active, women who are infecund, those who want to have a child in the next two years, and those who are currently experiencing a pregnancy they identify as having been intended or are experiencing postpartum amenorrhea from a pregnancy they identify as having been intended.

This measure somewhat underestimates the proportion of women who want to avoid a pregnancy, since some women who are not using contraceptives and want to wait less than two years to have a child want to avoid a pregnancy at the current time.[139] Reported desires for childbearing also reflect societal influences that may pressure them toward having children.[140]

Sexually active status

All currently married women were assumed to be sexually active. Women who were not married were classified as sexually active if they reported having had intercourse in the three months prior to the survey. This is a longer time period than used in the revised DHS definition, which considers unmarried women who have had sex in the month before the survey to be sexually active for calculation of unmet need estimates.[137,138]

Because of the stigma attached to nonmarital sex, the level of sexual activity—and therefore risk for unintended pregnancy—is likely to be underestimated among unmarried women, especially in Asian and Arab countries, where stigma is especially strong. Almost all surveys in Sub-Saharan Africa and Latin America include unmarried women, although their sexual activity is likely to be somewhat underreported. However, unmarried women are largely excluded from surveys in Asia and Northern Africa, and, where they are included, underreporting of their sexual activity is likely to be extensive. We made estimates for unmarried women in countries in these regions based on data from national surveys and from subnational studies. We used these estimates for countries in these regions where there were no data for unmarried women and for the few countries where the reported level of sexual activity was lower than the estimates.

Infecundity

Sexually-active women were classified as infecund if they reported when surveyed that they were infecund, had had a hysterectomy or were menopausal. Also considered infecund were women who were not using contraceptives and were neither pregnant nor experiencing postpartum amenorrhea but who had not had a menstrual period for six months or longer, and those who were married and had not used a contraceptive method during the past five years, but had not had a birth and were not currently pregnant.[137]

Childbearing intentions

Women wanting to avoid a pregnancy who wanted no (more) children in the future were classified as wanting to limit childbearing. Women wanting to avoid a pregnancy who did want children in the future, including women wanting to delay a first birth and women with children who wanted to wait two or more years before having another child, were classified as spacing births.

Modern contraceptive methods

There are a number of approaches to categorizing contraceptive methods.[141,142] These have included classifying methods as “modern” versus “traditional,” by method effectiveness, need for program support, duration of labeled use, which partner controls method use, relationship to timing of coitus, requirement for a surgical procedure to begin or end use, hormonal content, users’ ability to discontinue the method and return to fertility afterward. While acknowledging that no one classification system meets the needs for all users, providers or researchers, the

terms “modern” and “traditional” have been most often used in monitoring method use.

In Adding It Up, we have used the categories of modern and traditional to distinguish between methods with higher and lower use-failure rates, recognizing that use-effectiveness for many methods depends heavily on correctness and consistency of their use. We chose this focus as best suited to our focus on assessing how successfully women and their partners were to meet their own goals for number and timing of having children.[143]

In AIU reports for 2004, 2008 and 2012, we followed method classification used in DHS analyses and reports, classifying the following as modern: female and male sterilization; IUDs; hormonal methods, including implants, injectables and oral contraceptives; male and female condoms; and other supply methods, such as diaphragms and vaginal spermicides. In AIU-2014, we also included modern fertility-awareness-based methods, i.e., the Standard Days Method and TwoDay Method based on their classification by USAID and DHS.[144] In this category of fertility-awareness-based methods, we also included women reporting use of the Billings or Sympto-Thermal methods. We classified other methods as traditional, including other periodic abstinence methods, the lactational amenorrhea method (LAM—which involves exclusive breast-feeding for up to six months postpartum), withdrawal and folk methods. We chose not to classify LAM as a modern method in AIU-2014 because of the disparity in how it is classified across countries’ DHS reports; because of its short-term use requirement (up to six months compared with the AIU focus on making annual estimates); concerns about quality of reporting in DHS and other surveys; and high levels of incorrect LAM use.[145] We also used the AIU-2014 classification in the 2016 adolescent report[13]—that is, we included fertility-awareness-based methods, but not LAM, with modern methods.

In 2015, we participated in a technical consultation to address issues related to classifying contraceptives, convened by the WHO Department of Reproductive Health and Research and the USAID.[141] The consultation’s participants adopted the following criteria for classifying a method as “modern”:

- “A sound basis in reproductive biology;
- A precise protocol for correct use; and
- Existing data showing that the method has been tested in an appropriately designed study to assess efficacy under various conditions.”[141]

Using these criteria, all methods that were classified as modern in AIU-2014 were also considered modern in AIU-2017—male and female sterilization, IUDs, hormonal methods (including hormonal implants, injectables, oral contraceptives, the patch, ring and emergency contraceptive pills), male and female condoms, modern fertility-awareness methods and other supply methods. The consultation also recommended, “In regions where LAM is promoted, taught and used, it should be reported as a modern method.”[141] We were unsuccessful in identifying such regions or countries and decided to classify LAM as a modern method in all

countries where its use was reported.

AIU-2017 thus follows these WHO/USAID recommendations regarding classification of contraceptives as "modern," as does DHS.[146] UNPD uses a very similar classification, except that it includes fertility-awareness-based methods as "traditional" rather than "modern." [48]
The changes over time in classification of fertility-awareness-based methods and LAM make little difference in overall trends, though they may affect trends in some countries. In 2017, LAM accounted for 0.36% of total method use in all developing countries, and fertility-awareness-based methods accounted for 0.03%. The percentage of contraceptive users relying on LAM or fertility-awareness-based methods exceeded 1% in only seven countries—Central African Republic, Guinea-Bissau, Niger, Somalis, Syria, Uzbekistan and Yemen. In the adolescent AIU analysis, LAM accounted for 1% of method use among adolescent women aged 15-19 using any contraceptive method in 2016.

We followed the WHO/USAID recommendation to classify women reporting use of herbs, charms, and vaginal douching as their contraceptive methods as using no method because there is no scientific basis for these methods being effective in preventing pregnancy.[141] Such methods had been included with other traditional methods in previous AIU analyses. The change in classification had little impact on the numbers of traditional and no-method users. Only 0.0002% of women wanting to avoid a pregnancy and therefore in need of contraception in 2017 reported using these methods. They represented 0.001% of women in need using no method and would have accounted for only 0.003% of women using traditional methods.

Unmet need for modern contraception

Women with unmet need for modern contraception are those who want to avoid a pregnancy but are currently not using a method or are using a traditional method. Other studies may not define women using traditional methods as having unmet need, but AIU focuses on the need for *modern* contraceptives because women using traditional methods face higher risks of unintended pregnancy than those using modern methods.[76,79–82] Modern methods are most likely to help women and couples successfully meet their stated goals to postpone or stop childbearing.[143] In most tabulations of unmet need, we show separate estimates for women not using a method and those using a traditional method so that readers can calculate unmet need for only those women using no contraceptive method.

Contraceptive need and use distribution

Using these definitions and classifications, we estimated numbers and percentages of women aged 15–49 by marital status, age and country according to the following categories:

Not wanting to avoid a pregnancy and not in need of contraception—Unmarried women who are not sexually active (in the last three months), women who are infecund, those who want to have a child in the next two years, and those who are currently experiencing a pregnancy they

identify as having been intended or are experiencing postpartum amenorrhea from a pregnancy they identify as having been intended.

Wanting to avoid a pregnancy and in need of modern contraception—Women using a contraceptive method and nonusers wanting to avoid a pregnancy, including women not wanting a child in the next two years (spacing) and those wanting no (more) children (limiters).

Using a modern contraceptive method (Met need)—Women relying on female or male sterilization (limiters only), IUD, implant, injectable, oral contraceptives, contraceptive patch or ring, emergency contraceptive pills, male or female condom, LAM, fertility-awareness-based method or other supply methods.

Using a traditional contraceptive method (Unmet need)—Women relying on periodic abstinence, withdrawal or other nonsupply methods.

Nonusers in need (Unmet need)—Women using no contraceptive method wanting to avoid childbearing for at least two years, pregnant/in postpartum amenorrhea from an unintended pregnancy or using an ineffective method (herbs, charms, folk methods or vaginal douching).

Data Sources

Nationally representative surveys are the principal source of data on women's need for and use of contraceptives (Table 12). For some countries, we used two or more available sources, usually taking advantage of recent, but incomplete, data (e.g., from a preliminary report of national survey findings) to update information from a prior survey. Countries with two or more sources of information are shown in Table 12.

Full coverage

We made tabulations for this project for all countries with available data sets or survey reports. These include Demographic and Health Surveys (DHS), U.S. Centers for Disease Control and Prevention Reproductive Health Surveys (RHS), United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Surveys (MICS), Performance Monitoring and Accountability 2020 (PMA2020) surveys. As shown in Table 12, data on the distribution of women aged 15–49 by age group, by contraceptive need (wanting or not wanting to avoid a pregnancy) and use of modern contraceptives, traditional methods or no method while wanting to avoid a pregnancy, were available for 80% of all women aged 15–49 in developing regions in 2017, ranging from 54% of never-married women to 70% of formerly married and 91% of currently married women.

For countries in which the distribution of contraceptive users by childbearing intention was unavailable, we assumed that all women relying on sterilization were limiting childbearing, and women using each reversible method were equally split between spacing and limiting.

Partial coverage

For countries in which the proportion of women not in need of contraception was available, but not the distribution across subcategories of no need—infecundity, not sexually active in the past three months (for unmarried women), wanting a child in the next two years or pregnant or in postpartum amenorrhea related to an intended pregnancy—we assumed the distribution was the same as the weighted distribution of women of similar age and marital status and not in need in other countries with available data in the subregion or region. Similarly, for countries for which the proportion of women using contraception was available, but there were no data on the pregnancy intention of nonusers wanting to avoid a pregnancy, we used the proportions of nonusers in need of contraception wanting to space or limit childbearing from other countries with data in their subregion or region. Finally, for countries in which only the proportion of women using contraception was available, we used the weighted subregional distribution of nonusers who were not in need of contraception or wanting to space or limit pregnancies. Partial data were available, and estimates made of the distribution of women not in need and/or nonusers in need by childbearing intention for 4% of all women aged 15–49 (2% of never-married women, 1% of formerly married women and 6% of currently married women).

Estimation

Some countries lacked recent national survey data and we found no other published data that could be used in this project; others lacked available data for either never-married women or unmarried women. We therefore made estimates for these countries and women, accounting for 16% of all women aged 15–49 in developing regions. While we estimated the distributions by contraceptive need and use and childbearing intention for only 3% of currently married women, estimation was required for 29% of formerly married and 43% of never-married women.

For most such countries, we assumed the distributions of women by need for contraception, future childbearing intention and/or contraceptive use were similar to those in other countries in the same subregion or region or to other countries that are demographically or socioeconomically similar. However, as noted above, for most countries in Asia and Northern Africa, we made estimates for unmarried women based on data from national surveys and from subnational studies.

For women aged 15–19, we used estimates of the proportion of never-married women who were sexually active in the prior three months that had been made for the adolescent AIU study in 2016. We estimated that 4% were sexually active in Southern Asia based on a six-state study in India;[147] 4% were sexually active in Eastern Asia based on data from China[148,149] and the Mongolia 2010 MICS national survey; 2% were sexually active in Central Asia based on the 2011 and 2015 MICS surveys for Kazakhstan; and, 3% in South Eastern Asia based on the 2013 DHS in the Philippines. We used these subregional values for countries in each subregion lacking data or having a survey estimate lower than these levels. For Northern Africa and Western Asia, we used the weighted average of 4% from other subregions in Asia. We estimated the distribution

of never-married women aged 15–19 in these subregions to be sexually active across categories of contraceptive need and use according to the average of the countries in Asia with available survey data (Armenia, Bhutan, Cambodia, China, Indonesia, Kazakhstan, Kyrgyzstan, Laos, Mongolia, Nepal, Philippines, Timor-Leste, Thailand and Uzbekistan).

For never-married women aged 20–49 for which no data were available on sexual activity, or where almost all never-married women aged 15–49 were reported not to be sexually active, we used estimates from analyses done for AIU-2014[12] since no more recent data were available. In Eastern Asia, we assumed that 84% were not in need of contraception, 8% used modern contraceptives, and 8% used traditional methods or no method, even though they want to avoid a pregnancy. In Southeast Asia, we assumed 94% were not in need, 3% used modern contraceptives and 3% used traditional or no methods; and, for Western Asia, we assumed 98% were not in need, 1% used modern methods and 1% used traditional or no method. Within these categories, we distributed women not in need and in need of modern contraceptives into subcategories of childbearing intention and method-type (including no method) based on the weighted distribution of never-married women in countries in Asia with available data.

We calculated the distribution of women aged 15–49 by contraceptive need and method use in each country separately for women in five-year age groups who were currently married, formerly married or never married (Tables 20 and 22). We applied these distributions to the estimated numbers of women in 2017 by age and marital status, and summed these subgroup estimates to calculate the numbers and distribution of contraceptive need and use for all women aged 15–49 and for each marital-status category. This approach yielded total estimates that reflect the age and marital-status distributions of women 15–49 in 2017, rather than the distributions at the time of the data source for each country.

From available national survey data files and reports, we estimated the contraceptive need and use distributions of women aged 15–49 according to marital status and household wealth quintile, rural or urban residence and intention to delay, space or stop childbearing (Tables 21 and 23). For these subgroup estimates, we included in the "delay" category women who had not yet had a live birth wanting to wait at least two years before having a child, and those who had previously had a live birth in the "spacing" category. When data were not available, we estimated the distributions, within marital-status groupings, from a similar nearby country or weighted subregional or regional distribution. To ensure the sums of the subgroup estimates were consistent with the totals in our age-specific tabulations, we multiplied the resulting numbers in each need and use category by the ratio of the total numbers of women 15–49 by marital status in 2017 to the sum of the comparable subgroup estimates.

Estimates of Contraceptive Need and Use

The methodology used to develop the 2017 estimates of the need for and use contraceptives among women aged 15–49 is similar to that used for the prior Adding It Up estimates, but it has

been changed to take into account differences across age groups. Estimates of contraceptive need and use were calculated separately for currently married, formerly married and never-married women in five-year age groups and summed to obtain estimates for all women of reproductive age. Women in each marital status group were first classified into those wanting and not wanting to avoid a pregnancy; those wanting to avoid a pregnancy were further subdivided into those wanting to delay or space births and those wanting to have no more children; women within these two groups were then classified according to their contraceptive use status.

Tables 14 and 15 show, for each country and for selected country groupings, the resulting distributions of women aged 15–49 by marital status and according to their need for and use of contraception, i.e., not wanting to avoid a pregnancy (not in need of contraception), using modern or traditional contraceptive methods, or wanting to avoid a pregnancy but using no method. In addition, Table 15 shows the distribution of women in each marital-status group who want to avoid a pregnancy. The proportion of women wanting to avoid a pregnancy using modern contraceptives represents the percentage of demand for family planning met with modern contraceptive methods.[143,150] Together, the proportions of women wanting to avoid a pregnancy who use traditional methods or use no methods are considered to have unmet need for modern contraceptives.

Tables 16 and 17 present the marital-status distribution of women in each of the main contraceptive need and use groups, showing that although most women wanting to avoid a pregnancy are currently married, substantial proportions are unmarried.

More detailed distributions of women by reasons for not wanting to avoid a pregnancy (not needing contraception) and by specific contraceptive methods used are shown in Table 18 for currently married women aged 15–49, and in Table 19 for all women 15–49, for each developing country. Detailed contraceptive need and use information for all women and for those in each marital status group are shown by selected country groupings in Table 20 and by wealth, residence and pregnancy intention subgroups in Table 21 (percentage distribution) and Tables 22 and 23 (numbers of women). Table 24 shows method use (in numbers and percentage distributions) among women wanting to avoid a pregnancy who want to delay or space births and who want no (more) children and are seeking to limit future childbearing.

Service Requirements

We used standard WHO protocols and expert opinions to specify the type and quantity of drugs, supplies and personnel time required for provision of each contraceptive method. All requirements are shown according to method, in the first eleven panels of Table 39, which shows treatment assumptions used in AIU-2017 for both contraceptive and maternal and newborn care.

For short-term methods (oral contraceptives, injectables, male and female condoms and emergency contraceptive pills), requirements are for one year of use. For long-acting reversible contraceptive methods (IUDs, implants), requirements include initiation, follow-up and removal of the method. Cycle beads for using the StandardDays Method can be used for more than one year, and the Lactational Amenorrhea Method can be used for up to six months. Assumptions regarding the average duration of use of IUDs, implants, cycle beads and sterilization are presented in Section 7. AIU-2017 updated estimates of the types of personnel needed to deliver many of the services based on task-shifting recommendations from WHO.[151,152]

SECTION 5: Need for and Receipt of Maternal and Newborn Health Care

The components of health services that women and newborns need are included in the basic package of care recommended by WHO.[153–162] We have estimated the proportions needing specific service interventions from published estimates of incidence or prevalence of specific pregnancy-related conditions. Estimates of the proportions receiving needed health services ("met need") are drawn from survey information for the most recent birth in the time period covered in the survey—usually the past two years (MICS) or three years (DHS)—and other published studies, including estimates developed for the Lives Saved Tool (LiST) and the OneHealth Tool.[163,164] Otherwise, we based estimates of the receipt of care on the type of care needed, women's receipt of antenatal care and whether birth occurred in a health facility. We used the Reproductive Health Costing Tool (RHCT) estimate that half of women who deliver in a facility have access to emergency obstetric care (EmOc), with no distinction between Basic and Comprehensive EmOC.[19] Estimates of receipt of postabortion care are from the Guttmacher Institute.[165–167]

For most estimates of the drugs, supplies and personnel needed to provide each intervention, we use assumptions from LiST and the OneHealth Tool, supplemented by literature and WHO recommendations. We generally used the same versions of LiST and OneHealth Tool assumptions as we did in the AIU-2014 estimates[12,168,169] because their assumptions updated in 2016–2018 were not available in time for their use in AIU-2017.[168,170,171] Similarly, we use the most recent WHO recommendations available at the time of preparing AIU-2017. Changes to some WHO intervention recommendations, such as the updated compendium of *Managing Complications in Pregnancy and Childbirth*[160,172] incorporate earlier updates. Other changes were not available for use in AIU-2017. Recent revisions to the OneHealth Tool assumptions were also not available in time for use in AIU-2017.[171]

Antenatal Care

Ectopic pregnancy case management

An ectopic pregnancy is a complication of pregnancy in which the embryo implants outside the uterine cavity. With rare exceptions, ectopic pregnancies are not viable. Most ectopic pregnancies occur in the fallopian tube, but implantation can also occur in the cervix, ovaries and abdomen. In developing countries, ectopic pregnancies are usually only recognized when they have ruptured or are in danger of rupturing and require surgical intervention.

Need. As noted earlier, we based the assumption that ectopic pregnancies equal 2% of live births plus induced abortions on an analysis of data from the early 1990s by researchers at the Centers for Disease Control and Prevention.[110] Following assumptions used in the OneHealth model,[164] we assumed that half of all ectopic pregnancies, i.e., 1% of live births plus abortions,

need surgical treatment. Based on this estimate, we assumed that, in developing countries, all ectopic pregnancies that do not resolve on their own (about 1% of all live births plus abortions) will require a laparoscopy or laparotomy.

Coverage. We assumed current coverage for women with ectopic pregnancies needing care equaled the estimated coverage for emergency obstetric care, i.e., 50% of the country's level of facility-based deliveries (see Table 26). Treatment needed for women with ectopic pregnancies was based on WHO recommendations.[172] Drugs, supplies and personnel time for an average case are shown in Table 39: Ectopic pregnancy case management.

Basic antenatal care

In 2016, WHO issued updated recommendations for pregnancy care.[159,161,173] WHO changed from recommending that a pregnant woman make at least four antenatal *visits*[162,174] to recommending women have at least eight *contacts* with an antenatal care provider.[159,161,173] Table 25 provides estimates of the proportions of women with live births who made any professional antenatal care visits, who made four or more and who made eight or more visits, by selected country groupings. However, in AIU-2017, we continued to consider at least four antenatal care visits, at least one of which was to a trained provider, to fully meet the standard. We also had no basis from available data for distinguishing contacts for antenatal care from those with providers in integrated settings for which the purpose was something other than antenatal care.

The new WHO recommendation for calcium supplementation to reduce the risk of pre-eclampsia is specific to "populations with low dietary calcium intake." We were unable to find data to categorize countries by their population's calcium intake or blood levels, and therefore did not include calcium supplements in the estimates for maternal care. We also did not include ultrasound as a separate intervention, although the WHO now recommends at least one routine ultrasound for pregnant women before 24 weeks.[175] We assumed that the average visit time of 10 minutes would include time for an ultrasound at one of the visits, and that equipment costs would be included in systems and program costs related to MNH care. Further, after publication, we discovered that our supplies cost for ANC visits was $.65 too high—$3.46 rather than the more accurate $2.83—because the first-visit cost included the equivalent of eight-visit supplies for gloves and urine test strips. We consider that this excess represents, in part, costs for ultrasound supplies that are not otherwise included in our estimates.

***Need*.** We assumed all women whose pregnancies end in birth (live birth or stillbirth) need at least four antenatal care visits. For women with miscarriages before 27 weeks' gestation, we assumed their pregnancies would have lasted long enough to require an average of two visits.

***Coverage*.** Estimates of receipt of needed health services ("met need") draw on a wide range of surveys of women who had live births in recent years—principally the DHS, supplemented by

the MICS, the RHS, independent national surveys and other national sources of data on health services, as well as estimates from published studies and literature reviews. Where available, we took information reported for the most recent birth in the period covered in the survey, usually the past two years (MICS) or three years (DHS).

In DHS, MICS and similar surveys, women are asked from what types of providers, if any, they received antenatal care. From surveys for which data files were available, we tabulated the numbers of visits to skilled professionals, recognizing that some of these visits may have been made to unskilled providers. We used country classifications of the types of providers who were deemed professional or skilled. Generally, these included physicians, midwives and nurses.

For some countries, data on the number of antenatal care visits were available from a more recent data source without available data sets, such as preliminary reports and UNICEF's database.[176] For these countries, we assumed that the numbers of visits among those reporting antenatal care visits included at least one visit to a professional provider. In most of these cases, the only detail on the number of visits was the 4+ category. We used prior survey tabulations for the country or subregional estimates from countries with full data to estimate the distribution of the numbers of visits.

Data on antenatal care is available from women who had live births. We assumed the same care was obtained by women with stillbirths. To estimate the number of women with miscarriages before 27 weeks who receive zero, one or two antenatal care visits, we used the proportions of women giving birth who made zero, one or two visits.

Components of basic antenatal care were based on WHO recommendations.[177] In the category of basic antenatal care, we included a pregnancy test, physical exams, blood tests for glucose, blood group and Rh factor and urine tests, along with 10 minutes of a nurse's time per visit. We treated other components as separate interventions. WHO recommends 20 minutes of provider time per visit,[177] but since this includes interventions (such as tetanus toxoid injection or syphilis detection and treatment) that are treated separately from antenatal care in the Adding It Up model, we allocated only 10 minutes of staff time per visit for basic antenatal care. See Table 39: Basic antenatal care – first visit and Basic antenatal care – visits 2+.

Tetanus toxoid injection

Tetanus is acquired when the spores of the bacterium Clostridium tetani infect a wound or the umbilical stump of a newborn baby. The disease is particularly common and serious in newborn babies. Neonatal tetanus can be prevented by immunizing women of childbearing age (pregnant or not) with tetanus toxoid. This protects the mother and, through a transfer of tetanus antibodies to the fetus, also her baby.[178]

***Need*.** We assumed that all women giving birth (live births or stillbirths), and all with miscarriages before 27 weeks, need two doses of tetanus immunization: "In countries where [maternal and neonatal tetanus] remains a public health problem, special attention should be given to immunizing women of childbearing age. As a minimum strategy, eligible pregnant women should be routinely immunized at their first contact with antenatal clinics or other health services offering vaccination. Pregnant women with an inadequate or unknown immunization history should always receive 2 doses of tetanus toxoid-containing vaccine: the first dose as early as possible during pregnancy and the second dose at least 4 weeks later. Efforts should be made to complete the recommended series of 5 immunizations, e.g. when the mother brings her baby for vaccinations and in connection with subsequent pregnancies, while respecting the minimum intervals between doses."[179]

***Coverage*.** We took the proportion of women with live births who had received at least two tetanus injections from tabulations of DHS, MICS and other national survey tabulations and reports, and from the World Bank's WHO and UNICEF database.[180] We estimated missing data from weighted subregional averages, and assumed that levels of immunization during pregnancy applied to women with both live births and stillbirths. Table 25 provides estimates of the proportions of women with live births who received at least two tetanus toxoid injections, by selected country groupings.

To estimate coverage among women with miscarriages, we looked to information on coverage levels according to the number of antenatal care visits women made. We used assumptions based on DHS tabulations for AIU-2014, showing the following proportions of women received at least two tetanus shots during their last pregnancy in the past three years, by their number of professional prenatal visits, as follows:[181]

- 0 visits: 19.4%
- 1 visit: 19.0%
- 0–1 visits: 19.2%
- 2 visits: 46.9%
- 3 visits: 55.3%
- 4+ visits: 57.8%
- 2+ visits: 56.2%
- Total: 48.5%

For women with miscarriages before 28 weeks, we assumed those with fewer than two visits had at least two tetanus shots, in a ratio of 19.2/48.5=0.39 of the country's level among women giving birth, and that those with at least two visits had a ratio of 46.9/48.5=0.97 of the country's level among women giving birth. For assumptions about supplies and staff time needed to provide two tetanus toxoid injections during antenatal care, see Table 39: Tetanus toxoid injection.

Syphilis screening and treatment for women

WHO recommends that all pregnant women be screened for syphilis at their initial antenatal care visit and shortly before birth, and that they be treated, if needed, for their own health and to prevent mother-to-child transmission of syphilis.[182,183]

***Need*.** We assumed that all women giving birth or having miscarriages need to be screened for syphilis. We assumed the proportion of women screened for syphilis at their first antenatal care visit[184] who were positive[185] represents the proportion of pregnant women who are positive for syphilis at first and at second screening. We estimated that 65% of pregnant women who test positive for syphilis need treatment for probable active syphilis.[186]

***Coverage*.** Following Newman et al.,[186] we used data from the WHO Global Health Observatory to estimate the proportion of women who received syphilis screening at their first antenatal care visit.[184] Table 26 provides estimates of the proportions of women with live births who received a syphilis test at a first antenatal care visit, by selected country groupings. This proportion times the proportion of women with at least one antenatal care visit was used to represent the percentage of pregnant women with an initial syphilis test. This proportion, in turn, times the proportion of women with at least four antenatal care visits was used to estimate the proportion of women giving birth who received a second syphilis screening.

We took the proportion of women who were screened at their first antenatal care visit and found to be positive who were treated, i.e., we assumed those who were not screened were not treated, from the WHO Global Health Observatory.[187] Lacking information on the proportion of women screened for a second time during pregnancy who would be infected with syphilis, we did not estimate treatment for these women. Table 25 provides estimates of the proportions of women with live births who needed treatment because they had probable active syphilis infection, by selected country groupings. Screening and treatment requirements are shown in Table 39: Syphilis screening for women and Syphilis treatment for seropositive women.

Hypertensive disease case management

Women with conditions associated with high blood pressure during pregnancy may progress from mild disease to a more serious condition over the course of their pregnancy. These hypertensive disorders of pregnancy include hypertension without proteinuria (covered in this intervention), and mild preeclampsia, severe preeclampsia and eclampsia (covered as separate interventions, below).

***Need*.** We assumed all women who give birth need screening for hypertensive disease as part of antenatal care, and that women who had miscarriages were not screened (because very few women had miscarriages at weeks 20–27, the period when they would have obtained screening). As described below, we estimated that 7.65% of women develop hypertensive diseases of pregnancy, including 3.73% of women who have hypertension without proteinuria

and 3.4% who develop preeclampsia, including 1.33% with mild preeclampsia at less than 37 weeks' gestation, 1.33% with mild preeclampsia at 37 weeks or later, and 0.75% with severe preeclampsia.

From Dolea and AbouZahr, we assumed the average incidence of preeclampsia in developing countries was 3.4% of births.[188]

In an analysis of 38,923,280 deliveries after 20 weeks in the United States in 1988–1997, Zhang et al. found that 5.9% of women had hypertensive disorders of pregnancy, including 3.01% with hypertension without proteinuria, 2.73% with preeclampsia and 0.11% with eclampsia (distributing the 1.8 per 1,000 deliveries with preeclampsia/eclampsia superimposed on chronic hypertension across categories of mild preeclampsia, severe preeclampsia and eclampsia).[189]

Of the women in Zhang et al.'s study with preeclampsia, 78% had mild preeclampsia and 22% had severe preeclampsia. Applying these percentages to the 3.4% average developing-country incidence of preeclampsia (from Dolea and Abouzahr), we estimated that 2.65% of women giving birth have mild preeclampsia and 0.75% have severe preeclampsia. Lacking data on timing, we assumed that half of women with mild preeclampsia develop it before 37 weeks' gestation and half at 37 weeks or later.

In Zhang et al.'s analysis, the number of women with eclampsia was 3.9% of the total with mild or severe preeclampsia. While this is higher than the 2.3% level estimated by Dolea and AbouZahr, we used the figure from Zhang et al. to estimate that 0.13% of women giving birth develop eclampsia. (Using the percentage from Dolea and AbouZahr would have resulted in 0.08% with eclampsia.)

In the Zhang et al. study, women with preeclampsia and eclampsia made up 48.6% of all those with hypertensive disorders of pregnancy. Based on this, we assumed that the total estimated levels of 3.53% with preeclampsia and eclampsia represented 48.6% of a total 7.26% with hypertensive disorders and that the difference, 3.73%, were women with hypertension without proteinuria.

***Coverage*.** We assumed that women who had any professional antenatal care visits and had a urine test during the visit(s) were screened for hypertensive disease, and that women who had miscarriages were not screened (because very few women had miscarriages at weeks 20–27, the period in which they would have obtained screening). We assumed the percentage of women with any antenatal care visits who had a urine test applies to those with any professional visit. Table 26 provides estimates of the percentage of women with live births who had a urine test during professional antenatal care, by selected country groupings.

We assumed that all pregnant women who have at least four antenatal care visits and a urine test and are found to have hypertensive disorder without proteinuria obtain weekly monitoring for high blood pressure.

For those with mild preeclampsia before 37 weeks' gestation, we assumed those who are identified (percentage with at least four antenatal care visits times the percentage of those with antenatal care who had a urine test) receive needed care (monitoring blood pressure and protein in urine twice weekly).

For those with mild preeclampsia at or after 37 weeks' gestation or severe preeclampsia, we assumed the proportion of those identified (percentage with at least four antenatal care visits times percentage of those with antenatal care who have a urine test) who receive treatment was equal to the estimated proportion of births that occur in facilities with emergency obstetrical care.

Treatment requirements. We based estimates of treatment requirements for women with hypertensive disorders of pregnancy on WHO sources.[172,190]

We assumed that hypertensive women without proteinuria need weekly monitoring for blood pressure and proteinuria, and that hypertensive disorders of pregnancy are usually discovered around week 35, with the average woman with hypertension without proteinuria needing five monitoring visits through the end of pregnancy.[191] For treatment requirements, see Table 39: Hypertensive disease case management for hypertensive women without proteinuria.

For those with mild preeclampsia before 37 weeks, treatment requirements include outpatient follow-up twice a week and weekly monitoring of blood pressure, urine (for proteinuria) and fetal condition. Anticonvulsants, antihypertensives and sedatives are not to be given. If urinary protein levels increase, it should be managed as severe preeclampsia (see below). Treatment requirements are shown in Table 39: Preeclampsia case management—mild cases <37 weeks.

For women with mild preeclampsia at 37 weeks or later, treatment recommendations are to expedite delivery if there are signs of fetal compromise. We assumed 50% of women can be monitored and 50% need immediate delivery and that treatment would be to rupture membranes and induce labor using oxytocin, if the cervix is favorable, or, if unfavorable, to ripen cervix using prostaglandins or deliver by cesarean section. Treatment requirements are shown in Table 39: Preeclampsia case management—mild cases ≥37 weeks.

Severe cases of preeclampsia require active in-hospital management with delivery, including antihypertensive drugs and, if needed, anticonvulsive drugs. See Table 39: Preeclampsia case management—severe cases.

Hookworm treatment

Infection with hookworm parasites causes intestinal bleeding that can lead to anemia and protein malnutrition that can in turn lead to poor pregnancy outcomes and maternal mortality.[192–194]

***Need*.** WHO recommends that for soil-transmitted helminthiasis "albendazole or mebendazole be offered to pregnant women in the 2nd and 3rd trimesters of pregnancy and to lactating women in preventive chemotherapy interventions targeting areas where the prevalence of any soil-transmitted helminth infection (ascariasis, trichuriasis and hookworm infection) exceeds 20%."[195] We assumed that pregnant women who have miscarriages or induced abortions do not need this preventive care.

We were unable to find any source of data classifying regions or countries with hookworm prevalence reaching 20%. Therefore, we estimated the proportions of pregnant women needing medication for soil-transmitted helminthiasis from the WHO estimates of the proportions of children (aged 1–4) needing such medication.[84,96,193,196] We estimated proportions for countries with missing data from Hotez et al.[192] Estimates by selected country groupings are shown in Table 25.

***Coverage*.** We used survey proportions of women with any professional antenatal care visit who took medication for intestinal parasites during pregnancy, when available. For countries with endemic hookworm for which there were no data, we used the subregional or regional proportion of pregnant women in endemic areas with antenatal care who took medication. For Sudan, we used proportions from Nigeria; for Eastern Asia, we used proportions from Southern Asia. Resulting estimates are presented in Table 25. Treatment guidelines were taken from WHO.[172] See Table 39: Hookworm treatment.

Malaria prevention—insecticide-treated bed nets

Pregnant women are especially susceptible to malaria infection, which can lead to malarial anemia and severe disease with a high risk of maternal mortality, pregnancy loss and poor infant outcomes.[197] Use of insecticide-treated bed nets is the primary strategy recommended for protecting pregnant women from infective mosquito bites.[198]

***Need*.** We assumed that pregnant women living in endemic (stable and unstable) areas need long-lasting insecticide-treated bed nets. Since we found no recent estimates, we used the AIU-2014 estimates of population in endemic areas.[199,200] We assumed that a country's percentage of pregnant women living in endemic areas for Plasmodium falciparum is equal to the percentage of population aged 15 and older in areas with unstable or stable transmission, and that the percentage in endemic areas for Plasmodium vivax equals the percentage of the total population in areas with unstable or stable transmission. We assumed the total percentage of pregnant women living in malaria endemic areas was the greater of the proportion in P.

falciparum or P. vivax. See Table 26 for estimates of the proportions of women in selected country groupings needing to use long-lasting insecticide-treated bed nets.

***Coverage*.** We took the proportion of pregnant women aged 15–49 sleeping under an insecticide-treated net the night prior to the survey as the most recent estimate from the UNICEF database[201] and the DHS STATCompiler.[146] For most countries without data, we used subregional proportions of women in endemic areas using insecticide-treated bed nets or weighted proportions for all developing countries with available data. For subregions with no countries that had data, we used weighted proportions from nearby subregions. We used proportions from South-Eastern Asia for countries in Eastern, Central and Southern Asia; Northern Africa for Western Asia; and the Caribbean for countries other than Guyana, for which data were available, in Central and South America. Coverage estimates for selected country groupings are shown in Table 25. We assumed that an insecticide-treated net lasts three years, i.e., one year of use equals, on average, one-third of a net. See Table 39: Malaria prevention— insecticide-treated bed nets.

Malaria prevention—intermittent presumptive treatment in pregnancy

WHO recommends that "All possible efforts should be made to increase access to IPTp [intermittent presumptive treatment in pregnancy] with SP [sulfadoxine-pyrimethamine] in all areas with moderate-to-high transmission in Africa, as part of antenatal care services...at each scheduled antenatal care visit...as early as possible during the second trimester of gestation; each SP dose should be given at least 1 month apart; the last dose of IPTp with SP can be administered up to the time of delivery. In some countries where IPTp with SP is currently being implemented, transmission of malaria has been reduced substantially. In the absence of information on the level of malaria transmission below which IPTp-SP is no longer cost-effective, such countries should not stop IPTp. There is currently insufficient evidence to support a general recommendation for the use of IPTp-SP outside Africa."[202]

***Need*.** We assumed that pregnant women living in endemic areas of Africa need IPTp, and that the percentage of pregnant women living in endemic areas is equal to the percentage of the total population aged 15 and older in that country who live in endemic areas.[199,200] See Table 25 for estimates of the proportions of women in selected country groupings needing intermittent preventive therapy.

***Coverage*.** We took the proportion of last births where the mother received intermittent preventive treatment (at least two doses of SP/Fansidar) through antenatal care visits during pregnancy, from the most recent source from the UNICEF database[201] and the DHS STATCompiler.[146] Where information was not available, we used the subregional proportion of women in endemic areas or the proportion for all developing countries with data. See Table 25 for estimates for selected country groupings and Table 39: Malaria prevention— intermittent presumptive treatment in pregnancy.

Malaria diagnosis and treatment

Pregnant women with malaria need treatment with antimalarial medicines, and those with severe malaria require hospital care.[203]

***Need*.** We assumed the estimated annual incidence of malaria per person applied to pregnant women. We took malaria incidence per person from the WHO Global Health Observatory.[204] For countries with endemic malaria but with no malaria incidence data, we used an unweighted average of incidence in endemic countries in their subregion. See Table 25.

***Coverage*.** We assumed the proportion of women with malaria who obtained needed care was the same as the proportion of women who gave birth who had four or more antenatal care visits (see Table 25 for estimated proportions of women receiving needed care), and the proportion of women with miscarriages other than stillbirths who had at least two antenatal care visits.

We estimated treatment needs from WHO treatment guidelines.[172,203] We assumed use of rapid diagnostic tests, although microscopy may be used in some settings. We assumed that 25% more women are tested than end up being diagnosed with malaria, that 75% of infected women are non-severe cases and that 25% are severe cases. Treatment requirements are shown in Table 39: Malaria - diagnosis and treatment for pregnant women.

Anemia screening

Screening identifies pregnant women with moderate anemia (hemoglobin level of 7–11g/dl) and severe anemia (<7g/dl).

***Need*.** All pregnant women need screening with a blood sample.

***Coverage*.** We assumed the proportion of women giving birth who had a professional antenatal care visit and had a blood sample taken during pregnancy equals the proportion of women giving birth screened for anemia. Estimated proportions of women with live births who were screened for anemia through an antenatal care blood test are shown in Table 25.

In DHS tabulations (except for India), the proportion of women giving birth who had only one antenatal care visit who had a blood sample taken was 53% of the proportion of all women with any professional antenatal care visit with a blood sample.[181] We assumed that women with miscarriages before 28 weeks had the same likelihood of having been screened as women with only one antenatal care visit.

We estimated supplies and staff time for measuring hemoglobin through a blood test. WHO recommends checking for anemia at subsequent visits, looking for conjunctival or palmar pallor.[177] Screening and treatment requirements are shown in Table 39: Anemia screening and treatment.

Anemia prevention—nonanemic pregnant women

Pregnant women who are not anemic need iron and folic acid supplementation to prevent development of anemia. The international recommendation had been for weekly supplementation for nonpregnant women of reproductive age, with supplements containing 120 mg of iron in the form of ferrous sulfate and 2800 mcg of folic acid.[205–207] The recent WHO recommendations are for daily supplementation for all pregnant women except those for whom daily iron is not acceptable due to side-effects, and in populations with an anemia prevalence among pregnant women less than 20%.[159] We used the weekly supplementation regimen for nonanemic pregnant women.

***Need*.** We took the proportion of pregnant women who were nonanemic (hemoglobin of at least 11g/dL) from Stevens et al.[206,207]

***Coverage*.** We took the proportion of pregnant women who took iron supplements during pregnancy from DHS tabulations, using regional estimates from countries with data, or the global developing country estimate from countries with data, for countries and regions with no information. We assumed the proportion taking iron supplements applied to women who gave birth, and that those with miscarriages before 28 weeks were half as likely to take supplements. We assumed nonanemic pregnant women taking iron supplements did so for an average of four months. See Table 39: Anemia prevention: iron and folic acid supplementation—nonanemic pregnant women.

Anemia treatment—anemic pregnant women

Daily iron and folic acid supplementation is recommended for pregnant women with anemia.[208]

***Need*.** We took the proportion of pregnant women who were anemic (hemoglobin less than 11g/dL) from Stevens et al.[206,207] Proportions for selected country groupings are shown in Table 25.

***Coverage*.** We found no data on the proportion of anemic pregnant women who take iron supplements. We used the proportion of all pregnant women who took iron supplements during pregnancy from DHS tabulations, using regional estimates from countries with data or global developing-country estimates from countries with data for countries and regions with no information, as shown in Table 25. We assumed that the proportion taking iron supplements applied to women who gave birth, and that women with miscarriages before 28 weeks were half as likely to be taking supplements. We assumed anemic pregnant women, including women with miscarriages, taking iron did so for an average of four months. Treatment is based on WHO guidelines; see Table 39.

Urinary tract infection

Urinary tract infection is a common infection that usually occurs when bacteria enter the

opening of the urethra and multiply in the urinary tract. The urinary tract includes the kidneys, the tubes that carry urine from the kidneys to the bladder (ureters), the bladder and the tube that carries urine from the bladder (urethra).

***Need*.** We estimated that 25% of women globally experience a urinary tract episode in any year.[164]

Coverage. We assumed that women needing urinary tract infection treatment who gave birth received care if they had at least four antenatal care visits, and that those who had miscarriages before 27 weeks who had two or more antenatal care visits received care. Treatment requirements are shown in Table 39: Urinary tract infection.

Labor, Delivery and Postpartum Care

Antenatal corticosteroids for preterm labor

Administration of steroids and inpatient care is recommended for women with suspected preterm labor.[158] The most effective intervention to improve newborn outcomes for women in preterm labor is the administration of corticosteroids. A significant reduction in respiratory distress syndrome is achieved if delivery can be postponed for 48 hours. Pharmacological treatment of preterm labor should aim at preventing preterm delivery for at least 48 hours.

***Need*.** We assumed that the proportion of women giving birth who need this treatment equals the proportion of births that are preterm.[109,209] Table 26 shows the estimated proportions of births that are preterm for selected country groupings.

***Coverage*.** We took the following coverage assumptions from the Lives Saved Tool (LiST): that 95% of women giving birth in facilities with emergency obstetric care and 20% of those delivering at other facilities have access to antenatal corticosteroids.[168] Care requirements for providing antenatal corticosteroids for women with preterm labor are taken from the literature.[210–212] See Table 39: Antenatal corticosteroids.

Antibiotics for premature rupture of membranes

Prelabor rupture of membranes is the rupture of the membranes before labor has begun. It can occur either when the fetus is immature (preterm or before 37 weeks) or when it is mature (at term). Administration of oral antibiotics to women with preterm premature rupture of membranes is recommended to prevent infection and its consequences.[213]

***Need*.** We assumed one-third of women with low-birth-weight deliveries need treatment for prelabor rupture of membranes, based on the OneHealth model.[164] We took estimated country-level proportions of births with low birth weight from the UNICEF database,[214] using subregional estimates for countries with no data. See Table 26 for estimated proportions of births that are low birth weight, by selected country groupings.

***Coverage*.** We took the following coverage assumptions from LiST: that 95% of women giving birth in facilities with emergency obstetric care and 20% of women delivering at other facilities have access to care for prelabor rupture of membranes.[168] Treatment components were based on a published literature review.[213] Delivery-related hospitalization was not included in this intervention, but in separate delivery interventions below. See Table 39: Antibiotics for pPROM (premature rupture of membranes).

Induction of labor (beyond 41 weeks)

Maternal complications of pregnancy can increase after 40 weeks' gestation in low-risk women.[215] We included induction of labor to prevent births occurring at or beyond 41 completed weeks. This intervention only includes the induction of labor with misoprostol; the actual delivery is included under delivery care below.

***Need*.** We used the OneHealth assumption that 5% of pregnancies ending in birth go beyond 41 weeks.[164]

***Coverage*.** Following LiST, we assumed 20% of births in facilities with emergency obstetric care have access to induction of labor.[168] Treatment was based on WHO recommendations for use of oral misoprostol (25mcg, twice hourly if necessary) for induction of labor.[216] Apart from easier administration, oral misoprostol has the advantage of an exact dose preparation. The 25mcg vaginal dose is usually prepared by cutting the 100mcg tablet into four sections. It is also possible to dissolve 200mcg misoprostol in 200ml tap water and give 25ml twice hourly. See treatment requirements in Table 39: Induction of labor.

Labor and delivery management—routine vaginal deliveries

In this intervention, we included care for women with routine vaginal deliveries.

***Need*.** We assumed all women giving birth need facility delivery. We estimated the proportion needing routine vaginal delivery in each country by subtracting from the total giving birth the proportions estimated to need assisted vaginal delivery or cesarean sections.

***Coverage*.** We tabulated the percentage of recent births that occurred in a facility from DHS, MICS and other national surveys, and used subregional estimates for countries with no data. We estimated the proportion of births occurring in facilities with routine vaginal delivery by subtracting from total births the proportions of births needing assisted vaginal delivery or cesarean sections. Proportions of all births in health facilities and of births in health facilities via routine vaginal delivery are shown in Table 26. This information is shown in Table 27 for all women giving birth and for subgroups of age, household wealth quintile, rural or urban residence and for first births and higher-order births 2+.

We assumed 50% of women require an episiotomy. Active management of the third stage of labor is detailed as a separate intervention below. See Table 39: Essential labor and delivery care for all women with routine delivery.

Active management of the third stage of labor

Active management of the third stage of labor (AMTSL) is an evidence-based, low-cost intervention used to prevent postpartum hemorrhage. Components include administration of a uterotonic agent (oxytocin is the drug of choice) within one minute after birth of the baby, and after ruling out the presence of another baby, controlled cord traction with counter-traction to support the uterus and uterine massage after delivery of the placenta.[217,218]

***Need*.** All women giving birth vaginally need AMTSL.

***Coverage*.** We took the following coverage assumptions from LiST: that 95% of women with routine vaginal births in facilities with emergency obstetric care and 20% of women with routine vaginal deliveries in other facilities have access to AMTSL.[168] Treatment requirements were based on WHO recommendations.[172,219] See Table 39: Active management of the third stage of labor (AMTSL).

Prereferral management of labor complications

Some women have major complications during pregnancy, delivery or the immediate postpartum period. For example, as noted above and below in discussion of specific conditions, complications of preeclampsia (3.4% of births in developing regions), antepartum hemorrhage (4%), obstructed labor (6%), eclampsia (0.13%), maternal sepsis (3.8%) and postpartum hemorrhage (6.9%) occur in 24.3% of births. Some women have complications that cannot be managed at lower-level health facilities and require referral to a higher-level facility.

***Need*.** There is little information available on how many women with complications seek care at a lower-level health facility and are subsequently referred to a facility that can provide them with the care they need. Further, women who do not deliver in a facility may well need referral to a higher-level facility, but they are not in a position to obtain the medical components of prereferral management.

We assumed that 20% of women with complications need referral for care. This is the assumption used in the Reproductive Health Costing Tool (RHCT),[19] based on the assumption that 20% of women who deliver in health facilities first seek care in a facility that cannot handle their care and need referral to another health facility for care.

***Coverage*.** We assumed the proportion of women needing prereferral management who receive it equals the proportion of births in facilities without emergency obstetrical care. Of those with care, we assumed that 10% were transported to the referral facility accompanied by a

nurse/midwife. We assumed that none of the women delivering outside a facility would be able to obtain prereferral management of complications.

We based treatment requirements on WHO recommendations. We assumed that all women being referred to a higher-level provider for care of complications need intravenous fluids, that 30% require management of antepartum or postpartum hemorrhage, 10% require treatment for eclampsia or preeclampsia, and 30% need treatment for fever/infection. Further, we assumed that all women need on average one hour for stabilization, and that 10% of women in addition will require ambulance transportation along with 10 hours of a nurse's/midwife's time to accompany the women to the referral facility. Treatment requirements are shown in Table 39: Prereferral management of labor complications.

Antepartum hemorrhage

Vaginal bleeding from 20 weeks' gestation until delivery requires diagnosis and care.[220] Antepartum hemorrhage accounts for an estimated 7% of maternal deaths in developing regions (Table 10).

***Need*.** We estimated that 4% of pregnant women need care for antepartum hemorrhage, based on findings that the prevalence of antepartum bleeding of unknown origin in the second and third trimesters of pregnancy is 2%,[221] and that in half of antepartum hemorrhage cases, the causes are unidentified.[222,223]

***Coverage*.** Coverage of women needing care is assumed to be equal to the proportion of births in facilities with emergency obstetrical care. We assumed that women with antepartum hemorrhage need treatment for shock and restoration of blood volume with intravenous fluids (a blood transfusion in 25% of cases) and iron supplementation for 6–9 months. In most cases, expedited delivery (vaginal delivery or cesarean section, in separate interventions below) is needed after bleeding is controlled.[172] Treatment requirements are shown in Table 39: Antepartum hemorrhage.

Prolonged labor

Prolonged labor is most often defined as regular, painful contractions accompanied by cervical dilation lasting longer than 24 hours without resulting in delivery. Women with slow progress to labor require clinical assessment and, in some cases, intervention to augment labor or intervene to deliver the baby.[156]

***Need*.** We assumed that 10% of women giving birth experience prolonged labor.[68] We assumed that 40% of cases of prolonged labor will end in normal delivery, 50% in assisted vaginal delivery and 10% in cesarean sections[172] (included in separate interventions, below).

***Coverage*.** We assumed the proportion of women needing care who receive it equals the proportion of births in facilities with emergency obstetrical care. We assumed women with prolonged labor need augmentation of labor with oxytocin. Treatment requirements are shown in Table 39: Prolonged labor.

Obstructed labor

Obstructed labor occurs when, in spite of strong contractions of the uterus, the fetus cannot descend through the pelvis because there is an insurmountable barrier preventing its descent.[224] Reasons for obstructed labor include disproportion between the size, shape or position of the birth canal or fetus. Women with obstructed labor need assistance to deliver the baby, either vaginally or through cesarean section.

***Need*.** We assumed that 6% of women giving birth would experience obstructed labor,[225] and that 10% of these women would require assisted vaginal delivery and 90% would require cesarean section. [68]

***Coverage*.** We assumed the proportion in need obtaining care equals the proportion of women who deliver in facilities that provide emergency obstetrical care. Requirements for assisted vaginal delivery and cesarean sections are included in separate interventions below.

Assisted vaginal delivery

Assisted vaginal delivery entails the use of either forceps or vacuum extraction.

***Need*.** We estimated half of women with prolonged labor and 10% of those with obstructed labor need assisted vaginal delivery.

***Coverage*.** We assumed the proportion in need obtaining care equals the proportion of women who deliver in facilities that provide emergency obstetrical care. Treatment needs were based on WHO recommendations.[172] See Table 39: Assisted vaginal delivery.

Cesarean delivery

Cesarean delivery is a surgical procedure used to deliver a baby through incisions in the mother's abdomen and uterus.

***Need*.** According to WHO, population-level rates of cesarean sections higher than 10% are not associated with reductions in maternal and newborn mortality rates.[226] We assumed that 10% of a country's births need cesarean sections, including women we estimate need cesarean deliveries because of obstructed labor (see above) and others needing them for other reasons. We have not estimated the numbers of women needing them for other reasons.

***Coverage*.** For women in need of cesarean delivery because of obstructed labor, we assume the proportion receiving appropriate care equals the proportion of births in facilities with emergency obstetric care coverage, unless the result was higher than the current level of a country's cesarean deliveries, in which case we used the current country level.

For other women giving birth, we assumed the need for and coverage of cesarean deliveries for other reasons was equal to the current country level minus those needed because of obstructed labor. Proportions of births delivered by cesarean section for obstructed labor and for other reasons are shown in Table 26 for selected country groupings. Treatment requirements for supplies, personnel and hospitalization were based on WHO recommendations; see Table 39: Cesarean sections.[172]

Management of eclampsia

Eclampsia is a life-threatening condition associated with high blood pressure and proteinuria from hypertensive disorders of pregnancy that results in convulsions or coma.

***Need*.** We assumed that 0.13% of women giving birth develop eclampsia (see "Hypertensive disease case management" above).[189]

***Coverage*.** We took the following coverage assumptions from LiST: that 95% of women giving birth in facilities with emergency obstetric care and that 20% of women delivering in other facilities receive care for eclampsia.[164] Treatment needs were based on WHO recommendations.[172,190,227] See Table 39: Management of eclampsia.

Maternal sepsis management

Maternal sepsis is infection of the genital tract occurring at any time between the rupture of membranes or labor and the 42nd day postpartum in which one or more of the following are present: pelvic pain, fever (oral temperature of 38.5°C or higher on any occasion), abnormal vaginal discharge (presence of pus, abnormal foul odor of discharge) or delay in the rate of reduction of the size of the uterus (<2cm/day during the first eight days).[228]

***Need*.** Based on the assumptions behind Dolea and Stein's estimates of the likelihood of maternal sepsis according to women's care at delivery, we estimated the incidence of maternal sepsis as 2.5% of vaginal facility deliveries, 5.3% of cesarean sections and 5% deliveries of deliveries outside of facilities.[228] Table 26 presents the estimated proportions of women with maternal sepsis by selected country groupings.

***Coverage*.** We assumed the proportion of women needing care who received it was equivalent to the proportion delivering in health facilities that provide emergency obstetric care. Treatment needs were based on WHO recommendations.[172] See Table 39: Maternal sepsis case management.

Postpartum hemorrhage treatment

Postpartum hemorrhage is defined as the loss of 500ml or more of blood from the genital tract within the first 24 hours after delivery of the baby, or in more than 24 hours but less than six weeks from delivery.[218]

***Need*.** We estimated the proportion of births with postpartum hemorrhage based on Dolea, AbouZahr and Stein's estimates of the likelihood by type and place of delivery care and their assumption that severe hemorrhage makes up 90% of all postpartum hemorrhage.[229] We took estimates of the proportion of deliveries likely to involve severe postpartum hemorrhage from Dolea et al., and used our estimates of where deliveries in 2017 occurred to estimate incidence of severe hemorrhage among births in 2017: 5.7% of births with skilled attendance outside of facilities with emergency obstetric care, 2.0% of births in facilities that provide emergency obstetric care and 11.4% of births without skilled attendance. The proportion of births with postpartum hemorrhage was estimated as the overall proportion with severe hemorrhage divided by 0.90, for an overall estimate that 6.5% of women giving birth in developing countries develop postpartum hemorrhage. The estimated proportions of women with live births experiencing postpartum hemorrhage are shown in Table 26 by selected country groupings.

Coverage. We assumed the proportion of women needing care who received it was equivalent to the proportion delivering in health facilities that provide emergency obstetric care. Treatment needs were based on WHO recommendations.[172,219] See Table 39: Postpartum hemorrhage.

Postnatal preventive care

Assessment and preventive care for maternal well-being includes prevention and detection of complications (e.g., infections, bleeding, anemia); anemia prevention and control (iron and folic acid supplementation); information and counseling on nutrition, safe sex, family planning and postnatal care planning; advice on danger signs and emergency preparedness; and provision of contraceptive methods, if desired. (Contraceptive service provision is included under the contraceptive interventions above.)

***Need*.** All women are assumed to need this intervention after delivery (either at home or in a facility).

Coverage. In the absence of data, we assumed half of women delivering with a skilled attendant received postnatal preventive care. Treatment needs were based on WHO recommendations;[230] see Table 39: Postnatal preventive care.

Mastitis care

Mastitis is an inflammatory condition of the breast, which may or may not be accompanied by infection. It is usually associated with lactation, so it is also called lactational mastitis or puerperal mastitis. It can occasionally be fatal if inadequately treated. Mastitis is most common

in the second and third week postpartum, and most reports indicate that 74–95% of cases occur in the first 12 weeks.

***Need*.** We assumed 15% of women giving birth need management of mastitis.[19]

***Coverage*.** We assumed half of women delivering with a skilled attendant receive postnatal preventive care and thus proper treatment for mastitis. The main principles of treatment of mastitis are supportive counseling, effective milk removal, antibiotic therapy and symptomatic treatment.[231] See Table 39: Mastitis care.

Obstetric fistula repair

A fistula is a maternal disability arising from obstructed labor.[232,233] An obstetric fistula is a hole which forms in the vaginal wall connecting to the bladder (vesico-vaginal fistula) or the rectum (recto-vaginal fistula) or both (recto-vesico-vaginal fistula), as a result of prolonged and obstructed labor. The immediate consequences of such damage are urinary incontinence, fecal incontinence if the rectum is affected, and excoriation of the vulva from the constantly leaking urine and feces. Secondary amenorrhea is a frequently associated problem.

Reconstructive surgery can mend the injury, and success rates are as high as 90% for uncomplicated cases. For complicated cases, the success rate is closer to 60%. Two weeks or more of postoperative care is needed to ensure a successful outcome. Counseling and support are also important to address emotional damage and facilitate social reintegration.

***Need*.** Following Dolea and AbouZahr, we assumed that 2.15% of women with untreated obstructed labor developed obstetric fistula.[225]

Coverage. In the absence of data, we assumed the proportion of women receiving care for obstetric fistula equals the proportion who deliver in a health facility providing emergency obstetric care. Treatment needs were based on WHO recommendations; see Table 39: Obstetric fistula.[232]

Breast-feeding counseling and support

According to WHO recommendations, women should be counseled to breast-feed exclusively for six months after delivery, followed by appropriate complementary feeding, and continued breast-feeding for two years or beyond. They should receive at least six counseling sessions: two during antenatal care, one immediately after birth, one within the first week after birth, one at 6 weeks, and one at 5–6 months. As our estimates generally do not go beyond six weeks after delivery, we included only four sessions in the costing.

Need. All women giving birth were assumed to need two antenatal sessions, and those with live births were assumed to need two sessions within the first week after birth.

Coverage. We assumed that half of women with at least four antenatal care visits received two breast-feeding counseling sessions before birth. We assumed that the proportion of women receiving postnatal breast-feeding counseling and support equals half the proportion of women with live births delivering in a facility. See Table 39: Counseling and support for appropriate breast-feeding.

Abortion and Postabortion Care

Abortion service provision

Induced abortions occur under a variety of conditions. Until recently, WHO defined unsafe abortion as any procedure to terminate a pregnancy done either by people lacking the necessary skills or in an environment that does not conform to minimum medical standards, or both.[234] In practice, abortions have been considered unsafe in countries with restrictive laws or occurring under illegal conditions in countries with more permissive laws. Other abortions, occurring under legal conditions in countries with more permissive laws, were categorized as safe.

In 2017, WHO researchers and colleagues from many organizations, including Guttmacher Institute, published new definitions and methods for estimating abortion safety.[105] The estimates classified abortions based on whether the method used was recommended by the WHO and appropriate to the pregnancy's duration, and whether the provider was trained or untrained. Abortions were defined as "safe" if they were performed with a WHO-recommended method (medical abortion, vacuum aspiration or dilatation and evaluation, appropriate to pregnancy duration) by a trained provider. "Unsafe" abortions were grouped into two categories: They were considered "less safe" if only one of the method and provider-training criteria was met, such as abortions performed by a trained provider with an outdated method or an appropriate abortion method used without adequate information or support from a trained individual. Procedures that met neither criteria were considered "least safe"; these include abortions by untrained individuals using methods not recommended by WHO guidelines. We adopted the new classification for AIU-2017.

For women undergoing an abortion, WHO recommends the least invasive abortion procedures depending on gestation (the number of weeks since the woman's last menstrual period).[235] Procedures include manual or electric vacuum aspiration, dilation and evacuation (D&E) or medication abortion (using the drugs mifepristone and misoprostol or misoprostol alone where mifepristone is not available).

***Need*.** All women seeking to terminate pregnancies need to obtain abortions in safe conditions.[235,167,7]

Coverage. Tables 6 and 7 show the numbers and percentages of induced abortions in 2017 that occurred under safe and unsafe conditions. We estimated treatment requirements for four methods of abortion provision—manual or electric vacuum aspiration (the recommended method for abortion up to 12–14 weeks' gestation), dilatation and evacuation (D&E, recommended for abortions of pregnancies over 12–14 weeks), and medical abortion with mifepristone and misoprostol (or with misoprostol only where mifepristone is unavailable), based on WHO technical guidance.[235,236]

There is very little information on the distribution of women having legal or safe abortions by procedure used. We made rough estimates based on broad patterns emerging from existing studies: Africa: 45% vacuum aspiration, 35% D&E and 20% medical abortion; and Asia and Latin America and the Caribbean: 35% vacuum aspiration, 25% D&E and 40% medical abortion.

We used these estimates for costing the treatment requirements but did not estimate need and coverage for specific types of abortion procedures. Treatment requirements are shown in Table 39, under various methods of abortion provision.

Postabortion care

Some women who have induced abortions, as well as those with later-gestation spontaneous abortions (miscarriages), have complications requiring medical care. WHO provides standards of care for addressing postabortion complications, such as hemorrhage or infection, which are most likely to occur where abortions are conducted under unsafe conditions. In addition to medical treatments for specific complications, WHO standards call for vacuum aspiration or treatment with misoprostol, rather than more invasive surgical methods, to be used for incomplete first-trimester abortions, and recommend contraceptive counseling and services for all abortion patients. We included the need for and use of contraceptive counseling and services for all women wanting to avoid a pregnancy under the contraceptive interventions and did not include them as part of the postabortion care intervention.

Need. We followed prior estimates that 1% of women having induced abortions under safe conditions and 42% of women having induced abortions under unsafe conditions have complications requiring medical treatment.[165] We assumed that 20% of miscarriages that occur at less than 28 weeks' gestation end in weeks 14–27.[106] We assumed that all women with miscarriages at weeks 14–27 need care, with vacuum aspiration, the preferred method of safe abortion at the same weeks' gestation).[237]

Coverage. We assumed that 100% of women having induced abortions under safe conditions who have complications requiring medical treatment receive that medical care. We assumed that 26% of women with unsafe abortions receive care for medical complications, equivalent to 62% (26/42) of those needing medical treatment for complications of unsafe abortion, and that 16% need treatment but do not receive it, equivalent to 38% (16/42) of those needing care.[165]

The estimate that 26% of women with unsafe abortions obtain medical treatment for complications is similar to an estimate based on more recent information. Singh and Maddow-Zimet estimated that 6.9 million women in developing regions, excluding Eastern Asia, were treated at health facilities for pregnancy termination complications in 2012.[166] This number represents 30% of annual unsafe abortions in developing regions other than Eastern Asia in 2010–2014.[105]

Based on information from country studies conducted between 2008 and 2012 in Colombia, Ethiopia, Rwanda and Uganda, we estimated that 82.3% of women requiring care for complications of induced abortion have incomplete abortion, 6.8% of patients require treatment for shock, 4.5% require care for uterine perforation and/or cervical lacerations and 15.2% have sepsis.[238–241] The percentages sum to more than 100% because some women need care for more than one of these complications.

We assumed the proportion of women with miscarriages at 14–27 weeks' gestation who received care was equivalent to half the proportion of births occurring in facilities (i.e., equivalent to level of emergency obstetric care).

Treatment requirements for each type of complication and care were based on WHO recommendations and country cost studies.[235,239,240,242] See Table 39: Postabortion care.

Newborn Health Care

We included basic newborn interventions that are low-cost and simple to perform and should be integrated with maternal health care. We did not include more complex, long-term care that is not generally available in developing countries, such as neonatal intensive care or surgery for congenital abnormalities.

Immediate essential care for all newborns

After delivery, newborns require immediate drying and skin-to-skin contact as well as initiation of breast-feeding.

***Need*.** We assumed all newborns need immediate care, and that it is most likely to be provided in health facilities.

Coverage. Based on LiST, we assumed that 60% of births in health facilities without emergency obstetric care and 95% of in facilities with emergency care are delivered with clean birth practices and other needed immediate care.[168] We tabulated the percentage of recent births that occurred in a facility from DHS, MICS and other national surveys, and used subregional estimates for countries with no data. Treatment requirements are shown in Table 39: Immediate essential care for all newborns.

Newborn resuscitation (institutional deliveries)

Newborns who do not get enough oxygen before, during or after birth, i.e., experience birth asphyxia, can need resuscitation.[243]

Need. We used the RHCT estimate that 3% of newborns experience asphyxia or other breathing difficulties.[19]

Coverage. Following LiST, we assumed that 70% of births in facilities providing emergency obstetric care have access to neonatal resuscitation.[168] The average cost of equipment was estimated as the total cost divided by average caseload of a midwife (200 births per year).[244] See Table 39: Newborn resuscitation (institutional deliveries).

Newborn local infections

Newborn infections include conjunctivitis, infection of the umbilical stump and other local infections.

Need. We assumed that 10% of newborns will develop some type of local infection at current levels of care, and we reduced this to 5% under conditions of full maternal and newborn health care.[19]

Coverage. We assumed half of newborns delivered by a skilled attendant would receive care for local infections, regardless of whether the birth occurred in or outside of a health facility. We took treatment needs from WHO.[245] See Table 39: Newborn local infections.

Neonatal syphilis treatment

Newborns whose mothers are syphilis-positive require care for congenital syphilis.

Need. We assumed that babies would need treatment if they were born to women who tested positive for syphilis (based on screening at the first antenatal care visit or before birth) but who had not received the necessary treatment.

Coverage. We assumed all babies needing care who were delivered in a health facility received treatment. Treatment requirements for newborns of syphilis-positive mothers are shown in Table 39: Management of newborn syphilis.[246,247]

Postnatal preventive care for newborns

Routine postnatal care for all babies includes promotion and support of breast-feeding, cord care, thermal care, detection of illness and extra care for low-birth-weight infants. Infants delivered at home may be seen by a community level health worker (four visits). Those

delivered in a facility often receive their first check-up at facility level, followed by continued facility care or by three home visits at community level.

Need. All newborns are assumed to need this intervention after delivery (either at home or in a facility).

Coverage. We assumed half of infants born to women delivering with a skilled attendant received postnatal preventive care. Other interventions provided to the newborn during postpartum care are covered elsewhere. See Table 39: Preventive postnatal care.

Kangaroo mother care

Kangaroo mother care, defined as skin-to-skin contact between a mother and her newborn, frequent and exclusive or nearly exclusive breast-feeding, and early discharge from the hospital, has been proposed as an alternative to conventional neonatal care for low-birth-weight infants.

Need. Birth weight of less than 2,500 g (5.5 pounds) is considered low birth weight. [248]
We estimated the proportion of newborns who were low birth weight from estimates compiled by UNICEF.[214] We chose to use this measure rather than preterm births (before 37 weeks)[209] because there is uncertainty around both estimates and preterm births in need of care are likely also low-birth-weight babies.

We assumed two-thirds of low-birth-weight infants need kangaroo mother care. Lacking other information, this proportion was informed by Blanc and Wardlaw's unweighted summary of DHS respondents' reports that 30% of births that were below average in size were very small.[249,250]

Coverage. We assumed half of the newborns needing kangaroo mother care who were delivered in a facility received it.[251,252] WHO has described kangaroo mother care requirements.[253] See Table 39: Kangaroo mother care.

Treatment of low birth weight

Birth weight of less than 2,500 g (5.5 pounds) is considered low birth weight.[248]

Need. We estimated the proportion of newborns who were low birth weight from estimates compiled by UNICEF.[214] We assumed one-third needed supportive care (intravenous glucose). Lacking other information, this proportion was informed by Blanc and Wardlaw's unweighted summary of DHS respondents' reports that 30% of births that were below average in size were very small.[249,250]

Coverage. From LiST, we assumed that in countries where fewer than 30% of deliveries occur in health facilities, 10% of low-birth-weight infants in those facilities receive care, compared with 20% in countries where 30–49% of deliveries occur in health facilities, half in countries where

40–94% of deliveries occur in health facilities and 80% in countries where at least 95% of deliveries occur in health facilities.[168] The treatment included in these estimates includes only very basic care[254] and excludes management of complications such as breathing difficulties, jaundice, intraventricular bleeding, etc. Treatment requirements included in these estimates are shown in Table 39: Treatment of low birth weight.

Neonatal sepsis management

This intervention includes management with injectable antibiotics for neonatal sepsis, meningitis, or pneumonia (90% of newborn sepsis cases) and full supportive care (10% of newborn sepsis cases).

Need. We assumed 10% of newborns develop sepsis. This estimate is based on a review of studies reporting rates of infection among infants up to 60 days of life in which the incidence of clinically diagnosed neonatal sepsis ranged from 49 per 1,000 live births in babies older than 24 hours in rural Guatemala to as high as 170 per 1,000 live births as detected by village health workers in rural India.[255] We assumed 90% of newborns with sepsis can be treated with injectable antibiotics, and 10% will require full supportive care.[256]

Coverage. We estimated the proportion of newborns with sepsis treatable with injectable antibiotics who would receive needed care was equivalent to half the proportion delivered by a skilled attendant. From LiST, we assumed that in countries where fewer than 30% of deliveries occur in health facilities, 10% of infants born in those facilities and requiring full supportive care receive it, compared with 20% in countries where 30–49% of deliveries occur in health facilities, half in countries where 50–94% of deliveries occur in health facilities and 80% in countries where at least 95% of all deliveries occur in health facilities.[168] Inputs for management with injectable antibiotics and for full support were based on OneHealth,[164] incorporating input by the Child Health Epidemiological Reference Group (CHERG) and child health expert, Joy Lawn. For treatment requirements, see Table 39: Newborn sepsis/severe infection, management with injectable antibiotics and Newborn sepsis/severe infection—full supportive care.

Newborn vaccination

We included three vaccines recommended for all newborns at or soon after birth: BCG vaccine for prevention of tuberculosis; hepatitis B vaccine, which is usually given as a course of two to three vaccine injections (one at birth, one a month later and one six months after the first); and polio vaccine, which WHO recommends at birth and at weeks 6, 10 and 14 in endemic countries (in nonendemic areas, the regimen can begin at 6 weeks).

Need. All newborns.

Coverage. We assumed all infants born in a health facility would receive one dose of each of the three vaccines. See Table 39: Newborn vaccines.

SECTION 6: Impacts of Interventions

We estimated impacts of services by comparing varying scenarios of health care coverage for women and newborns in need, as follows:

- Current care scenario—2017 levels of care
- No-needs-met scenario—No service needs were met
- Full-needs-met scenario—An ideal scenario in which all women wanting to avoid a pregnancy and all women and newborns receive WHO-recommended maternal and newborn health care.

In addition, we estimated some scenarios combining different levels of needs met for modern contraception and for maternal and newborn health care. We estimated impact by comparing scenario results, usually in terms of events averted through increased coverage for needed care. For instance, the impact of current care is the difference in health events (e.g., intended/unintended pregnancies and maternal or newborn deaths) and costs between the current situation and the no-needs-met scenario. The difference in impacts between the current scenario and the full-needs-met scenario represents the additional impact of fully meeting women's needs for services, and the difference between the full-needs-met scenario and the no-needs-met scenario is the total impact.

Contraceptive Use

Impacts of contraceptive use were based on differences in the numbers of unintended pregnancies and their outcomes under varying contraceptive use scenarios, assuming conditions of constant proportions of women wanting to avoid a pregnancy and in need of contraception.

Table 22 shows the numbers of women in 2017 who were using modern contraceptives and the numbers with unmet need for modern contraception (i.e., wanting to avoid a pregnancy and using traditional or no methods). Table 28 shows the assumed distribution of modern methods that would be used by women with unmet need for modern contraception in 2017 if they were to use modern methods in the same proportions as current users in their country, according to their age, marital status and childbearing intention subgroups. This table also shows the numbers of women that would be using each specific contraceptive method if 100% of needs were met, i.e., the sum of current users of each method and the assumed new users resulting from movement of those with unmet need to modern method use.

Unintended pregnancies

Pregnancy rates. To estimate the number of unintended pregnancies resulting from each scenario, we estimated country- and method-specific rates of pregnancy among women wanting to avoid a pregnancy, for each contraceptive or nonuse category. Since such rates are not available for most countries, we began with aggregate estimates of failure rates. We used age-

specific, 12-month use-failure estimates for users of oral contraceptives, injectables, male condoms, IUDs, periodic abstinence and withdrawal from a pooled analysis of 16 surveys judged to have the most reliable data among available DHS surveys in low- and middle-income countries.[82] We supplemented these with data from the United States[257] and a few developing countries (Table 29).[258,259] We assumed LAM users breastfeed exclusively and are amenorrheic for six months and use male condoms for the other six months of the year, and estimated their failure rate as 1% for the first six months[260] and half the one-year failure rates reported by Bradley et al. for male condoms.[82] We used the average failure rates for all women for periodic abstinence and withdrawal from Bradley et al. to estimate the rate for users of other traditional methods.

The all-women rates in Table 29 from Bradley et al. are based on the age-distribution from women in the DHS surveys used in their analysis, while the age-adjusted rate for all women is calculated by applying the five-year age group rates to numbers of contraceptive users and nonusers in need in developing regions. Thus, these summary age-adjusted total rates represent the age distribution of method users in 2017 in all developing regions, as estimated in AIU-2017.

For the "initial" pregnancy rate for women wanting to avoid a pregnancy but using no contraceptive method, we used a rate of 40%. The commonly-used estimate of 85% represents the estimated pregnancy rate during the first 12 months of couples attempting to get pregnant.[257,261] The 40% pregnancy rate is likely more realistic for a general population of couples who want to avoid a pregnancy, but are not using a contraceptive method, because it reflects probable lower levels of sexual activity and fecundity among actual nonusers, many of whom have not become pregnant despite being sexually active and not using a method for more than 12 months.[257,262–264] Also, based on the DHS approach to categorizing women using no contraceptive method as having unmet need, nonusers wanting to avoid a pregnancy include women who identify their current pregnancy as unintended or are experiencing postpartum amenorrhea after an unintended pregnancy.[265]

***Adjustments to pregnancy rates*.** We multiplied the numbers of women in each five-year age group in 2017 wanting to avoid a pregnancy by the age-specific, "initial" method-specific pregnancy rates to estimate the total number of unintended pregnancies in developing regions and the distribution of those pregnancies by method used. In doing so, we assumed that all users of a specific method in an age group had the same average use-failure rate (Table 29), with no adjustments for differences by marital status, childbearing intention or country of residence. The resulting total number of unintended pregnancies for all developing regions (82.553 million) was lower than the number of unintended pregnancies estimated from available data on pregnancies by intention in developing regions in 2017 (88.954 million; Table 6). A mismatch between the two estimates is not surprising: the "initial" pregnancy rates refer to the first 12 months of use while exposed to the chance of becoming pregnant; however, use-failure rates tend to decrease over time, and women wanting to avoid a pregnancy comprise

varying lengths of method use. Also, estimating total unintended pregnancies in a year's time from annual failure rates and numbers of users based on survey responses assumes that the need and method-use distribution from a one-point-in-time survey reflects annual use patterns.

Lacking data to reconcile the two estimation approaches more closely, we calculated "adjusted" use-failure rates based on the total *number* of unintended pregnancies from the external sources described above (see Table 6) and the *distribution* of unintended pregnancies by contraceptive method used from the multiplication (weighting) of the number of method users by age- and method-specific pregnancy rates. To do this, we applied adjustment ratios of the externally estimated number of unintended pregnancies to the number estimated by multiplication, and we applied the resulting ratio for each country to the failure rate for each method, including the pregnancy rate for women wanting to avoid a pregnancy and using no method. This adjustment ensured that the total number of unintended pregnancies in each country in the current-use scenario would equal the number estimated from external sources, and that the relationships between the "initial" pregnancy rates across method use categories (including nonuse) would be maintained.

Table 30 shows the adjustment ratios and the estimated distributions of unintended pregnancies in 2017 by contraceptive method and according to subregion and other country groupings. The overall adjustment for women wanting to avoid a pregnancy in all developing regions was 1.08. The median country adjustment ratio was 1.02 and the unweighted average was 1.08, with an interquartile range of 0.77 to 1.32. Differences across country groupings in the distributions of unintended pregnancies by contraceptive method used reflect the combined impacts of differences across groups in method use among women wanting to avoid a pregnancy and the relative differences in pregnancy rates across contraceptive methods/no method use.

Sterilization use-failure rates. As noted in Table 29, we used incorrect decimal points in the sterilization use-failure rates, i.e., rates of 0.005% for female sterilization and 0.0015% for male sterilization, were intended to have been 0.5% and 0.15%, respectively, as estimated by Trussell.[257]

Even though the differences in the sterilization use-failure rates are dramatic, this error has little impact on AIU-2017 results in terms of the impacts of various scenarios of contraceptive use. The relative relationships, not the actual values of the failure rates, are important for comparing the impacts of the contraceptive use scenarios. The sterilization use-failure rates are so small compared to the nonuse pregnancy rates that differences in the sterilization failure rates have small impacts on the unintended pregnancy estimate, overall and even in regions where sterilization is heavily used.

Further, the data behind sterilization failures are very limited. Although many women rely on contraceptive sterilization (233 million women aged 15–49 in developing regions use female sterilization, 35% of all modern method users; see Table 22), use-failure rates have not been estimated in analyses based on DHS surveys or the U.S. National Survey of Family Growth (NSFG). For example, Cleland and colleagues noted that while sterilization has been the most commonly used method worldwide, they excluded it from their analyses because "failure rates or discontinuation due to surgical reversal are negligible."[78] Trussell and Kost noted that the only U.S. information on sterilization failures comes from clinical trials since no failures were reported during the first year of sterilization (male or female) in the three NSFG surveys available as of their review (conducted in 1972, 1976 and 1982).[261] Over this period, female sterilization rose from 12% to 26% of all contraceptive use among currently married women aged 15–44 in the United States, and male sterilization rose from 11% to 15% of users.[266]

The CREST study, a multicenter prospective study carried out in 1978–1986 in the United States, is the primary source for Trussell's estimated first-year use-failure for female sterilization of 0.5%.[261,267] The combined first-year failure for all methods of tubal sterilization in the CREST study was 0.55%, but for salpingectomy, the most common sterilization procedure in developing countries,[268] it is 0.2% for interval and postpartum salpingectomy combined.[267] The 95% confidence intervals for both types of salpingectomy (and for most other methods) include 0.0%.

Furthermore, sterilization is used for long periods of time, 10–13 years on average,[269–271] and failure rates for current sterilization users in developing countries are likely closer to those of the 5th year of use than the first year of use. There is no difference in the CREST study for salpingectomy use-failure rates between years 5 and 6 of use, i.e., the 5th year failure rate is estimated to be 0.0.

Trussell and Kost note that pregnancy rates are usually not calculated for partners of men who have vasectomies.[261] They estimated a first-year pregnancy rate of 0.15% from four clinical studies, noting that they believed this may be too high.

Based on this information, we did not re-estimate AIU-2017 results with the higher sterilization use-failure rates from Trussell. We did include the Trussell rates in limited estimates incorporating more recent data for India that were unavailable in time for the AIU-2017 analyses (See Section 8). We will continue to evaluate sterilization use-failure rates for use in the next AIU analyses.

Unintended pregnancies averted by modern contraceptive use. We applied the adjusted use-failure rates to the numbers of women wanting to avoid a pregnancy using each contraceptive method in the no-needs-met and full-needs-met scenarios to estimate the numbers of unintended pregnancies under the different contraceptive use scenarios. The resulting

unintended pregnancies in each scenario were distributed by outcome based on the current outcomes of unintended pregnancies in 2017 (Table 7).

The estimated numbers of pregnancies by intention and outcome in each scenario are shown in Table 31 for selected country groupings along with estimates of the numbers of unintended pregnancies averted by contraceptive use. The impact of current modern contraceptive use is the difference between the number of unintended pregnancies in the scenario of no modern method use versus the current number of unintended pregnancies. The additional pregnancies that would be averted under a full-needs-met scenario equal the difference between the full-needs-met scenario and current use; and the total number of pregnancies that would be averted in the full-needs-met scenario is the sum of these two values (and also equal to the difference between the full-needs-met scenario and the no-needs-met scenario).

Mortality

Rates and ratios of deaths. We chose not to use the overall maternal mortality ratio for estimating deaths in each contraceptive use scenario or the numbers averted through the impact of contraceptive use on unintended pregnancy levels. As discussed above, the ratio of maternal deaths per 100,000 live births comprises deaths from many causes, including induced abortion (Table 9). Since different patterns of contraceptive use affect only unintended pregnancies, estimates of related mortality need to take into account that induced abortions make up a larger proportion of unintended pregnancies and maternal deaths from unintended pregnancies than they do of all pregnancies, and that there are wide differences in mortality based on pregnancy outcome and on the safety of abortion procedures. Some 54% of unintended pregnancies end in induced abortion (Table 7), compared to 32% of all pregnancies (calculated from Table 6).

We therefore estimated rates of death per 100,000 safe and unsafe abortions and a non-abortion maternal mortality ratio of maternal deaths from all other causes per 100,000 live births (Table 32). We applied the most recent country-level maternal mortality ratios, for 2015, from WHO[124] to the number of live births in each country in 2017[84,100] to estimate the number of maternal deaths in 2017 in each country. As noted in Section 3, we assumed that the mortality rate for women having abortions classified as safe was two per 100,000, resulting in 478 maternal deaths from safe abortions. The remainder of the 29,855 deaths from abortion were assumed to be related to unsafe abortions, a total of 29,377. From this information and the estimated numbers of unsafe abortions, we estimated a mortality rate across all developing regions of 116 per 100,000 unsafe abortions. Subtracting the abortion-related deaths from total maternal deaths yielded an estimate of 277,698 maternal deaths from other causes. Using this information, we calculated the non-abortion maternal mortality ratio analogous to the overall maternal mortality ratio, as 219 maternal deaths from non-abortion causes per 100,000 live births. We applied the non-abortion maternal mortality ratio to the number of live births from

both intended and unintended pregnancies, and we applied mortality rates from safe and unsafe abortions to the number of safe and unsafe abortions, respectively.

We assumed that mortality rates for live-born newborns and for infants in the first year after birth were the same regardless of mother's pregnancy intention (Table 11).

Numbers of deaths. Table 33 shows the numbers of maternal and newborn deaths estimated to be associated with all pregnancies and intended and unintended pregnancies in each contraceptive use scenario, and the numbers averted by current modern contraceptive use and under the 100%-needs-met scenario.

Maternal and Newborn Health Care

Estimating the total impact of maternal and newborn care on mortality is difficult because studies typically assess the impact of specific interventions in isolation. Where available, we took condition-specific effectiveness rates of components of maternal and newborn care in reducing maternal and newborn deaths from specific causes from LiST.[272] Because LiST effectiveness estimates were not available for all the interventions in our report and because we could not model all the interventions for which LiST provides estimates, we underestimate the impacts of care.

We used the intervention effectiveness rates, country-specific maternal and newborn deaths (by cause), and numbers of women and newborns needing and receiving cause-specific treatment (in each scenario), to estimate cause-specific mortality. We applied these rates to the numbers of women and newborns in each scenario who received or had unmet need for each intervention to estimate the numbers of deaths among those in need of maternal and newborn care in each scenario.

Cause-specific mortality rates

LiST takes information from numerous studies and literature reviews to estimate intervention effectiveness—the proportion of deaths from a specific cause that are reduced by the intervention, the affected fraction—the proportion of deaths due to a specific cause that might potentially be impacted by a specific intervention.[168,272] From this and other information presented earlier, we estimated cause-specific mortality rates for women and for newborns receiving relevant interventions and for all other women giving birth and newborns not receiving each intervention. Table 34 shows the causes of maternal mortality and interventions for which we were able to make estimates, and Table 35 shows this information for newborn mortality.

When only one intervention was associated with a cause of death, effectiveness (the estimated reduction from the mortality rate among women or newborns not receiving the intervention) equals effectiveness * affected fraction. For example, for women with hypertensive diseases of

pregnancy, the effectiveness of hypertensive case management is 0.50 * 1.00 = 0.50. When more than one intervention was relevant for a cause of death, the joint effectiveness was estimated by applying each successive intervention's effectiveness to the proportion of potential 100% effectiveness remaining after accounting for other interventions. For example, the joint effectiveness of hypertensive disease case management and preeclampsia management with magnesium sulfate was estimated as 0.50 + (1.00–0.50) * 0.59 = 0.795.

We matched the Adding It Up and LiST interventions to the extent possible. We took numbers of women with live births and stillbirths and numbers of newborns covered and not covered by each intervention and the estimated numbers of deaths for relevant causes from our country-level mortality estimates. Using data from the current scenario for 2017, we estimated the rate of deaths from a specific cause among all women with births or all newborns who received no care relevant to that cause of death. These estimates used the following approach, where, for example,
X = the no-care mortality rate for the specific cause of death; maternal death rate = 0.64; proportion of women receiving intervention = 0.32; intervention effectiveness = 0.80

Maternal death rate from multiple causes among all women giving birth = [% of women receiving intervention(s) * (1-intervention effectiveness) *X] + [% of women not receiving intervention(s) * X]
0.64 = [.32 * (1–0.80) * X] + [(1.00–0.32) * X]
0.64 = [.32 *0 0.20* X] + [0.68 * X]
0.64 = 0.064 X + 0 0.68 X
0.64 = 0.744 X
0.64/0.744 = X = 0.86

The no-care mortality rate is 0.86, i.e., 860 out of every 100,000 women with births who did not receive the intervention. The mortality rate if all women giving birth had access to the intervention (i.e., in the full-needs-met scenario) would be 0.86 * (1–0.80) = 0.86 * 0.20 = 0.172, or 172 out of every 100,000 women.

When multiple interventions were related to a cause of death, the calculation was expanded to take into account the numbers of women giving birth covered by each intervention and the total number covered by none of the relevant interventions. The no-care mortality rate therefore reflected no coverage by no relevant intervention for that cause of death. The full-needs-met mortality rate assumed coverage and effectiveness of the most complete intervention relevant to the cause of death. For example, the full-needs-met assumption for intrapartum and postpartum hemorrhage was that all women had access to emergency obstetric care and active management of the third stage of labor. The estimated reductions in mortality for various interventions, by cause of maternal and newborn mortality, are shown in Tables 34 and 35.

When LiST estimates of intervention effectiveness and affected fractions did not match an intervention included in our estimates, we estimated no impact. These included maternal mortality from embolism, indirect causes or from miscarriages less than 28 weeks and newborn mortality from congenital causes. Likewise, LiST contains some interventions and outcomes that we did not include in our estimates or that could not be matched with how we estimated them. Both of these factors mean that the reductions in mortality that we are presenting underestimate the full impacts of maternal and newborn health care.

Mortality across care scenarios and deaths averted

Tables 36 and 37 present the resulting estimates of total and cause-specific mortality rates and ratios and numbers of deaths for women and newborns across scenarios of no-care, current-care and full-needs-met. The tables also show the numbers of deaths averted by current care compared with no care, and the additional deaths that would be averted by fully meeting needs for the estimated types of care compared with the current scenario. In the left panel of Table 36, mortality ratios are expressed per 100,000 live births plus stillbirths. This differs from the common maternal mortality ratio, which expresses mortality as maternal deaths per 100,000 live births,[124] but the larger group of women with live births and stillbirths better matches the population of women at risk for most of the outcomes that are estimated. In the right panel, we show abortion mortality rates per 100,000 total abortions and safe and unsafe abortions. Further, we show the impacts of current levels of postabortion care provided to women with unsafe abortions and the impacts that would occur if women with unsafe abortions were able to obtain them under safe conditions, including access to postabortion care.

Contraceptive Use and Maternal and Newborn Health Care

As discussed above and shown in Table 33, different levels of contraceptive use lead to different levels of unintended and total pregnancies, births, miscarriages and induced abortions. To assess the impacts of different contraceptive use scenarios on women's needs for maternal and newborn health care and the impacts of varying levels of both contraceptive use and maternal and newborn health care, we estimated several overlapping scenarios. Table 38 shows results of the different scenarios in terms of their impacts on maternal and newborn deaths for all developing countries and for the major regions.

SECTION 7: Service Costs

We estimated costs separately for each contraceptive method and each maternal and newborn care intervention listed in Table 39 and discussed in Sections 4 and 5. All costs were estimated in 2017 U.S. dollars, and these were used for each of the health-care coverage scenarios.

Direct Costs

For direct costs, we used a bottom-up, or ingredients-based, costing methodology. For each intervention, we compiled a list of all inputs required to treat an average case: contraceptive commodities, drugs, supplies (gloves, syringes, sutures etc.), labor (time in minutes) for each type of staff needed to provide the intervention, and, where relevant, the direct costs of hospitalization not captured by the program and system cost estimates (e.g., food costs). Inputs were based on prior work for UNFPA's Reproductive Health Costing Tool[19] and the OneHealth Model,[164] with updates from more recent sources, especially the WHO recommendations of service requirements noted in Sections 4–5. The assumptions used for each intervention included in AIU-2017 estimates are shown in Table 39.

We summed the costs of drugs, supplies, labor and hospitalization to arrive at an average direct cost per client for each intervention component. We combined estimated proportions of women and newborns needing specific care components and the proportions receiving them with the component-specific costs to estimate total direct costs in each scenario.

Contraceptive commodity costs

We estimated contraceptive commodity costs for each country and method based on average unit costs incurred by donors for the most recent three-year period (2013–2015), as documented in the Reproductive Health Interchange database.[273] The cost data in the database include the total landed cost for the commodity (unit price, shipping, insurance, any related test, fees, etc.). We did not have data to adjust for in-country transportation costs. Using the information in the database on total cost and number of units in each method-specific shipment, unit costs per shipment were calculated by dividing the total shipment cost by the total number of units in each shipment. All unit costs were checked for plausibility. Obviously flawed unit costs, mainly caused by probable typos in the amounts or total cost numbers in the database, were eliminated. The average unit cost per method for each country was calculated by dividing total costs of all method shipments by the total number of units shipped to the country. For methods for which there were no shipment records over the three-year period, we used the weighted average of unit costs in the subregion or region. Costs were inflated 4.6% from the 2013–2015 midpoint of 2014 to 2017 U.S. dollars.[274]

In calculations of method costs from the Reproductive Health Interchange database, we tabulated the costs of different categories of oral contraceptives (combined and progestin-only formulations), copper and levonorgestrel IUDs, two- and three-month injectables (the only

formulations with data in the database) and Implanon, Jadell and Sino-Implant implants. We used the percentage distributions of units shipped of the different categories within each method type to estimate average unit costs for pills, IUDs, injectables and implants.

We based estimates of the average amount of contraceptive commodities needed for one year of use on the analyses done for the 2011 update to the USAID couple-years of protection (CYP) conversion factors.[269–271] Calculation of CYP conversion factors includes assessment and adjustment for use-effectiveness (all methods), duration of use for long-acting and permanent methods and fertility awareness methods (continuation rates and age), coital frequency and consistency of use (for coitus-dependent methods such as condoms and spermicides) and wastage (for user-controlled short-acting methods, like pills, condoms and spermicides). Since AIU estimates account for method use-effectiveness in a separate step (see Section 6), we estimated commodities needed for one year of use by recalculating CYP factors to take out the contribution of method use-failure.

Cycle beads provided to users of the StandardDays Method of fertility awareness are assumed to last for an average of 1.5 years of use.[270] For long-term methods and permanent methods, the 2011 CYP estimates assume 100% use-effectiveness, and estimate the following average durations of method use:

- Copper IUD: 4.6 years of use
- Levonorgestrel IUD: 3.3 years
- Implanon implant: 2.5 years
- Sino-Implant: 3.2 years
- Jadelle implant: 3.8 years
- Sterilization: 13 years in Bangladesh, India and Pakistan and 10 years in other developing countries

We converted country-specific unit costs for these methods to annual costs by dividing total lifespan method costs for insertion, follow-up and removal by the expected average number of years of use. Annual costs for short-term methods were estimated by multiplying commodity unit costs by the number of units assumed to be needed during an average year of use. The CYP factors for injectable methods are based on the number of injections required per year of use, assuming 100% use-effectiveness. We also assumed an average year of injectable method use requires four three-month injections, six two-month injections or 13 one-month injections.

One year of oral contraceptives requires 13 pill cycles. The CYP pill conversion factor of 15 reflects an estimate of 13 pill cycles for annual coverage plus roughly one cycle to account for use-failure and one cycle for pills wasted by clients who lose, destroy, discard or otherwise fail to use them. We assumed that one year of pill use requires an average of 14 pill cycles, excluding the adjustment for use-failure and including the wastage adjustment.

The conversion factor of 120 condoms per CYP is 11.4% higher than the 105 condoms per CYP estimated to be needed to account for an average of 5.6 sexual acts per month, tabulated from DHS data (67 condoms per year), and another 38 to account for use-failure, inconsistent use and use overlapping with amenorrhea, infecundity or use of other methods. Assuming the difference between 120 and 105 condoms per CYP reflects wastage, we assumed one year of condom use requires, on average, 67.2 condoms for sexual acts plus 10 condoms (67.2*0.114) for wastage, for a total of 77 condoms per year. Given the small numbers of women relying on a variety of methods categorized as "other modern methods", we used condom costs for these methods.

Annual commodity costs per user for each method and country are shown in Table 40.

Other drug and supply costs

Because of data limitations, we assumed all other drug and supply costs to be the same across countries in all developing regions. Drug costs were based on the median cost cited in the most recent Management Sciences for Health's International Medical Products Price Guide.[275] These data primarily cover medicines, and they provide an overview of prices that have been paid by international buyers and those listed by sellers to aid buyers in procurement negotiations and decisions. We took costs for other supplies from the UNICEF Supply Catalogue at the end of 2016.[276] This catalogue covers a wide range of products needed for medical service provision. In additional to providing price information, UNICEF offers procurement services to national governments, non-governmental organizations (NGOs), UN agencies, philanthropic organizations and universities. Based on consultation with WHO colleagues, we added 45% to the base prices of all drugs and supplies to account for shipping and wastage.

We inflated the supply costs for contraceptive services by 2.1% from 2016, the year of the most recent prices available, to 2017 U.S. dollars.[274] Supply costs for maternal and newborn health care, tabulated separately from contraceptive costs, were taken primarily from the UNICEF database. We did not apply any inflation factor to these maternal and newborn health care supply costs.

The drug and supply costs used in our analyses are shown in Table 41. Table 39 provides details on intervention treatment requirements and their associated drug and supply costs.

Hospital costs

Direct costs of hospitalization were estimated at $.50 per person per day for food; other costs of hospitalization were assumed to be included in indirect costs. Table 39 shows the interventions assumed to require hospitalization and the associated hospital-food costs.

Personnel costs

Country-specific personnel salaries came from the most recent WHO-CHOICE personnel cost estimates.[277,278] In the CHOICE project, WHO researchers used salary data from the International

Labour Organization wage-estimate database to estimate annual wages for four skill levels of health personnel. They constructed a regression model to predict earnings for each category of personnel relative to country per capita GDP, with fixed relationships between personnel categories. The predicted salaries refer to the gross earnings received by the employee and include salary, paid vacation and regularly paid guarantees or allowances (such as social security, health insurance and bonuses).

For countries not included in the WHO-CHOICE estimates, we used the unweighted average of countries with data in the same WHO region and mortality stratum.[279] We converted annual salaries to costs-per-minute of service provision assuming 40 weeks of work per year and 30 hours of work per week.

To estimate earnings for all physicians, including both general and specialist physicians, we used skill level four, equivalent to the second stage of tertiary education. For nurses and midwives, we followed Serje et al.[277] and used the average salaries in category 3 (equivalent to the first stage of tertiary education) and category 4. We also used this average for auxiliary attendants in hospitals and laboratory technicians. Staff time for contraceptive services combined community health workers and assistant nurses. For this category, we used the average of skill categories 1–3. Staffing assumptions for maternal and newborn health care separated community health workers, for whom we used the average of categories 1–3, and assistant nurses, for whom we used skill category 3.

Following WHO's methodology for costing progress toward the health-related Sustainable Development Goals,[46] we used IMF estimates and projections to calculate ratios between per capita GDP in each country in 2010 and 2017, and applied these ratios to the 2010 earnings values to estimate their levels in 2017 U.S. dollars.[274] Table 42 shows the resulting 2017 country-earnings estimates used in our calculations. Staffing requirements for each intervention are shown in Table 39.

Indirect Costs

For the 2008, 2012 and 2014 Adding It Up projects, we estimated indirect costs from work done by researchers at UNFPA.[9–12] They estimated total indirect costs for the following categories of program and systems costs related to sexual and reproductive health care services other than STI management and care related to HIV/AIDS.[18]

- Program management—developing and assessing policies, regulations, and strategic and operational plans for programs
- Staff supervision
- Monitoring and evaluation—establishing or integrating services into monitoring and evaluation frameworks and designs, conducting household-based surveys (such as DHS) and conducting facility-based surveys
- Human resources development—increasing training capacity and number of trained staff

to scale up to target coverage levels, accounting for attrition; upgrading pre-service training; reviewing training materials; establishing refresher training courses; and establishing in-service training programs
- Transport and telecommunication—acquiring, running and maintaining vehicles and telecommunications systems for transporting patients, supervising staff, and performing training and outreach services
- Health education—mobilizing the community to raise awareness of family planning and maternal and newborn health-related issues using mass media (radio, TV) and printed material (posters, fliers)
- Advocacy—developing advocacy strategy and materials, and implementing advocacy activities
- Infrastructure—upgrading and maintaining existing facilities and building new ones
- Commodity supply systems—establishing, upgrading and maintaining
- Health management information system improvements

As part of the AIU-2014 analysis, we investigated other major works in the hope of updating and expanding these indirect costs to include more recent information on cost components, to break total indirect costs into subcategories and to expand the investments covered.[280–283] The UNFPA estimates, for instance, did not cover costs for health financing and governance found in some other studies,[282,283] and it is doubtful that any estimates include adequate costs for ensuring that information and care are delivered with high quality that is fully respectful of the human rights, life circumstances and needs of all groups within the population.[7,159,284–289]

After extensive evaluation,[290] we judged that each approach was so unique that reconciliation was not possible, and that there was no adequate basis at this time for changing to another source or making adjustments to UNFPA's indirect cost estimates. More recent costing efforts have made use of Adding It Up data and results, and have, in turn, provided insights and data that are useful to Adding It Up analyses,[21,59,291] but they have not provided a good alternative for estimating indirect programs and systems costs.

Therefore, in AIU-2017, we have continued to calculate indirect costs based on the regional ratios of indirect to direct costs provided by UNFPA,[292] i.e., we assumed that UNFPA's estimated indirect cost ratio for 2008 (pre-scale-up) applies to the current scenario, and the higher ratio for 2009 applies to scenarios in which all needs are met. Given the inadequate levels of investment in recent years, we assumed it was appropriate to apply the higher 2009 indirect ratio to the future scenario to account for the costs of building capacity and improving services to fully meet all women's needs for sexual and reproductive services.

For the current scenario, indirect costs were estimated to account for 35% of sexual and reproductive health service costs in Sub-Saharan Africa, 56% in Northern Africa and Western Asia, 49% for developing countries in the rest of Asia and 57% in Latin America and the

Caribbean.[292] For scenarios with improved and increased service coverage, indirect costs were estimated at 79% of service costs in Sub-Saharan Africa, 58% in Northern Africa and Western Asia, 53% for developing countries in the rest of Asia and 60% in Latin America and the Caribbean.[17,18]

Total Costs

Total costs are the sum of direct and indirect costs. These costs are paid for through a number of sources that vary in importance from country to country: national government budgets, external agencies and donors, employers (through insurance benefits) and service users themselves, through contributions to insurance coverage and out-of-pocket payments for services and supplies. We used a bottom-up costing methodology to estimate service costs because information on actual expenditures and the breakdown by source of payment is not available. Since most of the sources we used to estimate contraceptive commodities and other drugs and supplies reflect public-sector prices, the resulting service costs are likely to be underestimates, especially for countries with substantial proportions of private-sector service providers.

Table 43 presents the estimated annual, per-user direct costs for each modern method, including contraceptive commodities, supplies and staff time, by selected country groupings. Table 44 lists the other sexual and reproductive health interventions for which we made estimates, noting which groups of women and newborns were covered by each intervention.

Table 45 shows detailed cost estimates for selected country groupings. Total, direct and indirect costs are shown for the current service-coverage scenario, for a scenario of current contraceptive use and full coverage of maternal and newborn care and for a scenario in which all contraceptive and maternal and newborn health care needs are covered. The table also shows differences in costs between the full-needs-met and current scenarios and the cost savings that would result from moving to full coverage, as well as costs per woman of reproductive age and costs per capita.

SECTION 8: Estimates Incorporating New Data for India

The Guttmacher Institute has joined colleagues from other organizations to understand similarities and differences in the models widely used for estimating the impacts of contraceptive services and use on unintended pregnancy and its outcomes and on maternal health.[74,293] The researchers leading the work on the most widely used models agreed to use results from Adding It Up to harmonize key aspects of their models.[75] These include the pregnancy rate for women in need not using any contraceptive method, i.e. the pregnancy rate women using contraceptives would experience if they did not use a method; the distribution of unintended pregnancies by outcome; maternal mortality ratios for women with pregnancy outcomes other than induced abortion; and mortality rates for women with safe and unsafe induced abortions.

Colleagues from the key organizations involved in constructing and using modeled impacts of contraceptive use met in January 2018 to review methods, data sources and results from Adding It Up 2017 and to assess their implications for ongoing model harmonization. Shortly before and after this meeting, key data from India became publicly available that were relevant to the impact estimates, including findings from a new approach to estimating the safety of abortion procedures,[105] new estimates of induced abortion in India[294] and the data file from the India National Family Health Survey–4 2015-2016 (NFHS).[295] The estimated number of induced abortions in India in 2015 was 15.6 million,[294] compared with an annual estimate of 15.7 million abortions in all of Southern and Central Asia in 2010–2014, indicating that the 2010–2014 estimates for India and these regions (which we were using) were likely seriously underestimated. Given the large size of India, i.e., it accounts for 22% of women aged 15–49 in all developing regions in 2017, the group was concerned that using the AIU-2017 estimates for harmonization would not reflect this large change in pregnancy outcomes, and that there would be a need for large revisions of the harmonized estimates again when Adding It Up 2019 became available.

At the request of the group, Guttmacher made new estimates taking the new India data into account. Jonathan Bearak updated Bayesian-model estimates of abortion[113] and unintended pregnancy[101] that incorporated both the new NFHS data on contraceptive method use and birth intentions and the recent abortion-incidence estimates for India. We used results from these analyses, and failure rates of 0.5% and 0.15% for female and male sterilization, respectively,[257] (see discussion of sterilization use-failure rates in Section 6) to reestimate the AIU-2017 contraceptive analyses.

Table 46 and 47 show the reestimated numbers and distributions of pregnancies in 2017. The new (weighted) adjustment ratio for women in need in all developing regions rose from 1.08 to 1.11. The median country adjustment ratio changed only from 1.02 to 1.03, and the unweighted average changed from 1.08 to 1.07. The interquartile range also changed little, from 0.77–1.32

in the original AIU-2017 to 0.78–1.29 in the reestimated models. The median pregnancy rate of nonusers wanting to avoid a pregnancy was stable at 0.41. The group decided to use the reestimated distribution of unintended pregnancies and the pregnancy rate of 0.41 in estimating impacts in their models. (The earlier pregnancy rate among nonusers wanting to avoid a pregnancy, based on AIU-2014 calculations, was 0.31.[75]) The large increase primarily reflects the increased number of unintended pregnancies in developing regions, from the 73.7 million estimated in AIU-2014 to 89.0 million estimated in AIU-2017, incorporating Bayesian model-based estimates,[113] and to 93.9 million in 2017 when the new data for India were incorporated.[296]

Table 48 shows updated estimates of maternal mortality ratios and rates that incorporate the new estimates. They were calculated using the approach described in Sections 3 and 6. While the total numbers of maternal deaths in 2017 related to abortions and to other pregnancy outcomes were unchanged,[124,127] the total numbers of induced abortions and unintended pregnancies increased when the new data from India were taken into account.

Table 49 presents comparisons of selected results for the current contraceptive use scenario and the full-needs-met scenario. Measures include need for and use of and contraceptives, cost of contraceptive services, unintended pregnancies and maternal deaths.

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125 Maiden Lane
New York, NY 10038
(212) 248-1111; fax (212) 248-1951
info@guttmacher.org

www.guttmacher.org