# Family Planning 2

# Contraception and health

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Increasing contraceptive use in developing countries has cut the number of maternal deaths by 40% over the past 20 years, merely by reducing the number of unintended pregnancies. By preventing high-risk pregnancies, especially in women of high parities, and those that would have ended in unsafe abortion, increased contraceptive use has reduced the maternal mortality ratio—the risk of maternal death per 100 000 livebirths—by about 26% in little more than a decade. A further 30% of maternal deaths could be avoided by fulfilment of unmet need for contraception. The benefits of modern contraceptives to women's health, including non-contraceptive benefits of specific methods, outweigh the risks. Contraception can also improve perinatal outcomes and child survival, mainly by lengthening interpregnancy intervals. In developing countries, the risk of prematurity and low birthweight doubles when conception occurs within 6 months of a previous birth, and children born within 2 years of an elder sibling are 60% more likely to die in infancy than are those born more than 2 years after their sibling.

## Introduction

The most substantial benefits of contraceptive use for the health and survival of women and children stem from reductions in the number of pregnancies, especially those that are a greater-than-average risk to maternal, perinatal, and child survival. These risks are associated with pregnancies at very young (<18 years) and old (>34 years) maternal ages, at high parities, and with short inter-pregnancy intervals, and with pregnancies that would have ended in unsafe abortion. We assess the effect of contraception on these demographic features of repro-duction (appendix). We estimate that an increase in contraceptive use of 10 percentage points reduces fertility by 0·6 births per woman, decreases the proportion of all births to women with four or more children by 5 percentage points, reduces births to women aged 35 years or older by 1·5 percentage points, and lowers birth intervals of less than 2 years by 3·5 percentage points. We consider the effects of these factors on maternal, perinatal, and child health. The emphasis throughout is on countries of low and middle income. We summarise the evidence for the well-established non-contraceptive benefits and risks of

specific contraceptive methods for women's health. Where appropriate, we have updated systematic reviews by doing another search with the same terms used in those reviews, with the addition of our own search terms, and analysed secondary data.

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See Online for appendix

### Key messages

- Increases in contraceptive use account for about 75% of fertility decline in developing countries in the past six decades and have substantially reduced the proportion of pregnancies in women of high parity, which pose a greater-than-average risk to maternal survival
- In 2008, contraceptive use averted over 250 000 maternal deaths worldwide by reducing unintended pregnancies, which is equivalent to 40% of the 355 000 maternal deaths that occurred that year
- If all women in developing countries who want to avoid pregnancy use an effective contraceptive method, the number of maternal deaths would fall by a further 30%
- Because of its effect on births to women of high parity and on the need to resort to unsafe abortion, contraception also reduces the risk of maternal death per pregnancy; each 1 percentage point increase in contraceptive use reduces the maternal mortality ratio by 4·8 deaths per 100 000 livebirths
- Contraceptive use has the potential to improve perinatal outcomes and child survival by widening the interval between successive pregnancies; in rich and poor countries the risks of prematurity and low birthweight are substantially raised by short intervals, and in developing countries, risk of death in infancy (ages <1 year) would fall by 10%, and in ages 1–4 years by 21%, if all children were spaced by a gap of 2 years
- The health benefits of specific contraceptive methods far outweigh the health risks, although minor side-effects result in high probabilities of discontinuation, particularly of hormonal methods

### Search strategy and selection criteria

We searched Medline, Embase, Popline, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS) with a combination of words related to contraception or family planning, birth or pregnancy spacing, fertility, unintended pregnancy, adolescent pregnancy, high-risk pregnancy, abortion, maternal health, maternal mortality, perinatal health, infant health, infant mortality, child health, and child mortality, without imposing any language restrictions. We also searched proceedings of international meetings on family planning or contraception, reference lists of identified studies, textbooks, previously published systematic reviews, and review papers. We also contacted experts in the specialty.
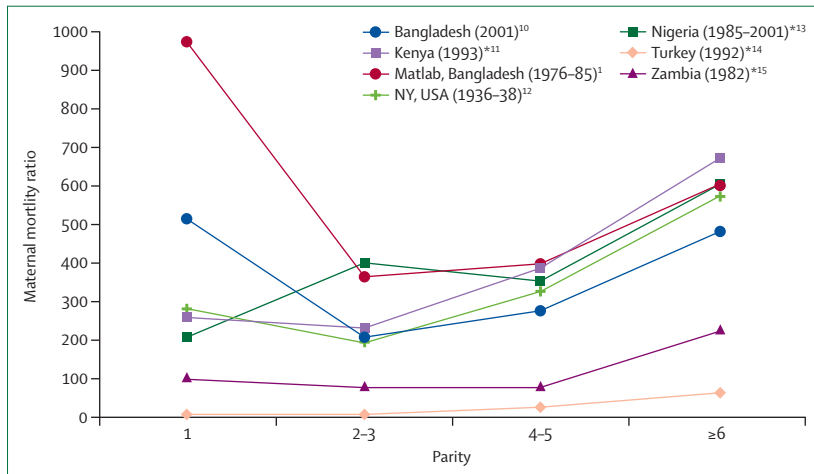
*Figure 1:* Selected studies of the relation between parity and maternal mortality ratio
*Hospital-based or facility-based data.

## Maternal survival and health

### Maternal mortality measures and fertility

Maternal mortality risk is affected by the number and timing of pregnancies in a woman's reproductive lifespan, by the presence of comorbidities, and by obstetric care. The effect of these factors is quantifiable by four measures: the number of maternal deaths, the maternal mortality rate (MMRate), the maternal mortality ratio (MMRatio), and the lifetime risk of maternal death.

The MMRate is the yearly number of maternal deaths per 1000 women of childbearing age (15–49 years). The MMRatio has the same numerator, but is expressed per 100 000 livebirths. Lifetime risk of maternal death is the cumulative probability of a woman dying of maternal causes during her reproductive life, and is a measure of pregnancy-related female death. Both the MMRate and lifetime risk of maternal death respond directly to fertility rates and thus quantify the risk of maternal death per woman, whereas the MMRatio is indicative of risk per pregnancy due to poor access to and quality of obstetric services. A fall in the number of pregnancies lowers the number of maternal deaths because, self-evidently, in the absence of pregnancy, the risk of maternal death is non-existent.

### Prevention of high-risk and unintended pregnancies and maternal mortality

Although the MMRatio is linked directly to improvements in maternity care, it also responds to fertility rates, which can affect the proportion of births to women with greater-than-average obstetric risk—ie, those who are younger than 18 years or older than 34 years, those with only one child or more than three children, and those whose births are closely spaced.[1–6] The extent to which these factors affect obstetric risk has been debated.[7–9]

As shown in the appendix, increased contraceptive use and subsequent fertility decline results in decreased obstetric risk, mainly by reducing unwanted pregnancies in women of high parity. The risks associated with high parity are seen in parity-specific MMRatios, most of which, in developing countries, are derived from hospital delivery records (figure 1). MMRatios tend to be raised at parity 1, then become lowered at parities 2–3, then raised again at 4–5, and highest at parities greater than 6. Raised maternal mortality risks at high parities have been seen in Pakistan, Senegal, and west Africa, in addition to the countries featured in figure 1.[16–18]

In terms of birth spacing, an analysis of more than 450 000 births in Latin America and the Caribbean between 1985 and 1997 identified an adjusted odds ratio (OR) of 2·5 (95% CI 1·2–5·4) for maternal death when the interpregnancy interval (the length of time between pregnancies) was less than 6 months.[19] However, a systematic review of 22 studies, a third of which were done in developing countries, examined birth spacing and maternal outcomes and showed inconsistent effects from short interpregnancy intervals on maternal mortality.[20] The investigators reported a strong relation between short birth intervals and poor pregnancy outcomes and maternal morbidity, but a weak relation with maternal mortality, a paradoxical pattern warranting further research.

Another category of high-risk pregnancies are those that end in unsafe abortion. Singh and colleagues[21] reported that there were 208·2 million pregnancies worldwide in 2008. 185·4 million of them occurred in developing regions, of which two-fifths (40%) were unintended, with 16% ending in livebirth, 19% in abortion, and 5% in miscarriage. Sedgh and colleagues[22] estimated that 42 million pregnancies were aborted worldwide in 2003, of which 19·7 million (48%) took place in unsafe conditions. 97% of unsafe abortions occur in developing countries, and an updated estimate puts the number in 2008 at 21·6 million, with increased rates in sub-Saharan Africa and Latin America since 2003.[23] About 47 000 maternal deaths (13% of all maternal deaths) in developing countries are caused by complications of unsafe abortions.[24] Contraceptive use can prevent recourse to induced abortion and eliminate most of these deaths.

### Estimation of the reduction in maternal deaths from contraception-induced fertility reduction

Ross and Blanc[25] estimate that fertility decline between 1990 and 2008 in developing countries averted 1·7 million maternal deaths, corresponding to a 54% reduction in the MMRate. Because increased contraceptive use accounts for 73% of fertility decline (appendix), a 40% reduction in the MMRate during these 18 years can be attributed to contraception. Darroch and Singh[26] estimate that 43·8 maternal deaths are averted per 100 000 modern-contraceptive users every year. This ratio implies that, in the absence of contraception, the number of maternal deaths in 2008 (about 355 000[27]) would have been 74% higher, at 619 114. A subsequent analysis with a different approach gave an almost identical estimate of the

proportion of maternal deaths in 2008 in developing regions averted by contraceptive use.[28]

The estimates by Ross and Blanc[25] and Darroch and Singh[26] assume that the obstetric risk is the same for averted and other births. To assess the additional contribution of contraceptive use to reduced obstetric risk (MMRatio), we examined their covariance over time for 40 developing countries (figure 2). The simple relation shows that each percentage point increase in contraceptive use is associated with a reduction of 8·5 maternal deaths per 100 000 births. To control for confounders, we did a panel regression analysis of change in MMRatio and contraceptive use for these 40 developing countries over 12 years (appendix). The model shows that for each percentage point gain in contraceptive use, the MMRatio decreased by 4·3 deaths per 100 000 births. We estimate that increased contraception use resulted in a 26% overall decrease in MMRatio over the 12 years studied. In terms of the number of maternal deaths averted, contraceptive use contributes to an additional 3·7% reduction per year.

By assessing the results of meeting unmet need for family planning, investigators can gauge the potential of contraception to further reduce maternal mortality. With Demographic and Health Survey data (1985–2000), Collumbien and colleagues[29] estimated that 90% of abortion deaths and 23·6% of obstetric deaths per year (32% of all maternal deaths) are preventable if all women wanting to stop childbearing use effective contraception. A subsequent analysis reached a similar conclusion—ie, that maternal deaths could be reduced by 28% by the fulfilment of unmet contraceptive need.[30]

Because contraceptive use is estimated to have averted 43–44% of maternal deaths in 2008,[27,28] and to account for an additional 3·7% reduction in maternal deaths due to its indirect effect on obstetric risk, contraceptive use in developing countries prevents 47–48% of maternal deaths per year. Its effect is further amplified if near-miss cases (severe but non-fatal maternal morbidity episodes) are considered along with maternal deaths.

## Perinatal health

Conde-Agudelo and colleagues[31] reported the results of a comprehensive systematic review and meta-analysis of observational studies investigating the association between interpregnancy interval and adverse perinatal outcomes. 67 studies whose results were adjusted for at least maternal age and socioeconomic status, including more than 11 million pregnancies, met the strict inclusion criteria. 26 of these studies provided data for meta-analyses, 16 provided data for preterm birth, ten for low birthweight, 13 for small for gestational age, seven for fetal death, and four for early neonatal death.

The meta-regression curves showed a J-shaped relation between risk of these five adverse perinatal outcomes and interpregnancy interval (figure 3). For preterm birth, low birthweight, and small for gestational age, the highest
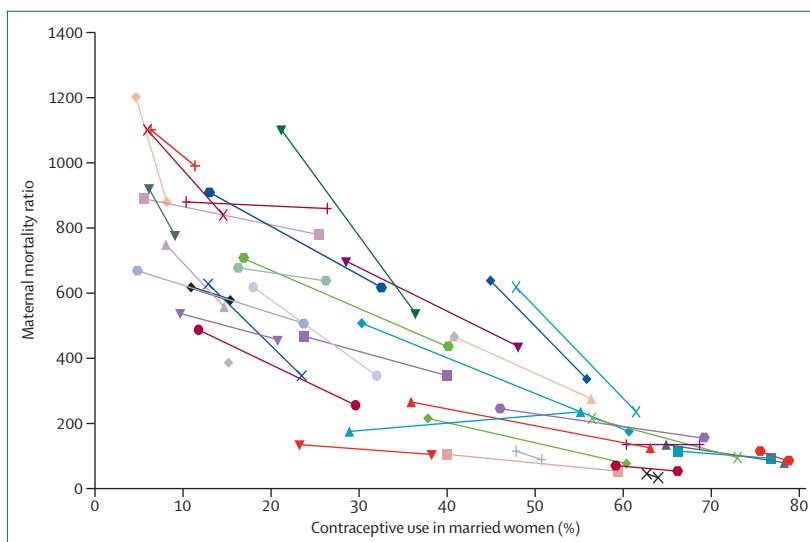


*Figure 2:* **Maternal mortality ratio and contraceptive use in married women in 40 countries over time**
Estimates of contraceptive use were obtained from Demographic and Health surveys, done between 1986 and 2009, in 40 developing countries (countries and dates listed in the appendix). The WHO time series of estimates[27] was used to obtain maternal mortality ratios that corresponded to the dates of each of the contraceptive use estimates. The first datapoint corresponds to the earliest Demographic and Health survey data available for that country, and the second datapoint corresponds to the most recent survey data. The average length of time between surveys was 12 years (ranging from 4–21 years). Median slope –8·5 (IQR –22·2 to –2·3).
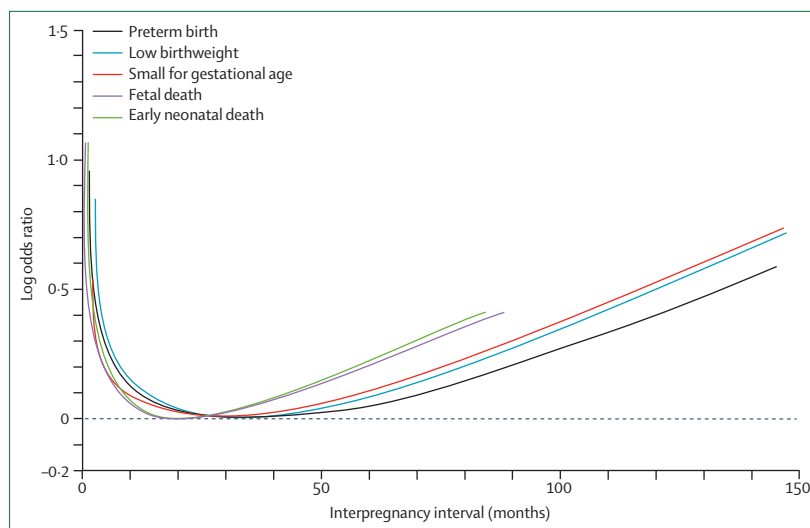


*Figure 3:* **Log odds ratio of adverse perinatal outcomes according to interpregnancy interval**
Meta-regression curves of adverse perinatal outcomes according to interpregnancy interval, adapted from results from Conde-Agudelo and colleagues' meta-analysis.[31]

risk was for intervals shorter than 20 months and longer than 60 months. For both fetal and early neonatal death, the highest risk was for intervals shorter than 6 months and longer than 50 months. Infants conceived 18–23 months after delivery of the previous child had the lowest risks of adverse perinatal outcomes and were used as the referent category. Infants born to women with interpregnancy intervals shorter than 6 months had pooled adjusted ORs of 1·4 (95% CI 1·2–1·6) for preterm
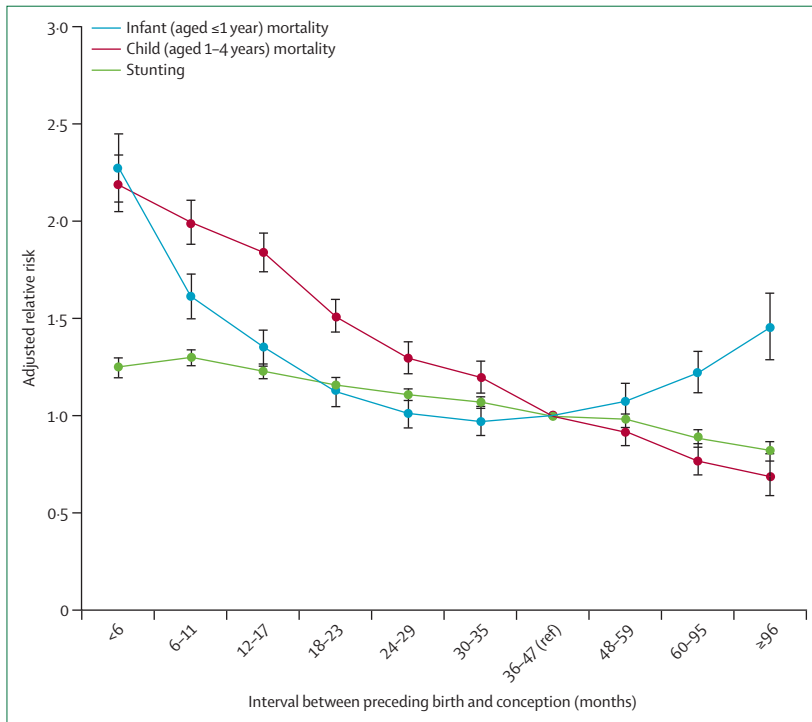
*Figure 4:* **Adjusted relative risks of infant mortality, child mortality, and stunting according to interval between preceding birth and conception**
Pooled data from 52 Demographic and Health Surveys, adapted from results from Rutstein's analysis.[42]

birth, 1·6 (1·4–1·9) for low birthweight, and 1·3 (1·2–1·3) for small for gestational age, compared with infants born to women with intervals of 18–23 months. Likewise, infants born after an interval of 6–17 months were 5–14% more likely to have these adverse outcomes than were the referent group. Intervals longer than 59 months were also associated with a significantly greater risk for these three adverse perinatal outcomes (OR 1·20 [95% CI 1·17–1·24] for preterm birth; 1·43 [1·27–1·62] for low birthweight; 1·29 [1·20–1·39] for small for gestational age). Subgroup analyses according to study setting revealed that the negative effect of interpregnancy intervals shorter than 6 months on the risk of both preterm birth and low birthweight was significantly greater in developing countries (adjusted ORs 2·3 [95% CI 2·2–2·4] and 2·1 [2·0–2·3], respectively) than in developed countries (adjusted ORs 1·3 [1·2–1·3] and 1·5 [1·4–1·6], respectively). These results showed that interpregnancy intervals shorter than 18 months and longer than 59 months were significantly associated with increased risk of preterm birth, low birthweight, and small size for gestational age.

Subsequent studies from both developed and developing countries have corroborated the results reported in this systematic review.[32–39] A nation-based cohort study from Israel, of 440 838 livebirths, reported that an interpregnancy interval shorter than 6 months was associated with a statistically significant increased risk for early neonatal death (adjusted OR 1·64 [95% CI 1·22–2·19]).[36]

The mechanisms by which short intervals between pregnancies can affect perinatal health are widely debated. The most important hypothesis is maternal nutritional depletion caused by the close succession of pregnancies and periods of lactation. Smits and Essed[40] suggested that the excess risk of adverse perinatal outcomes after short interpregnancy intervals could be attributable to insufficient repletion of maternal folate resources. In pregnant women not taking folic acid supplements, maternal serum and erythrocyte concentrations of folate begin to decrease 5 months into pregnancy and remain low for several months after delivery. If a woman becomes pregnant before complete folate has been restored, she will have a higher risk of folate deficiency and a subsequent increased risk for adverse perinatal outcomes. With respect to the adverse effects of long intervals, Zhu and colleagues[41] suggest that physiological reproductive capacities gained during pregnancy begin to gradually decline after delivery, and reported that perinatal outcomes after an interpregnancy interval of 60 months or longer were similar to those of primigravid women.[41]

### Infant and child mortality and health
Of the possible demographic effects on child health, birth spacing has been the main focus. A comprehensive analysis by Rutstein[42] examined the effect of the length of time from the birth of the preceding child to the conception of the index child using pooled data for more than 1 million births from 52 Demographic and Health Surveys. A large number of demographic and socioeconomic factors were controlled through regressions. We show the key adjusted results in figure 4. For infants (children younger than 1 year), the shorter the interval (18 months or less), the greater the mortality risk. Very long intervals of 60 months or more were associated with higher risks. In the 52 surveys, about 50% of second births and 70% of third-order (or higher) births were conceived after intervals of less than 24 and 36 months, respectively, and the population attributable risk suggested that infant mortality would fall by 7·5% if women avoided conceiving during the 24 months after a preceding birth (equivalent to a birth interval of less than 33 months). These results are broadly similar to a systematic review[43] and earlier crossnational studies.[44–48] Expressed in terms of interbirth intervals, children born within 2 years of an elder sibling have a 60% increased risk of infant death, and those born within 2–3 years a 10% increased risk, compared with those born after an interval of 3 years or longer. We discuss issues of measurement error, confounding, and causation in the appendix.

In early childhood (ages 1–4 years), Rutstein's analysis[42] suggests that the risks associated with short intervals are greater than are those in infancy, and decrease consistently as the interval lengthens. However, most other investigations have noted that the effects of short

intervals on mortality in children older than 1 year are smaller than are those in infants.[43–45,48] A conservative interpretation of all major studies suggests that a preceding interval of less than 2 years raises risk of death at ages 1–4 years by about 40%. Finally, Rutstein's analysis points to substantially raised risks of stunting in surviving children born after a short preceding interval (figure 4), a result consistent with a systematic review.[49]

Earlier crossnational studies reported that the birth of a younger sibling within 2 years of the index child was associated with a doubling of mortality at ages 1–2 years, and smaller adverse effects at ages 2–4 years.[43–45] Therefore, if all children were spaced by a gap of at least 2 years, estimates suggest that the infant mortality rate would fall by about 10%, and mortality of children aged 1–4 years by 21%.[8]

Other avoidable demographic risk factors for child survival include births to mothers at the limits of the reproductive age range, and those of a high order. Children born to women younger than 18 years have an excess mortality risk of about 40%[45] and are more likely to be stunted and anaemic than are those born to women older than 18 years.[50] However, after adjustment for birth spacing, children born to women aged 35 years or older were not disadvantaged. Excess child mortality caused by birth order is restricted to orders seven or higher and is 20%, relative to orders two to three.[51] Because births to very young mothers and of very high order are uncommon, their avoidance would do little to reduce child mortality.

## Non-contraceptive health benefits and risks of specific methods

Compelling evidence exists for the overall health benefits of modern contraceptives exceeding the health risks for most women, and that the risks associated with use are less than are those of non-use.[52] Although the contraceptive benefits of modern methods are broadly the same, the non-contraceptive benefits and risks are specific to each method.

The most prevalent method of contraception worldwide is surgical sterilisation. Female sterilisation (tubal sterilisation) and male sterilisation (vasectomy) have immediate surgical risks, but the risks of death and serious morbidity are very small with tubal sterilisation and even lower with vasectomy.[53] Many studies have shown that, in general, both tubal sterilisation and vasectomy seem to have little long-term health effects—either positive or negative—beyond the noted beneficial effects on pregnancy prevention. Tubal sterilisation is associated with a reduced risk of ovarian cancer.[53] Although the risk of pregnancy is low after tubal sterilisation, when pregnancy does occur, it is more likely to be ectopic; however, the absolute risk of ectopic gestation is lower than when no contraception is used.[53]

Worldwide, intrauterine devices (IUDs) are the most widely used modern method of reversible contraception, and results of studies show overall health benefits and few long-term risks for most women. The risk of pelvic inflammatory disease is very low in women fitted with an IUD who have a low risk for sexually transmitted infections (about 1·6 per 1000 women), but women with cervical chlamydial or gonococcal infections who have an IUD are at increased risk.[54] IUDs have been associated with a reduced risk of endometrial cancer,[55] and a pooled analysis suggests a possible reduced risk of cervical cancer.[56] Levonorgestrel-releasing IUDs reduce menstrual blood loss. As with tubal sterilisation, pregnancies during use are very uncommon, but are more likely to be ectopic when they occur, but the absolute risk is lower than when no method is used.[57]

Combined oestrogen–progestogen oral contraceptive pills (OCPs) are among the most widely used modern contraceptive methods in many countries and are also among the best studied drugs in history. An analysis of data from a large UK cohort study with long-term follow-up reported that use of OCPs slightly reduces all-cause mortality.[58] OCPs are associated with very low relative and absolute risks of cardiovascular disease in young healthy women who do not smoke, although women aged 35 years or older who smoke are at increased risk.[59] They reduce the prevalence of anaemia[59] and decrease the risk of endometrial and ovarian cancer, with this effect increasing with length of use and persisting long after discontinuation of use.[60,61] Whether OCPs have any effect on the risk of breast cancer is unclear. A pooled analysis of 54 studies reported a small increase in risk of breast cancer in OCP users that was not present in past users,[62] but a subsequent large US study reported no such increase.[63] Studies suggest an increased risk of cervical cancer in OCP users who are positive for human papillomavirus (HPV) DNA, but not in those negative for HPV DNA.[59] A pooled analysis showed that OCP users had a raised risk of cervical cancer that increased with duration of use and decreased after cessation of use, with the risk returning to that for never users after 10 years.[64]

Progestogen-only implants and injections are also common in some countries. Depot medroxyprogesterone acetate injections are associated with bone loss during long-term use that seems to be largely, if not fully, reversible with discontinued use. Whether use by adolescents will affect their peak bone mass and risk of fractures as they get older is unknown.[65]

Evidence for the safety of hormonal contraceptives and IUDs in women with HIV/AIDS is scarce, but available studies are generally reassuring about adverse health effects, including disease progression in infected women and HIV transmission to uninfected partners.[66] One randomised trial,[67] however, reported increased risks of disease progression and death in hormonal contraceptive users compared with IUD users, and a prospective cohort study of HIV-1 serodiscordant couples in seven African countries[68] reported that use of hormonal contraception

increased risk of both male-to-female and female-to-male transmission of HIV to uninfected partners. Studies of whether hormonal contraceptives increase the risk of HIV infection have been difficult to interpret because of challenges in controlling for several confounding factors. A 2012 WHO technical consultation concluded that the use of hormonal contraceptive methods by women with HIV or at high risk for HIV should not be restricted, but issued a detailed clarification for women receiving progestogen-only injections because of the inconclusive evidence about risk of HIV infection.[69]

Although serious health risks associated with contraception are uncommon, side-effects are common, particularly with the most effective methods. For example, menstrual bleeding abnormalities are a frequent side-effect of hormonal contraceptives and IUDs, and the loss of regular menses might affect the acceptability of these methods in some regions.[70] In general, although side-effects are minor, they can be unacceptable and are the most frequently cited reason for discontinuation. Typically, 30–50% of women discontinue use of OCPs or contraceptive injections within 12 months because of side-effects or health concerns, although most switch promptly to alternatives.[71]

## Discussion

Contraception is unique among medical interventions in the breadth of its positive outcomes. Reproductive choice is one of the more fundamental human rights, and by freeing women from an incessant cycle of pregnancy, breastfeeding, and child care, contraception represents a huge step towards greater gender equality. The benefits to families of fewer children, in whom more resources can be invested, and the benefits to societies of reduced fertility and slowed population growth for social and economic advance and preservation of local environments are likewise important.

Evidence for the effect of contraceptive use on the health and survival of women is particularly striking. We estimate that increased contraceptive use has cut the number of maternal deaths in developing countries by about 40% over the past 20 years by reducing unintended pregnancies and thus the number of times women face hazards of pregnancy. Additional deaths have been prevented by a reduction in births to women of high parities, who are at greater obstetric risk than are those of low parities, and by a reduction of recourse to unsafe abortion. Over an average period of 12 years, we estimate that increases in contraceptive use in developing countries reduced the risk of death per 100 000 livebirths by 28%.

The life-saving effect of contraception has largely run its course in developed countries, and future major contributions to reductions in maternal deaths, and associated morbidity, are mainly restricted to countries with high fertility, where unmet need for family planning tends to be high and where abortion is typically illegal and often unsafe. Most of these countries are located in sub-Saharan Africa, and not surprisingly the proportion of all maternal deaths worldwide occurring in this region rose from 23% to 52% between 1980 and 2008.[72] Two independent analyses[29,30] using different methods came to the same conclusion: elimination of the unmet need for contraception in developing countries would reduce maternal deaths by about 30%. This estimate overstates the potential short-term contribution of contraception, because unmet need can never be eliminated; however, it understates the long-term contribution because need for contraception in high-fertility countries will inevitably increase over time. Especially in rural areas with poor health infrastructure, family planning is the most cost-effective and feasible way to reduce maternal deaths because it does not rely on complex technology, unlike some alternative interventions.[73]

Contraception is implicated in perinatal, infant, and child health mainly through its potential to ensure optimum spacing between successive pregnancies. Evidence shows that, in developing countries, the risk of prematurity and low birthweight doubles when conception occurs within 6 months of a previous birth. The importance of this link is magnified by the association between fetal growth and the incidence of coronary heart disease and stroke in adult life.[74]

The relation between spacing and infant survival is well known and frequently given as a compelling reason for investments in family planning. Less well known is the persistence of the effect of short preceding intervals into early childhood (ages 1–4 years). Moreover, survival chances in early childhood are seriously jeopardised by the birth of a younger sibling within 2 years. This double jeopardy is of huge importance for child health programmes in high fertility countries of sub-Saharan Africa where about 60% of children have older and younger siblings and where deaths of children older than 1 year comprise 30–50% of all deaths in children younger than 5 years.

The main contribution of increases in contraceptive use to perinatal, infant, and child health has been to reduce the number of pregnancies and thereby increase the proportion of children who are first born (and thus have no preceding interval) and last born (and thus have no succeeding interval). However, the effect of contraceptive use on interbirth spacing has been disappointingly small. One reason for this weak link is the emphasis in some countries on sterilisation to restrict family size, which has overshadowed promotion of methods for birth spacing. A greater emphasis on post-partum family planning services is needed and attempts to re-invigorate the idea of birth spacing, spearheaded by the US Agency for International Development and WHO, are welcome.[75] This initiative holds particular promise in Africa, where great value is attached to adequate intervals between successive births.

The substantial effect of contraception on health is often overlooked by medical specialists, perhaps because

the evidence, with the exception of the important non-contraceptive health benefits of specific methods, has been generated largely by demographers and reported in non-medical journals. Another reason for neglect might be that contraceptive technology is well established and perceived as unexciting. Additionally, emphatic advocacy of family planning is linked to population control, which has become deeply unfashionable. One result of the long silence on these subjects has been the steep decrease in international funding of, and vocal support for, family-planning programmes. In terms of maternal and child health, a heavy price has been paid for this neglect, particularly in Africa. We believe that redress of this imbalance is long overdue.

### References
1    Koenig MA, Fauveau V, Chowdhury AI, Chakraborty J, Khan MA. Maternal mortality in Matlab, Bangladesh, 1976–85. *Stud Fam Plann* 1988; **19:** 69–80.
2    Bhatia J. Levels and causes of maternal mortality in southern India. *Stud Fam Plann* 1993; **24:** 310–18.
3    Wee DW, Mullany LC, Katz J, Khatry SK, LeClerq SC, Tielsch JM. Pregnancy-related mortality in southern Nepal between 2001 and 2006: independent estimates from a prospective, population-based cohort and a direct sisterhood survey. *Am J Epidemiol* 2010; **172:** 855–60.
4    Atrash HK, Koonin LM, Lawson HWA, Franks AL, Smith JC. Maternal mortality in the United States, 1979–1986. *Obstet Gynecol* 1990; **76:** 1055–60.
5    Cecatti J, Correa-Silva EPB, Milanez H, Moraise SS, Souza JP. The associations between inter-pregnancy interval and maternal and neonatal outcomes in Brazil. *Matern Child Health J* 2008; **12:** 275–81.
6    Jain AK. Measuring the effect of fertility decline on the maternal mortality ratio. *Stud Fam Plann* 2011; **18:** 247–60.
7    Fortney J. The importance of family planning in reducing maternal mortality. *Stud Fam Plann* 1987; **18:** 109–14.
8    Trussell J, Pebley A. The potential impact of changes in fertility on infant, child and maternal mortality. *Stud Fam Plann* 1984; **15:** 267–80.
9    Winikoff B, Sullivan M. Assessing the role of family planning in reducing maternal mortality. *Stud Fam Plann* 1987; **18:** 128–43.
10   National Institute of Population Research and Training, ORC Macro. Bangladesh maternal health services and maternal mortality survey 2001. Dhaka, Bangladesh, and Calverton, MD: NIPORT, ORC Macro, 2003.
11   Magadi M, Diamond I, Madise N. Analysis of factors associated with maternal mortality in Kenyan hospitals. *J Biosoc Sci* 2001; **33:** 375–89.
12   Yerushalmy J, Palmer C, Kramer M. Studies in childbirth mortality: age and birth as factors in puerperal fatality. *Public Health Rep* 1940; **55:** 1195–20.
13   Ujah IAO, Aisien OA, Mutihir JT, Vanderjagt DJ, Glew RH, Uguru VE. Factors contributing to maternal mortality in North-central Nigeria: a seventeen-year review. *Afr J Reprod Health* 2003; **9:** 27–39.
14   Tuncer RA, Erkaya S, Sipahi T, Kutlar I. Maternal mortality in a maternity hospital in Turkey. *Acta Obstet Gynecol Scand* 1995; **74:** 604–06.
15   Mhango C, Rochat R, Arkutu A. Reproductive mortality in Lusaka, Zambia, 1982–83. *Stud Fam Plann* 1986; **17:** 243–51.
16   Fikree F, Midhet F, Sadruddin S, Berendes H. Maternal mortality in different Pakistani sites: ratios, clinical causes and determinants. *Acta Obstet Gynecol Scand* 1997; **16:** 637–45.
17   Garenne M, Mbaye K, Bah MD, Correa P. Risk factors for maternal mortality: a case-control study in Dakar hospitals (Senegal). *Afr J Reprod Health* 1997; **1:** 14–24.
18   Bouvier-Colle MH, Ouedraogo C, Dumont A, Vangeenderhuysen C, Salanave B, Decam C. Maternal mortality in West Africa: rates, causes and substandard care from a prospective survey. *Acta Obstet Gynecol Scand* 2001; **80:** 113–19.
19   Conde-Agudelo A, Belizán JM. Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. *BMJ* 2000; **321:** 1255–59.
20   Conde-Agudelo A, Rosas-Bermudez A, Kafury-Goeta AC. Effects of birth spacing on maternal health: a systematic review. *Am J Obstet Gynecol* 2007; **196:** 297–308.
21   Singh S, Sedgh G, Hussain R. Unintended pregnancy: worldwide levels, trends and outcomes. *Stud Fam Plann* 2010; **41:** 241–50.
22   Sedgh G, Henshaw S, Singh S, Åhman E, Shah IH. Induced abortion: estimated rates and trends worldwide. *Lancet* 2007; **370:** 1338–45.
23   Shah I, Ahman E. New estimates and trends regarding unsafe abortion mortality. *Int J Gynaecol Obstet* 2011; **115:** 1338–45.
24   WHO. Unsafe abortion. Global and regional estimates of the incidence of unsafe abortion and associated mortality in 2008. Geneva: World Health Organization, 2011.
25   Ross J, Blanc AK. Why aren't there more maternal deaths? A decomposition analysis. *Matern Child Health J* 2012; **16:** 456–63.
26   Darroch J, Singh S, for the Guttmacher Institute. Estimating unintended pregnancies averted from couple-years of protection (CYP). New York: Guttmacher Institute, 2011.
27   WHO. Trends in maternal mortality: 1990 to 2008. Geneva: World Health Organization, 2010.
28   Ahmed S, Li Q, Liu L, Tsui AO. Maternal deaths averted by contraceptive use: an analysis of 172 countries. *Lancet* 2012; published online July 10. http://dx.doi.org/10.1016/S0140-6736(12)60478-4.
29   Collumbien M, Gerressu M, Cleland J. Non-use and use of ineffective methods of contraception. In: Ezzati M, Lopez AD, Rodgers A, Murray CJL, eds. Comparative quantification of health risks, global and regional burden of disease attributable to selected major risk factors. Geneva: World Health Organization, 2004: 1255–320.
30   Singh S, Darroch JE, Ashford LS, Vlassoff M. Adding it up: the costs and benefits of investing in family planning and maternal and newborn health. New York: Guttmacher Institute, 2009.
31   Conde-Agudelo A, Rosas-Bermúdez A, Kafury-Goeta AC. Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. *JAMA* 2006; **295:** 1809–23.
32   DeFranco EA, Stamilio DM, Boslaugh SE, Gross GA, Muglia LJ. A short interpregnancy interval is a risk factor for preterm birth and its recurrence. *Am J Obstet Gynecol* 2007; **197:** 264.e1–e6.
33   Rodrigues T, Barros H. Short interpregnancy interval and risk of spontaneous preterm delivery. *Eur J Obstet Gynecol Reprod Biol* 2008; **136:** 184–88.
34   Auger N, Daniel M, Platt RW, Luo ZC, Wu Y, Choinière R. The joint influence of marital status, interpregnancy interval, and neighborhood on small for gestational age birth: a retrospective cohort study. *BMC Pregnancy Childbirth* 2008; **8:** 7.
35   Nabukera SK, Wingate MS, Kirby RS, et al. Interpregnancy interval and subsequent perinatal outcomes among women delaying initiation of childbearing. *J Obstet Gynaecol Res* 2008; **34:** 941–47.
36   Grisaru-Granovsky S, Gordon ES, Haklai Z, Samueloff A, Schimmel MM. Effect of interpregnancy interval on adverse perinatal outcomes—a national study. *Contraception* 2009; **80:** 512–18.
37   Cecatti JG, Correa-Silva EP, Milanez H, Morais SS, Souza JP. The associations between inter-pregnancy interval and maternal and neonatal outcomes in Brazil. *Matern Child Health J* 2008; **12:** 275–81.
38   Williams EK, Hossain MB, Sharma RK, Kumar V, Pandey CM, Baqui AH. Birth interval and risk of stillbirth or neonatal death: findings from rural north India. *J Trop Pediatr* 2008; **54:** 321–27.
39   Adam I, Ismail MH, Nasr AM, Prins MH, Smits LJ. Low birth weight, preterm birth and short interpregnancy interval in Sudan. *J Matern Fetal Neonatal Med* 2009; **22:** 1068–71.
40   Smits LJ, Essed GG. Short interpregnancy intervals and unfavourable pregnancy outcome: role of folate depletion. *Lancet* 2001; **358:** 2074–77.

41  Zhu BP, Rolfs RT, Nangle BE, Horan JM. Effect of the interval between pregnancies on perinatal outcomes. *N Engl J Med* 1999; **340**: 589–94.

42  Rutstein SO. Further evidence of the effects of preceding intervals on neonatal, infant and under-five-years mortality and nutritional status in developing countries: evidence from the Demographic and Health Surveys. Demographic and Health Surveys working paper 2008 no. 41. Calverton, MD: Macro International, 2008.

43  Rutstein SO, Johnson K, Conde-Agudelo A, Rosas-Bermudez A. Effect of birth spacing on infant and child mortality: a systematic review and meta-analysis. WHO technical consultation and scientific review of birth spacing; Geneva; June 13–15, 2005.

44  Hobcraft J, McDonald JW, Rutstein SO. Child spacing effects on infant and early child mortality. *Popul Index* 1983; **49**: 585–618.

45  Hobcraft J, McDonald JW, Rutstein SO. Demographic determinants of infant and child mortality. *Popul Stud* 1985; **39**: 363–85.

46  UN Department for Economic and Social Information Analysis, Population Division. The health rationale for family planning: timing of births and child survival. New York: United Nations, 1994.

47  Rutstein SO. Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status: evidence from demographic and health surveys. *Int J Gynaecol Obstet* 2005; **89** (suppl 1): S7–24.

48  Mahy M. Childhood mortality in the developing world: a review of evidence from the Demographic and Health Surveys. Demographic and Health Surveys comparative reports no. 4. Caverton, MD: ORC Macro, 2003.

49  Dewey K, Cohen R. Does birth spacing affect maternal and child nutritional status? A systematic review literature review. *Matern Child Nutrition* 2007; **3**: 151–73.

50  Canning D, Ozaltin E, Finlay JE. Association of maternal health with infant mortality, child anthropometric failure, diarrhea and anaemia in low and middle income countries. Boston: Harvard School of Public Health, 2011.

51  Hobcraft J. Does family planning save children's lives? Technical background paper for the International Conference on Better Health for Women and Children through Family Planning; Kenya, Nairobi; October 5–9, 1987.

52  Kost K, Forrest JD, Harlap S. Comparing the health risks and benefits of contraceptive choices. *Fam Plann Perspect* 1991; **23**: 54–61.

53  Peterson HB. Sterilization. *Obstet Gynecol* 2008; **111**: 189–203.

54  Farley TMM, Rowe PJ, Meirik O, Rosenberg MJ, Chen J-H. Intrauterine devices and pelvic inflammatory disease: an international perspective. *Lancet* 1992; **339**: 785–88.

55  Beining RM, Dennis LK, Smith EM, Dokras A. Meta-analysis of intrauterine device use and risk of endometrial cancer. *Ann Epidemiol* 2008; **18**: 492–99.

56  Castellsagué X, Diaz M, Vaccarella S, et al. Intrauterine device use, cervical infection with human papillomavirus, and risk of cervical cancer: a pooled analysis of 26 epidemiological studies. *Lancet Oncol* 2011; **12**: 1023–31.

57  Franks AL, Beral V, Cates W Jr, Hogue CJR. Contraception and ectopic pregnancy risk. *Am J Obstet Gynecol* 1990; **163**: 1120–23.

58  Vessey M, Yeates D, Flynn S. Factors affecting mortality in a large cohort study with special reference to oral contraceptive use. *Contraception* 2010; **82**: 221–29.

59  Petitti DB. Combination estrogen-progestin oral contraceptives. *N Engl J Med* 2003; **349**: 1443–50.

60  Cibula D, Gompel A, Mueck AO, et al. Hormonal contraception and risk of cancer. *Hum Reprod Update* 2010; **16:** 631–50.

61  Collaborative Group on Epidemiological Studies of Ovarian Cancer. Ovarian cancer and oral contraceptives: collaborative reanalysis of data from 45 epidemiological studies including 23257 women with ovarian cancer and 87303 controls. *Lancet* 2008; **371**: 303–14.

62  Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and hormonal contraceptives: collaborative reanalysis of individual data on 53297 women with breast cancer and 100239 women without breast cancer from 54 epidemiological studies. *Lancet* 1996; **347**: 1713–27.

63  Marchbanks PA, McDonald JA, Wilson HG, et al. Oral contraceptives and the risk of breast cancer. *N Engl J Med* 2002; **346**: 2025–32.

64  International Collaboration of Epidemiological Studies of Cervical Cancer. Cervical cancer and hormonal contraceptives: collaborative reanalysis of individual data for 16573 women with cervical cancer and 35509 women without cervical cancer from 24 epidemiological studies. *Lancet* 2007; **370**: 1609–21.

65  WHO. WHO statement on hormonal contraception and bone health. *Wkly Epidemiol Rec* 2005; **35**: 302–04.

66  Curtis KM, Nanda K, Kapp N. Safety of hormonal and intrauterine methods of contraception for women with HIV/AIDS: a systematic review. *AIDS* 2009; **23** (suppl 1): S55–67.

67  Stringer EM, Levy J, Sinkala M, et al. HIV disease progression by hormonal contraceptive method: secondary analysis of a randomized trial. *AIDS* 2009; **23**: 1377–82.

68  Heffron R, Donnell D, Rees H, et al. Use of hormonal contraceptives and risk of HIV-1 transmission: a prospective cohort study. *Lancet Infect Dis* 2012; **12**: 19–26.

69  WHO. Hormonal contraception and HIV: technical statement. http://www.who.int/reproductivehealth/topics/family_planning/ Hormonal_contraception_and_HIV.pdf (accessed Feb 24, 2012).

70  Glasier AF, Smith KB, van der Spuy ZM, et al. Amenorrhea associated with contraception-an international study on acceptability. *Contraception* 2003; **67**: 1–8.

71  Ali MM, Cleland J. Contraceptive switching after method-related discontinuation. *Stud Fam Plann* 2010; **41**: 129–33.

72  Hogan MC, Foreman KJ, Naghavi M, et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010; **375**: 1609–23.

73  Goldie SJ, Sweet S, Carvalho N, Natchu UCM, Hu D. Alternative strategies to reduce maternal mortality in India: a cost-effectiveness analysis. *PLoS Med* 2010; **7**: e1000264.

74  Barker DJ. The origins of the development origins theory. *J Intern Med* 2007; **261**: 412–17.

75  WHO. Report of a WHO technical consultation on birth spacing: Geneva, Switzerland, 13–15 June, 2005. WHO/RHR/07.1. Geneva: World Health Organization, 2007.