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John Bongaarts is Vice President, Policy Research Division and Elof Johansson is Vice President, Center for Biomedical Research, Population Council. Revised version of a paper prepared for the IUSSP Seminar on “Family Planning Programmes in the 21st Century” at ICDDR,B, Dhaka, January 2000. The authors gratefully acknowledge comments on earlier drafts of this paper from Rodolfo Bulatao, Vasantha Kandiah, John Ross, and John Stover, and financial support from USAID and the Hewlett and Mellon Foundations.

Abstract

The main objectives of this study are to review existing methodologies for projecting future trends in contraception, evaluate the validity of the assumptions underlying these projections, propose methodological improvements, and assess the prospects for new methods of contraception in the coming decade. The prevalence of contraception in the developing world has increased sharply over the past several decades from near zero in 1960 to around 60 percent in 2000. Demand for contraception can be expected to continue to rise rapidly for the next few decades as population size continues to grow and fertility declines further to near the replacement level. As a result of these trends the number of users of contraception in the developing world is expected to rise from 549 million to 816 million over the next 25 years according to the most recent UN projection. An examination of the projection methodology found it to be reasonable. The rate of growth in users will be much more rapid in Africa than in Asia or Latin America.

Projecting the future distribution of specific contraceptive methods is more difficult. Method choice is affected by trends in several factors, including access to different methods, user characteristics, and technology. The procedures employed by the Futures Group to project the method mix were found to be less than optimally designed and a new methodology was therefore proposed. The general approach is one of slow and incomplete convergence toward a more balanced method mix in each country, with uniform reductions in the role of traditional methods. The new alternative projections to 2015 are quite different from those made by the Futures Group. For example, for the developing world as a whole the proportions relying on female sterilization are higher in 2015 (37 percent rather than 26 percent), and proportions using traditional methods are lower (7 percent instead of 14 percent).

Contraceptive behavior in the developing world has changed markedly over the past three decades. Around 1960 only a tiny fraction of couples practiced contraception, and knowledge of methods was very limited. In contrast, contraceptive knowledge is now widespread and more than half of married women in the developing world are current users of contraception. The large majority of these users rely on modern methods, including male and female sterilization, the IUD, and the pill. This revolution in contraceptive behavior has been driven by a desire to reduce family size, as social and economic changes have increased the cost of children and reduced their benefits. Another key factor contributing to this rise in contraception has been the diffusion of information about and access to contraceptive methods, aided by a rapid expansion of family planning programs. This expansion of access to a range of methods has helped couples implement their preferences for smaller families and avoid unwanted pregnancies.

While past trends in contraceptive behavior are fairly well established, there is uncertainty about what lies ahead. Because contraceptive prevalence levels among married women of reproductive age in many developing countries are approaching levels often found in the industrialized world, one might conclude that contraceptive demand is about to level off. Although future increases in contraceptive use could well occur at a slower pace than heretofore, a further expansion of demand is likely for two reasons. First, the fertility transition in the developing world is not yet complete. The average number of children per woman has declined from six to three since 1960, but this still leaves fertility about 50 percent above the replacement level of about two children that is expected to prevail in the long run. These further fertility declines will almost certainly be achieved by additional increases in the practice of contraception. Second, as population growth continues, the number of women of reproductive age (15–49 years) is expected to rise in most developing countries. These two factors will drive up the number of users of contraception in the developing world for the next few decades. In contrast, the demand for contraception in the industrial world will likely see little rise in aggregate because neither the level of fertility nor the number of women in the reproductive ages is expected to change much from current levels. However, in specific countries prevalence could rise, in particular where levels of abortion are high (e.g., in Eastern Europe and Japan). In addition, the method mix could well change substantially in both the industrial and the developing world. Such a change would occur even if no additional methods are made available, and it will likely be accelerated by the prospect of new contraceptive technologies.

To assess prospects for future trends in contraceptive use, projections have been made recently by the United Nations (1999a) and the Futures Group (Ross et al. 1999). The UN projects numbers of users for different world regions from 1993 to 2025. The Futures Group provides similar results for individual developing countries to 2015, and also projects numbers of users of different methods. The main objectives of this paper are to review the methodologies used in these projections, evaluate their results, propose methodological improvements, and assess the prospects for new methods of contraception in the coming decade. Before analyzing these projections we summarize past trends because they provide the basis for the projections. The focus throughout is on the developing world.

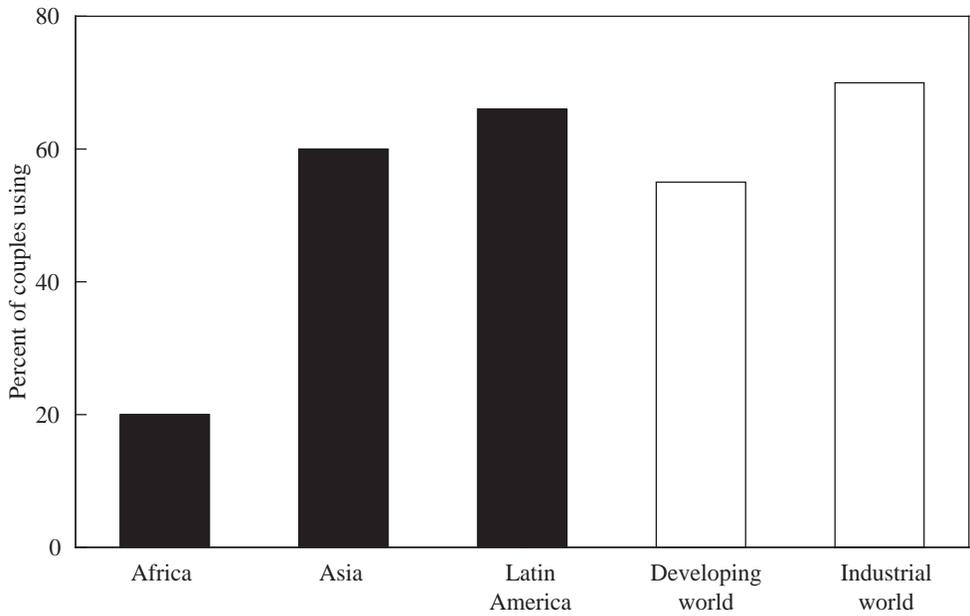
LEVELS AND TRENDS IN CONTRACEPTIVE PREVALENCE AND METHOD MIX

Prevalence

Figure 1 plots estimates of contraceptive prevalence (i.e., the percentage practicing a method among women who are married or in union) for the developing and industrial worlds as well as for selected regions for the latest available year, 1993 (UN 1999a). For the developing world as a whole, prevalence in 1993 stood at 55 percent. This is 15 percentage points less than the estimate of 70 percent for the industrial world in the same year. The developing-world average is heavily influenced by the high prevalence in China (83 percent); without China, this average would have been only 43 percent. Sharp differences between regions are evident, with prevalence ranging from 20 percent in Africa to 66 percent in Latin America. If, as seems likely, fertility has continued to decline since 1993, then prevalence today should be a few percentage points higher than in 1993. In fact, the developing-world average (including China) in 2000 is estimated at 60 percent (UN 1999a).

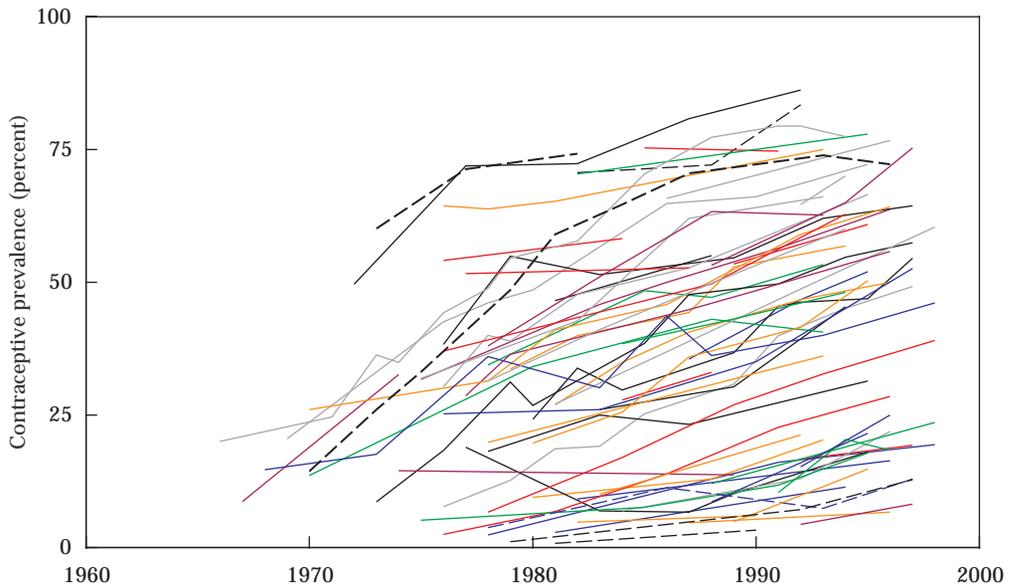
Past trends in contraceptive prevalence for 98 developing countries are plotted in Figure 2. Each line in this figure represents one country with two or more observations per country. A full discussion of this set of detailed data is not attempted here, but a few conclusions can be drawn: 1) In the early 1990s prevalence levels varied from a few percent in several African countries to over 75 percent in a small number of countries in Asia and Latin America (Brazil, China, Hong Kong, and South Korea). 2) There has

Figure 1 Level of current contraceptive use by region, ca. 1993



Source: UN 1999a.

Figure 2 Trends in contraceptive prevalence among married women, by country



Source: UN 1999a; Ross et al. 1999.

been a pervasive upward trend in prevalence over the past quarter-century. This trend is evident in most countries into the 1990s, except in populations where prevalence remains low (mostly in sub-Saharan Africa). 3) The number of countries for which prevalence estimates are available is greatest in the late 1980s and early 1990s and decreases for earlier dates. The relatively small number of countries with estimates for the 1960s and 1970s tend to be selected for higher-than-average prevalence (UN 1999a). It is therefore difficult to obtain unbiased estimates of global and regional averages for the past. It is possible to obtain indirect estimates through backward projection, but this approach has not been implemented systematically (Bongaarts 1984).

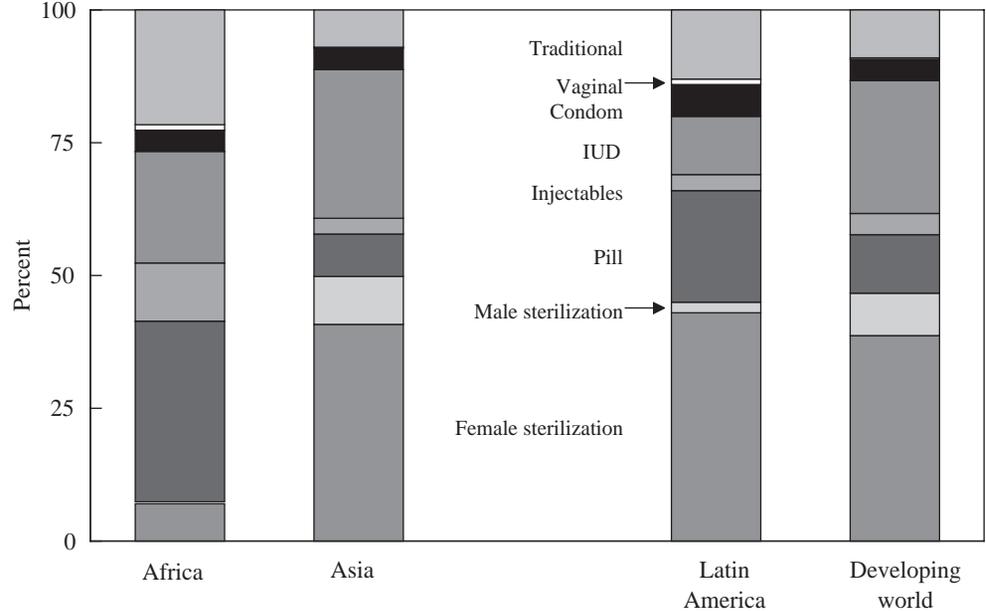
Contraceptive methods

Methods of contraception practiced today include “modern” and “traditional” ones. Modern refers to clinic and supply methods such as voluntary surgical sterilization, IUD, pills, injectables, condoms, and vaginal barrier methods. The main traditional or nonsupply methods are periodic abstinence and withdrawal as well as traditional folk methods with uncertain efficacy. Figure 3 (right bar) presents estimates of the method mix for the most recent available date (ca. 1993) for the developing world. Sterilization (mostly female) accounts for nearly half of all contraceptive use. Other modern methods (mostly IUDs and the pill) account for most of the remainder, while only 9 percent of women rely on traditional methods. This mix of methods has changed only modestly over time. Since 1980, the proportion of users relying on sterilization and injectables (a new method) has increased, and the pill, IUD, and other methods have become correspondingly less prevalent (UN 1996).

The mix of methods varies considerably among regions and countries. Users in Africa are much less likely to have been sterilized than their counterparts in Asia and Latin America, and they are more likely to rely on the pill or traditional methods. Sterilization is about equally common in Asia and Latin America, but in Asia the prevalence of the IUD is much higher and pill use lower than in Latin America.

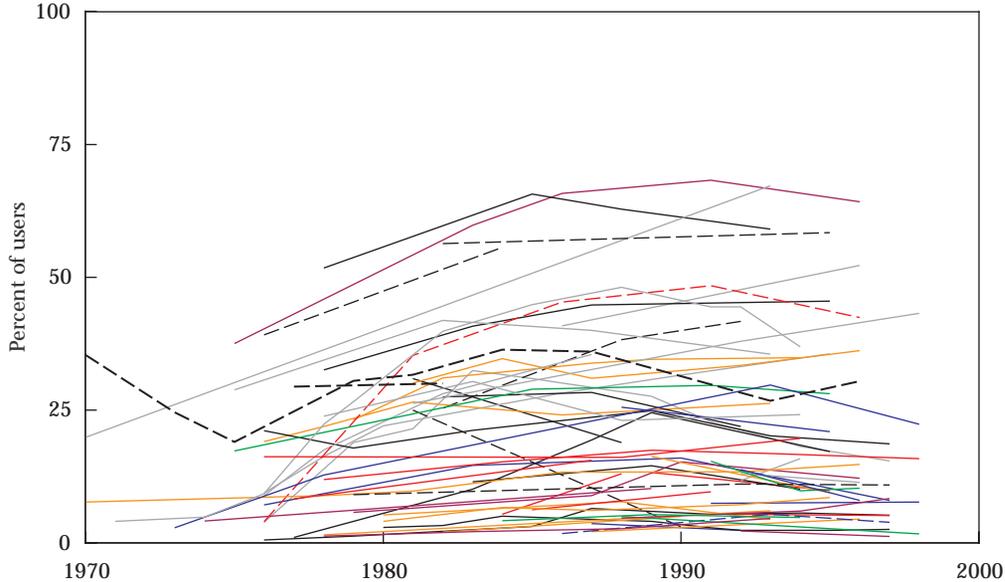
At the country level, variation in method mix is even greater than at the regional level. This is illustrated in Figure 4, which presents levels and past trends for one method—female sterilization—for 98 countries. The proportion of users relying on female sterilization ranges from a tiny percentage in a few countries (mostly in Africa) to well over

Figure 3 Percent distribution of contraceptive methods used by married women, by region, ca. 1993



Source: UN 1999a.

Figure 4 Trends in the proportion of users relying on female sterilization, by country



Source: UN 1999a; Ross et al. 1999.

half in India (67 percent) and over half in Brazil (52 percent) and a few other Latin American countries. Aside from this variation in levels there is also variation in past trends in the proportion of women sterilized, but no pervasive upward or downward trend is evident in the data plotted in Figure 4 from the mid-1980s onward. A similarly wide range exists in relative levels of use of other methods (data not shown). As was the case for female sterilization, in a few countries more than half of all use is accounted for by a single method. This is the case for the pill in Algeria (83 percent), Morocco (64 percent), and Zimbabwe (69 percent) and for the IUD in Egypt (63 percent) and Vietnam (51 percent). Among the main reasons for the heavy reliance on a single method in these countries are an emphasis on that method in family planning programs and limited availability of providers of other methods in the private sector. There is little doubt that the method mix would be less skewed in these countries if couples were given a wider choice.

FUTURE TRENDS IN CONTRACEPTIVE PREVALENCE AND NUMBERS OF USERS

Results from recent projections

As noted above, the United Nations and the Futures Group have prepared projections of the number of contraceptive users and contraceptive prevalence. The main results of these exercises are summarized in Table 1. In 1993, the base year of the UN's projection, the number of users in the developing world was estimated at 436 million. By 2000 this total had grown to an estimated 549 million. Over the next quarter-century the UN expects a further increase of 49 percent to 816 million in 2025. The corresponding regional projections indicate a far larger increase in Africa (254 percent) than in Asia (28 percent) or Latin America (37 percent).

The projections of contraceptive prevalence among married women are presented in panel B of Table 1. For the developing world as a whole the UN estimates prevalence in 2000 at 60 percent (up from 55 percent in 1993), and in 2025 prevalence is expected to reach 67 percent. The current sharp regional differences in prevalence are expected to moderate considerably, with very rapid increases in Africa's prevalence from 29 percent in 2000 to 55 percent in 2025. Smaller increases are projected for Asia and Latin America, reaching 69 percent and 73 percent respectively over the next quarter-century.

Table 1 Projections of numbers of contraceptive users and contraceptive prevalence by region and source

						Percent increase	
A. Number of contraceptive users (million)						2000–	2000–
	Source	1993	2000	2015	2025	2015	2025
Africa	UN	26	47	111	167	135	254
Asia	UN	357	437	544	560	24	28
Latin America	UN	53	65	83	89	28	37
Developing world	UN	436	549	738	816	34	49
	Futures Group		525	742		41	
B. Contraceptive prevalence (percent among women in union)							
	Source	1993	2000	2015	2025		
Africa	UN	20	29	46	55		
Asia	UN	60	64	69	69		
Latin America	UN	66	70	72	73		
Developing world	UN	55	60	65	67		
	Futures Group		58	66			

Note: Asia excludes Japan, Australia, and New Zealand.

Source: UN 1999a and Ross et al. 1999.

The projections by the Futures Group up to 2015 also indicate substantial increases in the number of users and in prevalence. However, the UN and Futures Group differ significantly in a number of key respects. For example, the Futures Group's estimates of the number of users for the year 2000 is lower than the corresponding number for the UN (525 vs. 549 million, a difference of 24 million or 4 percent). The cause of this difference is difficult to pinpoint in the absence of country-specific estimates from the UN, but one of the main reasons appears to be a lower Futures Group estimate of the number of users in China. Another notable difference between the two projections is that Futures expects the number of users to increase by 41 percent between 2000 and 2015, compared to a rise of 34 percent projected by the UN. These results are due to differences in projection methodology, which will be explored further below.

Why the number of users keeps rising

An obvious cause of future increases in the number of users in the developing world is the rise in contraceptive prevalence that presumably will accompany anticipated further declines in desired fertility. Several other variables, however, also affect the future number of users. Specifically, the projected growth in contraceptive users over any time interval in any country is attributable to changes in one or more of the following five factors:

P = Population size

F = Proportion of P that is female aged 15–49

M = Proportion of F that is married/in union

C = Proportion of M that practices contraception (i.e., prevalence)

T = Ratio of all users (married and unmarried) to married users.

The number of users (U) at any point in time is the product of these five factors:

$$U = P \times F \times M \times C \times T.$$

For example, the number of users in the developing world in 2000 is estimated by the UN at 549 million, which equals $4867 \times 0.26 \times 0.71 \times 0.60 \times 1.03$. The corresponding equation for the projected number of users in 2025 is $6609 \times 0.25 \times 0.68 \times 0.67 \times 1.08 = 816$ million. The growth in the number of users from 549 million to 816 million over this 25-year period is therefore attributable to increases in population size, P (from 4867 to 6609 million), contraceptive prevalence, C (from 0.60 to 0.67), and the ratio of all users to married users, T (from 1.03 to 1.08). These trends are partly offset by small declines projected in the proportion of the population female and 15 to 49, F (from 0.26 to 0.25) and in the proportion married, M (from 0.71 to 0.68).

The specific contributions of the factors (P, F, M, C, and T) to future increases in the number of users can be measured by comparing the percent increase or decrease in each over the projection period 2000 to 2025. These estimates are provided in Table 2. For the developing world as a whole, the number of users is projected to be 48.6 percent higher in 2025 than in 2000. This rise is largely attributable to anticipated increases in population size (35.8 percent) and in contraceptive prevalence (12.6 percent). The re-

Table 2 Projected percent change (2000–2025) for components of growth in the number of contraceptive users, by region

	Percent change 2000–2025					
	Population size P	Proportion		Contraceptive prevalence C	Total married T	Total
		female 15–49 F	Proportion married M			
Africa	65.5	10.8	–4.2	85.2	8.7	253.7
Asia ^a	29.5	–5.8	–3.8	9.2	0.0	28.1
Latin America	34.2	–5.0	4.2	4.2	–0.9	37.2
Developing world	35.8	–3.1	–3.9	12.6	4.3	48.6

^aExcludes Japan, Australia, and New Zealand.

Source: Derived from data in UN 1999a.

maining factors F, M, and T have substantially smaller effects (–3.1, –3.9, and 4.3 percent, respectively) and they partly offset one another. This same analysis of the roles of different factors has been conducted separately for Africa, Asia, and Latin America (see Table 2). Future increases in population size and contraceptive prevalence are also the dominant causes of future increases in users in each region. This is especially the case in Africa, where the huge expected increase in the number of users (253.7 percent) is much higher than the average for the developing world. This difference between Africa and other regions is attributable primarily to much more rapid-than-average increases in population size (65.5 percent) and in prevalence (85.2 percent).

A comment on projection methodology

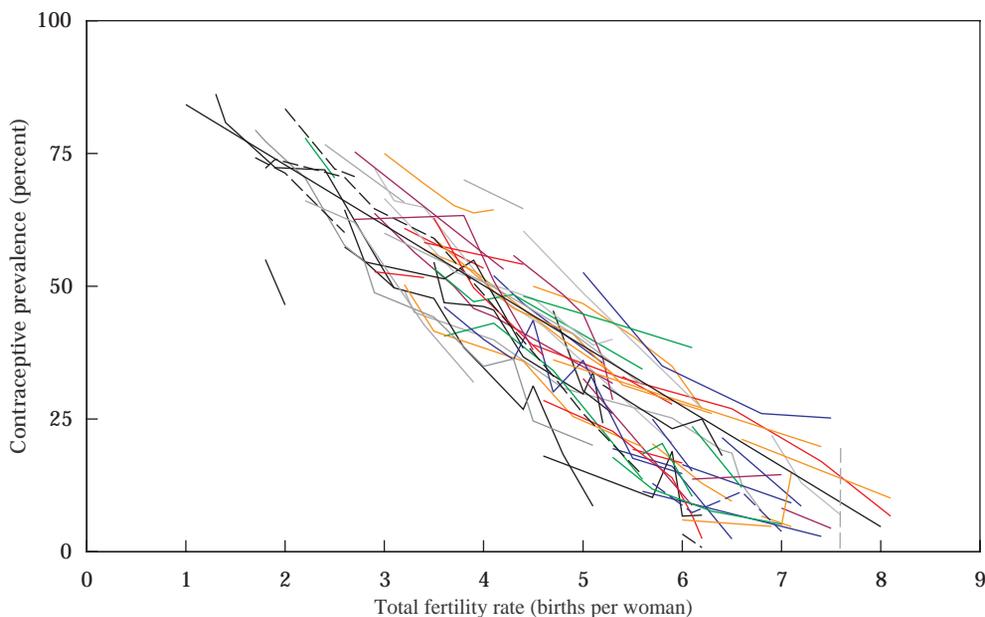
A projection of the future number of users in a population can be made by preparing separate projections for each of the variables P, F, M, C, and T. The procedures employed by the UN and Futures Group for forecasting these factors directly or indirectly are complex but broadly similar. They both rely on the UN’s standard projections of population size and the proportion female and 15–49 (UN 1999b). Estimates of future proportions of women currently married differ slightly (the UN assumes a small decline while the Futures Group holds this proportion constant) and the future trend in the ratio

of total users to the number of married users is similar.¹ However, the two agencies differ significantly in the way future trends in contraceptive prevalence are projected, and a brief comment on this difference is in order.

The UN and the Futures Group both assume that future trends in prevalence can be derived from future trends in fertility and that the level of fertility will change (mostly decline) over time as predicted in the standard UN population projections. Given these assumptions, the question is how to turn a fertility trend that is presumed known into a contraceptive prevalence trend.

The Futures Group's procedure for projecting prevalence trends is based on the well-established close statistical relationship between levels of prevalence and fertility (as measured by the total fertility rate, TFR). Figure 5 plots the relationship for these variables in 98 developing countries. Each line in this figure represents one country and connects the prevalence and fertility levels observed in all past years for which estimates are available in that country. The level of correlation between fertility and preva-

Figure 5 Relationship between contraceptive prevalence and the total fertility rate, by country



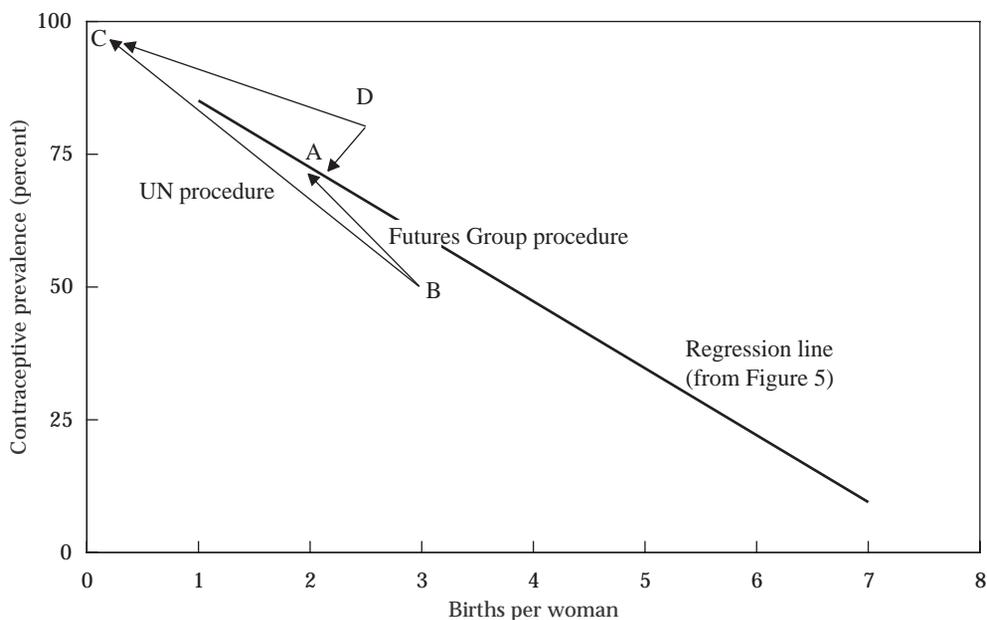
Source: UN 1999a; Ross et al. 1999.

lence is clearly high ($r=0.90$), which is not surprising since the practice of contraception is the main proximate determinant of fertility (Bongaarts and Potter 1983). Variations around the regression line in Figure 5 are due to measurement errors as well as to variations in a number of other proximate determinants that also influence fertility (e.g., the proportion of women in union and the propensity to rely on induced abortion). It is also evident from the figure that the lines representing the different past country experiences generally run parallel to the regression line. This implies that, as expected, a decline in fertility is almost always accompanied by a rise in prevalence. There is some convergence to the regression line as prevalence rises—that is, the variation around the regression line declines at lower levels of fertility. The Futures Group relies on these features to estimate future trends in prevalence from fertility trends.

The key assumption made by the Futures Group is that all countries move over the course of the projection from the level of prevalence measured at the latest post-1980 survey to a prevalence level of 72.5 percent when the TFR reaches 2 births per woman. This endpoint for the projection is located on the regression line and is illustrated as point *A* in Figure 6. For example, a country located at point *B* in Figure 6 in 2000 (TFR=3, C= 50 percent) at the beginning of the projection is expected to move along a linear trajectory toward point *A* (TFR=2, C=72.5 percent) during the projection. In other words, any country that is now located above or below the regression line is expected to be on this line when the TFR reaches 2 births per woman at some future time. The rate at which a country moves along this trajectory over time depends on the trend in the total fertility rate (which is taken from the standard UN population projections). If a country's TFR does not decline to 2 by 2015, it completes only part of the trajectory and prevalence remains below 72.5 percent in 2015.

The UN's procedure is more complex and, among other things, takes into account differences in contraceptive effectiveness. However, the basic principle on which it is based is easily demonstrated for a hypothetical country with an average level of contraceptive effectiveness. The UN assumes that such a country moves over time from its current level of prevalence and fertility toward a prevalence level of 100 percent when the TFR reaches zero births per woman.² For example, a country located at point *B* in Figure 6 in 2000 (TFR=3, C= 50 percent) would move along a linear trajectory toward point *C* (TFR=0, C=100 percent). Since no country is expected to reach zero

Figure 6 Illustrative projected trends in contraceptive prevalence by level of fertility



fertility, only part of the path *BC* is traversed by countries over the next quarter-century. In general, the UN projects a slightly lower future level of prevalence than the Futures Group for countries that are located below the regression line at the beginning of the projection and a somewhat higher trajectory for those that start above this line. Since there are roughly as many countries above as below the regression line, the average trend for the two projections is similar.

For most countries the procedures followed by the two organizations provide plausible projections. The results are generally similar for countries that fall on or near the regression line at the start of the projection. The main differences occur in countries that are near the end of the fertility transition but are still some distance from the regression line (e.g., point *D* in Figure 6). In such cases the Futures Group procedure typically projects a fairly sharp change in the trend (path *DA*) compared with the past, while the UN's projection (path *DC*) represents a smoother transition. The UN also takes into account differences in contraceptive effectiveness and assumes modest improvements in effectiveness over time. These desirable features should improve the accuracy of UN's projections.

FUTURE TRENDS IN CONTRACEPTIVE METHOD DISTRIBUTION

Results from recent projections

The Futures Group is the only organization that makes projections of the distribution of contraceptive methods used by women. According to these projections substantial changes will occur in the method mix by 2015 (see Table 3). For the developing world as a whole, at least a doubling is expected between 1993 and 2015 for the proportion of users relying on the condom (from 4 to 10 percent) and the pill (from 11 to 22 percent). Increases are also expected for traditional methods (from 9 to 14 percent), injectables (from 4 to 6 percent), and vaginal methods (from 0.3 to 0.6 percent). However, substantial declines are forecast by 2015 for the proportion relying on female sterilization (from 39 to 26 percent), male sterilization (from 8 to 3 percent), and for the IUD (from 26 to 18 percent).

Table 3 Estimates of method distribution in 1980 and 1993 and alternative projections for 2015

Method	Past Estimates		Projections	
			Futures Group	New procedure ^b
	1980	1993	2015	2015
Female sterilization	24	39	26	37
Male sterilization	13	8	3	5
Pill	13	11	22	17
Injectables ^a	0	4	6	5
IUD	32	26	18	20
Vaginal	0	0.3	0.6	0.4
Condom	5	4	10	9
Traditional	12	9	14	7
Total	100	100	100	100

^aIncludes Norplant®.

^bSee Appendix for discussion.

Source: UN 1996, 1999a; Ross et al. 1999.

These projections indicate a continuation of past trends (1980–93) for the IUD, male sterilization, and vaginal methods, but for all other methods the Futures Group expects reversals of past trends. Some of these results are surprising, especially the sharp drop in female sterilization and the rise in traditional methods. There are no obvious reasons to expect such large reversals. In our view, these projections are not optimally designed in some respects, and we will propose changes in the projection procedures. Before turning to these methodological issues we briefly describe the factors that might affect trends in method choice.

Determinants of method choice

The mix of contraceptive methods selected by couples who wish to avoid pregnancy will continue to evolve in response to changes in several factors:

Improved access. In many developing countries potential users have a very limited choice of methods. A main reason for this is that program managers often emphasize just one or two methods, largely to reduce costs, thus restricting the user's options in countries where national family planning programs are the dominant source of contraceptive supplies. For example, the copper IUD is inexpensive and provides highly effective contraception for up to a decade. Female sterilization and the pill are also commonly made available through national programs. Regulatory barriers often contribute to limited use of some methods. In a number of countries choice is so limited that the majority of users must rely on a single method. Examples of this situation are the dominance of female sterilization in India, of the IUD in Egypt and Vietnam, and of the pill in Algeria, Morocco, and Zimbabwe. It is plausible to assume that with a general move toward a market economy and greater emphasis on quality of care, the choices available to potential users will increase in the future.

Changing characteristics of users. Knowledge of contraception has increased enormously in recent decades. In most countries women and men are fairly well informed about different methods and their costs, side effects, benefits, and sources of supply. Higher levels of education also have made users more assertive, a trend that should lead to improvements in services. Another important trend with implications for the selection of methods is a continuation of the decline in desired family size. In con-

temporary pretransitional societies women often want large families and, as a consequence, demand for contraception is low and focused on methods for spacing births rather than limiting them. This situation has characterized much of sub-Saharan Africa until recently (Caldwell et al. 1992; Westoff and Bankole 1995). However, as countries develop, desired family size declines and the demand for limiting family size rises sharply. Permanent methods are often used by women who want no more children. Over the next few decades these trends toward lower desired family size and increasing proportions of women who want no more children can be expected to continue. This, in turn, will lead to a high future demand for long-acting methods. In the past these women have often relied on sterilization, but the irreversible nature of this method is an important drawback. There clearly is a need for new methods that are inexpensive, long acting, safe, and reversible.

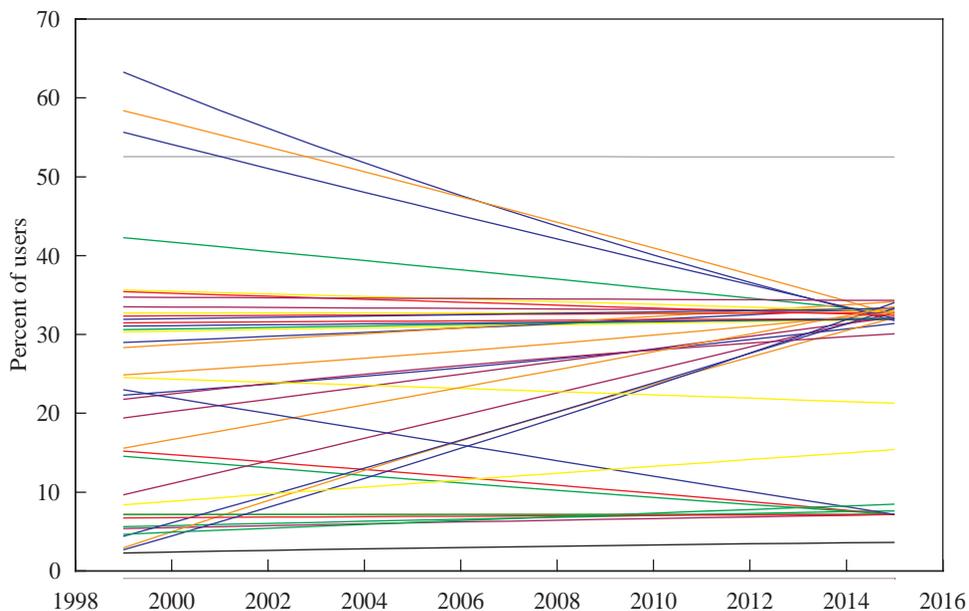
New and improved technology. Among the available methods, users select the ones that are least costly, most convenient, most effective, and that have the fewest health and other side effects. This explains why traditional methods were largely abandoned in the 1960s and 1970s when modern methods became widely available. Around 90 percent of users in the developing world now rely on modern methods, and in most countries the proportion of users relying on traditional methods will no doubt continue to decline. The availability of new and improved technology is likely to lead to further changes in method use in future decades. This topic is discussed in greater detail in the last part of this paper.

Trends in these three general factors will result in future changes in the mix of methods used by couples in the developing world. Although changes will vary from country to country, it is likely that in most countries the dominant methods will become somewhat less prevalent and the other less-used methods will rise in prevalence. It is important to note, however, that such changes typically occur rather slowly.

A comment on methodology

A full discussion of the methodology employed by the Futures Group is beyond the scope of this paper. Instead, we illustrate the main features of the projection procedure for one method—female sterilization. Figure 7 plots the Futures Group’s projec-

Figure 7 Projections by the Futures Group of the proportion of users relying on female sterilization for countries expected to reach low fertility by 2015



Source: Ross et al. 1999.

tions to 2015 of the proportion of users relying on female sterilization for all countries that are expected to complete the fertility transition by 2015. The key feature of the methodology is clear from the patterns in this figure: most countries move from their current level of female sterilization to an average just above 30 percent. In other words, regardless of the current level, each of these countries moves either up or down toward the same level by 2015 (populations still in transition by 2015 move only partway to this endpoint). This pattern applies to a majority of countries, but a second smaller group consisting solely of Muslim countries is assumed to converge to a lower average of around 7 percent. Finally, for a third set of countries, special projections were made in ways that are not specified (see Ross et al. 1999 for details).

How reasonable are these procedures used by the Futures Group? Since the accuracy of projections cannot be assessed a priori, it is not possible to ascertain whether particular assumptions about the future are valid. However, the procedure seems less

than optimally designed. Specifically, while some convergence toward an average can be expected, there is no evidence for rapid convergence in the late 1980s and early 1990s, just as no convergence was seen earlier in Figure 4 for female sterilization. In addition, an inspection of the new projections to 2015 for individual countries reveals some surprising and probably unrealistic future trends that result from this assumed rapid convergence. For example, between 2000 and 2015 the proportion of users relying on female sterilization is projected to decline from 63 percent to 32 percent in India, from 28 percent to 7 percent in Pakistan, and from 15 percent to 7 percent in Bangladesh. Another question is raised by the assumed trends in the role of traditional methods. Although the Futures Group projects declines in the proportion of traditional methods in the majority of countries, it also projects increases for a substantial number. For example, in China this proportion is expected to rise from 2 percent to 17 percent between 2000 and 2015. Such increases seem unlikely. This large projected increase in China and the expected rising proportion of all users who live in Africa (where traditional methods are relatively common) are the main causes of the upward trend in traditional methods projected by the Futures Group for the developing world as a whole by 2015 (see Table 3).

An alternative projection

The preceding comments suggest the following desirable characteristics for a methodology that projects the method mix within countries. First, convergence to a more balanced method mix is likely to occur, but it seems important to allow for considerable inertia. In the past the distribution of methods changed only slowly over time in most countries and the mix at one point in time was highly correlated with the mix 10 or 15 years later.³ In the Futures Group's procedure this correlation largely disappears between 2000 and 2015. Second, countries will not all reach the same method distribution in 2015. A range of historical, cultural, socioeconomic, and other factors have contributed to the preference of some methods over others in the past. Although such preferences might well diminish in the future, they will almost certainly not disappear altogether. Third, there seems to be little justification for using different projection procedures for different groups of countries. Instead, the fact that a country has a particular charac-

teristic (e.g., Muslim) can be considered as one of several factors that lead to current preferences for a particular mix in that country. This preference should be maintained to some degree in the future. Fourth, declines in traditional methods can be expected in the future and this trend should be explicitly acknowledged.

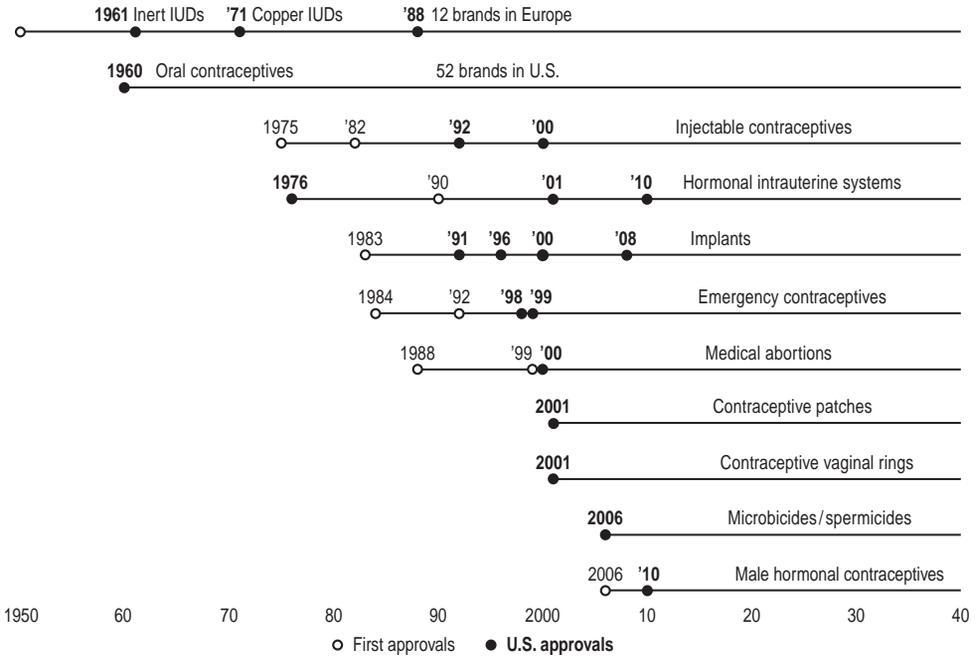
These proposed features have been incorporated into a simple new projection procedure, which we describe in the Appendix. The general approach is one of slow and incomplete convergence toward a more balanced method mix in each country, with uniform reductions in the role of traditional methods. All countries are treated in the same way. The main results of the application of this new methodology are presented in the last column of Table 3. As expected, these alternative projections to 2015 are quite different from those made by the Futures Group. For the developing world as a whole the proportions relying on female sterilization are higher in 2015 (37 percent rather than 26 percent), and the proportions using traditional methods are lower (7 percent instead of 14 percent). Trends for individual countries are also quite different. For example, a more modest decline in female sterilization is forecast for India (from 67 percent to 53 percent rather than to 32 percent), and increases are expected in Pakistan (from 28 percent to 32 percent) and in Bangladesh (from 15 percent to 25 percent) rather than declines to 7 percent. These trends seem plausible, although any projection is subject to potentially substantial errors.

The simple alternative procedure presented here should be considered to be no more than a first step toward a detailed and comprehensive methodology for projecting method distribution. Given the scant attention in the literature to the causes of variation in method mix, it is not clear which refinement would improve the accuracy of these projections. Further methodological developments will no doubt benefit from more in-depth studies of the factors affecting choice of methods in specific countries (see Potter 1999 for an excellent example).

PROSPECTS FOR NEW CONTRACEPTIVE TECHNOLOGY

A new method requires many years to gain general acceptance, because the contraceptive market moves slowly and is conservative⁴ (see Figure 8). For example, the first market approval of a copper IUD occurred in 1971, but almost two decades passed

Figure 8 Time line of the development of modern contraceptives



before the device became the most widely used contraceptive after female sterilization. During this period, the copper IUD was greatly improved both in efficacy and duration of use. A similarly slow evolution has occurred in the case of oral contraceptives. The oral contraceptive available to women worldwide in 2000 is very different from the pill first introduced in the United States in the 1960s. The dosage has been drastically reduced, the steroids used are different, and the greater knowledge of the pill’s biological effects enables providers to counsel users more thoroughly.

From a market perspective, female sterilization and vasectomy differ from the other modern methods because sterilization is not a product provided by any manufacturer. The development of improved surgical methods has reduced the surgical trauma and time required for the procedure. However, the efficacy and safety of sterilization are largely dependent on the skill of the provider and the quality of the institutions offering the supporting services, such as anesthesia, blood supply, and sterilization of the surgi-

cal instruments. The individual user can do very little to improve the outcome of the procedure. Unfortunately, sterilization is sometimes the only long-term contraceptive available.

In most countries, women are increasingly able to choose good alternative contraceptives developed during the last two decades. There are now four long-term reversible contraceptive products that are virtually as effective as female sterilization. Table 4 lists their generic and trade names, protection times, and approximate number of users worldwide.⁵

1) The copper IUD is the most commonly used long-term reversible contraceptive, and the most affordable one ever developed. The cost of the device when bought in large quantities from the manufacturer is very low (around US \$1.00). In fact it is unlikely that any long-term method with such low cost per year of protection will ever be developed again. The IUD with greatest efficacy is the copper T 380A. This method is convenient, but increases menstrual blood loss and menstrual pain. The hormonal methods, on the other hand, reduce these side effects.

2) Norplant[®], the first hormonal implant developed for female contraception, has been found acceptable in most cultures. Having gained approval in 60 countries including the United States, Norplant is effective and safe but requires trained providers for both insertion and removal. Its main disadvantage for the user is unpredictable vaginal bleeding, which, however, tends to be light and is accompanied by little or no pain. A number of new hormonal implant methods are expected to become available in the near future (see Table 5). Jadelle[®] consists of two levonorgestrel rods that offer effective

Table 4 Characteristics of currently available long-term contraceptives

Method	Trade name	Use time	Million users
Copper T 380A	Paragard [®]	10–12 years	30–40
6 levonorgestrel-filled Silastic [®] capsules	Norplant [®]	7 years	8
Levonorgestrel intrauterine system	Mirena [®]	5 years	1
Medroxyprogesterone acetate 150 mg i.m. ^a	Depo Provera [®]	3 months	12

^aBy intramuscular injection

pregnancy protection for up to five years. Jadelle has been approved in the United States and Finland, and wider European approval is pending. Implanon® consists of one ketodesorgestrel rod with proven efficacy for up to three years. Implanon is approved in Europe and Indonesia, while approval in the United States is pending. Nestorone®-one, a single implant that offers protection for two years, is still in the pipeline. It is specially designed for use during lactation and does not affect the nursing infant. A single rod containing gestodene is under development in China, and a norgestrel acetate Silastic® implant (Uniplant®) with a lifespan of one year is pending approval in Brazil.

3) Mirena® is a levonorgestrel-releasing intrauterine system that is highly effective for at least five years. It also provides significant health benefits, including drastic reduction of pain and blood loss during menstruation, as well as reduction in uterine pathology. Menstrual blood loss is reduced by more than 90 percent, an important characteristic for use in developing countries, where anemia is a widespread health problem. Mirena is now widely accepted in Europe after introduction in 1990 in Scandinavia. It is particularly popular among women who are dissatisfied with existing methods and those who are candidates for female sterilization. Mirena may also be used to treat excessive menstrual bleeding and to protect the uterus from the effects of estrogen therapy during and after menopause.

4) Injectable contraceptives are likely to occupy a fairly small niche among contraceptive systems. This category is currently dominated by Depo Provera®, which provides three months of contraception per injection, but longer-lasting systems are in development. A monthly injectable, Lunelle®, has just been launched in the United States

Table 5 Current global development status of implants for contraception

Name	Number of implants	Use experience	Approval status	Effectiveness (years)	Sponsor
Norplant®	6	10 million	60 countries	5–7	Schering AG, Wyeth
Jadelle®	2	studies	US, Finland	3–5	Schering AG, Wyeth
Implanon®	1	studies	Europe, Indonesia	2–3	Organon
Nestorone®-one	1	studies	phase 3	2	Population Council
Uniplant®	1	studies	pending in Brazil	1	South-to-South

and is quite popular in Mexico. Lunelle is the only injectable contraceptive associated with a predictable bleeding pattern.

Long-term hormonal contraceptive use is likely to grow in the future. Mirena is being introduced in developing countries, and the monthly injectable is already popular in Latin America. Within our time frame (2015), cost will be a limiting factor for widespread use of hormonal contraception in developing countries. However, with extensive use in the developed world, the cost is likely to decrease. The popularity of these contraceptives will also depend on a shift in attitude toward changes in menstrual bleeding patterns. Long-term hormonal methods reduce menstrual blood loss—for example, by 50 percent with the use of Norplant (Fraser et al. 2000) and by more than 90 percent with Mirena (Andersson and Rybo 1990)—and in some women monthly bleedings are eliminated altogether. In northern Europe, women's attitudes regarding menstruation are changing rapidly. Even among young women, menstrual bleeding is considered a nuisance (den Tonkelaar and Oddens 1999). Educated women have also learned that the monthly bleedings produced by oral contraceptives have nothing to do with the normal menstrual cycle because they are caused by the discontinuation of the pill. The timing of these bleedings, therefore, may be manipulated at will. Women in Europe also realize that the collecting of menstrual blood is a cumbersome procedure that limits their mobility and social life (Kristjansdottir et al. 2000). However, the liberation of women from the burden of menstruation will likely be slow—following improvements in education and in the availability of methods that reliably suppress bleeding. Predictability will be the main selling point. Unfortunately, most currently available methods generally offer poor predictability for women.

Other hormonal methods now under development are expected to become available in the next decade. Hormonal contraception will soon be available in the form of patches, utilizing the transdermal route of administration with a mode of action similar to that of oral contraception. A weekly patch is likely to improve compliance, the lack of which is the main drawback of oral contraceptives. In the foreseeable future, women will be able to choose vaginal rings that provide hormonal contraception in much the same way as oral contraceptives, but without the first-pass metabolic effects on the liver that occur with oral delivery. In clinical trials vaginal rings give excellent bleeding control and are well accepted by women.

Emergency contraceptives in the form of hormones or copper IUDs will be widely used in the future. Copper IUDs are very effective in preventing a pregnancy up to five days after unprotected coitus. Hormonal tablets are less effective and should be taken as soon as possible after coitus. In the next decade specially designed emergency contraceptives will be on the market; these new products will be more effective and will have fewer side effects. Widespread availability and use of emergency contraceptives are likely to reduce the need for induced abortions.

We expect that medical abortion will become much more widely available within a few years. Mifepristone in combination with misoprostol is now widely used for medical abortion in China. Mifepristone was approved by the French government in 1988, by the European regulatory agency in 1999, and by the FDA in September 2000. It will be distributed in the United States under the trade name Mifeprex[®]. Medical abortion with these substances is safe and will greatly reduce mortality and morbidity associated with both induced and spontaneous abortions in developing countries.

Vaginal microbicides that protect women from sexually transmitted infections, including HIV, are high on the list of needed products. Many such compounds are in early development, but none to date has entered efficacy trials. Microbicides could be combined with spermicides to have a contraceptive effect as well. Microbicides will provide greater protection for women, many of whom currently have to negotiate condom use with their sexual partners.

Research on the development of male hormonal contraceptives has accelerated recently and several methods are in the late stages of development. Aside from birth control, hormonal contraceptives may provide other health benefits in men, as hormonal contraceptives do in women. Acceptability, however, is likely to vary widely among societies, as is the case with female contraceptives.

CONCLUSION

The number of users of contraception in the developing world is expected to rise from 549 million to 816 million over the next 25 years according to the most recent UN projection. An examination of the projection methodology found it to be reasonable. The two main factors driving this increase were identified as the growth in population size (and hence the number of women of reproductive age) and the rise in the contracep-

tive prevalence level that will accompany further declines in fertility. The rate of growth in users will be much more rapid in Africa than in Asia or Latin America, because growth in both factors will be higher in Africa than elsewhere.

Projecting the future distribution of specific contraceptive methods is more difficult. Method choice is affected by trends in several factors, including access to different methods, user characteristics, and technology. In addition, the health effects of contraceptives will become a more important consideration to women and men in the future, because contraceptives will be used during a large proportion of the reproductive years. We expect the mix of contraceptives to change slowly over the coming years. No new product currently in development will radically alter the prevailing pattern. However, a gradual increase in availability of a wider range of methods is likely as the quality of services is improved, as markets for contraceptives become more open, and as levels of contraceptive knowledge and education rise. This should result in a greater variety of contraceptives in use and a more balanced distribution among different modern methods. These trends will likely favor new hormonal contraceptives, especially if their cost can be reduced, and diminish the current heavy reliance on female sterilization.

APPENDIX: AN ALTERNATIVE METHODOLOGY FOR PROJECTING METHOD MIX

We employed the following procedure to project the distribution of contraceptive users by method from the date of the latest available survey to 2015. First, the (unweighted) average method mix for countries with contraceptive prevalence exceeding 65 percent was calculated to represent the typical pattern at the end of the fertility transition. This produces the following percent distribution:

Female sterilization	Male sterilization	Pill	Injectables	IUD	Vaginal	Condom	Traditional	Total
30.0	3.2	19.8	3.4	16.0	0.5	11.8	15.3	100.0

Next, the target distribution in 2015 for each country is determined by averaging the observed distribution at the time of the most recent survey and the above typical pattern. Finally, each country is moved along a linear trajectory from its current mix to

its target mix by 2015.⁶ This procedure is followed for each method except traditional ones; their proportion is assumed to be reduced in all countries to one-half the most recently observed level by 2015, with linear interpolation for intervening years. The proportions projected with this procedure are adjusted proportionally to ensure they add to 100 percent.

This procedure differs from the one used by the Futures Group in that the rate of convergence in the method mix over time is much slower (by about half on average), method mixes vary much more among countries in 2015, all countries are treated in the same way, and proportions of users relying on traditional methods are reduced in all countries.

To test the accuracy of this new methodology, we used it to prepare a projection from the late 1970s to the early 1990s for each of 31 countries. The latest available survey before 1981 provided the baseline data and the method mix was projected forward from that base to the date of the latest available survey (mostly in the 1990s). Two sets of projections were made, one with the new procedure and the other with the Futures Group's methodology. A comparison of the projected method mix with the observed mix provided a measure of the accuracy of the two approaches. With the new approach the average error in the 31 countries between the projected and observed proportions using a method ranged from 9.5 percentage points for the pill to 2.0 percentage points for male sterilization, averaging 5.6 percentage points. The comparable errors for the Futures Group procedure were similar in magnitude, averaging 5.5 percentage points. Although the new procedure is not more accurate in projecting past trends than the Futures Group's procedure in the average country, it is simpler to apply. More importantly, it avoids some large and, to us, implausible changes in method mix projected for 2015 in several of the largest countries in the developing world, including China, India, Bangladesh, and Pakistan.

Notes

- 1 The value of T is actually not projected independently in most countries because where data on prevalence among all women are available from surveys they are used directly. The future trend in T is then calculated as the ratio of the projected number of all users to married users and it is not the result of explicit assumptions about T.

- 2 The projection equation used by the UN simplifies to $TFR_1/TFR_2=(1-u_1)/(1-u_2)$ if contraceptive effectiveness is assumed to equal the average level of 93 percent (UN 1999a). In this equation TFR and u represent, respectively, the total fertility rate and contraceptive prevalence, and the subscripts 1 and 2 refer to the beginning and end years of the projection.
- 3 The correlation between the proportion of users of a particular method in the latest survey before 1981 and the same proportion in the latest available survey (mostly in the 1990s) for the different methods ranged from 0.90 for female sterilization to 0.46 for the IUD, averaging 0.68.
- 4 Figure 8 gives past and estimated future dates of approval by the US Food and Drug Administration (FDA), together with the date of first launch of a product in the given category. FDA approval has global consequences, not only because of the high quality of the approval process, but also because the US Agency for International Development can purchase only FDA-approved products for distribution in developing countries.
- 5 These products, with the exception of Depo Provera, were originally developed by the Population Council.
- 6 No specific assumptions are made about trends beyond 2015, but it seems unlikely that they will continue along the pre-2015 trajectory.

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