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Europe the continent with the lowest fertility

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INTRODUCTION: Although fertility rates are falling in many countries, Europe is the continent with the lowest total fertility rate (TFR). This review assesses trends in fertility rates, explores possible health and social factors and reviews the impact of health and social interventions designed to increase fertility rates.

METHODS: Searches were done in medical and social science databases for the most recent evidence on relevant subject headings such as TFR, contraception, migration, employment policy and family benefits. Priorities, omissions and disagreements were resolved by discussion.

RESULTS: The average TFR in Europe is down to 1.5 children per woman and the perceived ideal family size is also declining. This low fertility rate does not seem directly caused by contraception since in Northern and Western Europe the fertility decline started in the second half of the 1960s. Factors impacting on lower fertility include the instability of modern partnerships and value changes. Government support of assisted human reproduction is beneficial for families, but the effect on TFR is extremely small. Government policies that transfer cash to families for pregnancy and child support also have small effects on the TFR.

† The list of ESHRE Capri Workshop Group participants are given as appendix.

CONCLUSIONS: Societal support for families and for couples trying to conceive improves the lives of families but makes no substantial contribution to increased fertility rates.

Key words: fertility / infertility / contraception / ART / postponed childbearing

Introduction

Virtually, all European countries have reached the final stage of demographic transition characterized by low fertility and high life expectancy (Lutz, 2006). The demographic transition from the steady state of high mortality and fertility rates found in Europe during the nineteenth century began with declining mortality rates resulting in a rapid increase of the population, followed by a reduction in birth rates during the twentieth century, as the population continued to increase (Fig. 1). Population growth provides a favourable structure for economic growth because there is a consistent expansion of the number of young adults entering the working population in relation to aged dependants. The rapid fall in total fertility rate (TFR) during the first stage of the demographic transition, and the more recent fall in mortality rates over age 60 years, has caused concern that the increasing ratio of ageing dependants to wage-earners will inevitably lead to economic decline. As life expectancy continues to rise, it has been calculated that about 30% of the population will be older than 65 years by 2050 (Population Division, 2005). Since it is unlikely that a modern democracy would willingly revert to the conditions of higher old age mortality or limit future increases in life expectancy to halt population ageing attention has therefore focused on fertility rates. Despite a recent small upward trend in some countries, fertility rates have been declining since the 1970s in Europe (Myrskylä *et al.*, 2009). In the absence of biological causes explaining the reduced fertility, it is necessary to understand the components of the decline. In essence more couples are not having children, or they are having fewer children, or couples are delaying childbirth until the woman is beyond her most fertile years (The ESHRE Capri Workshop Group, 2009). The factors which influence these decisions and lead to lower fertility rates are complex and probably vary from country to country. Western countries have undergone variable economic expansion, marriage is no longer essential to family life, fewer people adhere to religions that encourage large families, tertiary education is more available for men and women and women are now more likely to be employed outside their home (Lutz, 2006; Gauthier, 2007; Rychtarikova, 2007). Countries also have different positions on family-friendly social and health policies, such as support for having children, paid parental leave and easily accessible advanced treatment for infertility (Bjorklund, 2006; Hoorens *et al.*, 2007).

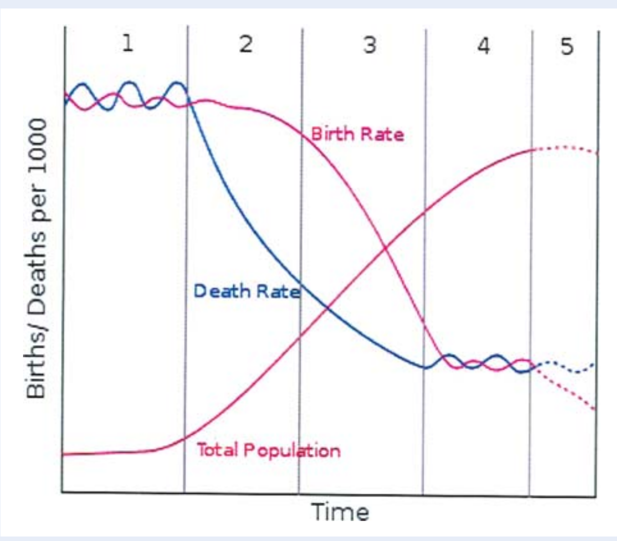

Figure 1 Schematic illustration of the different stages of demographic transition (Mateos-Planas, 2002).

Aside from the impact of an ageing population on the economics and burdens of society (Christensen *et al.*, 2009), several important questions are relevant to reproductive medicine. Why has fertility declined? What are the most likely future trends? Can country-wide policies have an impact on fertility? These complex questions have been studied by many disciplines, including demography, economics, psychology, epidemiology, sociology and anthropology, leading to a diverse literature. The existing literature includes surveys of individuals and families, European and world surveys of changing attitudes and values, and studies of economic, employment and demographic statistics within countries and across countries. Many of the findings are supported or explained by well-constructed theories that may help to assess whether specific social policies might have an impact on fertility rates (Neyer and Andersson, 2008).

The goals of this review are to summarize the literature on declining fertility from the viewpoint of the specialist in reproductive medicine. To do so and also provide an indication of potential future trends, it has been necessary to select relevant studies from the wide literature, and to forgo much of the rich discussion on theories that may help to explain the trends and impacts of interventions. The questions that we hope to address are the following. How well do health, economic, social, psychological and other factors explain the demographic trends in declining childbirth? Were reproductive factors such as contraceptive availability involved in the fertility decline? Would support for assisted reproduction technology (ART) reverse declining fertility? What is the estimated impact of family-friendly health and social benefits?

Methods

Searches were done in MEDLINE, EMBASE, Social Sciences Citation Index and Sociological Abstracts by individual subjects: fertility rate, TFR, delayed childbearing, contraception, (assisted reproductive technologies AND age), migration, cross-border reproduction, employment policy and family benefits. The selection criteria were: (i) studies relevant to Europe; (ii) studies relevant to reproductive medicine and (iii) the most recent studies published where choices existed. Each subject summary was presented to the Workshop Group where priorities were determined and omissions or disagreements were resolved by discussion.

Trends in European fertility

This section will describe some terms that are relevant to changes in fertility, summarize recent trends in fertility in Europe and outline some of the theories that may account for the changes in fertility during recent years.

Terminology

Age-specific fertility rate is the number of births per individual within a specific age interval during a specified time, usually 1 year. The pattern of age-specific fertility rate takes the form of a (somewhat skewed) normal curve which rises from near zero at 15 years to peak at around 0.10–0.15 births per woman per year in the early 1930, and falls to near zero around 47 years. The TFR is calculated as the sum of these age-specific fertility rates of a current year (a period indicator of fertility) which is not identical to the fertility levels of actual birth cohorts of women. Cohort fertility rate is the sum of the age-specific fertility rates that actually apply to each birth cohort (e.g. 1950–1954) as they age through time. The TFR is a problematic measure of fertility since it is subject to tempo distortions resulting from changes in the mean age of childbearing. During times of postponement of childbearing, the TFR is lower than the corresponding cohort fertility. Under current mortality conditions, the average fertility level needed to maintain population size in the absence of migration is slightly below 2.1 children per woman (accounting for childhood mortality).

Trends in fertility

In 2005, the European TFR was only 1.31–1.50 in 15 countries and less than 1.30 in 10 countries (Frejka and Sobotka, 2008). Most recently, the TFRs have slightly increased in some of these countries which can partly be attributed to a reduction of the distorting tempo effect. Fig. 2 shows estimates of tempo-adjusted fertility rates for Europe which are generally higher than the TFRs because the depressing tempo effect has been eliminated. There is a distinct contrast between the highest rates (over 2.0) in Denmark, France, Iceland, Ireland, Norway and Turkey, which are mainly in western and northern Europe, and the lowest rates less than 1.54 mainly in southern and eastern Europe (Belarus, Greece, Italy, Russia, Spain and the Ukraine, for example). Thus, rates in some countries approach the replacement level while other countries fall far below replacement levels. It is challenging to determine whether these differences can be attributed to any country level factors.

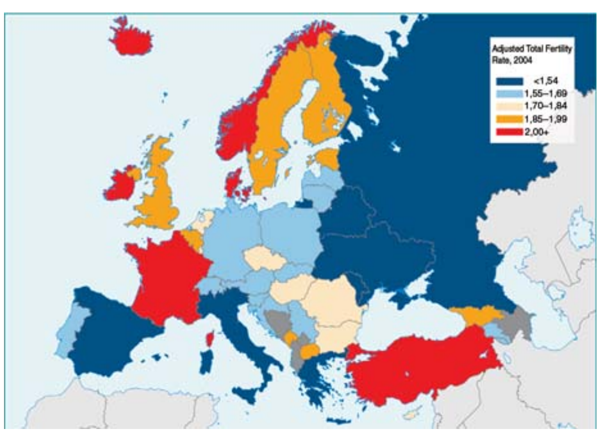

Figure 2 Adjusted total fertility rate (TFR) for European countries (Lutz *et al.*, 2008b). (The values have been adjusted for the tempo effect arising from postponement of childbearing which depresses the values of the conventional period TFR) The lowest fertility rates in 2004 were registered in Eastern Europe, Italy, Greece and Spain.

Recent trends show a small increase from 1998 to 2008. Eurostat data on TFRs in 32 countries show that there has been an overall increase in the TFR during that period of time (http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main_tables). Weighted by 2005 population, the average TFR in these 32 countries was 1.46 in 1998 and 1.59 in 2008, still well below replacement levels. This overall trend may reflect a tempo effect, as noted above, although the duration of the trend is now more than 10 years. Only nine countries had lower TFRs in 2008 than 1998 of which the largest were Germany, Poland, Portugal and Slovakia. Countries showing the largest increases in TFR were those that began with TFRs below 1.3. These countries were Bulgaria (1.11–1.48), Czech Republic (1.16–1.50), Estonia (1.28–1.65), Slovenia (1.25–1.53) and Spain (1.16–1.46). One exception was Sweden, where the TFRs were 1.50 and 1.91 in 1998 and 2008, respectively. The rising TFRs may reflect different influences which are difficult to identify in cross-country data: making up for part of previously postponed births, improved family living conditions in former eastern bloc countries and, in Sweden, possibly directed social policies (Goldstein *et al.*, 2009). The small recent upward trend has not reversed the overall decline in TFR since the 1970s (http://epp.eurostat.ec.europa.eu/portal/page/portal/population/data/main_tables).

Theoretical considerations

Changes in fertility rates may reflect (i) secular events such as changes in the availability of contraception and new legislation about abortion (Atoh, 2001), or (ii) economic factors affecting education, employment and family life (Gauthier, 2007), or (iii) changes in the attitudes and cultural values of men and women (Hakim, 2010). With regard to the first category, legislative events seem unlikely to account for fertility changes that swept Europe, given the political and social differences among the European countries. Whether there is an impact from secular trends in contraceptive availability is discussed in the next section. Economic factors and socio-cultural trends may not be easily disentangled, and are very likely to be insufficient explanations of the sweeping change in fertility during the last part of the twentieth century (Bjorklund, 2006). The main theories that are relevant to this general discussion are outlined in the following paragraphs.

Economic theories about declining fertility postulates that with increased women's educational attainment, more employment opportunities and higher wage levels, the opportunity cost for childrearing also would rise and women would prefer employed labour to childcare (Vikat, 2004). Thus, fertility depends on the economic cost and benefits of children, which might differ among income levels (Gauthier, 2007). In the economic model, reducing the cost of children by means of government policy would increase the demand for children (Englehart *et al.*, 2004; Bjorklund, 2006). Policies might include child and family cash allowances, tax relief for the number of children in a family, subsidized childcare and parental leave benefits. Such policies theoretically would increase fertility by reducing the cost of having children or by increasing family income (Gauthier, 2007; Duvander *et al.*, 2010). Among the weaknesses of the economic model are the attendant assumptions that potential parents have sufficient knowledge of the economics of having a child, and that they make economically rational decisions about childbearing (Vikat, 2004; Gauthier, 2007).

Socio-cultural theories postulate that changing individual values rather than economic factors are primary determinants of the decline in fertility rates. In this concept, the Second Demographic Transition reflects a process of value change regarding personal goals, relationships, family formation and adherence to religion (Lutz, 2006). Temporal changes in a broad range of values have been documented in the cycles of the European Values Study (Halman and Draulans, 2006; Kalmijn and Kraaykamp, 2007). In this socio-cultural setting it is possible that lifestyle preferences and values are the principal determinants of women's fertility choices and outcomes. The Preference Theory holds that cultural factors are the key behind the recent changes in family and fertility that have occurred in modern industrialized societies (Hakim, 2010). Preferences also contribute to decisions made by men, but attitudes play a stronger role among women because women are more directly affected by the balance between employment and home-making (Vitali *et al.*, 2009). The Preference Theory envisions three different types of women: family oriented women (10–30%), adaptive women (40–80%) and career-oriented women (10–30%) (Hakim, 2010). Survey results confirm an association between preferences and actual fertility, although the association with intended fertility was not consistent (Vitali *et al.*, 2009).

Reproductive factors as possible causes of reduced fertility

Contraceptive use

Very low birth rates in Europe in the twentieth century were experienced during the 1930s depression, with fertility increasing after the end of the Second World War resulting in the 'baby boom' of the 1950s and 1960s. Since then there has been a steady decline in TFRs, as well as cohort fertility throughout Europe with many in populations in southern and eastern Europe well below replacement level (Population Reference Bureau, 2007) (Fig. 3).

It is doubtful that any of these trends are directly related to the availability of contraception (Leridon, 2006). Throughout modern Europe, contraceptive prevalence is very high and the variation in the range of methods used appears to be related to cultural and marketing factors but has little influence on the overall fertility. For example, in both France and UK a wide range of contraceptives is available free or at little cost to the individual. While 17% of British couples use condoms and 22% the pill, in France the corresponding figures are 8 and 46% (Bajos *et al.*, 2003; Taylor *et al.*, 2006). There are even more striking differences in the use of sterilization (5% of women and <1% men in France, versus >20% of men and women in UK). There is a corresponding increase in the use of IUDs in France (8%). In spite of these differences in type of contraception,

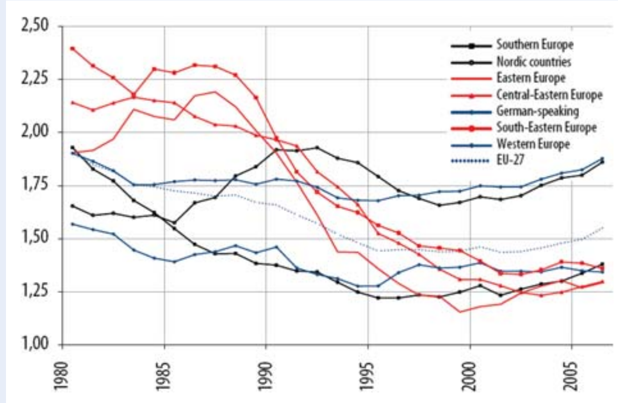

Figure 3 Changes in the TFRs (period TFRs) observed in Europe in the last 30 years (Lutz *et al.*, 2008b). (As discussed in the text some of the declines—in particular the steep declines in Eastern Europe around 1990—as well as some of the recent recovery is due to changes in the tempo effect on the period TFR).

the TFR and incidence of unplanned pregnancy are similar (United Nations, 2007, 2009).

Outside Europe, there is convincing evidence from less developed countries that the reduction in TFR which occurs in Stage 2 of the demographic transition is accompanied and facilitated by an increased prevalence of the use of modern contraceptive methods and abortion (Cleland *et al.*, 2006). The difference is that contraceptive prevalence in these countries was not high initially; moreover, it seems likely that high contraceptive prevalence will reduce the number of unplanned pregnancies in those countries (Leridon, 2006).

Reduction in fecundity

There is little evidence that the decline in TFR is related to an overall increase in the incidence of infertility due to specific causes. A prominent reason for reduced fertility is the age-related decline in the number and quality of eggs as women in all European countries wait longer to have their first birth (Lutz, 2006). Thus, the reduction in fertility is due initially to individual and social factors rather than biological parameters such as oocyte number and quality.

Influence of lifestyle choices on fertility rates

The reduced desire for children

Both fertility rates and the perceived ideal family size have been declining in many countries (Billari *et al.*, 2006; Coleman, 2007; Lutz, 2007; McDonald, 2007; Testa, 2007) and fertility rates are falling because couples are choosing to remain childless or to have fewer children (The ESHRE Capri Workshop Group, 2009).

With respect to not having children, childlessness in the UK doubled from the birth cohorts of 1940–1960: 1 in 10 women born in 1940 reached the end of their reproductive life without a child compared with one in five women born in 1960 (Berrington, 2004). In pre-1950 European birth cohorts, not being married was the predominant reason for remaining childless, while in later birth cohorts many women remained childless even though they were in stable partnerships (Keizer et al., 2008). In the UK again, the percentage of childless women who intended to have no children was 5% among those who were age 18–20 in 1980 and rose to 9% in women of the same age in 2000 (Smallwood and Jefferies, 2003) and to 50% at age 34 (Proudfoot et al., 2009). Among 1940 female Finnish university students in 2004, the stated desire for no children increased from 10% if less than 30 years of age to 17.5% in the minority who were 30–34 years of age (Virtala et al., 2006). The family size wishes of men have also changed over time: in 1990 50% of young Austrian men and women aged 16–24 said that it was very important for a couple to have children; the percentage answering in this way had fallen to 27% in 2000 (Goldstein et al., 2003). In men, higher education reduces the likelihood of childlessness, in contrast to women (Sobotka and Testa, 2008). Among 2867 Dutch women aged 40–79 years educational attainment and a stable career increased the likelihood of remaining childless (Keizer et al., 2008). This condition can only be changed if women get the opportunity to have children earlier without being socially prejudiced (Esping-Andersen, 2002).

A second factor contributing to falling fertility rates is that couples want fewer children. Although the number of families with one child has not changed in the UK, fewer families have four or more children (Simpson, 2007). Family size is primarily determined by personal choices related to education, income, political stability, the (im)possibility of combining paid work with a family and whether or not a woman meets an appropriate partner in time (Blossfeld, 1995). Although the average desired family size is steadily decreasing in Europe (Billari et al., 2006), it remains true that a majority of women and men may still desire two children (rather than zero, one or more than two) (Virtala et al., 2006). Among Finnish students, more than 50% of men and more than 40% of women reported two children as their ideal family size. A higher proportion of men and women wanted three or more children than the numbers wanting zero or one combined (Virtala et al., 2006). Thus, there is a gap between family wishes and realized fertility, a gap which may reflect the difference between ideal and real life wishes about family size (Philipov, 2009).

To explain the tendency towards smaller family size, the 'low fertility trap hypothesis' (Lutz et al., 2006) assumes self-reinforcing mechanisms leading to a bifurcation in trends among industrialized countries. While countries which are at or only slightly below replacement level fertility can expect rather stable levels, those that have been well below replacement for longer periods would enter a downward spiral of birth rates due to negative population momentum, declines in ideal family size among younger cohorts as a consequence of being socialized in a low fertility setting, and worsening relative income of young couples as compared with their parents. While some recent data support this hypothesis, more rigorous testing is needed.

In some parts of Eastern Asia, fertility levels are even lower than in Europe. The 20 million people living in Shanghai have a TFR below 1 and recent surveys seem to indicate that this low rate corresponds to low family size desires (Nie and Wyman, 2005). After decades of a one-child policy, young women state that they have never seen a couple with more than one child and that they simply cannot imagine that anybody would want to have more than one child—although now in Shanghai the government would allow them to have more than one child. This is an illustration of the Low Fertility Trap Hypothesis (Lutz et al., 2006), though it cannot be generalized.

Delayed childbearing

Delaying childbirth means that more couples reach the end of the woman's reproductive career without having attained their desired family size and is another obvious factor contributing to falling fertility rates (Broekmans et al., 2009). Couples have been forming partnerships and marrying at later ages beginning in the early 1980s, in part because of more available tertiary education and rising age at completion of education (Buckles, 2008). With later partnerships, average age at birth was also delayed, beginning in the early 1980s in European countries. By 2000, the age at first birth in most European countries was 28–29 years, compared with 24–25 years in the early 1970s. Even in Central and Eastern Europe, where women used to have children at an earlier age, the trend to postpone is strong (Fig. 4). Nevertheless, delayed childbirth alone is not sufficient to reduce fertility rates: in France despite the average high age at first birth, fertility rate remains close to the 2.1 replacement value (Frejka and Sobotka, 2008).

The factors in delayed reproduction identified in country studies include the instability of modern partnerships, declining ideal family size, higher population density and pressure from globalization of business to relocate without regard to partnerships (Lutz, 2006). Studies at the level of individuals, however, give a different impression of the reasons for late reproduction. In a couple level analysis where the women were in their 1930s in the British Household Panel Study, those who had a partner and were in the highest earnings quartile were most likely to have a birth during the next 6 years (Berrington, 2004). Among women more than 33 years of age who planned to conceive, 74% gave reasons to do with their relationship(s) as the most common reason for delay, 52% had other distractions in life and only 34% delayed because

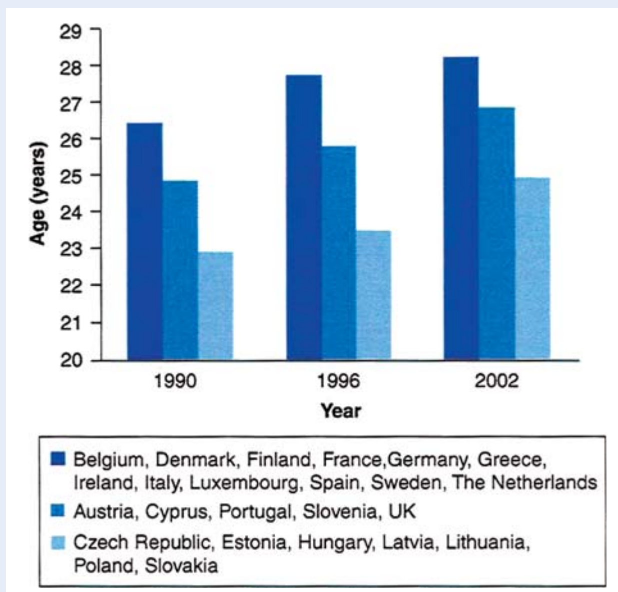

Figure 4 Mean age of European women at first childbirth according to the data of Rychtarikova (2007) (Crosignani, 2009). Country grouping is based on hierarchical cluster analysis.

of work or training issues (Proudfoot *et al*., 2009). Other studies report additional factors such as more available education (Blossfeld and Huinink, 1991), the rise in women's employment and insufficient institutional support for families (Keizer *et al*., 2008).

Thus, there are different reasons for couples to delay childbirth to a later age when the woman's fertility will be lower, but their individual decisions appear to reflect complex cultural, demographic and economic trends while the impact of these trends differs according to socio-economic status and by country.

Inadvertent loss of fertility caused by postponed reproduction

In the so-called natural fertility populations in which no birth control is practised, fertility starts to decline from age 30 onwards or earlier. On the basis of such historical cohorts, the time required to conceive a child increases with age; also the risk of infertility is higher for older women (Menken *et al*., 1986). Data derived from the National Survey of Family Growth demonstrate that 1-year infertility rates increased from 6% in the below 24 age group to more than 30% in the 35–44 year group (Abma *et al*., 1997). The mean monthly probability of conception leading to live birth was found to remain optimal until age 31 and to progressively decrease thereafter. At age 35, it dropped to one-half and at age 38 to one-quarter of that in women of 30 or younger (van Noord-Zaadstra *et al*., 1991). From natural fertility populations, we also know that age at last childbirth which marks the end of female fertility, comes to an end on average at 40–41 years of age; thus sterility starts about 10 years earlier than age at menopause.

These median ages hide considerable variations among women, but inspite of the variability, the almost equal distributions of age at last child birth in natural populations (Bouchard, 1989), the transition from cycle regularity to irregularity (den Tonkelaaret *al*., 1998) and age at menopause (Treloar, 1981) suggest that individual women also experience a 5 year difference between the end of fertility and the onset of cycle irregularity, and a 10 year difference between their last fertile year and age at menopause (te Velde and Pearson, 2002; Lambalk *et al*., 2009) (Fig. 5).

These biological and behavioural factors have been combined in a micro simulation (Monte Carlo model) (Leridon, 2004). The model shows that postponing pregnancy does increase the risk of failing to produce a live birth (Table I).

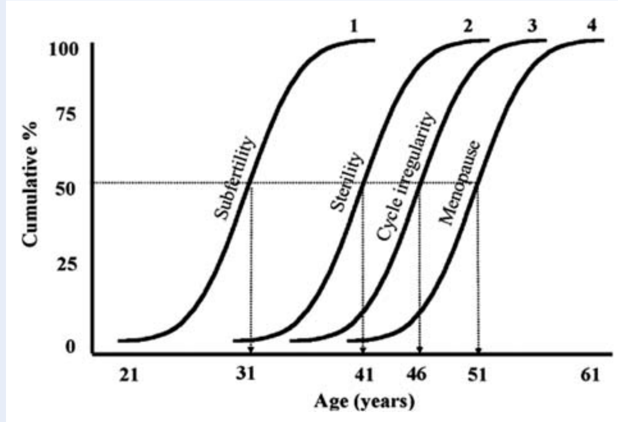

Figure 5 The distributions of age at the onset of subfertility (curve 1), at occurrence of natural sterility (curve 2), of cycle irregularity (curve 3) and of menopause (curve 4) according to the fixed interval hypothesis of te Velde and Pearson (2002) (Lambalk *et al*., 2009). The fixed interval hypothesis assumes that the ages of the onsets of declining fertility, sterility, cycle irregularity and menopause are determined by the ovarian aging process from fetal life until menopause. The cumulative ages of these events, therefore, show the same variation as ages at menopause with the same time intervals in between. Median ages for these events are depicted on the X-axis. Curve 4 is based on data by Treloar (1981), curve 3 is based on data from den Tonkelaar *et al*. (1998), curve 2 is based on data on last child birth in a nineteenth century natural fertility population (Bouchard, 1989) and curve 1 is a hypothetical construct based on the age distribution of related reproductive events as depicted in curves 2–4.

Table I Expected natural conception rate (%) ending in live births according to the age and the length of coital exposure (Leridon, 2004).

	Starting age (years)		
Length of exposure (months)	**30**	**35**	**40**
12	75	66	44
48	91	84	64

Can ART contribute to higher fertility rates?

The availability of ART may foster delay of childbearing because many couples are inclined to think that it will solve any fertility problems they might encounter in the future (Gillan, 2006). The result of delaying childbirth is that more couples are infertile and more women aged 40 or more need ART procedures (Andersen *et al*., 2006, 2008). If ART can help those who postpone births to the period of lower fertility, will widely accessible ART also increase fertility rates?

Some authors (Hoorens *et al*., 2007; Ziebe and Devroey, 2008) have argued that ART 'does have a potential to contribute to TFR and influence population structure' and that the costs necessary to do this are comparable to those of existing governmental pro-natalist and pro-family policies. These reports, favourable to ART, however, overestimate the effectiveness of ART and they ignore spontaneous pregnancies that have been shown to occur before and after access to ART (Collins *et al*., 1995; Osmanagaoglu *et al*., 2002; Hunault *et al*., 2005; van der Steeg *et al*., 2007). The favourable reports also assume a systematic use of ART techniques after only 12 months of infertility (underestimating the psychological and medical costs for the women), and they ignore the burden of multiple pregnancies and the effects of premature birth throughout childhood.

The true effect of ART on TFRs is difficult to assess because numerous biological and behavioural factors must be taken into account. The biological factors include the declining success of ART with female age (Lintsen *et al*., 2007), and the likelihood of miscarriage in ART cycles. Also, the heterogeneity in fecundability induces a selection process: women who need ART because they have not yet conceived after a period of exposure have, on average, lower fecundability.

The behavioural factors include the age at which women start being voluntarily exposed to conception, the duration of use of contraception and the prior effectiveness of this practice (women with higher fecundability are more likely to conceive involuntarily during this period). Other behavioural factors include the number of desired children, and the number of months a couple will wait to ask for infertility treatment.

The impact on fertility rates can be estimated by setting the parameters to the current situation in a country like France, where cohort fertility is close to 2.0 children per woman and the mean age at first pregnancy attempt is around 25 years (Table II). ART adds about 0.05 points to the TFR in the French model. In Denmark, where ART utilization is high, ART fertility was estimated to contribute an absolute net effect on the cohort TFR among the cohort of 1975 at between 0.049 and 0.079 (Sobotka *et al.*, 2008). It is worth noting that even in Demark, only 3.9% of national births are children born after ART procedures (Schmidt, 2006). In 2002, if the 625 ART cycles per million women in the UK were increased to the 2106 level seen in Denmark, the UK TFR would increase by only 0.04, from 1.64 to 1.68 (Hoorens *et al.*, 2007). Thus, the effects of ART on TFR are small; also, because ART success declines with female age, ART would make up for a decreasing share of the deficit due to longer postponement (Leridon and Slama, 2008).

Incomplete ART treatment: the drop-out factor

Modelling the impact of ART on population fertility usually assumes that couples will complete a hypothetical number of cycles. However, the motivation to seek clinical advice and adhere to a care programme differs among infertile couples. While 20% of couples have subfertility at some point during their reproductive life, only half (10%) seek specialist care (Beurskens *et al.*, 1995; Snick *et al.*, 1997; Boivin *et al.*, 2007) and many leave before completing a programme of care.

Various studies report that 10–14% of couples stop a programme of treatment prematurely because of an unexpected spontaneous pregnancy (Beurskens *et al.*, 1995).

Other published reasons for drop-out include psychological distress (Oddens *et al.*, 1999), and a concern that the prognosis is poor (Bevilacqua *et al.*, 2000; Malcolm and Cumming, 2004). Although national data show reductions in ART utilization after price increases, among couples who discontinue care, costs and distance from clinics are not reported as important reasons for their decision; (Malcolm and Cumming, 2004). Some couples, rather than starting a treatment with a high chance of success, continue to pursue pregnancy on their own (Penzias, 2004). Clearly, models of the effect of ART on population fertility need to include a factor for the drop-out rate and for the treatment independent births that occur in that group.

Table II The contribution of ART to conpensate for the fertility lost with postponed childbearing (French model). It is assumed that all eligible women will use ART (Leridon and Slama, 2008).

	Mean age at first attempt		
	25	27.5	31
Years of postponement	–	2.50	6.00
No. of naturally conceived children	2.00[a]	1.90[b]	1.77[c]
ART contribution	0.04[d]	0.05[d]	0.05[d]
Total No. of children	2.04	1.95	1.82

[a]CF, Cohort fertility.
[b]Minus 5% of CF.
[c]Minus 11% of CF.
[d]Plus 2.5% of CF.

Declining male fecundity

Various studies, including some on trends in sperm capacities (Carlsen *et al.*, 1992) have suggested a possible decline in fecundity of the population over the last 50 years. If the effect had been a 7% decrease in fecundability, as suggested by a study on French donors (Auger *et al.*, 1995; Slama *et al.*, 2004), then TFR would fall by a small 0.02 (1% of 2.0). If the trend observed over 15 years was extended to 45 years, the reduction in fecundability would be doubled. Under the extreme hypothesis of a 50% reduction, the TFR would be lowered only by 0.16 (8% of 2.0) (Leridon and Slama, 2008) and ART could compensate for a reduction in fecundability of up to 15% at most. Habbema *et al.* (2009) have shown that under realistic assumptions, the impact of ART on fertility rates would indeed be modest, equivalent to only half of the births lost by postponing a first attempt to conceive from age 30 to 35 years (Leridon, 2004).

'Political approaches' to low fertility rates

Because of fears that a low TFR may lead to a slowing in economic growth and an eventual decline in total population (Table III), there have been suggestions that national policies should be promoted to increase the birth rate. The compelling reason for such social policies should be to improve family life, however, not simply to increase population. Thus, direct measures (family-friendly social measures) and secondary measures (widely available ART), should be designed primarily with the intention of facilitating births, improving child care and providing treatment for infertility. Policy makers in Europe have not yet decided whether they should make the level of the birth rate an explicit objective of government policies. Aside from France, which made this decision many decades ago, in most of the very low fertility countries there is a rather fundamental opposition to direct government interference with private decisions in the field of family size, although this is combined with an expressed unhappiness about the low level of fertility. The recent communication by the European Commission on this topic is indicative of this ambivalent attitude with respect to pronatalistic policies. The section that addresses possible birth-enhancing policies has the supposedly euphemistic title 'Promoting demographic renewal in Europe' (Commission of the European Union, 2006).

France has a long history of consistent pro-natalist policies that include generous social benefits for pregnancy and child care. In 2006, the TFR in France (1.98) was slightly higher than in other comparable North-Western European countries (UK 1.85; Sweden 1.85) but still slightly below replacement (Population Reference Bureau, 2007). TFR is determined by the decisions of individual couples as to how many children they want and feel would suit them. Aside from significant long-term efforts of totalitarian regimes such as the

Table III Population increase or decline expected in 25 European countries 2004–2050 (Rychtarikova, 2007).

More than 10% decline	More than 10% increase
Latvia	Sweden
Estonia	Malta
Lithuania	Cyprus
Czech Republic	Ireland
Hungary	Luxembourg
Slovakia	
Poland	
Germany	
Italy	
Between 1 and 10% decline	**Between 1 and 10% increase**
Slovenia	Finland
Portugal	Denmark
Greece	Spain
	Austria
	Belgium
	Netherlands
	UK
	France

Peoples' Republic of China, evidence suggests that national government policies have more influence on birth rate in the short-term than in the long-term. Even in communist Romania a temporary increase in birth rates was observed for only a few years after the introduction of draconian laws to restrict access to abortion and contraception, but this was followed by a decline due to an increased use of illegal abortion (David, 1992).

Whether or not governments should abstain from birth-enhancing policies or should start targeted and efficient programmes depends largely on the perceived negative consequences of low fertility. Moreover, not all countries consider low fertility rates as a disadvantage.

Do family-friendly policies increase fertility?

Many countries with high female employment rates have policies that reconcile the balance between work and family life, policies that might increase fertility rates (Ahn and Mira, 2002; Billari and Kohler, 2004; D'Addio-Dervaux and Mira d'Ercole, 2005). Fertility rates are higher in northern European countries such as Sweden and UK where more women work outside the home, than in southern European countries such as Italy and Greece (Shah, 1997; Billari and Kohler, 2004; Population Reference Bureau, 2007).

These southern European countries generally have low levels of child care support, barriers to part-time work, low state support for families and young adults who stay in the family home (Kohler *et al*., 2002). In Italy, where men and women leave home at 26.7–23.6 years, respectively, the TFR was less than 1.3 from 1995 to 2003 (Billari and Kohler, 2004). While in theory government policies might address such barriers to fertility, these conditions existed decades before the decline in fertility rates.

Ideally, policies supporting families would include compensation for child-rearing costs, maintenance of child well-being and development and support for female employment and gender equity. Supporting fertility is not an explicit aim of such support for families, although it is a positive by-product. Some European countries have adopted policies enhancing fertility which allow for increased employment of parents and a reduced gap between ideal and realized fertility. Denmark and Iceland show relatively good performances with regard to all outcomes, whereas in Germany many scores including fertility are below the average for the Organization for Economic Cooperation and Development (OECD) (OECD, 2007 and OECD Family database).

The effectiveness of such policies crucially depends on whether they influence the 'quantum' or the 'timing' of births. The quantum of births is the total number of births in a cohort. Timing or tempo of births is the mean age at each successive parity. Effects on quantum of births reflect the long-term effect of influences or policies, while effects on timing may be no more than temporary.

Studies that use age- and parity-specific fertility rates conclude that policies impact more on timing than on the overall number of children (Sleebos, 2003; Gauthier, 2007). For instance, the rise in child allowances in Britain increased the higher-parity births but also encouraged young motherhood (Ermisch, 1988). Recent analyses conducted in Italy (Boccuzzo *et al*., 2008) and Israel (Cohen *et al*., 2007) also conclude that childbearing is accelerated with the introduction of a lump-sum birth grant, a tempo effect. A tempo effect of policies reconciling work and family life was also observed in Sweden where the parental-leave allowances were held constant at 80% of pre-birth salary only if the next child was born within 24 months of the prior birth (30 months after 1986). This speed premium accelerated childbearing decisions by reducing the spacing between the first and second births (Andersson *et al*., 2006). Swedish parents from all educational and social levels responded in a similar manner (Andersson *et al*., 2006).

More general measures that help to reconcile work and family life also appear to positively impact fertility timing and fertility intentions (Table IV). These measures include leave entitlements, childcare service provision, in-work cash transfers and the opportunity to work part-time. This copious literature was thoroughly reviewed in 2007 (Gauthier, 2007), and Table IV is a brief summary of the more recent studies in Gauthier (2007) and a sampling of those published since 2007. Family support policies may reduce differences in fertility patterns in different socio-economic groups (Ekert *et al*., 2002; Cohen *et al*., 2007).

An impact on quantum or long-term fertility is uncertain. Policies may increase the period fertility rate while also having an indirect effect on cohort fertility, an effect that would alter population dynamics (Lutz and Skirbekk, 2005). However, empirical evidence is limited because the impact of an overall family-friendly package cannot be easily assessed. Overall family support may explain the minimal changes in cohort fertility rates (around 2 during the 1980s and 1990s in Sweden) (Hoem, 2005) and France (Thévenon, in press, 2010). Macro-level comparisons also suggest that policy differences may explain some of the cross-country differences in fertility rates, although the impact of each measure taken separately is only about 0.02, or 1% of a 2.0 TFR (Table IV) (Sleebos, 2003; Gauthier, 2007; Thévenon and Gauthier, 2010).

Table IV Estimated impact of family policies on fertility.

Intervention	Studies	Outcome
1. Income support. Net transfers to families with children are computed as the difference between the average effective tax rates of singles without children earning the average wage and a married couple with two children aged six and four, where one spouse earns the average wage	Blanchet and Ekert-Jaffé (1994)	An increase in transfers to families by 25% leads to a long-run increase of 0.05 children per women
	Gauthier and Hatzius (1997)	Reasons for the limited impact: (i) income transfers to families contribute little to the cost of children. (ii) the complementarity between supports in cash, in kind and in time and the continuity of support over the childhood period. (iii) policies have a greater impact in the long-term. (iv) other issues matter: work-life balance, attitudes, gender relations
	Landais (2003)	An unconditional child benefit with a direct cost of 0.3% of GDP might raise total fertility by about 0.3 point (Laroque and Salanie, 2008)
	Laroque and Salanie (2008)	
2. Work-related policies	Studies showing small changes:	A 1-week increase in the total length of parental leave would on average increase the total fertility rate by 0.3%
	Castles (2003)	A 1-unit increase in the percentage of wages replaced during maternity leave or in the net income transfers to families produces an increase in TFR of 0.9–1%, respectively
	Di Prete *et al*. (2004)	The negative association between education and completed fertility is resistant to family policy changes (Bjorklund, 2006)
	Del Boca *et al*. (2007)	Taking maternal leave and other factors into account, fathers' parental leave use is positively associated with continued childbearing (Neyer and Andersson, 2008; Duvander *et al*., 2010)
	D'Addio-Dervaux and Mira D'Ercole (2005)	
	Bjorklund (2006)	
	Neyer and Andersson *et al*. (2008)	
	Duvander *et al*. (2010)	
	Studies showing no changes:	
	Hank and Kreyenfed (2002) (Germany)	
	Andersson *et al*. (2004) (Sweden)	
3. All policies	Ekert-Jaffé *et al*. (2002)	Reduced difference across social groups

Future trends in European fertility: effects on ageing and migration

The four causes of population ageing are: (i) declining fertility, (ii) rising life expectancy, (iii) anomalies in the age pyramid due to past fluctuations in deaths, births and number of immigrants and (iv) the age pattern and volume of current international migration. The decline in fertility rates changes the population.

Pyramids from the bottom while the impact of rising life expectancy affects mainly the size of the older age groups. In France since 1950 the decline in mortality has accelerated the increase in the population proportion who were 65 years or more, to 16% in 2000 and a projected 23% in 2050. If fertility remained constant at the 2000 level, the proportion of 65+ would be even higher, 29%. The ageing of European populations will continue in association with the long-term decline in fertility and the effect of the past baby boom.

The most obvious reaction to the ageing population is to redefine the limits of economic dependency by deferring the age of retirement.

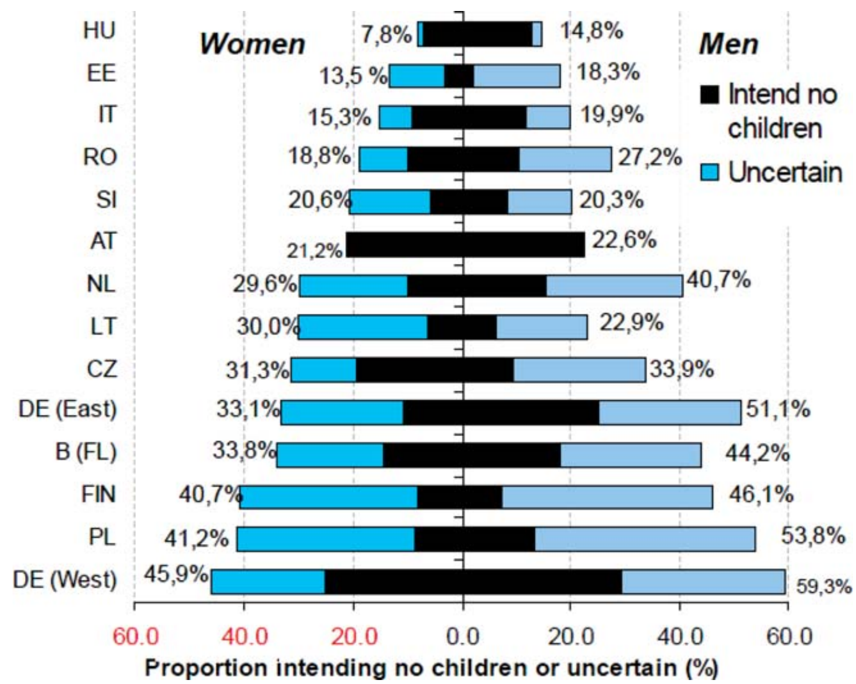

Figure 6 Legend: prevalence of childlessness intentions for childless males and females age 18–39 years in Belgium, Germany, Italy and Poland. Data from the Population Policy and Acceptance Survey 2000–2003 (Sobotka and Testa, 2008). HU, Hungary; EE, Estonia; IT, Italy; RO, Romania; SI, Slovakia; AT, Latvia; NL, The Netherlands; LT, Lithuania; CZ, Czech Republik; DE (East), East Deutchland; B(FL), Belgium (Flamish); FIN, Finland; PL, Poland; DE (West), West Deutchland.

It has been calculated that in the UK the ratio of dependants to workers (Real Support Ratio—RSR - the ratio of the total number of persons employed to the total number of persons not employed) could be kept at the current level until 2050 by extending the average age of retirement from 58 to 65 (Coleman, 2002). Demographic options to offset population ageing include new and effective pronatalist policies, although some governments are reluctant to espouse pronatalist policies for their own population while supporting population control in developing countries (Bongaarts, 2004). Other adjustments in society such as increasing the proportion of trained able women in the work force and part-time re-employment of able elderly may be more realistic approaches to Europe's ageing population than vigorous pronatalist policies and massive immigration.

Even extensive immigration could not stop the ageing of population in Europe that is resulting from low fertility and mortality and the already changed age pyramid. For example, around 100 million young people would be needed to migrate to France in the next 50 years to maintain the present age structure (United Nations, 2001). With respect to the effects of immigration on fertility rates, in Greece, Italy and Spain where about 16% of births were to foreign women, TFRs were 1.24, 1.28 and 1.30, respectively among native women, and 2.12, 2.40 and 1.70 among foreign women (Goldstein *et al.*, 2009). Total fertility rates for all women were 1.33, 1.37 and 1.45, respectively, and the net effect of births to foreign women on TFR was small—0.09, 0.09 and 0.05 in Greece, Italy and Spain, respectively. Thus where immigration births account for one-sixth of total births, the contribution from immigration is no more than 2–4% of the 2.1 replacement TFR (Coleman, 2001).

Conclusions

As men and women choose to have fewer children (Fig. 6), TFRs in Europe have fallen below replacement levels to a period TFR of around 1.5 and around 1.7 children per woman for the cohorts born in 1965. This is due to individual decisions arising from the instability of modern partnerships and the higher cost of maintaining a family together, decisions that easily can be implemented, given the widespread use of contraception and abortion to reduce the incidence of unplanned pregnancy. Government support is beneficial for families and it may hasten decisions to conceive. Government policies have only small effects on fertility rates, however, whether the governments transfer cash to families for pregnancy and child support or provide payments for assisted human reproduction. On the contrary, efforts to improve education are associated with better quality of life and higher economic growth at the societal level (McAllister and Baskett, 2006; Lutz *et al.*, 2008a). Support of education and compatibility of work and family life are the most likely strategies in the long-term to improve prosperity and allow couples to have the family size they prefer.

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Appendix

A meeting was organized by ESHRE (2–3 September 2009) to discuss the above subjects. The contributors included: D.T. Baird (Centre for Reproductive Biology, University of Edinburgh, UK), J. Collins (McMaster University, Hamilton, Canada), J.L.H. Evers (Department of Obstetrics Gynecology, Academic Hospital Maastricht, The Netherlands), H. Leridon (Director of Elfe Projet, INED, Paris, France), W. Lutz (Leader, World Population Program, International Institute for Applied Systems Analysis, Laxenburg, Austria), E. te Velde (Emeritus Professor Reproductive Endocrinology, University of Utrecht, Voortplantingsgeneeskunde, Utrecht, The Netherlands), O. Thevenon (Chargé de recherche INED, Paris, France). The discussants included: P.G. Crosignani (Fondazione IRCCS Ca' GrandaOspedale Maggiore Policlinico, Milano, Italy), P. Devroey (Centre for Reproductive Medicine, Universitair Ziekenhuis Vrije Universiteit Brussel, Belgium), K. Diedrich (Klinik für Frauenheilkunde und Geburtshilfe, Universitätsklinikum Schleswig-Holstein, Campus Lübeck, Germany), B.C.J.M. Fauser (Department of Reproductive Medicine and Gynecology, University Medical Center, Utrecht, The Netherlands), L. Fraser (Reproduction and Rhythms Group, School of Biomedical and Health Sciences, Kings College London, UK), J.P.M. Geraedts (Head Department of Genetics and Cell Biology, University Maastricht, The Netherlands), L. Gianaroli (S.I.S.Me.R., Bologna, Italy), A. Glasier (Family Planning and WW Services, Edinburgh, UK), A. Sunde (Department of Obstetrics Gynecology University of Trondheim, Norway), B. Tarlatzis (Infertility & IVF Center, Thessaloniki, Greece), A. Van Steirteghem (Centre for Reproductive Medicine, Universitair Ziekenhuis Vrije Universiteit Brussel, Belgium), A. Veiga (Director CMRB Barcelona Stem Cell Bank, Barcelona, Spain). The report was prepared by J. Collins and P.G. Crosignani.