

Demographic relevancy of increased use of assisted reproduction in European countries

Jirina Kocourkova^{1§*}, Boris Burcin^{1*}, Tomas Kucera¹

¹Department of Demography and Geodemography, Faculty of Science, Charles University in Prague, Albertov 6, Prague, Czech Republic

*These authors contributed equally to this work

§Corresponding author

Email addresses:

JKO: koc@natur.cuni.cz

BB: burcin@natur.cuni.cz

TK: kucera@natur.cuni.cz

Abstract

Background

Delayed childbearing in European countries has resulted in an increase in the number of women who decide to have children later in their lifetime. As a result, more women face the problem of infertility and thus cannot achieve their desired number of children. Fertility postponement is one of the main causes of the increasing use of assisted reproduction technology (ART). And, on the other hand, the use of ART may be one of the factors contributing to the rise in women's childbearing age. The research goal of the article is to evaluate demographic importance of increased use of ART and to examine the impact on both the fertility level and birth timing.

Methods

A comparative analysis based on demographic and ART data collected by EIM Consortium for the ESHRE.

Results

A positive correlation between total fertility rate (TFR) and the number of treatment cycles per million of women aged in reproductive age was confirmed. A more significant impact of the ART use on fertility level was observed in the countries where couples were encouraged to seek help sooner rather than later. Despite the strong positive correlation between the degree of fertility postponement and the demand for ART among women aged 35 and older the highest share of children born after ART was not found in the countries characterized by very late childbearing pattern but in those countries with less advanced fertility postponement.

Conclusions

ART can have a demographic impact when women take advantage of it rather early than late in their lifetime. Accordingly, it is suggested to promote rather earlier use of ART in order to fulfil one's reproductive plans and to avoid the higher risk of reproductive health problems resulting in low success rate of ART. However, such reproductive health policy should be a part of policies promoting early parenthood preventing further delay in fertility timing and enabling early diagnose of potential reproductive health problems requiring application of ART.

Keywords

Fertility level, Delayed childbearing, Assisted reproduction, European countries

Background

Reproductive behaviour of most Europeans has shifted from an early to a late or very late childbearing pattern [1,2,3,4]. At present, women start to have a family only in around their 30s or even later. In 2010, the mean age of mothers at first childbearing was between 28 and 30 years in EU Member States [5]. Delayed parenthood has many advantages as people are much more mature and considerate when they start a family [4]. On the other side, there are several disadvantages that need to be studied. The longer people wait, the higher the risk of not realising the preferred family size, the higher the risk of negative health outcomes (for mother and child), and the higher is the risk of having to rely on assisted reproductive technology (ART), mainly in vitro fertilisation (IVF), are.

Starting childbearing later means having less time to fulfil their reproductive plans as the biological limits of childbearing have not shifted to later ages. Besides, increasing part of reproductive plans is implemented at the age of women's fecundity decrease which, in addition, has an impact on woman's reproductive health. Hence,

the fertility postponement is considered to be the main factor of the ART increasing use in the countries in question. As a result, both postponed parenthood and assisted reproduction have become an important issue related to reproductive health.

Fertility postponement (fertility decline at women's younger age) has a considerable impact on the number of children born and, as a result, the fertility level has remained in most countries well below the replacement level until the start of fertility recuperation (a compensatory fertility increase at women's higher reproductive age) [6]. European countries significantly differ by the intensity of fertility recuperation which is reflected in the large cross-country variation in current fertility level. Accordingly, there is a tendency to reconsider public policies related to fertility and assisted reproductive technology (ART) promotion at both national and supranational levels. Indeed, ART policies have become more discussed [7]. However, ART treatments have generated important policy questions regarding their cost-effectiveness and safety [8].

Since the 1990s, there has been an expansion of ART in developed countries. At first, ART helped to fulfil fertility desires among infertile couples. Nowadays, ART is rather believed to serve to compensate for a part of the effect of rising infertility due to delay in childbearing. However, it turns out that ART may not make up for all births lost by the natural decline in fertility after the age of 35 [9]. Due to the decrease in fecundity, an increasing amount of couples experience a period of infertility for more than one year and seek help from infertility specialists. For those who need some form of assistance with conception, the range of treatment options has increased.

Nevertheless, a variation in the use of ART across European countries remains. Based on the fact that only some European countries carry on complete

statistics on ART, in 2009 the average number of treatment cycles per million inhabitants ranged from 166 in Moldova to 2726 in Denmark [10]. As mentioned above, delayed childbearing has been contributing to an increase in the proportion of infertile couples. Nonetheless, there are other factors that may play some role since it is rather improbable that countries would significantly differ in the share of infertile couples in their populations.

It has been observed that the large span in the use of ART may be particularly a result of an unequal access to ART. It was estimated that while roughly 3000 couples per million inhabitants may be eligible for ART, only one half of them really seek assistance [11]. Provided that each couple needs on average more than one treatment cycle, the real need would exceed the 2500 cycles. In 2009 Denmark, Iceland, and Belgium were above this estimated number, while other European countries were well below it. Therefore, with the need of ART raising, most European countries have not been able to satisfy it accordingly.

While the impact of the postponement of parenthood on fertility level and demand for ART have been analysed and discussed [12,7,13,14,15], the impact of the increasing ART use on both fertility level and birth timing has not been studied comprehensively. The research goal was to evaluate demographic potential of increasing use of ART in relation to degree of fertility postponement. Accordingly, higher use of ART is expected in the countries with higher fertility level and very late childbearing pattern.

Methods

The cross-national comparison based on available retrospective ART used the data collected by the European IVF-monitoring (EIM) Consortium for the European

Society of Human Reproduction and Embryology (ESHRE) since 1997 and published in Human Reproduction [16,17,18,19,20,10]. Only countries that provided data from all clinics in a given year were included in the analysis. However, as regards the age structure of women treated with ART, countries with a low rate of incompleteness were taken into account as well, which is specified in note of Table 1. ART includes all forms of treatment and techniques related to the in vitro handling of both human oocytes and sperm, or embryos, for the purpose of establishing a pregnancy [21]. ART does not include assisted insemination. Available tables covered the data on IVF (in vitro fertilization), ICSI (intracytoplasmic sperm injection), FER (frozen embryo replacement), ED (oocyte donation), IVM (in vitro maturation), PGD (preimplantation genetic diagnosis), and FOR (frozen oocyte replacement). Although the data on ART were collected by national registers, the method of reporting varied across countries and some countries did not provide complete information. As a result, the data were analysed and interpreted with caution. It is particularly pertinent to the live births following the use of ART due to difficulties when gathering pregnancy outcomes. Only the countries with 100% coverage, i.e. if all clinics participated, were included in the analysis. Differences in the use of ART among countries were analysed in relation to the data on fertility [22]. The data analysis was based on total fertility rate (TFR), fertility postponement ratio (FPR), and structure of TFR by age groups of women. TFR is defined as the average number of live births per woman during her lifetime if she were to pass through all her childbearing years conforming to the age-specific fertility rates of a given year. FPR is defined as fertility rate of women aged 30 and over divided by fertility rate of women aged 20 to 29. When FPR is higher than 1, the fertility level of older women exceeds that of younger women. The more the value is above 1, the higher the level of fertility

postponement. Pearson correlation coefficient was used to analyse the statistical relationship between demographic and ART data.

Results

Trends in use of ART

Trends in the demographic impact of ART use are presented in Figure 1 for the countries that provided complete data at least for three years within the period under observation. Between 1997 and 2007, all selected countries except Iceland experienced a continuous increase in the percentage of live births following the use of ART. However, due to an unequal rate of increase in ART use across countries, the differences deepened. The highest increase in percentage of live births following the use of ART was found in Denmark, Belgium, Slovenia, and the Czech Republic. The highest proportion of children born after an ART was reached in Denmark (close to 5%) in 2007. The year 2007 can be taken as a turning point particularly for the countries with the proportion exceeding 3.5%. Until 2009 all of them recorded a decrease or stabilization at around the level of 4.5%, suggesting that a possible threshold was reached. Uninterrupted increase in the proportion of children born after the use of ART was only found in some countries with lower percentage such as Italy (1.4% in 2009), France (1.9% in 2009) and the United Kingdom (2% in 2009) as well as Sweden (3.5% in 2009) and Norway (3.1% in 2009). Recently the percentage of children born after ART exceeded 3% in northern European countries, Belgium, the Czech Republic and Slovenia.

Relationship between the use of ART and fertility level

In 1997 a positive correlation between TFR and the number of treatment cycles per million of women aged 15–49 could be found (Figure 2). Indeed, countries with

higher TFR reported higher amount of treatment cycles in relation to the number of women in reproductive age. By 2009 the number of treatment cycles had doubled especially in the countries that registered TFR close to 2 children per woman (Figure 3). Besides, substantial increase in ART cycles was also relevant for the countries with low TFR, i.e. the Czech Republic and Slovenia. In contrast to 1997, the Czech Republic and Slovenia reported a higher number of treatment cycles per million of women aged 15–45 than France and Netherlands in 2009. Consequently, both the Czech Republic and Slovenia experienced a significant increase in TFR between 1997 and 2009. As a result, until 2009 a positive statistical relationship between TFR and the number of treatment cycles per million of women in reproductive age had continued, along with a slight increase in the degree of correlation.

The impact of fertility postponement on age structure of women treated with ART

The countries under study significantly differ by age structure of the women who asked for IVF/ICSI (Table 1). Variations have even increased between 1997 and 2007 as the proportion of women aged 40 and over ranged between 9% in the Czech Republic and 15% in Switzerland in 1997, while by 2009 the range had risen from 7% in the Czech Republic to 28% in Italy. Interestingly, a quite important proportion of the women who asked for IVF is constituted by younger women aged below 35 years. In the Czech Republic, women below 35 years made up almost 70% of all those who asked for ART. Moreover, in the Czech Republic there was almost no change in age structure of the women who asked for IVF/ICSI between 1997 and 2007. On the contrary, most other countries in Table 1, i.e. Italy, Switzerland, Spain, Sweden, Germany, Portugal, and Hungary, registered quite a significant increase in the share of women aged 35 and over. An increasing prevalence of women aged 35 and over among all women who asked for IVF/ICSI has been undoubtedly part of the effect of

fertility postponement. Recently the highest share of women aged 35 and over was found in Ireland and Italy (almost 70%), while in Denmark or Slovenia that registered the highest proportion of ART births, women aged 35 and over accounted for less than 50% of those who asked for ART.

The impact of ART use on birth timing

In order to analyse the impact of increased use of ART on birth timing, fertility postponement ratio was constructed to measure the level of fertility postponement. FPR close to the value of 1.3 or higher identifies a very late childbearing pattern where most of fertility is concentrated in the women's age group of 30–34. On the contrary, the FPR under 0.8 is the sign of a rather early childbearing model, with the highest fertility rate concentrated in the women's age group of 25–29. Finally, the values of FPR at around 1 bear witness of low differences in fertility rates of women between 25 and 34 which can be described as a broad peak fertility model.

Surprisingly, weak and negative relationship between the percentage of children born after ART and fertility postponement ratio was found, as the correlation coefficient was less than 0 (Figure 4). Hence, the highest percentage of children born after ART was not found in the countries with the highest level of fertility postponement, but in those with less advanced fertility postponement, i.e. with the FPR at around 1.

Accordingly, the effective usage of ART is rather connected with the broad peak fertility model found in Denmark or Slovenia (Figure 5). The highest level of fertility postponement found in Italy has not been reflected in high percentage of children born after ART, but the reverse is true. An increasing demand for ART among those who have delayed childbearing can be found particularly among older women.

Indeed, the correlation between fertility postponement ratio and the percentage of

women aged 35 and older treated with IVF/ICSI has been found statistically significant (Figure 6).

Discussion

We have found out that though the use of ART is widespread in the countries under study, large inequalities in the access to ART still prevail. The rapid increase in the number of treatment cycles reflects the increasing demand for ART given by recent fertility recuperation trends, a compensatory fertility increase at women's higher reproductive age that followed a previous fertility decline at younger age groups.

Until 2008 in most countries the increase in percentage of live births following ART treatment was in relation to the increase in TFR [23]. As countries differed in the rate of increase in proportion of children born after ART, the use of demographic potential of ART has become increasingly dependent on state's supportive policies, particularly health insurance policy and availability of new techniques to all public. Denmark and Belgium seem to be at the top as regards the reimbursement schemes. ART in Denmark is provided free of charge to women below the age of 40 up to three cycles and is easily accessible at public clinics [24]. In Belgium up to six cycles in a lifetime for all ART-related laboratory activities are reimbursed to the women aged under 43 [25]. Accordingly, both countries registered a substantial increase as well as the highest proportion of children born after ART. On the contrary, Germany gives the evidence of a negative impact of the introduction of more restrictive reimbursement policy since 2004 [26]. Co-payments of ART treatment were raised for childless couples and the number of subsidised treatments was limited to three. As a result, Germany has remained among the countries with a low use of ART treatment.

The level of affordability of ART treatment, namely how treatments are subsidized in a healthcare system, is an important determinant of the level of the ART use [8]. This has become particularly apparent since 2008 when an economic recession has placed an unbearable financial burden on consumers. The recent economic recession has strongly affected economies and government budgets across all developed countries. Massive cuts in public spending aimed at reducing budget deficits have lowered state family-related expenditures and consequently also fertility decision making [27]. A discontinuation of the increase in the proportion of children born after ART was seen particularly in the countries where the previous upturn in TFR has given way to stagnation or decline (Denmark, Slovenia, Belgium, Finland and Germany). While in Denmark or Belgium a threshold in the use of ART was probably reached prior to 2008, other countries like Germany had not fully utilised the ART potential so far and a stimulation of the increase in the use of ART would need extra investments.

The growing proportion of births through ART has become an important part of fertility trends. Moreover, a positive correlation between TFR and the use of ART measured by the number of treatment cycles per million of inhabitants was pointed to in 2002 [28]. A significant statistical correlation was confirmed above when data from 1997 and 2009 were applied. Some recent studies documented that the potential contribution of ART to rising fertility rates was not negligible [29,30,31]. Despite the limits in the increase of ART use, the impact on fertility level could be significant particularly in the countries with TFR below 1.5 [32]. Although it was pointed out that most of such studies overestimated the effectiveness of ART or neglected biological and behavioural factors when assessing the true effect [7], the ART support is considered to be an integral part of national strategies addressing demographic and

reproductive challenges [33]. However, it is rather exceptional in reality as only in Denmark the reimbursement scheme was influenced by demographic concerns [34]. Similarly to family policies in most European countries the explicit ART policy based on the aims different from the demographic ones may be more acceptable and more effective. Implicitly, an enhancement of fertility could be expected. Indeed, taking Belgium as an example, a well-founded strategy to improve access to ART treatment based on the aim to support the birth of a healthy singleton child can have a demographic impact.

A change in birth timing is another demographic aspect related to the increased use of ART. Although the upper age limit of fertility has been pushed to a new extreme since the 1990s as a likely result of the progress in reproductive technologies, trends towards a rectangularization of fertility, i.e. reduction of variability of mothers' age at first birth, have not been discerned [35]. Based on the results above the highest demographic impact of the use of ART can be rather expected in a population with less advanced fertility postponement and concentration of fertility in a broad women's age interval of 25 to 34. The recent increase in the proportion of women aged 35 and over among those who asked for ART can be explained by the ongoing trend towards delayed childbearing. As the success rate of ART dramatically decreases with the age of women aged 35 and over the increasing ART use does not significantly contribute to the increase in the mean age of women at birth. Stronger fertility postponement could develop if the success rates of ART improve particularly at late childbearing age groups. Currently, ART can have a demographic impact when women take advantage of it rather early than late in their lifetime.

It was argued that increased availability of ART might create a false perception in public that childbearing can be postponed until late reproductive age groups when ART would make pregnancy possible to almost any prospective mother [31]. A comparison of the recent age structure of women treated with IVF/ICSI in Denmark and the United Kingdom does not support this argument. In contrast to Britain, the age structure of women treated with IVF/ICSI is younger in Denmark although the ART is more subsidized there. Instead, better availability of ART might encourage couples to seek help sooner rather than later. Nevertheless, when explaining differences in age structures of women treated with IVF/ICSI a different approach of health insurance systems as well as differences in legislation across countries have to be taken into account. Firstly, guidelines related to “the waiting time” before applying for IFV when the attempt to conceive naturally failed may vary from one year in the Czech Republic [36] to three years in the Netherlands [37]. Secondly, the number of cycles reimbursed to females can play a role in the well-timed decision making. It could be expected that women in the country with a low number of reimbursed cycles would ask for the ART treatment rather early in their lifetime to have a higher chance of success than those who are entitled to up to six reimbursed cycles (for example in Belgium). Finally, differences in the women’s age limit for reimbursement can have an impact on the age structure of women treated with IVF/ICSI. To sum up, when a low number of cycles is reimbursed and this is coupled with a rather low women’s age limit for reimbursement, as was the case in the Czech Republic until 2011 (up to three cycles until the age 39), women probably ask for ART at a younger age.

Conclusions

ART can have a demographic impact when women take advantage of it rather early than late in their lifetime. Accordingly, it is suggested to promote rather earlier use of ART in order to fulfil one's reproductive plans and to avoid the higher risk of reproductive health problems resulting in low success rate of ART. However, such reproductive health policy should be a part of policies promoting early parenthood preventing further delay in fertility timing and enabling early diagnose of potential reproductive health problems requiring application of ART.

Abbreviations

ART: Assisted Reproduction Technology; TFR: Total Fertility Rate; EU: European Union; EIM: European IVF-Monitoring; ESHRE: European Society of Human Reproduction and Embryology; IVF: In Vitro Fertilization; ICSI: Intracytoplasmic Sperm Injection; FER: Frozen Embryo Replacement; ED: Oocyte Donation; IVM: In Vitro Maturation; PGD: Preimplantation Genetic Diagnosis; FOR: Frozen Oocyte Replacement; FPR: Fertility Postponement Ratio.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JK conceptualized the study, wrote the main body of the paper, contributed to the research, data analysis, and editing. BB was involved in the research, methodological design, data analysis, and editing of the paper. TK contributed to the research and data analysis. All authors have read and approved the final version of the paper.

Author detail

¹Department of Demography and Geodemography, Faculty of Science, Charles University in Prague, Albertov 6, Prague, Czech Republic.

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Figures

Figure 1 - Trends in percentage of ART births between 1997 and 2009 in selected European countries

Data source: ESHRE, The Czech National ART Register

Figure 2 - European countries by TFR and ART cycles per million women aged 15-49, 1997

Data sources: ESHRE, Eurostat

Figure 3 - European countries by TFR and ART cycles per million women aged 15-45, 2009

Data sources: ESHRE, Eurostat

Figure 4 - European countries by percentage of ART births and fertility postponement ratio, 2009

^a Fertility postponement ratio is defined as fertility rate of women aged 30 and over divided by fertility rate of women aged 20 to 29.

Data sources: ESHRE, Eurostat, The Czech National ART Register

Figure 5 - Structure of TFR by women's age groups in %, Denmark, Slovenia, Italy, 2009

Data source: Eurostat

Figure 6 - European countries by percentage of women 35+ treated with IVF/ICSI and fertility postponement ratio, 2009

^a Fertility postponement ratio is defined as fertility rate of women aged 30 and over divided by fertility rate of women aged 20 to 29.

Data sources: ESHRE, Eurostat

Tables

Table 1 - Age structure of women treated with IVF/ICSI in selected European countries, 1997 and 2009

^a Countries with partial data coverage – Reporting IVF clinics in the country/Total

IVF clinics in the country. Hungary – 6/7, Ireland – 6/7, Spain – 109/166, Switzerland

– 25/26.

^b 2006

^c 2007

Country	1997			Country	2009		
	IVF + ICSI (%)				IVF + ICSI (%)		
	≤34	35-39	≥40		≤34	35-39	≥40
Czech Republic	63.5	27.0	9.4	Czech Republic ^b	67.2	25.4	7.4
Denmark	NA	NA	NA	Denmark	50.6	31.0	18.4
Finland	57.9	27.9	14.1	Finland	55.0	31.6	13.5
France	58.3	29.7	12.0	France	NA	NA	NA
Germany	55.7	29.9	14.5	Germany ^c	45.5	41.2	13.3
Hungary ^a	66.7	22.5	11.0	Hungary	56.3	30.1	13.6
Iceland	40.8	29.6	14.7	Iceland	NA	NA	NA
Ireland	NA	NA	NA	Ireland ^a	30.8	47.2	22.0
Italy	54.3	33.2	12.5	Italy	31.3	40.5	28.2
Portugal	63.3	30.4	6.3	Portugal	49.1	39.0	12.0
Slovenia	NA	NA	NA	Slovenia	51.9	32.8	15.4
Spain	50.3	38.6	11.2	Spain ^a	40.9	45.9	13.2
Sweden	56.5	34.0	9.5	Sweden	49.0	39.0	11.9
Switzerland	49.1	36.1	14.8	Switzerland ^a	36.6	42.8	20.5
United Kingdom	54.4	32.9	12.7	United Kingdom	41.9	40.9	17.2

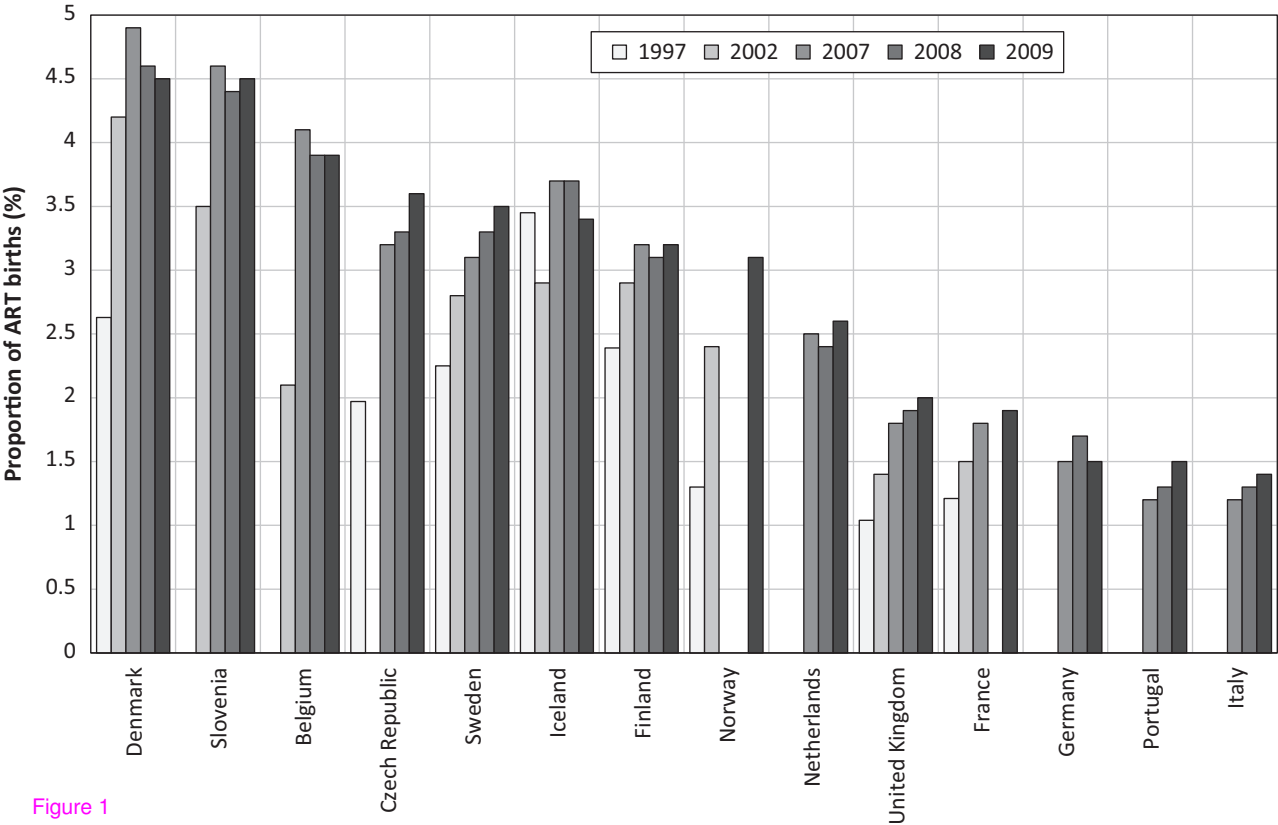


Figure 1

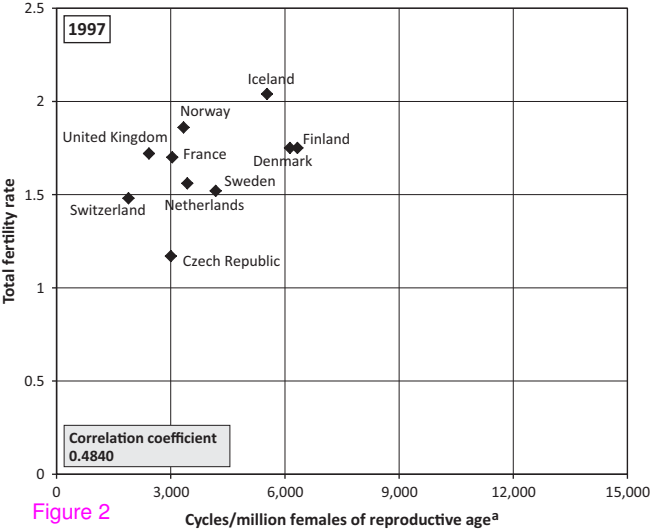


Figure 2

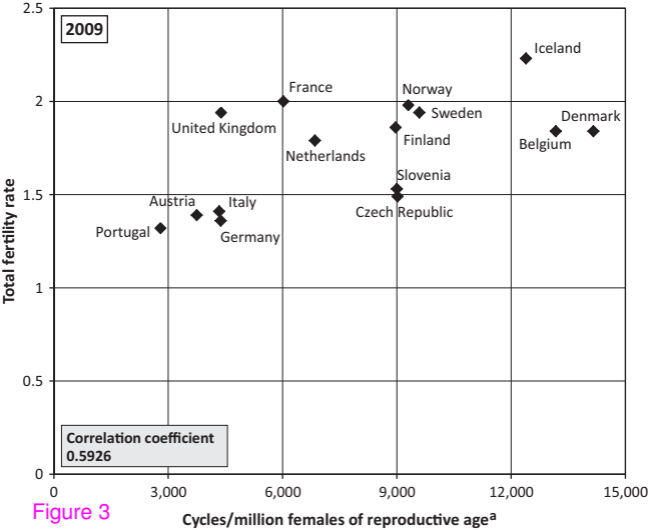
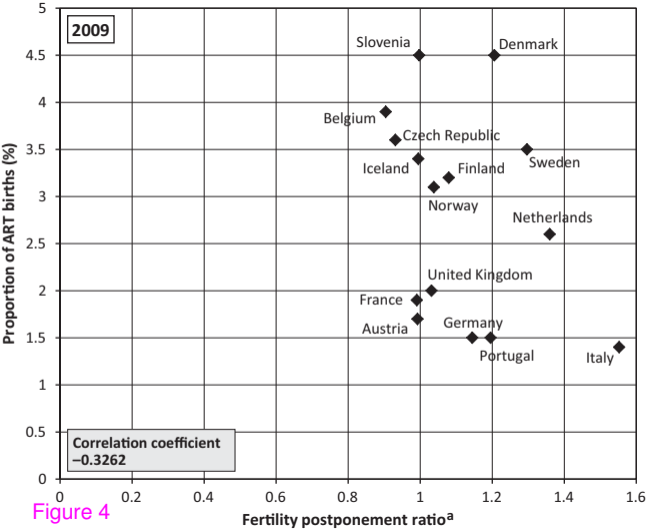


Figure 3



2009

Slovenia

Denmark

Belgium

Czech Republic

Iceland

Finland

Sweden

Norway

Netherlands

France

United Kingdom

Austria

Germany

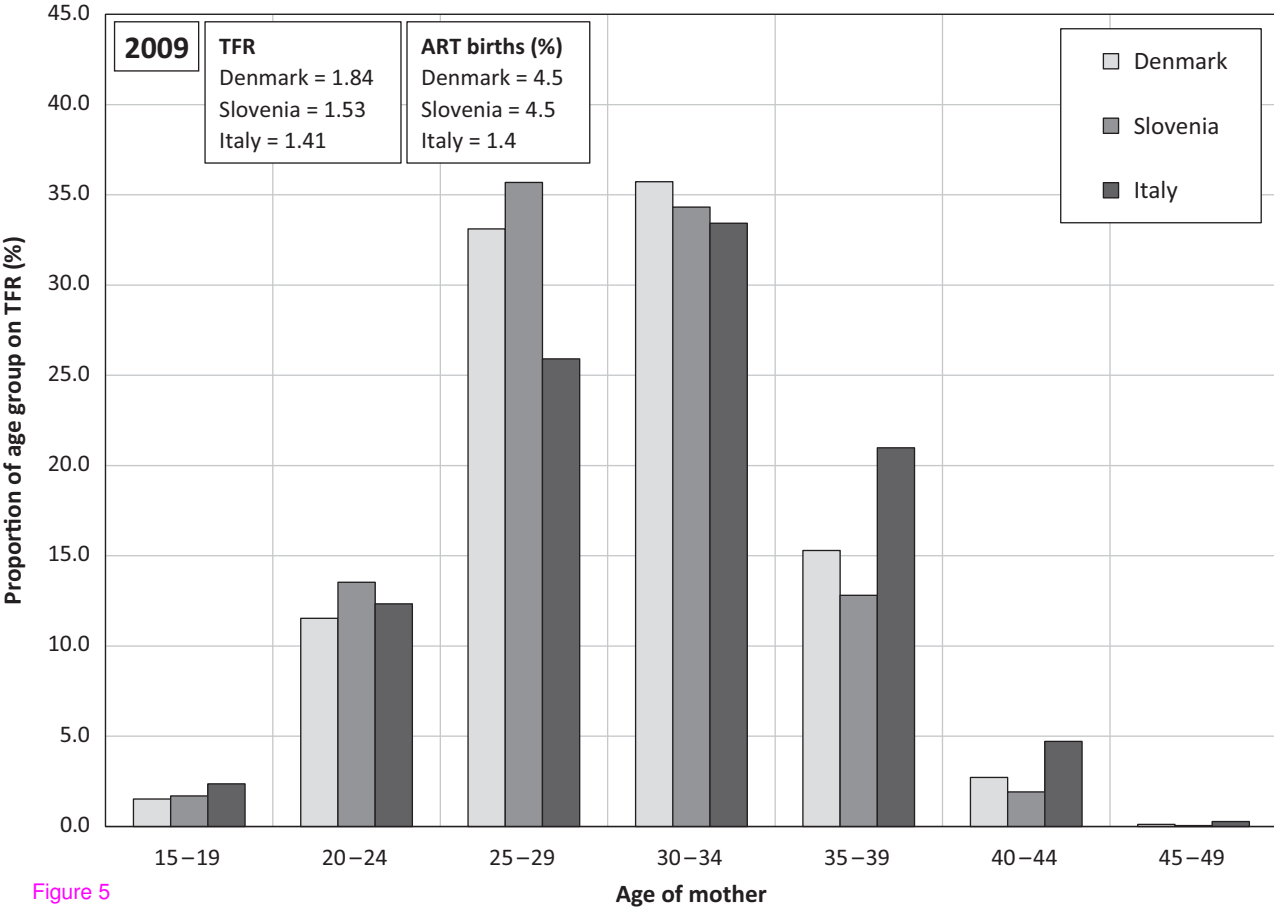
Portugal

Italy

Correlation coefficient
-0.3262

Figure 4

Fertility postponement ratio^a



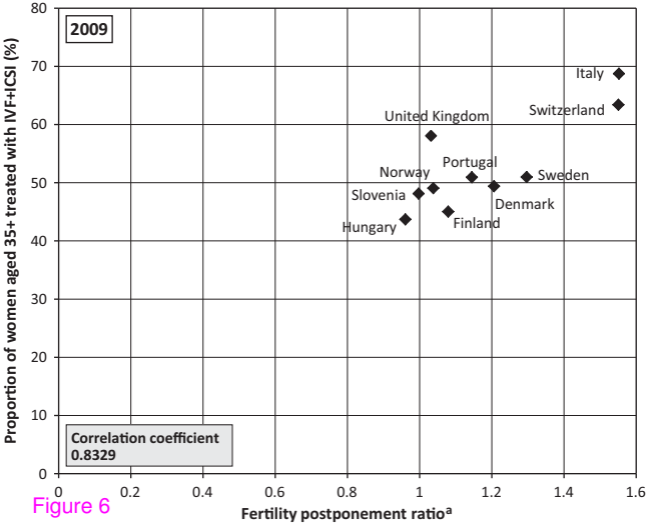


Figure 6