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Factors associated with having the first baby at an advanced age.

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ABSTRACT

Factors associated with having the first baby at an advanced age.
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The aims of this thesis were to investigate characteristics of women and men who have their first baby at an advanced age, reasons for postponing childbirth, and consequences in terms of adverse pregnancy outcomes.

Maternal age at first birth has increased in many modern societies; in both Sweden and Norway, first-time mothers are now about five years older, compared with the previous generation. This delaying of parenthood has been associated with an increased need for artificial reproductive techniques and adverse pregnancy outcomes, and it may also contribute to reduced fertility rates in a society.

In Studies I and II, data from the Norwegian Mother and Child Cohort Study were used, and the characteristics of 41 236 women and 14 832 men who had their first baby during the period 1999-2008 were investigated. Compared with younger reference groups (women aged 25-32 years; men aged 25-34 years), maternal age ≥33 years and paternal age ≥35 years were associated with fecundity problems and slightly more health problems and risky health behaviour. The vast majority of older first-time parents had a high level of education and annual income. However, a smaller group was socio-economically more disadvantaged with low level of education, single status, unemployment, unsatisfactory relationship with their partner and had an unplanned pregnancy.

Studies III and IV were based on data from the Swedish Young Adult Panel Study and the Swedish Total Population Register. Reproductive intentions and reasons for not having children at the age of 28, 32 and 36 or 40 were investigated in 365 childless women and 356 childless men. Many overestimated their fecundity, and one in three women and men aged 36 or 40 years wished to have children. Reasons for remaining childless at these ages were: lack of partner, no desire for children, not feeling mature enough, and wanting to explore other aspects of life before having a family (III). Predictors of still being childless at the age of 32 were investigated in 22-year-olds (518 women and 482 men). These predictors were: family background factors such as growing up in a large city, having highly educated parents, being an only child, still living in their original family, having a less than positive experience of their own mother and father as parents, an unsatisfactory relationship with their mother, and negative attitudes to children (IV).

Study V was a population-based register study including 955 804 primiparous women from the Swedish and Norwegian Medical Birth Registers who gave birth during the period 1990-2010. The risk of preterm birth, infant small for gestation age, low Apgar score, stillbirth and neonatal death was investigated in women aged 30-34 years, 35-39 years and ≥40 years compared with women 25-29 years of age. Additionally, the risks associated with advanced maternal age were compared with those of smoking and being overweight or obese. The adjusted Odds Ratios (aOR) of all outcomes increased

by maternal age in a similar way in Sweden and Norway, and there was a risk of fetal death already at the age of 30-34 years (Sweden aOR 1.24; 95% Confidence Interval (CI) 1.13–1.37, Norway aOR 1.26; 95% CI 1.12–1.41). The Swedish data showed that maternal age ≥30 years was a risk associated with the same number of additional cases of fetal deaths (n=251) as overweight/obesity (n=251).

In conclusion, this thesis confirms some of the findings from previous research regarding the selection of women who delay childbirth to advanced age, such as well-educated women and high-income earners. It adds information about the characteristics of first-time fathers and it also shows that a minority of first-time parents constitute a less advantaged group. The prospective longitudinal study suggests that, besides well-known factors, young persons' experience of their own parents may have an impact on reproductive behaviour, especially the relationship with the mother. Finally, the thesis confirms the association between advanced maternal age and severe pregnancy outcomes, but adds to previous knowledge that risk may increase already at the age of 30-34 years.

Keywords: Postponing parenthood, Reproductive Intentions, Nulliparity, Maternal Age, Paternal Age, Reproduction, Pregnancy Outcomes.

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CONTENTS

LIST OF ABBREVIATIONS

YAPS	The Young Adult Panel Study
MoBa	The Norwegian Mother and Child Cohort
MBRS	Medical Birth Register Sweden
MBRN	Medical Birth Register Norway
TFR	Total fertility rate - the number of births a woman is expected to have, provided that she lives throughout her reproductive period and the fertility pattern for the period persists (15-49 years) [1]
CFR	Cohort fertility rate - the number of children an age cohort of women actually have when their reproductive period is over [1]
BMI	Body Mass Index
OR	Odds Ratio
aOR	Adjusted Odds Ratio
CI	Confidence Interval

INTRODUCTION

Most young couples plan to have children, and in many modern societies this major life event in women's and men's lives is postponed to the age of 30 or later. Research into the phenomenon of postponing childbirth, which has mainly focused on medical outcomes and demographic effects, has shown that an increased risk of caesarean section [2-4] and adverse outcomes such as spontaneous abortions [5], preterm birth [6], longer labour [7], perinatal mortality [8, 9] and a decreasing fertility rate [10] are associated with the postponement of childbirth. These findings raise questions about the reasons for delaying childbirth and whether there are any specific groups of women and men who become parents at an advanced age.

This thesis investigates a wide range of possible explanations for the phenomenon of postponing childbirth in both women and men, based on data from two longitudinal cohorts from Norway and Sweden respectively. Also, adverse pregnancy outcomes were investigated in women expecting their first baby in Sweden, and compared with the risk of smoking and being overweight.

BACKGROUND

In Sweden and Norway, the mean age of first-time parents in 2012 was 29 and 28 years for first-time mothers, and 31 and 30 years for first-time fathers, respectively. This is an increase of five years as compared with the previous generation (Figure 1).

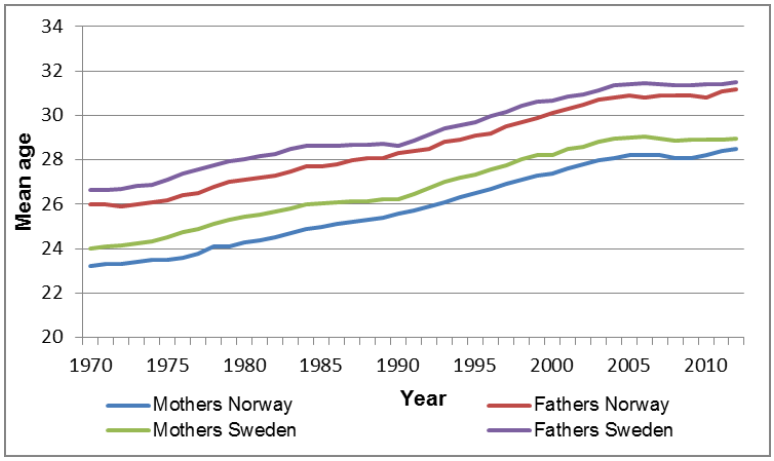

Figure 1. Mean age of first-time parents in Sweden and Norway, 1970-2012. Data sources: www.SCB.Sweden, www.SSB.Norway

DEMOGRAPHIC PERSPECTIVES

In the early 2000s, fertility rates in European countries have reached their lowest point since the Second World War, and one crucial factor behind this trend is the pronounced delay of entry into parenthood [11]. However, the general trend of decreased fertility during the last hundred years needs to be regarded in a historical perspective. Great changes in fertility patterns have taken place during the last two centuries.

The theory of demographic transitions was first described by Warren Thompson in 1929 [1]. He observed how changes in birth and death rates had occurred in industrialized societies over the previous two hundred years. Simultaneous with the development of a country from a pre-industrial to an industrialized economic system, a transition from high birth and death rates to low birth and death rates had taken place.

In pre-industrial societies, the first stage (Figure 2) was characterized by high birth rates and high death rates that fluctuated rapidly according to natural events, such as

famine and disease [1]. Children were important and contributed to the economy of the household from an early age. A relatively constant or slightly growing and young population was maintained.

The first transition (stage 2) took place when the industrial revolution brought improvements in the food supply by higher yields in agricultural practices, better transportation, and significant improvements in public health, which reduced mortality, particularly in childhood. The transition was characterized by continued high birth rates and, at the same time, a rapid decrease in death rates, which led to a similarly rapid growth in the population.

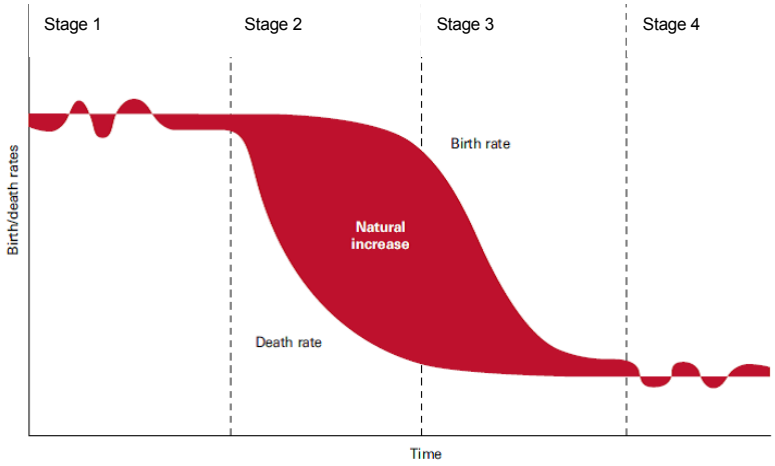

Figure 2. The demographic transitions. Data Source: Population Reference Bureau 2006, printed with permission.

The second demographic transition (stage 3) was shaped by economic and political forces and shifts in norms, values and attitudes [12-15], such as increased individualism, gender equality in education and labour, and delayed and more unstable partner relationships. This second demographic transition was categorized by strongly reduced birth rates while death rates remained low, which in turn led to a slowing growth in the population. In the fourth and current stage we see very low birth rates and death rates, and a slow population growth.

The crucial total number of births per woman to sustain a stable population size is 2.1 [1]. Three in four of all Europeans live in countries where fertility rates are considerably below replacement [11, 16]. The lowest low fertility rates (<1.5) have been reported from Italy (2010) and Spain (2011) (//epp.eurostat.ec.europa.eu/statistics explained).This is challenging for societies in an increasing competitive global economy. Countries with fewer young people, relative to population size, will have to face challenges related to an ageing population and declining rates of young people in the workforce [1, 14, 17]. An ageing population also means increased demands for expensive health services.

As in other European countries, the *total fertility rate* (TFR) has fluctuated during the last century in Sweden and Norway, depending on for instance wars, financial crises and changes in lifestyle, including the postponement of parenthood [10]. TFR is the number of births a woman is *expected to have* at a certain age, provided that she lives throughout her reproductive period (15-49 years) and the fertility pattern for the period persists [1]. In other words, TFR for a specific year represents the average number of children a woman *would* have if she had all her childbearing years in that single year. TFR is thus based on a theoretical assumption, not on the fertility of any real group of women, since this would involve waiting until they had completed their childbearing. Consequently, TFR is influenced by the postponing of childbirth in a society, which may result in estimates of the total fertility rate in the population that are too low. On the other hand, *cohort fertility rate* (CFR), which is the number of children an age cohort of women actually have when their reproductive period is over, is more stable since it is not influenced by the timing of birth. However, the fertility of the cohort is unknown until the cohort is above the reproductive age [1].

In Sweden and Norway, the TFR increased from the 1940s and reached its peak in the 1960s. It then decreased again to the mid-1980s, with the exception of a small peak in relation to a new Act 'speed premium' in 1980, which promoted having another child within 24 months; in 1986, this allowance was extended to 30 months [18]. The TFR then decreased dramatically, to its lowest level of 1.5 in 1999. Currently the TFR has again reached replacement level. The effect of postponing parenthood has had less effect on the CFR. Births are delayed but they do eventually occur [19]. Such a recuperation or 'catch up effect' implies that women who have postponed parenthood eventually have a second child, and will thus fulfil the two-child norm. This has mainly been explained by leading developments in gender equality and the generous welfare system in the Nordic countries, including generous policies regarding parental leave and childcare [20]. However, Statistics Sweden has reported that fewer women who were born in 1965 and 1970 had three children or more, compared with women who were born in 1960. The suggested reason for this was the postponement of the first pregnancy. The pattern may change because more women from the 1980 cohort are reported to have three children [21, 22].

CONSEQUENCES OF POSTPONED CHILDBEARING

Since having the first child late in reproductive life is associated with adverse pregnancy outcomes, causing suffering for the individual and costs for society, the development of postponing childbearing is problematic [23, 24].

Medical

Delaying the first pregnancy increases the risk of several adverse pregnancy outcomes [10]. Women's ability to conceive spontaneously or even by assisted reproduction technologies (ART) decreases with age [24-26], and this is most pronounced from the age of 35. Advanced maternal age is associated with complications during pregnancy, such as miscarriage [27], gestational diabetes [4,

27], hypertension [3, 28], preterm birth [6] and placenta praevia [3, 27]. During labour, the following complications and outcomes are more prevalent in older first-time mothers: dystocia [7, 29], abruption of the placenta [27], excessive bleeding [30], caesarean section and instrumental vaginal delivery [2-4, 10, 27].

Infant complications also increase by maternal age, such as prematurity [6], fetal growth restriction leading to infants small for gestational age (SGA) [6], chromosomal abnormality [31], low Apgar score [32], stillbirth [8], neonatal death [9] and birth defects [27, 31].

In most of the studies investigating medical outcomes in relation to increasing maternal age, 'advanced age' has been defined as 35 years or older. Whether the risk of severe pregnancy outcomes commence earlier has not been thoroughly investigated. Several of the outcomes mentioned are also associated with other 'lifestyle factors' that women may have to consider when planning for a pregnancy: smoking and overweight or obesity. The relative significance of the respective lifestyle factors during pregnancy has been little explored.

Studies have shown that also men's fecundity, i.e. the physical ability to reproduce, decreases by age [33, 34]. Furthermore, a review by Sartorius and Nieschlag [35] concluded that increasing paternal age was associated with miscarriage, fetal death, very preterm birth, preeclampsia, caesarean section, birth defects, as well as schizophrenia, autism and cancer, in the offspring.

Psychological

The higher risk of fecundity problems and medical complications in those who become pregnant at an advanced age also suggests psychological consequences. However, the direction concerning cause and effect may be uncertain; it is unclear whether complications related to a pregnancy at an advanced age affect emotional health negatively [36, 37], or if women and men with mental health problems delay childbearing. A recent study shows that advanced maternal age (≥32 years) was associated with a slightly higher prevalence of psychological distress, but only in those with previous depressions [38], who were less satisfied with life compared with a group of women aged 25-31 years (Aasheim 2014, in progress). Older nulliparous women are more often worried about the upcoming birth, more likely to prefer a caesarean delivery, and have a slightly increased risk of a negative birth experience [39].

High maternal age implies high paternal age, as men are around three years older than their partner, and men seemed to be affected by their 'old' partner's higher risk of obstetric complications. Compared with a younger reference group, Swedish first-time fathers aged ≥34 years assessed their partner's labour and birth as more difficult and had a less positive overall birth experience [40].

It has been argued that the adverse health outcomes of delayed childbearing could be weighed up against potential social advantages for the children, because the parents for instance are more likely to be well educated, have progressed in their careers, have financial security, are more mature and have more stable partner relationships [35, 41]. However, there is a lack of studies on such overall background characteristics of women and men who become parents at an advanced age, based on large national samples.

POSTPONING PARENTHOOD

The main explanation for the phenomenon of postponing childbearing is the changing role of women in society, due to the contraceptive revolution. With the introduction of the 'pill' and other effective contraceptives in the 1960s, as well as the right to legal abortions, it was possible to choose *if* and *when* to have the first child, as well as subsequent children.

The increased participation of women on the labour market, including their longer education [42-46] and career planning [43] are probably the most important reasons for postponing parenthood. A high educational level and a career increases the likelihood of delaying childbirth and remaining childless in Swedish and Norwegian women [42, 47], whereas a study from the Netherlands showed that high income and a stable job rather increased the likelihood of men to become fathers [48]. In Sweden, the conflict between paid work outside the family and work has also affected men's choice to postpone parenthood. The increased focus on gender equity has involved changes in attitudes and men are now expected to contribute to childrearing and household tasks [49], especially in relationships where the women are highly educated.

Other reasons for delaying childbearing are: a desire to prolong adolescence and continue an independent lifestyle [50], difficult housing conditions [51], financial uncertainty, changes in values, the absence of supportive family policies, gender equity, changes in partnership behaviour [43], and difficulties in establishing stable partner relationships [48, 52].

Childbearing intentions
The two-child norm is strong in high-resource countries. The vast majority of women and men who attend university in Sweden [53, 54], Finland [55], England [56], Canada [57], USA [58] and Australia [59] wish to have children, preferably two, and they most commonly intend to have their first baby in their late 20s and early 30s.

Childbearing intentions are commonly described as the *desire to have a child or not*, *timing of the first child* and the *number of wished-for children* [60, 61]. Childbearing intentions predict future reproductive behaviour [60, 62], even when reported as early as 14-21 years [63]. US data from the late 1980s and early 1990s suggest that both

male and female partners' desires for children influence the probability of having children, and the desires of each spouse contribute about the same [60]. A Swedish study showed that in couples where both partners said they definitely planned to have a child, 44% actually had one within two years. If the partners had opposite desires, the corresponding figure was 6%, and if neither partner wanted a child, less than 2% had a baby [62]. These results have been confirmed by more recent studies [63, 64].

Studies of women's and men's reasons for not yet having children and their intentions regarding future childbearing have mainly focused on the young, and specifically on students. Few studies have included more representative samples, for example participants other than students, and women and men of higher reproductive age.

DEFINING ADVANCED MATERNAL AND PATERNAL AGE

There is no consensus on how to define advanced maternal age in relation to the first pregnancy [10], and it is argued that age implies a continuum of risk [5, 27]. The trend of delayed childbearing is especially challenging in regard to women's reproductive age. A social deadline for childbearing exists alongside the biological one: around 40 years for women and 45 years for men [65]. Age limits also vary across countries influenced by factors such as the mean age when having the first child and the availability of Medically Assisted Reproduction (MAR) [65].

Advanced maternal age was first defined by Waters and Wagen in 1950 [66]. Since then, their suggested 35-year limit of advanced maternal age has been commonly used in research [2, 66-68]. However, other age limits – for instance, over 25 years [69], 30 years [70], 40 years [68] or ≥45 years of age [71] – have also been used, depending on the research question, but more often on limited sample sizes.

The definition of 'advanced' paternal age is even more unclear due to men's lifelong ability to reproduce [35]. In the medical literature, 40 years is a suggested limit for *optimal* fecundity [33, 35, 72] and has been used as a cut-off.

More knowledge is needed in the discussion towards a more clear-cut definition of advanced maternal and paternal age, from both a medical *and* a social point of view.

AIMS

The overall aim of this thesis was to investigate factors associated with advanced maternal and paternal age when having the first baby, using data from large national samples.

The specific aims of the studies were to investigate

- associations between advanced maternal age and socio-demographic background, social relationships, health behaviour, physical and mental health, and reproductive history (Paper I).

- associations between advanced paternal age and socio-demographic background, health behaviour, physical and mental health problems, social relationships, and partner's present pregnancy (Paper II).

- Swedish women's and men's childbearing intentions at the age of 28, 32, 36 and 40 years, in terms of: (1) time point for a first child, (2) number of children, and (3) reasons for not yet having children (Paper III).

- if family background and attitudes to children, parenthood, gender equality, and views about what is important in life at 22 years of age predict childlessness in women and men ten years later (Paper IV).

- associations between advanced maternal age and adverse pregnancy outcomes (preterm birth, SGA, low Apgar score, stillbirth and neonatal death) in nulliparous women aged 30 years and older with a singleton pregnancy, compared with women aged 25-29 years; and to compare risks associated with advanced maternal age with those of smoking, being overweight or obese (Paper V).

METHODS

GENERAL DESIGN OF THE STUDIES

The studies are based on selected data from Swedish and Norwegian cohort studies and national registers. Table 1 gives an overview of the design, year of data collection, samples and data source for each paper. More specifically, we used data from the Norwegian Mother and Child Cohort Study (Papers I-II), the Swedish Young Adult Panel Study with linkage to the Total Population Register in Sweden (Papers III-IV), and from the Medical Birth Registers in Sweden and Norway (Papers I-V).

The Young Adult Panel Study (YAPS)

The Swedish Young Adult Panel Study (YAPS) (www.suda.su.se/yaps) is run by the principal investigator, Professor Eva Bernhardt, at Stockholm University, Sweden. The aim of the YAPS is to investigate Swedish family and working life in the 2000s. The recruitment and data collection was made in collaboration with Statistics Sweden (SCB) and includes approximately 3 500 women and men who have contributed with questionnaire data from three waves of data collection.

The Norwegian Mother and Child Cohort Study (MoBa)

The Norwegian Mother and Child Cohort Study (MoBa) is carried out by the Norwegian Institute of Public Health. The primary aim of the MoBa is to explore associations between different exposures and diseases in order to improve prevention and treatment of serious illness and to explain trajectories and variability of health-related traits over total lifespan [73]. The study is designed as a cohort study, and women and their infants/children are followed by means of questionnaires from early pregnancy (gestational week 13-17) until the child is eight years of age. A questionnaire for the fathers is also included. Participants are linked to the MBRN [73].

The Medical Birth Registers in Sweden and Norway

The Swedish and Norwegian Medical Birth registers (MBRS and MBRN) include information about 98% of all births in the respective country. Data are collected prospectively by midwives and doctors in the antenatal and perinatal periods, and include information on maternal health, reproductive and medical history, obstetric interventions, and maternal and perinatal outcomes [74, 75].

Quality controls of the Swedish register were made in 1976, 1988 and 2001 by comparing original medical records with the corresponding register data [74, 76]. Several variables used in the present study, such as maternal age, gestational age and infant survival, have previously been validated with satisfactory results [74].

Quality controls of the Norwegian register were made in 2000, 2009, and the variables maternal age, gestational age and perinatal death have been found to be valid measurements [75, 77].

Table 1. Design of the Swedish and Norwegian population-based studies, year of data collection, samples and data sources.

Paper	Design	Year of data collection	Sample	Data sources
Paper I	Cross-sectional study	1999-2008	41 236 nulliparous women	MoBa (IV), MBRN
Paper II	Cross-sectional study	2005-2008	14 832 first-time fathers-to-be	MoBa (V), MBRN
Paper III	Cross-sectional study	2009	365 childless women 356 childless men	YAPS, TPR, MBRS
Paper IV	Cohort study	1999-2009	518 childless women 482 childless men	YAPS, TPR, MBRS
Paper V	Register study	1990-2010	955 804 nulliparous women	MBRS, MBRN

YAPS The Young Adult Panel Study
TPR Total Population Register of Sweden
MOBA The Norwegian mother and Child Cohort study, (versions IV and V)
MBRS Medical Birth Register of Sweden
MBRN Medical Birth Register of Norway

Recruitment

The studies are based on already collected data from population-based samples of women and men recruited before they became pregnant (YAPS), in their own/their partner's early pregnancy (MoBa), or when they had become a parent (YAPS). The last study includes the total populations of single first-births in Sweden and Norway (MBRS, MBRN).

Recruitment for the MoBa (Papers I and II) commenced in 1999. The aim was to include 100 000 pregnancies from all over Norway. Women were recruited in gestational week 13-17, when they received a posted appointment for the routine ultrasound scan. All delivery units in Norway with more than 100 births annually were included in the recruitment process, and 50 of 52 units participated. There were no exclusion criteria, except for not speaking sufficient Norwegian to answer the questionnaires [73]. Only women were invited in the initial phase of the data collection, but from year 2000 the expectant fathers were also requested to participate. The invitation letter included information about the study, a consent form

and two baseline questionnaires, one for the woman and one for the expectant father. The woman was asked to sign an informed consent form and fill in a questionnaire to return to the research team, and also to forward an invitation and a questionnaire to the father-to-be. If he agreed to participate in the study, he returned his signed informed consent form and the completed questionnaire. When the recruitment was completed in December 2008, the MoBa-cohort included 107 383 pregnancies, 90 996 women and 71 753 fathers. Of those invited, 38% and 32% of the women and men participated respectively.

The recruitment procedure for YAPS (Papers III and IV) was conducted by Statistics Sweden and based on stratified, randomly selected samples of 3 408 women and men of Swedish origin from the 1968, 1972, and 1976 birth cohorts, as well as 951 second-generation immigrants of Polish or Turkish origin from the 1972 and 1976 birth cohorts. A request for participation was added to a postal questionnaire in the first wave of data collection in 1999. Of all those invited, 65% (n=2 820) chose to participate. The second wave was conducted in 2003, for which 1 200 women and men of Swedish origin from the 1980 birth cohort were added to the original sample, with a response rate of 70% (n=2 816). The third wave took place in 2009 and included participants from the first and/or second wave, with a response rate of 56% (1 114 women, 871 men).

For Paper V, we used data from the MBRS from 1990-2010 (20 years) to reach a sufficiently large sample to explore the rare outcomes. To validate the findings, data from the MBRN during the same period were used.

SAMPLES

For Paper I, the sample included 41 236 nulliparous women. Nulliparity was defined as being pregnant and not having given birth previously to a live or a stillborn infant ≥22 gestational weeks of pregnancy [78].

Table 2 shows the age distribution and background characteristics of the study sample for Paper I, a sub-sample who gave birth in 2003 and for comparison the total Norwegian birth cohort of primiparous women in 2003.

Table 2. Characteristics of the study sample of primiparous women (n = 41 236), a sub-sample who gave birth in 2003 (n = 5 072) and all primiparous women in Norway in 2003 (n = 23 467). Data from The Norwegian Medical Birth Register.

	Study sample	Sub-sample who gave birth in 2003	All primiparous women who gave birth in Norway 2003	Sub-sample vs national birth cohort primiparous women, 2003
	%	%	%	p-value*
Age groups				<0.001
≤19	2.2	2.2	5.1	
20-24 years	16.9	18.6	23.5	
25-29 years	41.8	43.6	38.6	
30-34 years	29.6	28.0	25.1	
35-39 years	7.9	7.0	6.9	
≥ 40 years	1.0	0.6	0.9	
Married/cohabiting	94.5	95.0	90.7	<0.001
Smoking				<0.001
Sometimes	1.9	2.2	2.2	
Daily	9.6	12.2	15.9	
IVF	4.5	4.3	3.6	<0.01
Physical health problems				
Diabetes type 1	0.4	0.5	0.4	0.57
Hypertension	0.5	0.6	0.4	0.07
Recurrent urinary tract infections	4.0	3.4	2.8	<0.01
Thyroidea dysfunction	1.4	1.1	1.0	0.55
Asthma	4.8	5.0	4.5	<0.01

*P-value for differences between the sub-sample who gave birth in 2003 and primiparous women in a Norwegian birth cohort in 2003 (women in sub-sample excluded).

For Paper II, 36 879 men were recruited and 33 944 (92%) actually responded. We included those who responded to the questionnaires in 2005-2008 (n=33 944). Those who reported that they had at least one previous child (n=17 925) and the youngest first-time fathers ≤24 years of age (n=1 187), who were beyond the focus of this study, were excluded from the sample, leaving a final sample of 14 832 first-time fathers. Table 3 shows the characteristics of the sample compared with all first-time fathers in Norway during the study period.

Table 3. Characteristics of the study sample of first-time fathers (n = 14 832) compared with all first-time fathers in Norway (n = 211 762). Data from the Norwegian Medical Birth Register

	Study sample		All first-time fathers in Norway		
	n	%	in 2005-2008	%	p-value*
Age groups					<0.001
25-34 years	11363	76.6	163063	77.0	
35-39 years	2693	18.2	34291	16.2	
≥40 years	776	5.2	14408	6.8	
Mother tongue other than Norwegian	1016	6.9	46293	21.9	<0.001
Education					<0.001
Primary school	288	2.0	29511	13.9	
Secondary school	4862	33.7	87850	41.5	
Higher education ≤4 years	4301	29.8	53193	25.1	
Higher education >4 years	4984	34.5	27635	13.1	
Unknown	397	2.7	13573	6.4	

*P-value for differences between the first-time fathers in the study sample and first-time fathers in Norway in 2005-2008.

The recruitment and final study samples of the YAPS are shown in Figures 3 and 4.

Paper III was based on the third wave of the YAPS data collection in 2009 and included altogether 721 individuals, 365 women and 356 men, who neither had a biological child nor were expecting one, representing three age groups: 28 years, 32 years and 36/40 years. The two latter age groups were collapsed because of small numbers. Due to the study design, the sample did not include any second-generation Polish or Turkish participants aged 28, but more than 25% of the 32-year-olds and 10% of the 36/40-years-olds were of non-Swedish origin.

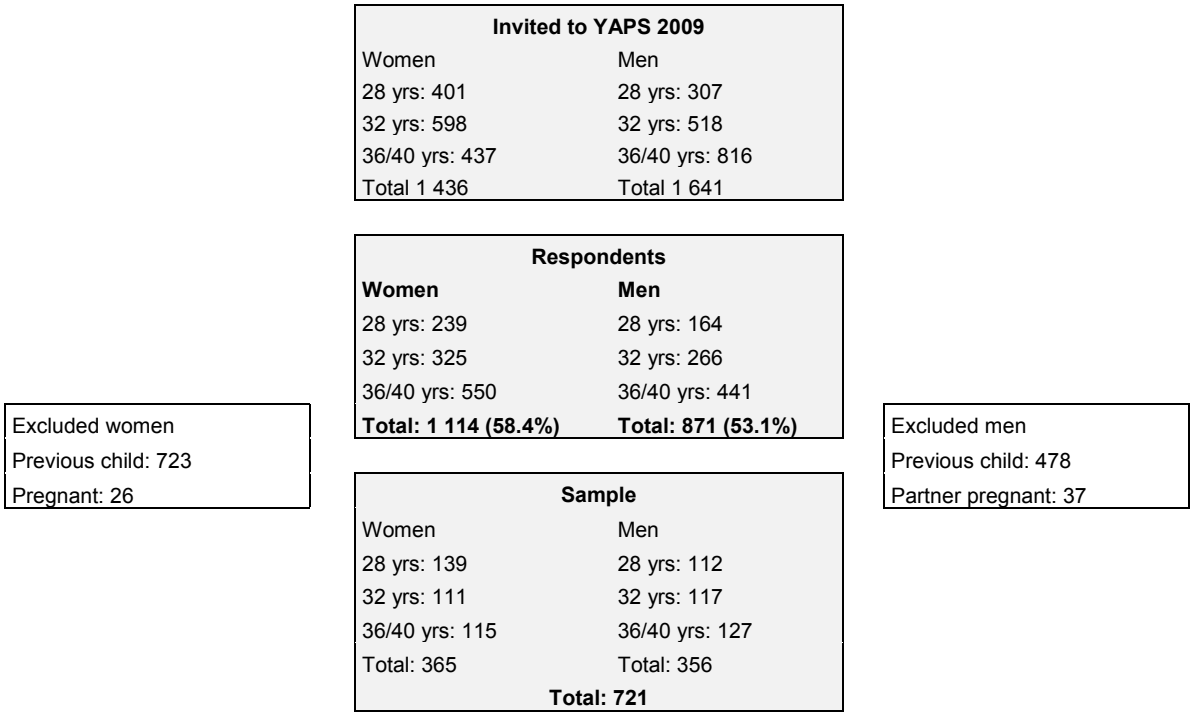

Figure 3. Recruitment of childless women and men aged 28, 32 and 36/40 years.

The sample for Paper IV included women and men from the1976 birth cohort, who did not have a biological child according to the Swedish Medical Birth Register in 1999. The sample consisted of 518 women and 482 men of Swedish and Polish/Turkish origin. Those who had emigrated or died in the follow-up period were identified through the Total Population Register (Emigration Register and Death Register) and were excluded. Figure 4 shows the recruitment of the first wave of participants in the YAPS and the final study sample of women and men who were childless in 1999, after exclusion of those who had at least one child or who had emigrated or died during the study period.

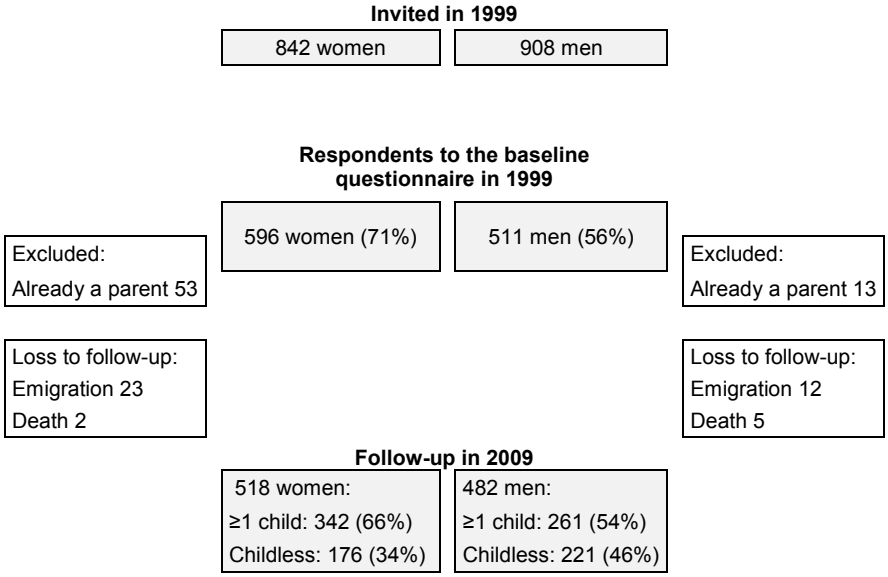

Figure 4. Flow chart of women and men from the 1976 birth cohort in the Swedish Young Adult Panel Study (YAPS)

The sample in Paper V consists of the total population of nulliparous women aged 25 years and older with singleton pregnancies at ≥22 weeks of gestation or birth weight ≥500g, who gave birth in Sweden and Norway between 1990 and 2010: 644 184 and 311 610 respectively. Thus, a total of 955 804 women were included.

DATA COLLECTION

Data were retrieved from national birth registers and from surveys using postal questionnaires or questionnaires on the internet.

Papers I-II (MoBa)

The data were baseline measurements retrieved from the first questionnaire (Q1) to the expectant mother in the MoBa Study, and from the questionnaire to the expectant father (www.fhi.no/eway/). The dependent variable, *age* when they became parents for the first time, was retrieved from the MBRN.

Papers III-IV (YAPS)

Data were collected by means of questionnaires in the first (1999) and the third waves (2009) of the YAPS study (http://www.suda.su.se/yaps/frågeformulär). The quality-assured data files were merged with register data from the Total Population Register by Statistics Sweden. The reproductive behaviour of women and men was

investigated by linking the questionnaire data to data from the Swedish Medical Birth Register, using the personal identification number. This enabled us to identify those who had at least one child during the ten years and those who were still childless.

Paper V (MBRS, MBRN)

For Paper V, we used data from The Swedish and Norwegian Medical Birth Registers. For the second aim of the study we used the Swedish population only, because the data required were not included in the Norwegian Medical Birth Registers.

VARIABLES

Age
Age categories and reference groups in the respective study are described in Table 4. In Papers I and II, data on the ages of first-time parents at the time of delivery of their first baby were retrieved from the Medical Birth Register.

For Paper I, the selection of age cut-offs was based on the study material; advanced maternal age at 32/33 years of age and very advanced maternal age at 37/38, based on the mean age (28.3 years) plus one (32.8 years) and two (37.3 years) standard deviations, respectively. The group aged 33–37 years included 5 949 women (14.3%) and the group ≥38 years comprised of 1 092 women (2.6%). As a comparison group, we chose women between 25 and 32 years (n=26 281; 63.3%), with cut-offs set accordingly, with plus and minus one standard deviation from mean age, respectively.

For Paper II, the selection of age cut-off points was based on five-year intervals. The group aged 35-39 years included 2 693 men (18.2%) and the group aged ≥40 years included 776 (5.2 %). As a comparison group, we chose men aged 25-34 years (n=11 363) (76.6 %).

In Paper V, we used the five-year interval categorization because the Norwegian data set did not include age as a continuous variable. We defined the reference group as maternal age 25–29 years and compared the outcomes in this group with those in the age groups of 30–34 years, 35–39 years, and 40 years or older, respectively.

Table 4. Age categories and comparison group in the different papers

Paper:	Gender	Age (years)	Comparison group	Basis for categorization
Paper I	Women	Advanced 33-37; Very advanced ≥38	25-32	Mean age +1SD, +2SD.
Paper II	Men	Advanced 35-39; Very advanced ≥40	25-34	Five-year intervals
Paper III	Women/Men	28 or 32 or 36/40	28	Birth cohorts 1968/1972, 1976, 1980
Paper IV	Women/Men	22	-	-
Paper V	Women	Advanced 30-34; 35-36; ≥40	25-29	Five-year intervals

Papers I-II

A*ge* was defined as the age at the time of delivery of the first baby.

Paper I
The outcome measurement was advanced (33-37 years) and very advanced (≥38 years) maternal age.

Independent variables

The variables describing the women's characteristics were classified into four blocks in accordance with the aim of the study. Block 1 included socio-demographic characteristics (mother tongue, ongoing or completed education, employment, income, civil status, timing of pregnancy). Block 2 comprised health behaviour in the last three months before pregnancy (smoking, use of alcohol, physical activity, body mass index), physical health problems (asthma, migraine, headache, abdominal pain, back pain, neck and shoulder pain, hypo- and hyperthyroidism, hypertension, cervical dysplasia, genital herpes, chlamydia, incontinence, salpingitis, endometriosis, diabetes with and without treatment, cancer) and mental health problems (fatigue, sleeping problems, anxiety, depressive symptoms). Block 3 covered reproductive background: menarche, menstruations, ectopic pregnancy, induced and spontaneous abortion, ectopic pregnancy, in vitro fertilization (IVF). Block 4 included social relationships (feeling lonely, support person other than partner, contact with family and friends, satisfaction with partner relationship).

Questions about physical and mental health problems were phrased *'Do you have or have you had any of the following illnesses or health problems before pregnancy?'*, whereas the questions about abdominal, back and neck and shoulder pain, fatigue and sleeping problems referred to problems during the first four weeks of pregnancy.

Relationship satisfaction was measured using the Relationship Satisfaction Scale, a shortened and modified version of the Marital Satisfaction Scale developed for the MoBa study [79]. To facilitate comparisons with data on fathers we used only the five items that were included in both the male and female questionnaires: *'My partner and I have problems in our relationship'*, *'I am very happy in my relationship'*, *'My partner is usually understanding'*, *'I am satisfied with my relationship with my partner'* and *'We agree about how children should be brought up'*. Each item is scored on a 6-point Likert scale, with the end points *'Completely agree'* and *'Disagree completely'*, and the total sum ranges from 5 to 30. A mean score was computed for each individual, which was then dichotomized into dissatisfied (score <4) and satisfied (scores 4–6). In cases of a maximum of three missing values on the 10-item scale, imputations were made [80].

Paper II
Outcome measurement was advanced (35-39 years) and very advanced (≥40 years) paternal age.

Independent variables
Variables on men's characteristics were classified into four blocks similar to those for the women's, however with a few differences: Block 2 included health behaviour at the time of the partner's early pregnancy, and physical and mental health problems included cardiovascular disease, Crohn's disease/ulcerative colitis, prolonged muscle pain, Mb Bechterew/rheumatoid arthritis, gonorrhea and psychological distress.

Questions about physical health problems and sleeping problems were phrased *'Do you have, or have you had any of the following illnesses or health problems?'* followed by a list of symptoms. Previous depressive symptoms were measured by the Lifetime Major Depression Scale [81]. After the question *'Have you ever experienced the following for a period of two weeks or more earlier in life?'* the respondent was asked to tick yes or no after the following statements: *'1=Felt depressed, sad', '2=Had problems with appetite or eaten too much', '3=Been bothered by feeling weak or lacking energy', '4=Really blamed yourself and felt worthless', '5=Had problems concentrating or had problems making decisions', and '6=Had at least three of the problems named above simultaneously'*. Respondents who ticked yes on items 1 and 6 were classified as having previous depressive symptoms [82]. Current psychological distress was measured using a short form of the Symptom Checklist (SCL-5) [83, 84]. The question *'Have you been bothered by any of the following feelings during the past two weeks?*' was followed by the items: *'feeling fearful', 'nervousness or shakiness inside', 'feeling hopeless about the future', 'feeling blue', and 'worrying too much about things'*. Each item is scored on a 4-point scale (1=not bothered, 2=a little bothered, 3=quite bothered and 4=very bothered), and the total sum ranges from 5 to 20. Mean scores were calculated and a cut-off at ≥2 was defined as psychological distress [84]. Block 3 included variables retrieved from the partner's questionnaire (Q1) and related to whether the present pregnancy was unplanned (Yes/No), if the woman had been treated for infertility in relation to the present pregnancy, and if so, what type of medically assisted reproduction (MAR) treatment she had received (hormone treatment, insemination, IVF).

Paper III

Outcome measurement
Reproductive intentions were investigated by the following questions: '*Do you think you will have children in the future?'* with the response alternative *yes* (yes, definitely + yes, probably), *no* (no, probably not + no, definitely not) and *don't know; 'When do you think you will have your first child?'* (Within the next two years/within two to five years/more than five years from now) and *'How many children would you like to have?'* (one child/two children/three children or more).

Reasons for remaining childless
Reasons for not having children included ten specified items listed in Figure 5a-c. The question was worded '*There may be several reasons for not having children (yet). Which of these reasons is (are) relevant for you?'*

We adjusted for the following socio-demographic factors: ethnicity, education, civil status, current main activity and gross income (SEK) in 2008 (See Paper III, Table 1).

Paper IV

Outcome measurement
Outcome measurement was *childless at the age of 32.*

Independent variables
Family background
Place of growing up, parents' level of education, family's financial situation, mother's employment, siblings, whether the parents lived together until the respondent's 16th birthday, and if the respondent had left their parental home by the age of 22. Further, conflicts in the family were investigated by the question '*Were there fights or serious disagreements in your family when you grew up?*' and the relationship with parents by the question *'Are you satisfied or dissatisfied with your relationship with your mother (father)?'* Experience of the parents was also investigated by the question *'If you think back on your childhood and adolescence, how would you rate your mother and father as parents?'* Questions about attitudes to children, parenthood, and gender equality and view about what is important in life were measured by a 5-point Likert scale with the anchors verbally defined. The responses were dichotomized into *'positive'* (scores 4+5) versus *'less than positive'* (1-3 + 'Don't know') (Tables 8-9).

Attitudes to children and parenthood
The variables included the following statements: *'I enjoy children'* and *'I think I can be satisfied with my life if I am a good parent'*. Reproductive intentions were measured by the question; *'Do you think you will have children in the future?*' with the alternative responses dichotomized into *'yes'* and *'perhaps + no'*. Gender attitudes were investigated by the statements *'A society where men and women are equal is a good society'* and *'It is as important for a woman as for a man to support herself'*. The participants also assessed whether or not the following aspects were important in life: *'To have children'*, *'To live in a good cohabiting or married relationship'*, *'To be successful in my work'*, *'To have a good financial situation'*, and *'To have plenty of time for leisure-time activities'*.

Paper V

The outcome measurement
The six outcomes of the study were defined as follows: very preterm birth (22-31 gestational weeks), moderately preterm birth (32-36 gestational weeks), small for gestational age (SGA, i.e.>2 standard deviations under normal weight for gestational age adjusted for the sex of the infant), Apgar score <7 at 5 minutes after the birth, fetal death (from gestational week 22), and neonatal death within 28 days after delivery.

Independent variables
Smoking referred to any smoking at the first antenatal booking in early pregnancy, regardless of the number of cigarettes smoked. Information about maternal weight and height was collected on the same occasion, and BMI was defined as underweight <18.5 kg/m^2; normal weight: 18.5-24.9 kg/m^2; overweight: 25-29.9 kg/m^2; obese: ≥30 kg/m^2.

Confounders
Adjustments of analyses were made for the following confounders: year of birth (continuous variable), civil status (Sweden: living with the baby's father vs. not; Norway: married or cohabiting vs. not), chronic hypertension and diabetes reported at the antenatal booking in both countries. The Swedish data were also adjusted for country of birth (Nordic=Sweden, Norway, Denmark, Finland and Iceland vs. other country), smoking and BMI. Information about smoking and BMI were not available for the entire observation period in the Norwegian sample, which precluded adjustment for these variables in the statistical analyses.

ANALYSES

Papers I-II

The Chi-square test was used when comparing the sub-samples of women and men with the national sample to assess representativity.

To investigate possible associations between advanced and very advanced maternal and paternal age and all the descriptive variables, analyses were conducted in three steps. First, all the variables were tested one by one in bivariate analyses. Second, a multivariate logistic regression analysis that included the statistically significant variables was conducted for each block of variables. Third, multivariate logistic regression models, one for each age category, were constructed, in which Blocks 1 to 4 were entered one by one in a sequential order as far as possible. Variables were left in the models if they proved statistically significant ($p<0.05$) in one or both age categories. Associations are presented as adjusted odds ratios (OR) with 95% confidence intervals (95% CI). To retain cases with one or more missing values for categorical variables in the final model, a specific category 'missing' (not shown) was constructed. Imputations on the Relationship Satisfaction Scale were made using the multiple imputation method on the basis of valid data for the remaining items on the scale [80]. Collinearity for the final model was assessed using a condition index. Percentages were calculated by column (Table 5).

Internal missing values in Paper I were between (0.0-3.1%), except for the alcohol variables (7.0-9.0%) and the relationship variables (3.1-4.5%). In Paper II, internal missing values were between (0.0-3.0%), except for the alcohol variables (3.2-3.4%) and social relationship (0.6-1.7%). In cases of a maximum of two missing values on either of the two five-item scales, single imputations were made using Missing Value

Analysis (MVA) and the Expectation Maximization (EM) algorithm method [85]. The remaining items on the scales were used as predictors for these imputations [80]. Collinearity for the final model was assessed using condition index. Imputation was performed in 0.8% of the cases on the SCL-5 Scale, and in 1.2% of the cases on the Relationship Satisfaction Scale.

Paper III

Descriptive statistics were used for baseline characteristics and reasons for not having children, and are reported as numbers and percentages for the total sample and for women and men separately. Differences between women and men regarding reasons for not having children and between age groups regarding reproductive intentions were calculated by chi-square test and between age groups regarding number of reasons given were calculated by the two-sample Mann-Whitney U test. Associations between age and the reasons for not having children were analysed by multivariate logistic regression analysis, adjusting for socio-demographic factors, and are described as odds ratios (OR) and 95% Confidence Interval. In the analysis, men and women were collapsed because of similarities in responses, and those who were 28 years of age constituted the reference.

Paper IV

Descriptive statistics were used for baseline characteristics, and are reported as numbers and percentages for the total sample and for women and men separately.

Associations between possible predictors and being childless were investigated by bivariate logistic regression analyses in the total sample and in women and men respectively. We also tested for gender differences by using interaction terms between gender and all variables in the regression models. The variables were too correlated to be tested in a multivariate analysis. Internal missing values were between (0.2-3.5%) in women and between (0.2-4.6%) in men.

Paper V

Logistic regression analysis was used to investigate the association between maternal age and each outcome in the two national samples. The crude and adjusted odds ratios were estimated with 95% confidence intervals.

To compare the risks associated with advanced maternal age with those related to smoking, and being overweight or obese we used the Swedish population only. As a first step, we estimated the association between each pregnancy outcome, one at a time, and maternal age, smoking, and BMI, and adjusted for confounders. Second, we investigated whether the effect of age was similar, regardless of whether the woman was a smoker or not, and regardless of BMI, and tested two-way (age x smoking; age x BMI) and three-way interactions (age x smoking x BMI) by adding each of the interactions, one at a time, to the model in the first step, which included eight factors;

p-values <0.05 were defined as statistically significant. To address the issue of multiple hypothesis testing a stricter threshold at p<0.001 was also used.

To estimate the attributable risk of advanced maternal age, compared with smoking, overweight and obesity respectively, we calculated the population rate of each outcome in a low-risk group of women corresponding to the reference levels for the risk factors (non-smokers, normal weight, age 25-29 years) and multiplied this rate with the aORs for the respective outcomes related to each of the three risk factors in the estimated models. Finally we estimated the number of additional cases of each outcome which might be explained by advanced maternal age (30-34 years; 35-39 years; ≥40 years; and ≥30 years), smoking, overweight and obesity (and overweight or greater), based on the differences between the adjusted rates and the absolute risk in the low-risk group.

Due to the long time span of the study all regression models were adjusted for year of birth, and the larger Swedish data set was split into two decades in order to compare outcomes from 1990-1999 with those from 2000-2010.

All statistical analyses were conducted using the IBM SPSS Statistics version 18.0-20.0 (SPSS, Inc., Chicago, USA).

ETHICAL APPROVAL

Papers I-II
The major Mother and Child project is approved by the Norwegian Regional Committees for Medical and Health Research Ethics, Ref number S-97045, and by the Norwegian Data Protection Authority, Ref no 01/4325-6. The present project is covered by a contract between the project leader Ulla Waldenström and the Norwegian Institute of Public Health, Ref no 10-1380, which also includes access to the Norwegian Birth Register.

Papers I-II
The Young Adult Panel Study is approved by the Regional Research Ethics Committee in Stockholm and the Swedish National Data Service Project no FAS 2007-0154 (SND), Ref no 2008-03-05 and 2008-04-02. Ethical permission of study, Ref number 2008/191-31.

Paper V
Approval for the use of Swedish data was obtained from the Regional Research Ethics Committee in Stockholm. No ethical approval from the Regional Committee for Medical Research Ethics in Norway was required (https://helseforskning.etikkom.no/).

RESULTS

CHARACTERISTICS OF WOMEN AND MEN WHO ARE EXPECTING THEIR FIRST BABY AT AN ADVANCED AGE (PAPERS I- II)

In two different studies we investigated characteristics in women (Paper I) and men (Paper II) who were expecting their first baby at an advanced and very advanced age.

Women

Socio-demographic factors associated with advanced maternal age were high annual income, immigrant background, a low level of education, unemployment, single status and unplanned pregnancy. The older women reported less contact with family and friends, and less satisfaction with the relationship with their partner, compared with younger women. Further, the older women were more often overweight and obese, and they used alcohol more often but drank less on each occasion, compared with the reference group. Physical symptoms were also more common in older nulliparous, as were fatigue, sleeping problems and depressive symptoms.

The strongest variable associated with having the first baby late in reproductive life was in vitro fertilization (IVF). The odds of women with a previous history of IVF giving birth at the age of ≥38 was 10.7 (CI 95% 7.0–16.4), and 6.2 (CI 95% 5.0–7.8) for those who had had an IVF previously *and* in the current pregnancy. Of the women in the advanced age category, 9.4% of current pregnancies had occurred after IVF treatment; the corresponding figure was 18% for women of very advanced age (Table 5).

Table 5. Associations between maternal age and sociodemographic characteristics (Block 1), health behaviour, physical reproductive background (Block 3) and social relationships (Block 4) in nulliparous women compared with a reference aged 25-32 years. Values shown for variables remaining in the final model only (n= 33 322, % presented by column).

	25-32 years n= 26 281		33-37 years n=5 949				≥38 years n=1 092			
	n	%	n	%	OR[a]	(95% CI)	n	%	OR[a]	(95% CI)
Sociodemographics (Block 1)										
Native language										
Norwegian	24611	93.6	5424	91.2	ref		1001	91.7	ref	
Other than Norwegian	1670	6.4	525	8.8	1.4	(1.2-1.6)	91	8.3	1.1	(0.9-1.4)
Education										
Primary school	96	0.4	31	0.5	1.5	(1.0-2.4)	12	1.1	2.3	(1.2-4.7)
Secondary school	9915	37.7	1943	32.7	ref		388	35.5	ref	
Higher education ≤4 years	8835	33.6	1905	32.0	1.9	(0.9-1.1)	346	31.7	0.9	(0.8-1.1)
Higher education >4 years	7177	27.3	2005	33.7	1.1	(1.0-1.2)	329	30.1	0.8	(0.7-1.0)
Employment										
Employed	23362	88.9	5469	91.9	ref		972	89.0	ref	
Unemployed	475	1.8	116	1.9	1.5	(1.2-1.9)	32	2.9	2.3	(1.5-3.4)
Student	1686	6.4	135	2.3	0.6	(0.5-0.7)	20	1.8	0.5	(0.3-0.9)
Other[b]	742	2.8	221	3.7	1.6	(1.3-1.9)	65	6.0	2.3	(1.6-3.2)
Income (NKr)										
<200 000	5535	21.1	654	11.0	0.7	(0.7-0.8)	124	11.4	0.7	(0.5-0.9)
200-299 999	10552	40.2	1563	26.3	ref		253	23.2	ref	
300-499 999	8721	33.2	2988	50.2	2.2	(2.1-2.4)	527	48.3	2.5	(2.2-3.0)
≥500 000	815	3.1	604	10.2	4.5	(4.0-5.1)	158	14.5	8.0	(6.3-10.1)
Civil Status										
Married or cohabiting	25490	97.0	5632	94.7	ref		971	88.9	ref	
Unmarried or not cohabiting	713	2.7	298	5.0	2.1	(1.8-2.3)	117	10.7	3.1	(2.3-4.2)
Unplanned pregnancy[c]	4134	15.7	743	12.5	0.8	(0.8-0.9)	217	19.9	1.5	(1.3-1.8)
Health behaviour, physical and mental health problems(Block 2)										
Body Mass Index (kg/m^2)										
Normal (18.5–24.9)	17740	67.5	3800	63.9	ref		644	59.0	ref	
Underweight (<18.5)	784	3.0	126	2.1	0.7	(0.6-0.9)	17	1.6	0.6	(0.3-0.9)
Overweight and obesity (≥25)	7066	26.9	1804	30.3	1.4	(1.3-1.5)	385	35.3	1.8	(1.5-2.3)
Alcohol (frequency)										
Less than once a month/never	7006	26.7	3303	55.5	0.8	(0.7-0.9)	549	50.3	0.7	(0.6-0.9)
Once a week/month	15146	57.6	1324	22.3	ref		246	22.5	ref	
2-3 times a week	2216	8.4	878	14.8	1.5	(1.4-1.7)	194	17.8	2.1	(1.8-2.6)
4-7 times a week	265	1.0	132	2.2	1.9	(1.5-2.4)	34	3.1	2.9	(1.9-4.4)
Alcohol (units[d] when consuming)										
≤1-2 units	8918	33.9	2680	45.0	ref		577	52.8	ref	
3-6 units	13098	49.8	2606	43.8	0.6	(0.6-0.7)	394	36.1	0.4	(0.4-0.5)
≥7 units	1867	7.1	182	3.1	0.3	(0.3-0.4)	13	1.2	0.1	(0.0-0.1)
Physical health problems[c]										
Abdominal pain	2296	8.7	489	8.2	0.8	(0.7-0.9)	23	2.1	0.6	(0.4-0.8)
Neck- and shoulder pain	964	3.7	253	4.3	1.1	(1.0-1.3)	62	5.7	1.5	(1.1-2.0)
Thyroidea dysfunction	532	2.0	178	3.0	1.4	(1.1-1.6)	62	5.7	2.3	(1.7-3.2)
Hypertension	239	0.9	80	1.3	1.4	(1.1-1.9)	23	2.1	2.1	(1.3-3.5)
Cervical dysplasia	1628	6.2	561	9.4	1.5	(1.3-1.7)	99	9.1	1.4	(1.1-1.7)
Genital herpes	813	3.1	277	4.7	1.3	(1.1-1.5)	59	5.4	1.6	(1.2-2.2)
Incontinence	183	0.7	59	1.0	1.2	(0.9-1.7)	17	1.6	2.1	(1.2-3.7)
Salphingittis	85	0.3	47	0.8	1.5	(1.0-2.3)	11	1.0	2.0	(0.9-4.1)
Endometriosis	405	1.5	217	3.6	1.3	(1.1-1.6)	42	3.8	1.0	(0.7-1.5)
Cancer	83	0.3	27	0.5	1.2	(0.7-1.9)	14	1.3	2.7	(1.4-5.3)
Diabetes without insulin	22	0.1	5	0.1	0.9	(0.3-2.7)	6	0.5	3.8	(1.1-12.8)
Mental health problems[c]										
Fatique	6006	22.9	1506	25.3	1.1	(1.1-1.2)	299	27.4	1.3	(1.1-1.5)
Sleeping problems	702	2.7	220	3.7	1.2	(1.0-1.4)	56	5.1	1.6	(1.2-2.2)
Depressive symptoms	1673	6.4	515	8.7	1.3	(1.2-1.5)	100	9.2	1.0	(0.8-1.3)
Reproductive background (Block 3)										
Menarche 9-16	25045	95.3	5578	93.8	ref		1018	93.2	ref	
Late menarche (>16 years)	1236	4.7	371	6.2	1.4	(1.2-1.6)	74	6.8	1.6	(1.2-2.0)
Interval between menstruations (days)										
Normal (21-35)	24324	92.6	5609	94.3	ref		1046	95.8	ref	
Polymenorré (<21)	327	1.2	65	1.1	0.9	(0.7-1.3)	16	1.5	1.1	(0.6-1.8)
Oligomenorré (>35)	792	3.0	112	1.9	0.6	(0.5-0.7)	9	0.8	0.2	(0.1-0.4)
Spontaneous abortion[c]	3657	13.9	1199	20.2	1.5	(1.3-1.6)	316	28.9	2.4	(2.1-2.8)
Induced abortion[c]	3460	13.2	1172	19.7	1.7	(1.6-1.8)	250	22.9	1.9	(1.6-2.3)
Ectopic pregnancy[c]	212	0.8	99	1.7	1.5	(1.2-2.0)	26	2.4	1.3	(0.8-2.2)
IVF[c]										
Previously only	102	0.4	101	1.7	4.6	(3.4-6.2)	46	4.2	10.7	(7.0-16.4)
Previously *and* present pregnancy	743	2.8	500	8.4	3.1	(2.7-3.5)	151	13.8	6.2	(5.0-7.8)
Present pregnancy only	52	0.2	58	1.0	4.0	(2.7-6.0)	46	4.2	9.0	(7.0-16.4)
Social relationships (Block 4)										
Contact with family and friends										
More than twice a week	20636	78.5	4310	72.4	ref		777	71.2	ref	
Twice a week or less	4783	18.2	1483	24.9	1.4	(1.3-1.5)	288	26.4	1.5	(1.3-1.7)
Partner relationship										
Satisfaction with partner relationship	24541	93.4	5409	90.9	ref		933	85.4	ref	
Dissatisfaction with partner relationship	599	2.3	266	4.5	1.7	(1.5-2.01)	70	6.4	2.0	(1.4-2.7)

[a]Odds ratio adjusted for all other variables in the model

[b]At home, rehabilitation/disabled, family member without steady income in family company (e.g. farming, business), other (not specified in the questionnaire)

[c]Reference: Women unexposed to the variable studied

[d]1.5 cl. pure alcohol

Table 6. Associations between paternal age and sociodemographic characteristics (Block 1), health behaviour, physical and mental health problems (Block 2), partner's present pregnancy (Block 3) and social relationships (Block 4) in expectant first-time fathers (35-39 years and ≥40 years) compared with a reference group aged 25-34 years. Values shown for variables remaining in

	25-34 years n=11 363		35-39 years n=2 693				≥40 years n=776			
	n	%	n	%	OR[a]	(95% CI)	n	%	OR[a]	(95% CI)
Sociodemographics (Block 1)										
Mother tongue other than Norwegian[bc]	733	6.5	205	7.6	1.26	(1.06-1.50)	78	10.1	1.40	(1.07-1.84)
Education										
Primary school	191	1.7	62	2.3	1.55	(1.13-2.13)	35	4.5	2.67	(1.74-4.10)
Secondary school	3780	33.3	830	30.8	ref		252	32.5	ref	
Higher education ≤4 years	3368	29.6	731	27.1	0.96	(0.86-1.09)	202	26.0	0.90	(0.73-1.11)
Higher education >4 years	3720	32.7	1000	37.1	1.03	(0.91-1.16)	264	34.0	0.83	(0.68-1.03)
Employment										
Employed	8968	78.9	2192	81.4	ref		592	76.3	ref	
Self-employed	1066	9.4	328	12.2	1.42	(1.23-1.63)	129	16.6	1.92	(1.54-2.39)
Student	804	7.1	54	2.0	0.51	(0.37-0.68)	11	1.4	0.39	(0.21-0.73)
Unemployed/disabled/rehabilitation	216	1.9	50	1.9	1.47	(1.04-2.08)	25	3.2	2.02	(1.23-3.33)
Annual income (NKr)										
<200 000	1271	11.2	114	4.2	0.48	(0.38-0.60)	39	5.0	0.50	(0.33-0.74)
200-299 999	1765	15.5	256	9.5	0.69	(0.59-0.81)	82	10.6	0.69	(0.52-0.92)
300-399 999	3995	35.2	775	28.8	ref		201	25.9	ref	
400-499 999	2262	19.9	633	23.5	1.42	(1.26-1.60)	155	20.0	1.40	(1.12-1.76)
≥500 000	1916	16.9	887	32.9	2.43	(2.16-2.73	290	37.4	3.29	(2.68-4.04)
Civil Status										
Single status[c]	182	1.6	66	2.5	1.90	(1.39-2.59)	44	5.7	3.58	(2.42-5.31)
Health behaviour, physical and mental health problems(Block 2)										
Body Mass Index (kg/m^2)										
Normal (18.5-24.9)	5319	46.8	1050	39.0	ref		322	41.5	ref	
Overweight or obesity (≥25)	5967	52.5	1629	60.5	1.42	(1.29-1.55)	452	58.2	1.28	(1.09-1.50)
Underweight (<18.5)	28	0.2	4	0.1	0.84	(0.27-2.54	1	0.1	0.47	(0.05-4.19)
Smoking[c]										
Yes, sometimes	1137	10.0	226	8.4	0.99	(0.85-1.17)	56	7.2	0.92	(0.69-1.24)
Yes, daily	1075	9.5	302	11.2	1.41	(1.21-1.65)	98	12.6	1.46	(1.13-1.89)
Alcohol (frequency)										
Less than once a month or never	2535	22.3	523	19.4	0.74	(0.65-0.84)	161	20.7	0.58	(0.46-0.72)
Once a week/month	6801	59.9	1487	55.2	ref		412	53.1	ref	
2-3 times a week	1482	13.0	489	18.2	1.57	(1.39-1.79)	131	16.9	1.63	(1.30-2.04)
4-7 times a week	187	1.6	101	3.8	2.46	(1.88-3.20	40	5.2	3.59	(2.40-5.36)
Alcohol (≥5 units[e] when consuming)										
Never or do not drink alcohol	1800	15.8	525	19.5	1.51	(1.32-1.72)	210	27.1	2.25	(1.83-2.77)
Less than once per month	4447	39.1	1107	41.1	ref		318	41.0	ref	
1-3 times per month	3595	31.6	708	26.3	0.67	(0.60-0.75)	147	18.9	0.44	(0.36-0.55)
Once or several times per week	1157	10.2	267	9.9	0.64	(0.54-0.76)	69	8.9	0.50	(0.37-0.68)
Physical health problems[c]										
Cardiovascular disease	33	0.3	17	0.6	2.18	(1.16-4.09)	10	1.3	3.94	(1.79-8.66)
High blood pressure	179	1.6	90	3.3	1.69	(1.29-2.22)	39	5.0	2.60	(1.76-3.83)
Neck and shoulder pain	1063	9.4	321	11.9	1.20	(1.03-1.39)	103	13.3	1.09	(0.85-1.40)
Low back pain	1571	13.8	453	16.8	1.21	(1.07-1.37)	150	19.3	1.45	(1.18-1.79)
Mb Bechterew	63	0.6	16	0.6	0.85	(0.48-1.52)	13	1.7	2.16	(1.11-4.21)
Sexually transmitted diseases[d]	611	5.4	182	6.8	1.26	(1.05-1.51)	52	6.7	1.32	(0.96-1.81)
Mental health problems[c]										
Sleeping problems	476	4.2	174	6.5	1.45	(1.19-1.77)	52	6.7	1.20	(0.86-1.69)
Previous depressive symptoms	1161	10.2	323	12.0	1.22	(1.05-1.41)	120	15.5	1.44	(1.14-1.82)
Present pregnancy[bc] (Block 3)										
Medically assisted reproduction										
Hormone treatment	302	2.7	106	3.9	1.43	(1.13-1.81)	32	4.1	1.70	(1.16-2.52)
Insemination	21	0.2	14	0.5	2.75	(1.34-5.63)	3	0.4	2.18	(0.60-7.90)
In vitro fertilisation	348	3.1	267	9.9	3.12	(2.62-3.72)	93	12.0	4.13	(3.17-5.39)
Unplanned pregnancy	1695	14.9	290	10.8	0.79	(0.68-0.91)	111	14.3	1.04	(0.82-1.31)
Social relationships (Block 4)										
Contact with family and friends										
More than twice a week	7574	66.7	1645	61.1	ref		426	54.9	ref	
Twice a week or less	3659	32.2	1016	37.7	1.22	(1.11-1.34)	343	44.2	1.48	(1.26-1.73)
No other support persons than partner	803	7.1	234	8.7	1.14	(0.97-1.34)	102	13.1	1.55	(1.22-1.98)
Partner relationship										
Satisfaction with partner relationship	11044	97.2	2593	96.3	ref		739	95.2	ref	
Dissatisfaction with partner relationship	211	1.9	79	2.9	1.48	(1.11-1.96)	31	4.0	1.52	(0.99-2.36)

[a]Odds ratio adjusted for all other variables in the model

[b]Data from the partner's questionnaire

[c]Reference: Men unexposed to the variable studied

[d]Chlamydia, genital herpes, genital wart, gonorrhoea

[e]1.5 cl. pure alcohol

Socio-demographic variables associated with advanced paternal age were: immigrant background, low level of education, self-employment, unemployment, low *and* high income, being unmarried or non-cohabiting.

Like the women, the older men were more likely to be overweight or obese, to be smokers and to consume alcohol more frequently but in lesser quantities than the comparison group. Physical health problems and mental health problems, such as sleeping problems (advanced age), and previous depressive symptoms (advanced and very advanced age) were also more common. The probability that the baby had been conceived after medically assisted reproduction was threefold in men aged 34-39 and fourfold for those 40 years and over, compared with the youngest group. Finally, limited contact with family and friends, lacking support from others apart from their partner, and a poor partner relationship were more common in new fathers of advanced age (Table 6).

SWEDISH WOMEN'S AND MEN'S REPRODUCTIVE INTENTIONS AT THE AGE OF 28 YEARS, 32 YEARS AND 36/40 YEARS (PAPER III)

The vast majority of both women and men aged 28 or 32 years intended to become parents in the future (Table 7). However, of the 36/40-year-old women and men, 45% and 39% respectively did not intend to have children, and many were uncertain. The older women intended to have their first baby sooner than the younger ones, and the desired number of children decreased with age. Of the women aged 36/40 years, a third intended to have their first child in two to five years, and the vast majority wanted to have two or more children. In men, the intended time point for the first child was later. Of men aged 36/40 years, 75% intended to become a parent, and they wanted two children or more.

The 36/40-year-olds had the highest odds for infertility problems (aOR 3.8, CI 95% 1.8–7.9) and lacking a suitable partner (aOR 1.8, CI 95% 1.1–3.0), and lower odds for reasons such as: wanting to complete education (aOR 0.2, CI 95% 0.1–0.4), wanting to become well established at work (aOR0.2, CI 95% (0.1–0.4) and wanting a suitable dwelling (aOR 0.2, CI 95% 0.1–0.4) (Paper III, Table 3).

Table 7. Reproductive intentions in women and men aged 28, 32 and 36/40 years (%).

	Women				Men			
	28 yrs	32 yrs	36/40 yrs		28 yrs	32 yrs	36/40 yrs	
	n=139	n=111	n=115	p-value*	n=112	n=117	n=127	p-value*
Intend to have children								
Yes	84.9	73.1	31.9	<0.001	79.1	67.3	37.2	<0.001
No	4.3	13.0	45.1		11.8	14.2	38.8	
Don't know	10.8	13.9	23.0		9.1	18.6	24.0	
*Timing of first child***								
Within 2 years	35.2	57.4	68.8	0.002	17.1	41.9	44.4	0.005
In 2-5 years	56.2	39.7	31.3		71.1	53.2	52.8	
In >5 years	8.6	2.9	0.0		11.8	4.8	2.8	
*Expected number of children***								
1	3.6	6.9	32.4	<0.001	3.8	19.4	26.2	0.004
2	72.1	76.4	55.9		74.7	65.7	66.7	
≥3	24.3	16.7	11.8		21.5	14.9	7.1	

*Analysed by chi^2-test
**Of those who intended to have children

The reasons for remaining childless in women and men aged 28, 32 and 36/40 years differed between age groups (Figure 5a-c). The most prominent reasons in the 28-year-olds were related to being too young; they had not wanted children up to now (differences between women and men $p<0.05$) and wanted to do other things before starting a family, and/or they did not feel mature enough to become a parent, and in many cases they had not yet met a suitable partner. Other reasons were related to establishing themselves on the labour market: completing their education, getting a permanent job, becoming well established at work and having a better financial situation and housing. In general, the pattern was very similar in women and men.

The most common reasons given by the 32-year-olds were the same as those given by the younger women and men: they had not wanted to have children up to now, had no suitable partner, felt immature, and/or wanted to do other things before starting a family. However, the reasons related to work, finances and housing were less prominent than in the youngest group.

The most prominent reason to remain childless at the age of 36/40 years, in women as well as men, was that they had not found a suitable partner (60%), and many reported that they had not wanted children up to now, felt too immature or wanted to do other things before starting a family. Few of the oldest reported education and work-related factors as reasons for their childlessness. Difficulties in getting pregnant were expressed by 16% and 13% of men and women respectively.

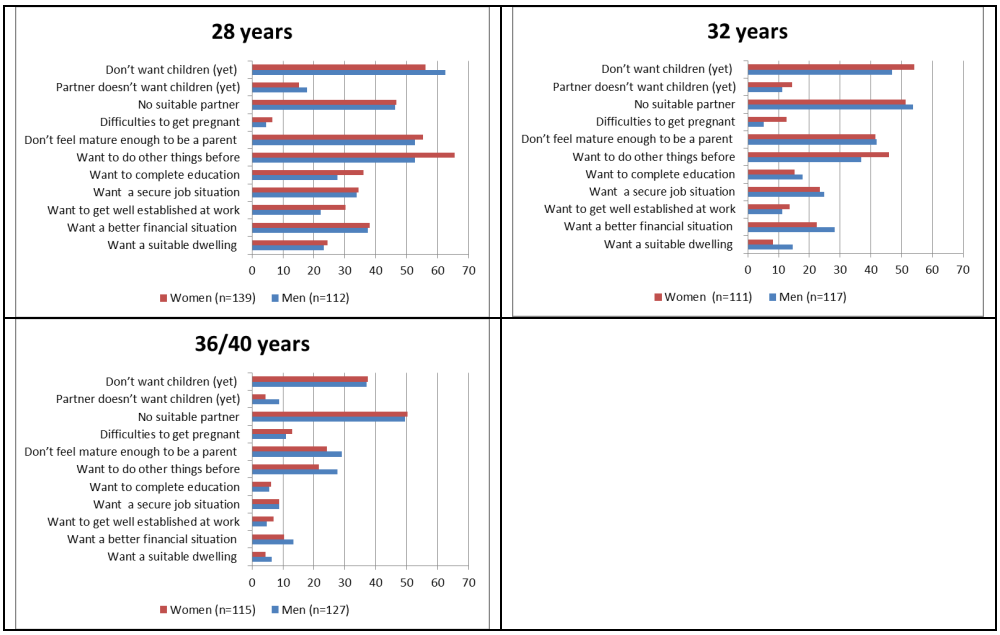

Figure 5 a–c. Reasons for not having children in childless men and women aged 28, 32, 36/40 years (%). More than one reason possible.

The 36/40-year-olds had the highest odds for infertility problems (OR 3.8, CI 95% 1.8–7.9) and lacking a suitable partner (OR 1.8, CI 95% 1.1–3.0), and lower odds for reasons related to work and financial situation.

PREDICTORS IN 22-YEAR-OLD WOMEN AND MEN FOR NOT HAVING CHILDREN TEN YEARS LATER (PAPER IV)

At the age of 32 years, 36.5% of the women and 47.3% of the men were still childless. Variables measuring family background that were associated with being childless at the age of 32 were: being second-generation Polish/Turkish, growing up in a large city, having well-educated parents, being an only child, not having moved from the parental home by 22 years of age, as well as less than positive experiences of the mother and father as parents, and a less satisfactory relationship with the mother (Table 8). All negative attitudes to children and own experience of parenthood predicted a two- to threefold increase in childlessness at the age of 32 (Table 9). Valuing a career, a good financial situation and plenty of time for leisure activities, did not predict childlessness.

Table 8. Associations between women's family background and being childless at the age of 32. Analyses by bivariate logistic regression analysis.

	Childless at 32 years			Childless at 32 years					
	All (n=1000)			Women (n=518)			Men (n=482)		
Family background	**No**	**% childless**	**OR (CI 95%)**	**No**	**% childless**	**OR (95% CI)**	**No**	**% childless**	**OR (CI 95%)**
Ethnicity									
Sweden	725	36.8	ref	367	29.7	ref	357	44.1	ref
Second-generation Polish/Turkish	275	47.3	1.5 (1.2-2.0)	151	44.4	1.9 (1.3-2.8)	123	50.8	1.3 (0.9-2.0)
Place of growing up									
Small or medium-sized city	517	36.4	ref	274	29.2	ref	243	44.4	ref
Large city (inner city/suburb)	329	46.5	1.5 (1.1-2.0)	172	44.2	1.9 (1.3-2.9)	157	49.0	1.2 (0.8-1.8)
Rural area	147	36.7	1.0 (0.7-1.5)	68	27.9	0.9 (0.5-1.7)	79	44.3	1.0 (0.6-1.7)
Mother's education									
High school or below	490	35.3	ref	244	29.1	ref	246	41.5	ref
College or university	362	44.2	1.5 (1.1-1.9)	212	38.2	1.5 (1.0-2.2)	150	52.7	1.6 (1.0-2.4)
Father's education									
High school or below	537	36.3	ref	282	30.5	ref	255	42.7	ref
College or university	287	44.6	1.4 (1.1-1.9)	147	39.5	1.5 (1.0-2.3)	140	50.0	1.3 (0.9-2.0)
Family's financial situation									
Mostly very good	232	35.8	0.8 (0.6-1.1)	118	28.8	0.8 (0.5-1.2)	114	43.0	0.9 (0.6-1.3)
Mostly rather good	581	40.3	ref	301	34.6	ref	280	46.4	ref
Mostly rather bad	134	39.6	1.0 (0.6-1.1)	78	38.5	1.2 (0.7-2.0)	56	41.1	0.8 (0.5-1.4)
Mother worked outside family during pre-school years									
Part-time	446	36.8	ref	240	30.8	ref	206	43.7	ref
Full-time	321	43.3	1.3 (0.9-1.8)	156	39.7	1.5 (1.0-2.3)	165	46.7	1.1 (0.7-1.7)
No	174	42.5	1.3 (0.9-1.8)	100	35.0	1.2 (0.7-2.0)	74	52.7	1.4 (0.8-2.4)
Siblings									
Yes	920	39.0	ref	477	33.1	ref	443	45.4	ref
No	55	54.5	1.9 (1.1-3.2)	30	50.0	2.0 (1.0-4.2)	25	60.0	1.8 (0.8-4.1)
Parents living together before age 16 years									
Yes	727	39.8	ref	373	33.0	ref	354	46.9	ref
No	269	39.8	1.0 (0.8-1.3)	142	36.6	1.2 (0.8-1.8)	127	43.3	0.9 (0.6-1.3)
Left parental home at ≤22 years									
Yes	825	36.4	ref	449	31.2	ref	376	42.6	ref
No	172	55.8	2.2 (1.6-3.1)	68	52.9	2.5 (1.5-4.2)	104	57.7	1.8(1.2-2.9)
Conflicts in family									
No	545	39.4	ref	261	31.6	ref	282	46.8	ref
Yes + Uncertain	429	39.4	1.0 (0.8-1.3)	245	36.7	1.3 (0.9-1.8)	184	42.9	0.9 (0.6-1.2)
Assessment of mother as a parent[1]									
Good	867	37.8	ref	458	32.1	ref	409	44.3	ref
Less than good	105	52.4	1.8 (1.2-2.7)	49	49.0	2.0 (1.1-3.7)	56	55.4	1.6 (0.9-2.7)
Assessment of father as a parent[1]									
Good	721	36.8	ref	375	30.7	ref	346	43.4	ref
Less than good	235	44.7	1.4 (1.0-1.9)	124	40.3	1.5 (1.0-2.3)	111	49.5	1.3 (0.8-2.0)
Relationship with mother[2]									
Satisfactory	804	37.6	ref	424	31.8	ref	380	43.9	ref
Less than satisfactory	168	47.0	1.5 (1.1-2.1)	84	45.2	1.8 (1.1-2.8)	84	48.8	1.2 (0.8-2.0)
Relationship with father[2]									
Satisfactory	695	38.0	ref	350	31.1	ref	345	44.9	ref
Less than satisfactory	268	42.5	1.2 (0.9-1.6)	145	39.3	1.4 (1.0-2.1)	123	46.3	1.1 (0.7-1.6)

[1] Five-point scale with the anchors verbally defined: 1 = Bad; 5 = Very good. Dichotomized as Good (4+5) and Less than good (1-3 + Don't know)

[2] Five-point scale with the anchors verbally defined: 1 = Very dissatisfied and 5 = Very satisfied. Dichotomized as Satisfactory (4+5) and Less than satisfactory (1-3)

Table 9. Associations between attitudes in 22-year-old women and men, and being childless ten years later. Analysed by bivariate logistic regression analysis.

	Childless at age 32 years								
	All (n=1000)			**Women** (n=518)			**Men** (n=482)		
Attitudes at age 22 years	**No**	**% childless**	**OR (95% CI)**	**No**	**% childless**	**OR (95% CI)**	**No**	**% childless**	**OR (95% CI)**
Attitudes to children and parenthood									
I enjoy children[1]									
Agree	730	33.0	ref	390	27.2	ref	340	39.7	ref
Don't agree	260	57.3	2.7 (2.0-3.6)	124	54.8	2.3 (1.4-3.8)	136	59.6	2.5 (1.6-4.1)
I think I can be satisfied in my life if I am a good parent[1]									
Agree	589	31.9	ref	308	26.6	ref	281	37.7	ref
Don't agree	377	51.5	2.3 (1.7-3.0)	197	45.7	2.3 (1.6-3.4)	180	57.8	2.3 (1.5-3.3)
Do you think you will have children in the future?									
Yes	775	33.9	ref	417	26.9	ref	358	42.2	ref
Perhaps or no	221	59.7	2.9 (2.1-3.9)	99	63.6	3.0 (1.7-5.1)	122	56.6	1.8 (1.1-2.9)
Attitudes to gender equality									
A society where men and women are equal is a good society[1]									
Agree	863	39.2	ref	466	33.0	ref	397	46.3	ref
Don't agree	113	42.5	1.2 (0.8-1.7)	43	46.5	1.8 (0.9-3.3)	70	40.0	0.8 (0.5-1.3)
It is equally important for both women and men to support themselves financially[1]									
Agree	928	38.7	ref	501	34.1	ref	427	44.0	ref
Don't agree	50	54.0	1.9 (1.1-3.3)	9	33.3	1.8 (0.9-3.3)	41	58.5	1.8 (0.9-3.4)
Attitudes to what is important in life									
Having children[2]									
Important	647	32.0	ref	361	26.3	ref	286	39.2	ref
Not so important	348	53.7	2.5 (1.9-3.2)	155	51.6	3.0 (2.0-4.4)	193	55.4	1.9 (1.3-2.8)
Living in a good partner relationship[2]									
Important	857	37.5	ref	459	31.4	ref	398	44.5	ref
Not so important	134	52.2	1.8 (1.3-2.6)	55	52.7	2.4 (1.4-4.3)	79	51.9	1.3 (0.8-2.2)
Being successful at work[2]									
Important	759	38.7	ref	393	32.6	*ref*	366	45.4	ref
Not so important	236	42.4	1.2 (0.9-1.6)	122	37.7	1.3 (0.8-1.9)	114	47.4	1.1 (0.7-1.7)
Having a good financial situation[2]									
Important	892	38.8	ref	472	33.3	ref	420	45.0	ref
Not so important	102	47.1	1.4 (0.9-2.1)	42	40.5	1.4 (0.7-2.6)	60	51.7	1.3 (0.8-2.2)
Having plenty of time for leisure-time activities[2]									
Important	711	40.4	ref	354	35.3	ref	357	45.4	ref
Not so important	282	37.6	0.9 (0.7-1.2)	160	30.6	0.8 (0.5-1.2)	122	46.7	1.1 (0.7-1.6)

[1] Five-point scale with anchors verbally defined: 1 = Don't agree; 5 = Agree completely. Dichotomized as Agree (4+5) and Don't agree (1-3, + don't know)

[2] Five-point scale with anchors verbally defined: 1 = Not important; 5 = Very important. Dichotomized as Important (4+5) and Not so important (1-3 + don't know)

Table 10. The odds ratios for childlessness at 32 in relation to the mother's level of education *and* the respondent's relationship satisfaction with the mother

	n	% childless	OR	95% CI
Level of education/Relationship satisfaction				
Low* /Satisfactory	399	32.8	1.0	
Low* /Less than satisfactory	80	41.3	1.4	0.9-2.3
High**/Satisfactory	296	57.6	**1.4**	**1.1-2.0**
High**/Less than satisfactory	59	41.2	**2.8**	**1.6-4.9**

*Low: High school or below

**High: College or university

ADVERSE PREGNANCY OUTCOMES RELATED TO ADVANCED MATERNAL AGE (PAPER V)

Table 11 shows that the adjusted Odds Ratio (aOR) for preterm birth, SGA, low Apgar score, stillbirth and neonatal death increased by age, in a similar way in Sweden and Norway. Exceptions were the aOR for fetal and neonatal deaths and low Apgar score in the oldest age group (≥40 years) in the Norwegian sample, where observations were too few (28 and 8 respectively) to allow valid conclusions. In both populations, there was already an increased risk in the group aged 30-34 years for the following outcomes: very preterm birth, SGA, low Apgar score, and fetal death. In this age group in the Swedish population, the risk of neonatal death also increased, and in the Norwegian sample moderately preterm birth increased.

Advanced maternal age, smoking, overweight, and obesity were each associated with all the outcomes of the study with the following exceptions: age 30–34 years was not associated with moderately preterm birth, smoking was not associated with low Apgar score, and overweight was not associated with SGA.

Maternal age of 30 years or older was associated with a larger number of additional cases of very preterm birth (693) and neonates with SGA (2 749) than smoking (very preterm birth: 158, SGA: 1.739) and overweight or obesity (very preterm birth: 470; SGA: 281) and with the same numbers of fetal deaths (251) as overweight or obesity (251). Of the three lifestyle factors, overweight or obesity was associated with the largest number of additional cases of moderately preterm births (1 255), neonates with low Apgar score (883), and neonatal deaths (92).

No statistically significant differences were found between the adjusted ORs for adverse outcomes in relation to maternal age, smoking, or BMI when comparing findings from 1990–1999 and 2000–2001, with the exception of moderately preterm birth at age 35–39 years (aOR 1.24, 95% CI 1.17–1.32).

Table 11. Adverse pregnancy outcomes in relation to maternal age in Sweden and Norway, 1990-2010.
Single-born infants to nulliparous women of advanced age compared with women aged 25-29 years (reference).

Crude and adjusted Odds Ratio (OR) and 95% Confidence Interval (CI). Statistically significant differences (p<0.001) indicated in bold

	Sweden (n=644184)				Norway (n=311620)			
Pregnancy outcomes by maternal age	**No. infants**	**%**	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio* (95% CI)**	**No. infants**	**%**	**Crude Odds Ratio (95% CI)**	**Adjusted Odds Ratio† (95% CI)**
Very preterm birth: 22-31 weeks								
25-29 years	2802	0.8	reference	reference	1937	1.0	reference	reference
30-34 years	2249	1.0	**1.23 (1.17-1.31)**	**1.24 (1.16-1.32)**	1164	1.2	**1.16 (1.07-1.24)**	**1.18 (1.10-1.28)**
35-39 years	981	1.4	**1.78 (1.65-1.91)**	**1.64 (1.51-1.78)**	497	1.8	**1.77 (1.61-1.96)**	**1.76 (1.59-1.95)**
≥40 years	229	2.0	**2.48 (2.16-2.84)**	**2.24 (1.93-2.61)**	87	2.2	**2.11 (1.69-2.62)**	**2.00 (1.59-2.50)**
Moderately preterm birth: 32 - 36 weeks								
25-29 years	17728	5.2	reference	reference	9439	5.1	reference	reference
30-34 years	11663	5.2	1.01 (0.99-1.04)	1.01 (0.98-1.03)	5119	5.3	**1.04 (1.01-1.08)**	**1.05 (1.01-1.09)**
35-39 years	4018	5.9	**1.15 (1.11-1.19)**	**1.12 (1.08-1.16)**	1718	6.4	**1.26 (1.20-1.33)**	**1.24 (1.18-1.31)**
≥40 years	734	6.4	**1.26 (1.16-1.36)**	**1.23 (1.13-1.33)**	288	7.2	**1.45 (1.28-1.63)**	**1.38 (1.22-1.57)**
SGA								
25-29 years	10417	3.1	reference	reference	7876	4.3	reference	reference
30-34 years	8059	3.6	**1.20 (1.16-1.23)**	**1.24 (1.20-1.28)**	4432	4.6	**1.08 (1.04-1.13)**	**1.08 (1.04-1.12)**
35-39 years	3273	4.8	**1.61 (1.55-1.68)**	**1.62 (1.55-1.69)**	1653	6.1	**1.47 (1.39-1.55)**	**1.43 (1.36-1.51)**
≥40 years	683	6.0	**2.03 (1.87-2.20)**	**1.96 (1.80-2.13)**	287	7.2	**1.74 (1.54-1.97)**	**1.65 (1.46-1.87)**
Apgar score <7 at 5 minutes								
25-29 years	4727	1.4	reference	reference	3061	1.7	reference	reference
30-34 years	3619	1.6	**1.18 (1.13-1.23)**	**1.16 (1.11-1.22)**	1847	**1.9**	**1.16 (1.10-1.23)**	**1.12 (1.06-1.19)**
35-39 years	1376	2.1	**1.48 (1.39-1.57)**	**1.40 (1.31-1.49)**	707	**2.6**	**1.60 (1.47-1.74)**	**1.52 (1.39-1.65)**
≥40 years	263	2.3	**1.69 (1.49-1.92)**	**1.56 (1.36-1.78)**	94	**2.4**	**1.43 (1.16-1.76)**	**1.31 (1.06-1.62)**
Fetal death‡								
25-29 years	1073	0.3	reference	reference	756	0.4	reference	reference
30-34 years	826	0.4	**1.23 (1.13-1.35)**	**1.24 (1.13-1.37)**	472	0.5	1.20 (1.07-1.35)	1.26 (1.12-1.41)
35-39 years	392	0.6	**1.85 (1.64-2.07)**	**1.73 (1.52-1.96)**	222	0.8	2.02 (1.74-2.35)	2.18 (1.87-1.54)
≥40 years	100	0.9	**2.80 (2.28-3.45)**	**2.33 (1.85-2.95)**	28	0.7	1.72 (1.18-2.51)	1.88 (1.29-2.75)
Neonatal death: 0-27 days								
25-29 years	649	0.2	reference	reference	357	0.2	reference	reference
30-34 years	474	0.2	1.12 (1.00-1.26)	**1.18 (1.04-1.35)**	211	0.2	1.13 (0.96-1.35)	1.16 (0.97-1.38)
35-39 years	178	0.3	**1.38 (1.17-1.63)**	**1.43 (1.19-1.72)**	82	0.3	**1.58 (1.24-2.00)**	**1.63 (1.28-2.08)**
≥40 years	44	0.4	**2.03 (1.50-2.76)**	**2.09 (1.48-2.95)**	8	0.2	1.04 (0.52-2.09)	1.09 (0.54-2.20)

CI, confidence interval; SGA, small for gestational age.

* Adjusted for year of birth, civil status, country of birth (Nordic vs. not Nordic country), diabetes, chronic hypertension, smoking and body mass index.

† Adjusted for year of birth, civil status, diabetes, and chronic hypertension.

‡ From 22 weeks of gestation.

DISCUSSION

Based on data from population-based cohorts from two Nordic countries, the Swedish Young Adult Panel Study (YAPS), the Norwegian Mother and Child Cohort (MoBa) and the Medical Birth Registers in the two countries, the findings of this thesis confirm many of the results in previous publications on the phenomenon of postponing parenthood, and also add further new information.

Having children or not

The 32-year-old participants in the YAPS cohort who were still childless had either postponed childbearing for a number of well-known reasons [19, 42, 47, 48, 54, 59, 86, 87] and still planned to have children or were involuntarily childless, and others had actively chosen to be childless. One of the consequences of delaying parenthood is that it is increasingly difficult to become pregnant. This is illustrated by the YAPS findings, where 14% and 12% of the oldest women and men respectively reported this problem, and by the MoBa findings, where *in vitro fertilization* had helped 9% of the 33-37-year-old women and 18% of those aged 38 years and older to have their babies. A review reported that regardless of age, the prevalence of 12-month infertility ranges from 3.5% to 16.7% in high-income nations [88].

Nearly one third of the older couples in the YAPS study were childless by choice, which was far more than among the younger couples. An obvious explanation for this difference is that those who wished to have children in the young group had already become parents. There has been a general increase in the prevalence of voluntary childlessness during recent decades [89], and Sweden is no exception. In 2009, 5% of all women under the age of 34 and men under 36 years of age reported that they preferred not to have any children; and in women aged 34-40 years and men aged 36-44 years the prevalence was 20% and 25% respectively [90]. These figures suggest that childcare responsibilities have become less attractive, and achieving other goals in life, such as a career, a good financial situation, and more extensive leisure time for personal activities, has become more important [89]. This development may have consequences for the future total fertility rate (TFR).

Predictors of childlessness at 32 years

Not planning to have children in one's early twenties was a strong predictor of being childless ten years later. This finding was supported by previous studies [63] and it shows that attitudes to becoming a parent are shaped at a relatively young age [91]. Family background was also important, and associations with being brought up in a large city [92], having highly educated parents [93], not having moved from the parental home [50], and not having any siblings [92] have also been reported by others. Highly educated parents are more inclined to encourage their children to proceed to higher education compared with less educated parents [48, 93]. The parents may have also been more career-oriented role models, affected by the second demographic transition [94]. In this study, the limited supply of affordable

accommodation in the large cities has prolonged the period when young people still live with their parents, and this may also prolong the period of dependence, adolescence and possibly also the inclination to plan one's own parenthood [50].

What this study adds is that young women's and men's *negative experience* of their own parents and their relationship with their mother predicted childlessness ten years later. One can only speculate about possible explanations for this finding. They might have been reluctant to repeat something, namely parenthood, which seemed to be unpleasant. Another explanation could be that an unsatisfactory relationship with parents could have led to psychological problems, such as uncertainty, low self-esteem and difficulty in taking on such a great responsibility as parenthood. The association between negative experiences of one's own parents and subsequent childlessness may always have existed, or it may be a new phenomenon caused by more absent parents, when both women and men work outside the home and most children spend the day in childcare. Our data support this latter interpretation, since the odds of being childless increased by having a highly educated mother and a good relationship with her, but they increased even more if the mother was highly educated and the relationship was not satisfactory. Qualitative studies using in-depth interviews might shed more light on this issue and provide further understanding.

Reproductive intentions and reasons given for being childless

As in other studies of childbirth intentions, the vast majority of women and men aged 28 and 32 years intended to have children [54-59, 61], mostly two [95], and the reasons given for delaying parenthood were related to maintaining an independent life, completion of education, establishment at work, achieving financial security [51], and finding a suitable partner [43, 48, 87]. In general, women and men overestimated their fecundity by planning to have their first child at an age when reproductive capacity is reduced.

In the study of women and men who remained childless at the age of 36 or 40 years, 32% of the women and 37% of the men still intended to have children, and a majority wanted to have more than one child. They had delayed childbearing because they lacked a suitable partner or had not wanted children up to now, and surprisingly many felt immature and wished to maintain an independent life. Their peers may also have postponed childbearing to their late thirties, as even an age of 40 years has become a socially 'acceptable' age limit for childbearing in many European countries [65]. Many may have had little knowledge about the age-related decline in fecundity, and this also seems to be the case for some women and men in their late thirties [57, 96-98]. In Sweden today, confidence in medical technology and specifically in ART is generally high, and this may lure young women and men into a belief that everything will work out well, despite the fact that the ART success rate also declines with age [53]. However, our results also suggest that many are well informed and have realistic expectations of their reproductive possibilities. Nevertheless, there is a need to inform young people at an early age about the optimal time to have their first baby and when fecundity starts to become a problem.

Lack of a partner was the most prominent reason for postponing parenthood; 60% reported that lack of a suitable partner was a reason for still being childless. Higher demands on a potential partner may be one explanation for this [99]. For instance, the increasing number of women with a high education may prefer a partner with similar qualifications, and this may cause problems since women's level of education is now higher than men's in Sweden, as in many other European countries [22]. Childlessness in men has been shown to increase [100], and mostly in men with low education [47]. Also, women generally prefer a male partner who is slightly older than themselves and has a higher level of education [22, 99]. Being single may be a voluntary choice [89, 101]but may also be an involuntary one, and difficulty finding a partner may be explained by the person not being physically or socially attractive [99, 102, 103].

Characteristics of first-time parents of advanced age

The general picture of women and men who have their first child at an advanced age is that they constitute a group of well-educated high-income earners. This thesis provides a more comprehensive and complex picture. The large data set from MoBa allowed more in-depth analyses and, most importantly, also enabled us to identify an overrepresentation of parents characterized by low level of education, unemployment, single status, unplanned pregnancy and an unsatisfactory relationship with their partner. Besides fecundity problems, other problems related to ageing were also more common, such as physical health problems, depression and fatigue. This means that advanced age could imply extra burdens for some women, both in terms of a higher risk of adverse pregnancy outcomes, but also problems related to health, financial situation and social support. This comprehensive picture could help healthcare providers to be more attentive to the individual needs of first-time parents of advanced age.

Pregnancy outcomes

The medical risks of late childbearing have been elucidated in a large body of literature [10, 24, 104]. However, the studies are inconsistent regarding the definition of advanced maternal age and the choice of reference group, and many studies have not had enough power to draw conclusions about severe outcomes of low prevalence. The choice of age cut-off and the definition of the reference group are both crucial when investigating effects of maternal ageing. If, for example, women of 35 years and older are compared with all women younger than 35, the effect of ageing may be underestimated because of the U-shaped distribution of some of the adverse pregnancy outcomes, such as the rates of preterm birth, low Apgar score and neonatal mortality, which are higher in teenagers than in women in their twenties [105]. Our study of medical outcomes showed that already at the age of 30-34, there was an increased risk of some serious outcomes, namely very preterm birth, small for gestational age (SGA), low Apgar score, stillbirth and neonatal death. These findings were related to the fact that we chose 25/29-year-olds as a reference group, and in this age group pregnancy outcomes are more or less optimal. Analyses from two

independent populations showing very similar results strengthened the validity of the findings.

The findings also suggest that advanced maternal age should be regarded as a risk factor comparable to smoking and overweight when it comes to the number of *additional cases* caused by the respective lifestyle factor. The number of additional cases is related to the prevalence in the population, and the comparability of risks in Sweden is related to the fact that the proportions of smokers and women who are overweight or obese are relatively small, whereas many women give birth at the age of 30-34. So, even if the risk for the individual woman in this age group is small, the number of cases of severe outcomes at a national level may still be comparable to those caused by smoking or overweight/obesity.

Women and men

This thesis showed that findings related to men were very similar to those for women. Delayed childbearing was associated with the same background characteristics, and predictors of childlessness and reasons for not yet having children at the age of 32 were also the same. Swedish men have almost the same views as their partner about *if* and *when* to have the first baby [106]. These findings may be related to factors such as high female employment rates, generous welfare sectors including access to childcare for almost everyone, and a relatively low level of gender inequity in both Sweden and Norway. The increased focus on gender equity has implied that men of today are expected to contribute to childrearing and household tasks [49]. Considerable measures have been taken in both countries towards more egalitarian parenthood, and to facilitate the combination of career and childbearing. For example, working parents are granted generous parental leave – in Sweden a total of 480 days with 80% of salary and in Norway 413 days with 80% of salary – and 60 and 98 of these days are specifically allocated to the other parent/father in Sweden and Norway respectively. Even if developments are slow, 24% of the fathers in Sweden used the opportunity to stay at home with their child in 2012 (www.forsakringskassan.se). In Sweden, an equality bonus was introduced in 2008, encouraging parents to share parental leave more equally (SEK 13 500 per year).

In spite of these efforts towards gender equity and legislation against discrimination due to pregnancy in Sweden and Norway [107], pregnant women *and* their partners are at higher risk of unemployment than their non-pregnant peers. An Italian study showed that disagreement in reproductive intentions was greatest in couples where women had a career of their own [108] but such findings were not reflected in the Swedish data, despite the fact that Swedish women's level of education is now higher than men's. There is however a trend in Sweden and Norway, as in many other countries [89], that an increasing proportion of women and men choose a childfree life, particularly women in traditionally male professions, whereas women in caring professions such as nursing prefer to combine family and work [109].

The definition of 'advanced' maternal and paternal age

There is no consensus regarding the definition of 'advanced' parental age in relation to having the first child, but ≥35 years has often been used in studies of maternal age , whereas there are too few studies of paternal age to allow any conclusions to be drawn. We used a higher cut-off for paternal age in Paper II than for maternal age in Paper I for two reasons. One is that men are older than women when they have their first baby, and the other is that men's reproductive capacity lasts longer than women's.

By illustrating the prevalence of maternal and paternal characteristics over the age span we found that many variables changed in a more continuous way than at a specific age, and also that advanced age should be defined earlier than the suggested 35 years in women: somewhere between 30 and 34 years. This was most important in the study of adverse pregnancy outcomes. By using ≥33 years and ≥38 years for advanced and very advanced maternal age respectively, we could identify the small but most disadvantaged groups in this large sample. Another study from the research group showed that 32-year-old women had a slightly higher risk of adverse psychological outcomes in pregnancy and the first three years of motherhood than a younger reference group [38]. For similar reasons, a slightly higher age cut-off for advanced and very advanced *paternal* age could be recommended: ≥35 and ≥40 years respectively.

Little is known about the combined effect of expecting the first child when both the mother and the father are of an advanced age. In a recent review of the consequences of postponing parenthood, Schmidt et al [24] concluded that 'as women in general have partners who are several years older than themselves, it is important to focus more on the combined effect of advanced female and advanced male age on reproductive outcomes in the future.'

Demographic aspects

Data from Swedish and Norwegian cohort studies were used in this thesis, and the countries have been treated as if they were very comparable. The development of increasing mean age for first-time parents has been very similar in the two countries. The associations found between the different factors and the delaying of childbearing in Norwegian women and men (Papers I and II) were also very similar to the pattern observed in the Swedish sample regarding predictors of childlessness at the age of 32 (Paper IV) and reasons for remaining childless (Paper III). Most important, the aOR for adverse outcomes was very similar in the two countries (Paper V).

In previous studies, fertility patterns in the Nordic countries have been sufficiently alike to speak of a common 'Nordic fertility regime' [19]. For instance, Andersson and colleagues [19] found remarkable similarities in postponement and recuperations (catch-up effect) between the Nordic countries, and also very small differences in completed fertility, for instance across educational groups.

The fertility patterns of the Nordic countries have received some attention, as the fertility rates have remained at replacement level. This is in contrast to most other European countries, for example Italy and Spain [110]. The Nordic countries were fore-runners in the second demographic transition, characterized by low fertility rates and low death rates, and the other European countries followed. In recent years, the economic situation has been more favourable in Sweden and Norway than for instance in Spain and Italy, and fertility rates in the latter countries have decreased to alarming figures. Improvement in economic and social development implies lower fertility [111]. However, at times of *greater* affluence, many choose to also have a third baby, and this is the tendency at the moment in both Sweden and Norway [21, 111]. The policy to facilitate the combination of work and childrearing by the granting of generous parental leave for working parents may have had a positive impact on the total fertility rate in Sweden [112], which increased from 1.55 to 1.97 between 2000 and 2011, but to a lesser extent in Norway, (1.85-1.88) . Equity may have come further in Sweden than in Norway, and whether or not there are opportunities for fathers to use their share of the parental leave has been questioned more in Norway [113, 114]. An equal proportion of women are in the workforce and the fact that all children can attend daycare centres in Sweden and Norway implies that parents may combine work and childrearing. Of all births in Sweden and Norway, 25% and 23% of the mothers have immigrant background. However, this is important for the fertility pattern in first-generation immigrants, and second-generation immigrants have already adapted to the fertility pattern of the new country [115, 116].

In summary, Sweden and Norway are very similar in demographic terms (mean maternal and paternal age at first birth, TFR, CFR), and regarding politics and care in connection with pregnancy, birth and childrearing. Our results confirm the similarity between Sweden and Norway in various aspects of postponing parenthood. The results of the studies may therefore be generalized to both countries from this point of view.

What now?

Large parts of this thesis confirm results from previous studies on the postponement of parenthood phenomenon, including the reasons for postponing childbirth in the YAPS-based study, the greater problems of 'older parents' to conceive, higher rates of physical and mental health problems, and the overrepresentation of well-educated high-income earners in the MoBa-based studies, and in the higher risk of adverse pregnancy outcomes in the study based on the Medical Birth Registers. In addition to these findings, we have added some additional knowledge, the most important being that medical risk may increase at an earlier age than previously described. In total, I believe that the new findings in combination with the confirmation of previous research findings underline that the importance of drawing conclusions about clinical practice.

From a political view, measures could be taken to make it easier for young couples to start a family at earlier age, for example around the age of 25-30 years when the

biological conditions are optimal. In the previous generation it was common to have the first baby after completion of education, but today many wait until they are established on the labour market and have a full income. This may partly be related to the fact that parental leave benefits are based on the annual income from the preceding year, and parents without such an income, e.g. those who are unemployed or students, receive only approximately 20 € per day. Investigations are warranted of the financial, social and demographic consequences of changing this system by increasing benefits for those who have not yet contributed to the workforce.

At present, women and their partners who are pregnant or planning to become pregnant are at higher risk of unemployment than their non-pregnant peers, despite the law against discrimination due to pregnancy [107]. If the generous parental leave were to also include the young and students, it might be more favourable for individuals to establish themselves on the labour market when they have already started a family. Pregnancy and parental leave take focus and time from a career, and sick leave in connection with childbearing is more common in women of advanced reproductive age [117, 118]. Employers might reconsider whether it is more or less cost effective to employ a young childless person who will soon become a parent and go on parental leave compared with a person who already is a parent. Whether it is more profitable to employ a 30-year-old mother of two children than her childless peer needs further investigation.

Our findings support what has been highlighted by many, that women and men need better information about the decline in fecundity [43]. Some may then attempt to have children at an earlier age. The unrealistic expectations of parenthood in women in their thirties and forties suggest that this is not the case at present. To make informed reproductive choices, young women and men need more information on reproduction issues; in school by teachers and nurses/midwives, in connection with contraception counselling and in youth clinics. Interventions may for instance be information campaigns in different media. Information based on reproductive life plan (RLP), tested by Stern and colleagues, seems to be one such promising intervention to improve Swedish female students' knowledge of reproduction [119]. Compared with a reference group who received standard care only in connection with contraception counselling, students who also received RLP-based information were more knowledgeable about reproduction, for instance the chance of becoming pregnant spontaneously and by ART. Health professionals may have a tendency not to interfere in patients' lives and decisions to avoid increasing any worries or self-blames, perhaps at the cost of childlessness or adverse pregnancy outcomes. A clearer message concerning their reproductive chances might help some women to start trying to become pregnant when they still have a good chance. Men also need to be aware of age-related pregnancy compactions and the decline in fecundity, as they often have partners who are around their own age.

METHODOLOGICAL CONSIDERATIONS

The strengths of the studies are primarily the large population-based samples, the longitudinal designs, and the fact that the information reported is not only on women, but also on men and on a sample of second-generation immigrants on whom data are seldom available from national statistics [120]. Many of the results have been validated by including two countries, which have fairly similar reproduction patterns in terms of age at first birth, TFR and CFR, as well as educational level, cultural norms for gender equity, women in the workforce, children in institutionalized care, and similar healthcare.

Study design
Data for all five studies were retrieved from cohort or register studies including population-based national samples. In cohort studies, exposed and unexposed participants are followed over a period of time, and the exposed are compared with the unexposed in terms of the occurrence of the outcome. It is possible to draw conclusions about associations but not on the direction of cause and effect. However, the direction will be strengthened if the exposure takes place *before* the outcome occurs.

In Paper IV, the longitudinal design was utilized to study background factors and attitudes that had taken place ten years before the outcome. Causal effects should be interpreted with caution but are nevertheless strengthened by the design. In Papers I and II, on the characteristics of women and men who were expecting their first baby, the data was analysed cross-sectionally. The expected changes in relation to age do not necessarily *explain* why some women and men delay the birth of their first child; for instance, a woman may have a high income because of the length of time she has worked, and not because she has actively delayed childbirth until she has a sufficient income. Nevertheless, the changes serve to *describe* characteristics of these women. These examples stress the importance of not interpreting the associations found in our study as causal.

Internal validity

Two types of error are of main concern in epidemiological study design, these are systematic and random errors [121]. Internal validity concerns the accuracy of estimates within the studied populations; validity is the degree of absence of systematic error (bias); and precision is the absence of random error. Systematic errors need to be dealt with when designing the study. In observational studies the most common sources of systematic errors are *selection bias*, *information bias* and *confounding* [121].

Selection bias
Selection bias may occur in the recruitment process or due to factors that influence participation in the study [121]. There can be a selection bias when the relationship between exposure and outcome for those who participate differs from that for the entire population to which one wishes to generalize the results. Selection bias may be

caused by, for instance, a lack of interest in the issue, too comprehensive questionnaires for certain groups, and loss to follow-up [121].

Although the vast majority of those who were recruited responded to the questionnaire (women 95%, men 94%), the participation rate was low in the MoBa cohort (38.5%). Nilsen and colleagues [122] evaluated the possible selection bias in women participating in MoBa by comparing the study sample with the total population using data from the MBRN. They concluded that the prevalence of outcomes may be underestimated, whereas *associations* between exposures and outcomes were unbiased. Because of the low participation rates, we investigated the representativeness of the samples by comparing some background factors of a MoBa sub-sample in 2003, halfway through the recruitment, with the total population of new mothers and fathers in MBRN from the same year, the MoBa sample excluded. The samples were fairly representative, but more women in the sub-sample were married or cohabiting, non-smokers, had an IVF pregnancy and slightly more physical problems. Immigrants were underrepresented because of language difficulties. Also, in the study of fathers' characteristics, men with a low level of education or a native language other than Norwegian were underrepresented. The lower participation rate for becoming fathers (32%) may be a consequence of the recruitment process. Non-responding and less advantaged women [122], or women who did not have any contact with the baby's father, would probably not assist in the recruitment by forwarding the invitation and questionnaire. Consequently, the most vulnerable fathers-to-be, as well as couples, are not included in this study, and the negative outcomes may therefore be underestimations.

In the YAPS, the participation rate of the randomly selected national sample was higher, 65%. As is common in surveys, women had the highest rate of participation [121]. Unfortunately, we lack information about those who did not respond (www.suda.su.se/yaps), but it is likely that the socio-economically disadvantaged, and those who are not so interested in family life and plan a childfree life, are underrepresented.

In order not to lose any cases in the multivariate analyses (Papers I-II), missing values were categorized into a specific category; 'missing'. All estimates where calculated *with* or *without* the missing group, these analysis gave similar results.

Information bias
Information bias may result from incorrect measurement or incorrect classification of the exposures or dependent variables in the studies [121]. This bias may lead to incorrect estimates of the associations between exposures and outcome.

The studies are based on information mainly collected prospectively by means of self-reports in questionnaires or retrieved from registers, and recall bias could therefore be minimized. We cannot rule out the possibility that recall bias has occurred when responding to some retrospective questions, such as physical and mental symptoms and family background (Papers I-II, IV). A limitation of surveys is

that respondents may interpret questions in a way that was different to that meant by the researcher [123]. We have mainly used single-item questions for independent variables from the MoBa and the YAPS questionnaires. However, when choosing variables, efforts were made to judge the validity of each question. Age-related attitudes to reporting personal information may also have led to underreporting of certain health behaviour, for example smoking and use of alcohol, especially since the responders to MoBa were pregnant and expected to have a healthy lifestyle.

Random error
The main sources of random error are lack of precision in measurement (low repeatability) and inadequate sample size. One way of dealing with random error is to include large study samples. In spite of precise measurements, the estimate could be inaccurate (biased).

Studies I, II and V are based on large population-based samples securing precise estimates. In addition the study power also made it possible to investigate women and men of advanced and very advanced age (Papers I and II) as well as rare infant outcomes (Paper V).

Confounding
The criterion for a confounder is that the variable must be associated with the exposure *and* the outcome, and not act as an intermediate factor. The confounder must be associated with the outcome either as a cause or proxy for the outcome. The effect of investigated exposure(s) is confused with the effect of the confounder(s) [124].

Confounding may be a challenge in studies with maternal age as the exposure. In Paper V, we followed the strategy to avoid adjusting for the natural process of ageing and restricted the confounders to the available socio-demographic factors, smoking, BMI, year of birth, civil status, chronic hypertension and diabetes. Despite the fact that smoking and overweight are associated with age (the independent variable) and infant outcomes, the effect estimates were very similar in the Swedish sample, where these data were available and could be adjusted for, and the Norwegian sample, where the information was lacking.

External validity

External validity refers to the generalizability of the results to the target population [121], and depends on the internal validity.

The low participation rate in the MoBa was of concern but comparisons with the total cohort in mid-recruitment showed that the samples were fairly representative. Studies I and II comprised women and men who were able to speak sufficient Norwegian, and had their first baby in a delivery unit with more than 100 births annually. Further, the studies focus on biological parenthood, which limits the generalization to not include other forms of parenthood (same sex parents, foster parents, and adoptive parents). The results may therefore be generalized only to biological parents. The

demographic pattern in the Nordic countries is very similar, especially in Sweden and Norway. Therefore the results from Papers I-II could also most likely be generalized to a similar Swedish population, and those from Papers III and IV to a Norwegian population, including second-generation immigrants from Poland and Turkey.

In Study V, nearly the entire Swedish and Norwegian populations were included, and the results can be generalized to these two populations. To validate the measurements, data from the two similar countries were used. Sweden and Norway have great cultural similarities, but also some differences, and we hoped to obtain more valid data that could be related to biological ageing. An important similarity in this context is the cultural background, with similar socio-economic standard, languages that can be mutually understood and obstetricians and midwives being trained and practising in a roughly similar way. One important difference is that maternity care in Norway has been more decentralized than in Sweden, with a larger proportion of smaller units run by midwives in remote areas [125]. The long period of time covered could also have been problematic, and was therefore controlled for by splitting the data into two decades to compare outcomes from 1990 to 1999 with those from 2000 to 2010.

CONCLUSIONS

Besides having more age-related reproductive and physical health problems, women and men who have their first baby at an advanced or very advanced age constituted a heterogeneous group characterized by either socio-economic prosperity or vulnerability.

Many childless 36-and 40-year-olds intended to have children but seemed to overestimate their fecundity. The most prominent reasons for being childless were: not having wanted children up to now, lack of a partner, infertility problems, and prioritizing an independent life.

Young persons' social background and the experience of their own parents, especially their relationship with their mother, and attitudes to children and parenthood in the early 20s may have an impact on reproductive behaviour.

By the age of 30-34, *maternal age* is already associated with an increased risk of serious infant outcomes (preterm birth, infant small for gestation age, low Apgar score, stillbirth and neonatal death). Although the risk is small for the individual, it may be significant for society as a result of the large number of women who give birth at this age.

Advanced maternal age is an independent risk factor for serious infant outcomes in relation to smoking and overweight, and the combination of the three factors is associated with a substantially increased risk of negative pregnancy outcomes.

Maternal age of 30 years or older was associated with the same number of additional cases of fetal deaths as overweight or obesity.

Future research

Although measures to turn the trend of postponing childbearing could be based on existing knowledge, further research may still be needed.

Interventions to improve young people's knowledge on reproductive issues need to be tested in randomized controlled trials.

Studies on the combined effect of advanced parental age on short- and long-term outcomes are lacking.

The costs and benefits of earlier childbearing, for society, businesses, and the individual, require further investigation.

THESIS SUMMARY IN NORWEGIAN

Faktorer assosiert med å være eldre førstegangs foreldre.

Anne Britt Vika Nilsen, Institutionen för kvinnors och barns hälsa, Karolinska Institutet.

Siden 1970-tallet har gjennomsnittsalderen for førstegangsforeldre økt i de fleste høy ressurs land. Hovedmålet med denne avhandlingen er å undersøke hva som kjennetegner eldre førstegangs forelder, kvinner og menn, årsakene til at de venter med å få barn og konsekvenser for utfallet av fødselen.

I Norge og i Sverige er gjennomsnittsalderen for førstegangsmødre henholdsvis 28 og 29 år, og for førstegangsfedre, 31 og 32 år. Forskning har vist at unge mennesker generelt sett ikke har vært tilstrekkelig oppmerksom på biologiens begrensninger. Med økende alder følger større risiko for komplikasjoner i forbindelse med svangerskaps- og fødsel.

I studie I og II ble det brukt data fra den norske Mor og Barn-undersøkelsen (MoBa). Utvalget bestod av 41 236 kvinner og 14 832 menn som fikk sitt første barn i perioden 1999-2008. Eldre hadde større problemer med å bli gravide sammenlignet med yngre, dette gjaldt kvinner som var 33 år eller eldre og menn 35 år eller eldre. De hadde flere helseproblemer og flere i denne gruppen var røykere, de drakk oftere alkohol og var oftere overvektige sammenlignet med kvinner i alderen 25-32 år og menn i alderen 25-34 år. På den annen side hadde de fleste av de eldre foreldrene høyere utdanning og inntekt, men det var også en liten gruppe som hadde lav utdanning, var arbeidsledige, enslige, hadde dårlig relasjon til sin partner og et ikke planlagt svangerskap.

Studie III og IV er basert på en svensk spørreundersøkelse: The Young Adult Panel Study (YAPS). Den ene studien undersøkte hvilke intensjoner man hadde for fremtiden når det gjaldt å få barn. Videre ble årsaker til barnløshet ved henholdsvis 28, 32, 36 og 40 år undersøkt, hos kvinner (365) og menn (356). Mange overvurderte sin evne til å få barn senere i livet; 1 av 3 kvinner og menn hadde intensjoner om å få barn etter 36 og 40 år. De viktigste årsakene til at 36/40 åringene var barnløse var; mangel på en passende partner, at man ikke ønsket å få barn, at man ikke følte seg moden nok eller at man ville prioritere annet før man fikk barn. I studie IV ble sammenhengen mellom familiebakgrunn og holdninger til barn og familie undersøkt, samt hva man vurderer som viktig i livet når man er 22 år. Utvalget var barnløse kvinner (518) og menn (482). Prediktorer for barnløshet ved 32 år var; å ha foreldre med høy utdanning, å ha vokst opp i storby, å være enebarn, at man fortsatt bodde med foreldrene som 22 åring samt negative opplevelser i forhold til egne foreldre, spesielt mor. Også negative eller ambivalente holdninger til selv å skulle få barn predikerte barnløshet 10 år etter.

Studie V er en populasjons-basert undersøkelse som inkluderte 955 804 førstegangsfødende kvinner, hvor data ble hentet fra det norske og svenske

fødselsregisteret over en tidsperiode på 20 år, 1990-2010. Risikoen for prematur fødsel, liten for tiden (SGA), lav Apgar score, dødfødsel og neonatal død ble undersøkt hos kvinner i tre aldersgrupper: 30-34 år, 35-39 år og ≥40 år, og sammenlignet med kvinner som fødte i alderen 25-29 år. Alder som risikofaktor ble sammenlignet med andre kjente risikofaktorer som røyking og overvekt/fedme. Risikoen for komplikasjoner for barnet økte på lignende vis med kvinnenes alder i Norge og Sverige. Allerede fra 30 års alder var det like mange tilfeller av dødfødsel som ved overvekt/fedme, og flere tilfeller enn ved røyking, sammenlignet med en gruppe normalvektige, ikke røykende kvinner i alderen 25-29 år.

Denne avhandlingen bekrefter funn fra tidligere forskning ved at kvinner som utsetter første fødsel er velutdannede og har høy inntekt. I tillegg bidrar avhandlingen med informasjon om eldre førstegangs fedre. Studiene har kartlagt at det også er en sårbar gruppe som blir foreldre sent i livet. Resultatene tyder også på at det er en sammenheng mellom opplevelse av egne foreldre og holdninger til barn/foreldreskap i ung alder og når man selv får barn. Videre viser studien at risiko for alvorlige komplikasjoner hos barnet øker allerede før 35 års alder hos førstegangsfødende kvinner.

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