

From Department of Women's and Children's Health
Karolinska Institutet, Stockholm, Sweden

BECOMING A MOTHER AT AN ADVANCED AGE

Pregnancy outcomes, psychological distress, experience of
childbirth and satisfaction with life

Vigdis Aasheim



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Institutet**

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BECOMING A MOTHER AT AN ADVANCED AGE. Pregnancy outcomes, psychological distress, experience of childbirth and satisfaction with life.

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Becoming a mother at an advanced age. Pregnancy outcomes, psychological distress, experience of childbirth and satisfaction with life.

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The objectives of this thesis were to investigate adverse pregnancy outcomes, and pregnancy and psychological experiences in women who become mothers in the later phase of the reproductive period.

The age of first-time mothers has increased in most high-income countries in recent decades. Research into the postponement of childbirth phenomenon has predominantly focused on pregnancy and infant outcomes, and only to a lesser degree on psychological aspects of postponement.

Study I is a population-based register study including 955 804 primiparous women from the Swedish and Norwegian Medical Birth Registers who gave birth between 1990-2010. It investigates the risk for preterm birth, infants small for gestation age, low Apgar score, stillbirth and neonatal death in women aged 30-34 years, 35-39 years and ≥ 40 years compared with women aged 25-29 years. Study I also compares risks associated with advanced maternal age with those associated with smoking and being overweight or obese. The adjusted Odds Ratios (aOR) of all outcomes increased with maternal age in a similar way in Sweden and Norway and the risk of fetal death already at age 30-35 years (Sweden OR 1.24; 95% CI 1.13-1.37, Norway aOR 1.26; 95% CI 1.12-1.41). The Swedish data showed that a maternal age of ≥ 30 years was associated with the same number of additional cases of fetal deaths as being overweight/obesity (251) and a larger number than smoking (67) compared with normal weight, non-smokers aged 25-29 years, and estimated over the entire time period.

Studies II-IV are longitudinal prospective population-based cohort studies based on data from the National Norwegian Mother and Child Cohort Study conducted by the Norwegian Institute of Public Health.

Study II investigated psychological distress in 19 291 nulliparous women from mid pregnancy to 18 months after the birth, comparing women of ≥ 32 years with those of 25-31 years. It was found that women in the oldest group had a slightly increased risk of psychological distress during pregnancy and the first 18 months of motherhood.

Study III investigated 30 065 women's experience of childbirth at six months postpartum in relation to antenatal expectations, using the same age categories as in Study II. The oldest women had a marginally higher risk of experiencing childbirth as worse than expected. Older women seemed to manage better than younger women when having an operative delivery.

Study IV investigated 18 565 women's satisfaction with life during pregnancy and the first three years of motherhood, comparing women of 32-37 years and ≥ 38 years respectively with the same reference groups as above. Women in the two oldest age groups reported a slightly lower degree of satisfaction with life, and the age effect was greatest three years after the birth.

In conclusion, this thesis shows that the postponement of childbirth in high-income countries may increase the risk of adverse pregnancy outcomes at an earlier age than has previously been reported, and that it may have marginal negative effects on

women's emotional wellbeing and satisfaction with life. These findings should be included when giving reproductive health information to young people.

Keywords: Advanced age, Smoking, Overweight, Maternal age, Postponement of childbirth, Pregnancy, Postpartum, Experience of Childbirth, Satisfaction With Life, Primiparous

LIST OF PUBLICATIONS

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LIST OF ABBREVIATIONS

ART	Assisted reproduction technologies
BMI	Body Mass Index
CI	Confidence Interval
EPDS	Edinburgh Postnatal Depression Scale
EM	Expectation Maximization
GEE	Generalised Estimation Equations
GLM	Generalised Linear Models
gwk	Gestational week
gwks	Gestational weeks
IVF	In Vitro Fertilization
MBRN	Medical Birth Register of Norway
MBRS	Medical Birth Register of Sweden
MoBa	The Norwegian Mother and Child Cohort Study
MVA	Missing Values Analyses
NICU	Neonatal Intensive Care Unit
OR	Odds Ratio
aOR	Adjusted Odds Ratio
Q	Questionnaire
RSS	Relationship Satisfaction Scale
SCL	Symptom Check List
SGA	Small for Gestational Age
SPSS	Statistical Package for the Social Sciences
SWL	Satisfaction with life
SWLS	Satisfaction With Life Scale
χ^2	Chi square test

SAMMENDRAG (NORSK)

Å bli mor sent i livet. Svangerskapsutfall, psykologisk distress, fødselsopplevelser og livskvalitet.

Vigdis Aasheim, Institutionen för kvinnors och barns hälsa, Karolinska Institutet

Målet med denne avhandlingen er å undersøke medisinske og psykologiske aspekter ved det å være en eldre førstegangs fødende kvinne.

Det er uenighet om hva som regnes for å være «eldre», men 35 år er ofte brukt som grense. I denne studien argumenterer vi for at alderen bør defineres lavere. Å utsette tidspunktet for å få barn innebærer at alderen ved første fødsel øker i forhold til tidligere generasjoner. Årsakene til at alderen har steget er sannsynligvis en kompleks blanding av individuelle og samfunnsmessige faktorer. Gjennomsnittsalderen blant kvinner ved første fødsel har steget betraktelig i de fleste høyinnkomstland i løpet av de siste tiår og er nå (i 2012) 28 år i Norge og 29 år i Sverige. Det er velkjent og godt dokumentert at ved økende alder øker også risikoen for svangerskaps- og fødselskomplikasjoner hos både mor og barn. Det man ikke er klar over er i hvilken grad medisinske komplikasjoner ved økende alder kan sammenlignes med de komplikasjoner som er ved livsstils fenomener som røyking eller overvekt.

Forskning innen dette området har stort sett fokusert på de medisinske aspektene, men de psykologiske aspektene og kvinnes opplevelser etter fødselen ved å få første barn relativt sent er lite forsket på.

Studie I er en populasjonsbasert registerstudie som inkluderer data fra 955 804 førstegangs fødende kvinner som fikk barn mellom 1990 og 2010. Dataene kommer fra det svenske og det norske medisinske fødselsregisteret. Risiko for komplikasjoner hos barnet blant kvinner i aldersgruppene 30-34 år, 35-39 år and ≥ 40 år ble sammenlignet med en gruppe av yngre kvinner, 25-29 år. Komplikasjoner forbundet med økende alder ble også sammenlignet med komplikasjoner som følge av overvekt og røyking. Resultatene viste at risikoen for premature fødsel, lav fødselsvekt i forhold til varighet av svangerskapet (SGA), lav Apgar score, dødfødsel og perinatal død økte allerede fra kvinnen er 30-35 år. Alder ≥ 30 år var også forbundet med like mange tilfeller av perinatal død som ved overvekt og fedme og med flere tilfeller enn ved røyking, sammenlignet med normalvektige, ikke røykende kvinner 25-29 år.

I studie II-IV ble data fra Den norske mor og barn-undersøkelsen (MoBa) i regi av Norsk Folkehelseinstitutt brukt. Studiene er kohort studier og baserer seg på spørreskjemaer som ble besvart 2 ganger i svangerskapet, i tillegg til 6, 18 og 36 måneder etter fødselen. Her ble eldre førstegangs fødende definert som kvinner ≥ 32 år.

Studie II undersøker symptomer på angst og depresjon blant 19 291 førstegangs fødende kvinner fra midt i svangerskapet til 18 måneder etter fødselen. Kvinner ≥ 32 år ble sammenlignet med kvinner 25-31 år. Det ble funnet at eldre førstegangs fødende kvinner hadde noe økt risiko for å oppleve angst og depresjonssymptomer i denne perioden.

Studie III undersøkte forventninger i svangerskapet og opplevelse av fødselen i forhold til forventningene blant 30 065 førstegangs fødende kvinner, målt 6 måneder etter fødselen. Det ble funnet at førstegangs fødende kvinner ≥ 32 år opplevde fødselen noe

mer negativt enn forventet, sammenlignet med de yngre kvinnene. De eldre kvinnene så imidlertid ut til å takle komplikasjoner bedre enn de unge.

Studie IV omhandler livskvalitet eller tilfredsstillelse med livet blant 18 565 førstegangsfødende kvinner. I denne studien ble to grupper av «eldre» kvinner, 32-37 år og ≥ 38 sammenlignet med kvinner 25-31 år. De to gruppene av eldre førstegangsfødende kvinner rapporterte noe lavere grad av tilfredsstillelse med livet sammenlignet med de yngre kvinnene og aldersforskjellen var størst når barnet var 3 år gammelt.

Samlet sett så konkluderes det med at det å utsette tidspunktet for første fødsel kan ha negative konsekvenser for kvinners helse og livskvalitet. Risikoen for komplikasjoner starter tidligere enn det man har trodd, selv om denne risikoen er liten for den enkelte. Denne studien viser at det å få barn påvirker kvinnen psykologisk sett mer fordelaktig hvis dette skjer før trettiårene. Funnene fra denne studien bør inkluderes når unge mennesker søker informasjon og har spørsmål om reproduktiv helse.

INTRODUCTION

The age of first-time mothers has increased in the majority of high-income countries over recent decades [1-4], which is problematic for both society and individuals. For society, demographic aspects of fertility and costs related to complications and reproductive technologies are in focus. For individuals, postponing childbearing can lead to an increased risk of medical complications for both the mother and the child. Another consequence is that potential life plans can be disturbed as women and couples might not be able to have children when desired, or the number wished for, or may suffer from involuntary childlessness.

The medical consequences of postponing childbirth have been an important topic for research for some years. The increased risk of pregnancy and obstetric complications seen in older new mothers as well as adverse outcomes for newborns is well documented [5-9]. The consequences for maternal psychological health, however, have not been researched in any depth and there is also a need for illuminating these aspects of late childbearing [10]. This thesis questions the partly anecdotal understanding that older women's maturity, life experiences, and economic prosperity are favorable from a psychological point of view when entering motherhood at an advanced age. With increasing numbers of primiparous women experiencing late childbearing, it is important to also examine the psychological aspects of this life transition.

BACKGROUND

POSTPONING CHILDBIRTH

Postponing childbirth implies that the mean age of a woman's first birth has increased compared with previous generations. In Norway and Sweden women were on average aged 23 and 24 years respectively when having their first baby in 1970, and aged 28 and 29 years respectively in 2012, an increase of five years compared with the previous generation. A similar development has occurred in all European and high-income countries [11].

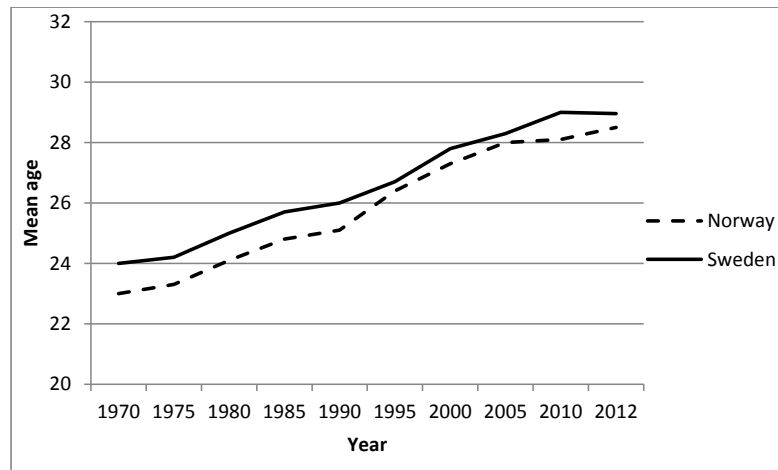


Figure 1. Age at first birth in Sweden and Norway from 1970 to 2012
(www.ssb.Norway, www.scb.Sweden)

When childbearing is postponed, the risk for infertility increases [12] and fewer fertile years remain for subsequent pregnancies. The female reproductive period is relatively short with the biological optimum in the range between 18 and 30 years. In spite of the present generation's prospect of longevity and good health, a woman's fertility starts declining as early as in her late 20s with substantial decline by her late 30s [13]. A dramatic increase in infertility is seen in women aged 35 years and older [13]. The ability to conceive spontaneously decreases as a woman's age advances and postponing pregnancy may lead to difficulties in conceiving and result in having fewer children than desired. This applies also to pregnancies assisted by reproduction technologies (ART) [14, 15].

Advanced maternal age is also associated with older partners as statistics show that older women often prefer older men, with the mean difference between the ages of women and men being between two and three years in Norway and Sweden (www.ssb.Norway, www.scb.Sweden). Even if men's fertility is less affected by age a statistically significant decline has been shown by the late 30s [13].

From a demographic perspective, the age of a first born baby is important for the total fertility rate, as it affects the expected number of children born per woman in her child-bearing years [16]. It is also important for keeping the birth rate over the replacement level, meaning the number of births per woman required to maintain the population (approximately 2.1 births per woman in industrialized countries). In Sweden and Norway, as a part of the Nordic region, the postponing of childbearing has not led to a serious decrease in number of children born to each woman so far. It seems that the two-child norm is fulfilled by most women. Generous family policies with long-term wage-compensated parental leave and subsidies partly explain this [17]. However, the commonly seen delay into parenthood has contributed to a fertility rate that is below replacement level for most of Europe's population [11, 18].

When debating the optimal timing for the first birth, the argument that social and psychological advantages of postponement make up for the biological disadvantages, has been included [19]. Postponement of childbirth is socially acceptable and may be normative [20] and it may even be seen as beneficial from a social point of view. The experience and knowledge of older parents may be greater as increasing age means maturity [21, 22], but even though psychological maturity increases with age, the benefits of this process may possibly start declining after a certain age. Older parents may also take fewer risks in the childbearing period and a more cautious approach towards pregnancy [22]. A child born to older parents might have certain advantages; it has for example been shown that children of older parents do better in school than those of very young parents [23, 24]. But increasing maternal age may also be associated with other problems. Older first-time mothers may be less flexible than younger mothers; they may be more worried and experience parenthood as more tiresome. In addition, negative events related to pregnancy and birth, such as an operative delivery and ill-health of the baby, occur more often in women of advanced age, and this may affect the psychological aspects of the childbearing period and overall well-being of the mother. The majority of older first time parents are well-

educated and socioeconomically better off than their younger counterparts, however the characteristics of older first-time mothers (33 years and above) and fathers (35 years and above) have been found to constitute a socioeconomically heterogeneous groups with more health problems than younger first-time parents [21, 25].

Regarding the mother's age at the time of the first birth there tends to be a cultural split between urban and rural areas [26]. The reasons for this difference might be due to influence from regional social contexts or due to individual characteristics in the population. In Norway, for example, the mean age of first time mothers in Oslo, the capital, was 30 years in 2011 while the mean age of first-time mothers in rural areas was lower (the lowest being 25.5 years). In addition the share of women giving birth at a young age has declined in the whole country, while the share of women giving birth after 40 years of age has increased (<http://www.fhi.no/dokumenter/2a92108f4f.pdf>).

Being a first time mother later than previous generations

This thesis deals with the postponement of childbirth in recent society with a focus on challenges related to medical and psychological aspects. Having a first child is a major life transition and since the 1960s, women and couples in the Western world have had the unique possibility of planning the timing of their first-born due to the introduction of 'the contraceptive pill' [27]. However, when investigating aspects related to the age of the mother at her first birth, a brief look at the history is relevant to put this demographic phenomenon into context. The age of the mother at her first birth has fluctuated earlier. In the beginning of the 19th century, after a decrease in mortality, a decrease in fertility was seen in Europe, known as the 'first demographic transition' [28]. This transition was explained by changes in society due to industrialization and secularization. During the latter part of this period, from 1921-25, the mean age of married women at the birth of the first child in Norway was 29 years of age www.ssb.Norway. These women were characterized by an advanced age at the birth of the first child and an overall decline in fertility compared with earlier generations. The postponing of building a family in this period can largely be explained by the difficult economic situation in society [29]. The women born between 1925 and 1950 are sometimes referred to as the 'Housewife generation' [30] and were characterized by a decline in age at her first birth and increase in fertility, explained by the development of the ideal that a woman should have the privilege of staying home with the family [30].

In the middle of the 1960s, the 'second demographic transition' followed with a reduction in fertility and also an increase in the age of the mother at her first birth [17, 31-33]. Longer education is a characteristic in these women and an important explanation for the postponing of childbirth [30]. It is these women that are investigated in this thesis.

Reasons behind postponement

The explanations for the trend of postponement of childbearing differ between the periods. While access to a house, economic factors, children's utility values, and living conditions are dominant factors for the historical transitions, varying and complementing theories circulate for the more recent changes. The possibility of family planning and the increase in women's autonomy and opportunities to shape their own lives are significant factors for changes seen after 1950. Education [1, 31, 34-37] and career planning [35] are important factors. Other reasons include a desire to prolong adolescence and continue an independent life style, difficult housing conditions, a desire to explore other aspects of life before the demands of parenthood sets any limits [38, 39], economic uncertainty, value changes, the absence of supportive family policies, gender equity, changes in partnership behavior [35], difficulties in establishing stable partner relationships [40, 41], as well as the current norms of society [42]. A recent Swedish study investigating reasons for being still childless at different ages between 28 and 40 found that the most prominent reasons included; not having wanted children up to now, lack of a partner, infertility problems, and prioritizing an independent life (Schytt, Nilsen & Bernhardt 2013, in progress). Results from qualitative studies show that the timing of childbearing depends on a complex interplay of factors which are outside the women's immediate control, such as being in a proper relationship, health, and fertility. Women felt that there was an element of chance involved as to whether these factors would be in place at the time they wanted to start a family. Finding the perfect partner was also deemed to be outside a women's control [43]. In cultural psychology, a new period or cultural construction between adolescence and adulthood has been described as 'emerging adulthood' [26]. This period is characterized by young people (approximately 18-25 years of age) getting more independent, and exploring various life possibilities before making enduring commitments. It exists in cultures where young people are allowed to postpone adult roles such as marriage or parenthood [44].

ADVANCED MATERNAL AGE

There is no consensus on how to define advanced maternal age. In medical literature as well as in obstetrical praxis, a woman is defined as an 'old' first-time mother when over 25 [45, 46], 30 [47], or 35 years of age [48, 49]. The definition of advanced maternal age has changed over time and has been related to the mean age of the woman at her first birth in the respective time periods. When the age of the total cohort is displaced upwards – the limits for old and young age have also been displaced in the same direction. The term 'advanced' regarding maternal age can also be understood differently depending on context.

On the other side of the age continuum are the young mothers. Teenage pregnancies are rare in Norway and Sweden nowadays (www.ssb.Norway, www.scb.Sweden) and are often associated with socioeconomic vulnerability [50, 51]. To have children too early is not accepted by society who regards young mothers and parents to be too young to manage their lives and to raise a child satisfactorily [52].

MEDICAL ASPECTS OF CHILDBEARING AT AN ADVANCED AGE

The physical changes that take place in women during the childbearing period are comprehensive and the medical aspects of childbearing in advanced age first-time mothers is focused on the increased risks for complications. There is an increased prevalence of pre-existing medical disorders in older women compared to younger women [53]. In pregnancy, older women are more exposed to conditions such as hypertension [5, 53], preeclampsia [7, 54, 55], and gestational diabetes [7, 8]. During birth an increased incidence of malpresentation [7, 56, 57], prolonged labour, and need for oxytocin [58] has been seen, as well as the birth more often ending with an instrumental vaginal delivery or caesarean delivery [5-7, 9], included intrapartum caesarean deliveries due to the increase in dystocia with increasing age [5, 58]. The medical consequences for infants include that they are at a higher risk of preterm birth [59], intrauterine growth restriction leading to them being small for gestational age [59], and low Apgar score [60]. An increased stillbirth frequency [61] has been shown and also a higher risk for perinatal death [5, 7, 9, 54]. In addition, infants born to older women more frequently have chromosomal abnormalities [62].

Possible explanations for age-related changes are largely unknown, but physiological degenerative processes in the women and in the placenta, such as placental pathology [61, 63] and dysfunction [64, 65] have been discussed. Biological mechanisms related to ageing myometrium and decidua, such as hormonal effects on the uterus [66], decreased uterine contractility, number of oxytocin receptors [67, 68], and low utero-placental perfusion caused by poor vasculature have also been reported [63]. Another explanation is related to the fact that physical health problems increase with age [69]. Several outcomes related to maternal age are also related to smoking, being overweight or obesity and the relative significance of these three life style conditions is little explored. Smoking is related to preterm birth [70], SGA [71], stillbirth [61], and neonatal death [70], while being overweight and obesity are related to preterm birth [72, 73], low Apgar score [60], stillbirth [61], and neonatal death [74].

Most research has focused on the adverse effects of maternal age, but it has also been found that advanced paternal age is associated with miscarriage, fetal death, very preterm birth, preeclampsia, caesarean section, and infant problems such as birth defects, schizophrenia, autism, and cancer [75].

In this thesis we report the following outcomes; preterm birth, SGA, low Apgar score, stillbirth and neonatal death. Preterm birth is defined as a birth occurring before 37 completed weeks of pregnancy [76]. Globally, preterm birth is the most important single cause of neonatal death [76] and very preterm birth is associated with neurodevelopmental impairments [77]. Children born preterm are also reported to have an increased risk of long term health problems [77]. SGA is defined as having a birth weight of less than the tenth percentile for gestational age [59, 71] while Apgar score is a judgment using a scoring system performed by birth attendants to evaluate the condition of the newborn. A score of less than three is considered critically low, 4-7 is moderate and 7 and above is normal [78]. Stillbirth is defined as fetal death from gestational week 22 and accounts for 60% of all perinatal deaths [79], while neonatal death is defined as death occurring within 28 days of delivery [80]. This study poses the question if the risk of adverse pregnancy-outcomes commence earlier than the commonly used defined of advanced age of 35 years and over, and we investigate if advanced maternal age is a risk factor comparable to smoking, being overweight and obesity.

PSYCHOLOGICAL ASPECTS OF CHILDBEARING AT AN ADVANCED AGE

To become a mother

The experience of pregnancy and birth and of having a newborn to take care of is a joyful and groundbreaking event, but also a vulnerable period both physically and psychologically. Pregnancy and childbirth are normal life events, but they are also demanding and require psychological adjustments, which involve moving from a known current situation to an unknown reality [81]. To become a mother is a process that requires adaptation to a new life and the establishment of an identity as a mother, a process that contributes to a woman's psychosocial development, but also implies vulnerability and need of support [82]. Disrupting this process can lead to attachment problems and to suboptimal adaptation processes [83]. 'Becoming a mother' is also a concept suggested by Mercer [81] and describes a cognitive and social process in the maternal role transformation that is dependant on the child's development. One qualitative study found that older mothers' adjustment occurs in a temporarily ordered sequence, starting with feeling overwhelmed by the responsibility, tired and uncertain in the first phase, and continuing on through phases of struggle and ambivalence to a turning point of 'finding their way', to the last phase (6-8 months after the birth) where they finally 'feel like a mother' [84].

Psychological distress

The seriousness of psychological distress and depressive symptoms in the transition to motherhood is related to the adaptation to motherhood and to the attachment with the child. A mother's sensitivity to her child can be affected and so can the quality of the care she provides to the child. Among depressed mothers, difficulties in early attachment and reduced quality of the emotional and cognitive development in the child are reported [83, 85-88], anxiety may also cause a significant risk regarding children's development [89].

Feelings of distress, unhappiness and tiredness are common following childbirth and may be experienced by 15-80 % of all new mothers. This is often referred to as 'postpartum blues', and refers to mood symptoms that are common in the first week to 10 days after delivery and that usually resolve within a short period of time. Symptoms include moodiness, irritability, interpersonal hypersensitivity, insomnia,

anxiety, tearfulness, and sometimes elation [90-93]. To differ between natural, common reactions to childbirth and what is abnormal can be delicate. Psychological disorders affecting women in relation to childbirth range in severity from mild depression to serious depression and even postpartum psychosis, the latter of which is a serious and rare condition [94]. The term psychological distress is used in this thesis and it refers to a broad aspect of mental health [95] or more precisely to symptoms of anxiety and depression, but not to depression as a diagnosis. Psychological distress is referenced frequently in health care literature, but is seldom defined as a distinct concept [96], but psychological stress responses such as excessive worrying and stress-related symptoms are often included [97]. As this thesis is aiming to find the differences related to maternal age and to cover a broad aspect of the maternal psychological aspects in pregnancy and postpartum, psychological distress was the chosen term for this concept, and findings are compared to the extensive research on postpartum depression and depressive symptoms.

Postpartum depression constitutes a heterogeneous and complex group of depressive disorders that occur during pregnancy or in the year after the birth and the content of the term depression varies [85]. Depending on the number and severity of symptoms presenting, perinatal depression can be referred to as major or minor [98], where major depression is a serious condition. Symptoms of postpartum depression are largely the same as for depression occurring in other life periods [85, 86] and include: persisting feelings of sadness, anxious or “empty” feelings, feelings of hopelessness, irritability, restlessness, anxiety, feelings of guilt, worthlessness, fatigue and decreased energy, difficulty in concentrating, remembering details and making decisions, insomnia, waking during the night or excessive sleeping, overeating or appetite loss, suicidal thoughts, suicide attempts, persistent aches or pains, and headaches (<http://nimh.nih.gov>). In addition symptoms of postpartum depression include mood fluctuations or moodiness and excessive concern for the infant and are also often comorbid with anxiety disorders or anxiety symptoms [86]. While most of the research carried out on psychological aspects during the childbearing period is about depression, anxiety is also common and often comorbid with depression [99]. The correlation between depression and anxiety is high and symptoms of anxiety often overlap symptoms of depression [85, 99, 100].

A considerable amount of uncertainty exists in the level of prevalence of depression in pregnancy and after birth, but it has been described to be 11.0% in the first trimester, 8.5% in the second trimester, 12.9% at three months postpartum and 10.6% at 4-7 months postpartum [98]. Prevalence rates of depressive symptoms vary between studies, ranging from 8 to 15% during pregnancy (11-13) and from 10 to 15% postpartum (14), and recent Scandinavian studies show a prevalence of 10 to 12% (15-17). The differences between studies may be explained by methodological factors, such as different populations, choice of instrument and cut-off scores, as well as time point for measurement (14). Antenatal risk factors for depression during pregnancy and after birth includes antenatal depression, lack of partner support, marital conflicts, stressful life events, and lower socioeconomic status [92, 101-106]. The partner relationship has been shown to be a predictor of maternal distress in pregnancy and a good partner relationship can protect against stressors [107].

A wide range of different instruments including interviews can be used to measure symptoms of depression and anxiety. For screening for postnatal depression, the most widely used instrument is the Edinburg Postnatal Depression Scale (EPDS) [108-110]. In medical and social science studies with a broad scope leading to extensive questionnaires, shortened versions of instruments with good psychometric characteristics are often used. In this study the shortened version of the Hopkins Symptoms Check List (SCL5) [111] is applied.

Age-related variations in psychological distress and depressive conditions are known, even though research findings differ [112], from reporting an increase in depression through a life time followed by a drop [113], to a U-shaped development, with the younger and the older being most vulnerable [114]. This thesis is mainly about older first-time mothers, but one should bear in mind that research on depressive disorders has primarily focused on teenagers and young adults, and these studies have consistently shown an increased risk of psychological distress compared with older mothers [115], and that teenage mothers have been shown to be particularly vulnerable to depressive symptoms [116, 117].

The relatively few studies investigating psychological distress or related conditions and advanced maternal age are inconclusive. Studies have reported that older first-time mothers did not have an increased risk of depressive symptoms during pregnancy [102,

118, 119], or the year after [102, 120], and some studies have also reported that older first-time mothers more often reported frequent daily hassles [121], worries during pregnancy [118], and that they were at greater risk of experiencing postnatal depression [48, 122-124] and even psychosis [49].

Birth experience and expectations

A child's birth marks the beginning of the relationship between parents and their newborn [125, 126] and the experience of the birth matters for how women manage this challenge. A positive experience of birth can be important for adaptation to parenthood but, equally, women may experience ill health due to a negative birth experience. Such negative experiences will be integrated into the person's life and can lead to depressive symptoms [127-129], post-traumatic stress disorder [130], disturbed bonding with the infant [131], a longer interval to a subsequent pregnancy [132, 133], and a desire for caesarean section in future births [134]. To measure birth experiences different tools are used; interviews, single global items, visual analog scales, instruments measuring different aspects of psychological outcomes, questionnaires measuring global birth experiences and more specific instruments of childbirth experience [128, 135-138].

In this thesis we related the question the women were asked about their birth experience to their expectations; as 'better than expected', 'worse than expected' or 'as expected', as this was the way the question was phrased in the questionnaire. High expectations or having experiences that exceed expectations has been associated with satisfaction with the birth experience [128, 138, 139]. On the other hand negative expectations, like worrying about the baby, fear of childbirth, and anxiety about pain have been associated with a more negative experience [128, 134, 136, 137, 140-142]. Women of advanced age have more often been reported to worry about an upcoming birth [143] and also to prefer a cesarean delivery [144] than younger women.

Risk factors for a negative birth experience are related to unexpected medical problems and also social background factors [136]. These include induction and augmentation of labour, infant transfer to neonatal intensive care, lack of support from partner, lack of control [128, 136, 145], lack of involvement in decision-making [138], and lack of caregiver support [136]. Young women have reported the highest prevalence of a negative birth experience [136, 146]. However, the factors that are associated with a negative birth experience are also more prevalent in women of advanced age. They

include instrumental vaginal delivery [5, 7], emergency caesarean section [147], premature birth [5], single marital status, and unemployment [69, 136]. Age has usually not been assessed as a risk factor for a negative birth experience, even though differences in birth experiences between older and younger women have been described, showing an increased level of concern among the older women and also corresponding increased levels of relief and gratitude after the birth [148]. One study found that primiparous women of advanced age (≥ 35) had more positive feelings about the upcoming birth than a younger reference group, but when asked after the birth, it was found that they had had a birth experience worse than expected, in contrast to the younger women who had had a birth experience better than expected [118].

Satisfaction with life

Women's satisfaction with life deals with a subjective experience and is an expression of positive psychology. Satisfaction with life (SWL) is an evaluation of life as a whole; a well-being dimension and it refers to a cognitive judgment and can be defined as a person's global evaluation of quality of life according to her chosen criteria [149, 150]. Different highly correlated concepts and terms like quality of life, happiness, subjective well-being, self-rated health and life satisfaction are also used in research literature. Even though levels of satisfaction with life are considered to be relatively stable [151], due to adaptation processes and genes [152], the degree of changes over time and through the life courses have been discussed [153], as well as to what extent personality factors and traits counts for differences between individuals [154, 155]. Having children is an important life event and is regarded as a basic motive [156], and fulfilling basic needs is a part of one's experience of life satisfaction. Satisfaction with life is also described to be an antecedent of fertility [157]. A satisfying romantic relationship has been found to be particularly important for retaining and increasing future life satisfaction [158]. Satisfaction with life is sensitive to major life events [153, 158-161], where childbearing is such a factor [158, 161]. Satisfaction with life is found to be negatively correlated with depression, but there has been no strong association found between life satisfaction and anxiety as people can be both satisfied and anxious [162]. A range of different instruments is used to measure quality of life, while satisfaction with life is specific to the measurement of Satisfaction With Life Scale (SWLS) that is used in this study.

The relationship between age and well-being in general is unclear [163]. From economic literature an understanding of a U-shape curve over age has been established [164], even though some controversy remains [165]. Studies have shown that life cycle happiness is greatest at midlife, increasing from age 18 to 51 and declining thereafter [153], while studies of subjective well-being have found little variation with age [163]. Some studies have reported that SWL increases during pregnancy [158, 161] but then decreases during the first years of parenthood to pre-pregnancy level, but whether this development varies with age is unclear [163]. One study found that SWL increased steadily during a woman's reproductive life [153], whereas others have suggested that SWL is relatively stable over the age span [151, 166]. The details on age distribution of satisfaction with life assessments in the age group focused in this study, from 25 years until end of the female reproductive period, is little explored.

IN SUMMARY

Postponing childbirth implies that the age of a woman at her first birth is higher than that of previous generations and the reasons for this postponement are probably a complex mix of factors related to society and to the individual. Several reports have documented that increasing the age of parenthood leads to pregnancy and obstetric complications and adverse outcomes for the newborns, even though the relative significance of lifestyle factors is not sufficiently explored. However, the consequences for maternal emotional health have not been researched in depth and there is the question whether biological disadvantages faced by first-time mothers of advanced age are weighted up by potential psychological advantages. The associations between advanced maternal age and psychological aspects of the childbearing period therefore need further investigation.

AIMS

The objectives of this thesis were to investigate adverse pregnancy outcomes and psychological experiences in women who become mothers in the later phase of the reproductive period.

The specific aims were:

1. to investigate the risk of adverse pregnancy outcomes (preterm birth, infant small for gestation age, low Apgar score, stillbirth and neonatal death) in women aged 30-34 years, 35-39 years, and ≥ 40 years compared with women of 25-29 years, and to compare risks associated with advanced maternal age with those associated with smoking, being overweight, and obesity (Paper I).
2. to investigate psychological distress in nulliparous women from mid pregnancy to 18 months after the birth, comparing women aged ≥ 32 years with those aged 25-31 years (Paper II).
3. to investigate the experience of childbirth at six months postpartum in relation to antenatal expectations, using the same age categories as in Paper II (Paper III).
4. to investigate women's satisfaction with life during pregnancy and the first three years of motherhood, comparing women aged 32-37 years and ≥ 38 years respectively with the same reference groups as above (Paper IV).

MATERIAL AND METHODS

GENERAL DESIGN OF THE STUDIES

Table 1 gives an overview of the design, data source, year of collection, time point and sample for the respective study. Data obtained from the Swedish (MBRS) and Norwegian Medical Birth Registers (MBRN), was used for Paper I, which was a population-based register study. For Papers II-IV we used data from the Norwegian Mother and Child Cohort Study (MoBa), which is linked to data from the MBRN. The MoBa was designed as a prospective population-based cohort study [167]. Women were followed by means of six questionnaires issued during the period from mid pregnancy until 36 months after the birth, including follow-ups of the children. For Paper II we used questionnaire data from gestational week 17 and 30 in pregnancy, as well as sex and 18 months after the birth. For Paper III we used data from the two questionnaires in pregnancy as well as the one at six months after the birth. For Paper IV we applied questionnaire data from the two questionnaires in pregnancy, as well as six, 18 and 36 months after the birth.

Table 1. Overview of design, data and sample Papers I-IV.

Design	Datasource	Version		Timepoint of measurement	Sample (n)
		MoBa	Year of data		
Paper I Population based register study	MBRS, MBRN		1990-2010	Pregnancy, labour and postpartum	955 804
Paper II Longitudinal population based cohort study	MoBa, MBRN	4	1999-2009	Gwks 17 and 30, 6 and 18 months pp*	19 291
Paper III Longitudinal population based cohort study	MoBa, MBRN	6	1999-2011	Gwks 17 and 30, 6 months pp*	30 065
Paper IV Longitudinal population based cohort study	MoBa, MBRN	6	1999-2011	Gwks 17 and 30, 6 and 36 months pp*	18 565

pp=postpartum

gwks=gestational weeks

MoBa=The Norwegian Mother and Child Cohort Study

MBRS=Medical Birth register of Sweden

MBRN=Medical Birth register of Norway

RECRUITMENT

Paper I

For the first aim of the thesis we obtained data from the MBRS and the MBRN. Data are based on compulsory notifications of all live births and stillbirths in both countries and we used data from women who had their babies from gestational week 22 and above. The standardized notification comprises information collected prospectively, regarding maternal health, reproductive history, medical history, obstetric interventions, and maternal and perinatal outcomes [168-170].

Papers II-IV

For the second, third and fourth aims we used questionnaire data from the MoBa study. The MoBa study investigates sociodemographic, physical, genetic, and mental health exposure variables and outcomes in mothers and children. The planning was not based on one single hypothesis, but rather the strategy was to collect data on as many relevant exposures and health outcomes as was feasible [167]. The women included in the present studies were recruited between 1999 and 2006 (Paper II) (questionnaire version 4) and between 1999 and 2008 (Papers III and IV) (questionnaire version 6). The target population of the MoBa study was all women who gave birth in Norway and there were no exclusion criteria, however, questionnaires were only supplied in the Norwegian language. All hospitals and maternity units with more than 100 births annually were included. Pregnant women were informed of the study at the time of the routine ultrasound examination offered in week 17-20 of gestation. Lists of the women's contact details were sent to the central data collection unit of MoBa who then carried out all further administration concerning data collection. The women received an invitation by post that included an information brochure, a consent form, the first questionnaire, and a consent form and questionnaire for their partner. The final sample consisted of women and their partners who gave written consent to participate and responded to the first questionnaire.

The unit of observation is a pregnancy, and a woman could participate in the study multiple times with more than one pregnancy [171]. The cohort included approximately 109 000 children, 91000 women and 71 700 men. The recruitment began in 1999, and gradually expanded geographically. It included expectant fathers from the year 2000. By 2005 it had become a nationwide study with 50 of 52 hospitals participating. After May 31st 2008, most of the hospitals terminated recruitment but the eight largest hospitals in Norway continued recruiting participants until December 31st 2008. The last birth into the cohort took place in June 2009. Participants who had responded to the first questionnaire but chose not to complete the next one, remained in the study and were later asked to complete the following. Participants who decided to actively withdraw from the cohort were asked if already collected data could remain in the database, so that their withdrawal would only affect future participation <http://www.fhi.no/dokumenter/6d6187a561.pdf> .

SAMPLES

Paper I

For the first paper the total population of nulliparous women aged 25 years and older with singleton pregnancies ≥ 22 gestational weeks who gave birth in Sweden and Norway between 1990 and 2010 numbered 955 804 women: 644 184 from Sweden and 311 620 from Norway were included in the sample.

Papers II-IV

The samples for Papers II-IV include pregnant nulliparous women. We defined nulliparous as women who had not given birth previously, either to a live or to a stillborn infant after the 21st week of pregnancy, based on the Nuffield Council of Bioethics [172].

The sample for Paper II includes women recruited for the MoBa Study between 1999 and 2006. The women were aged 20 years and above. We included only those who had answered the questionnaires in gestational weeks 17 and 30, and also six and 18 months after the birth and who had complete data on the Medical Birth Register on parity and maternal age. The included women had also responded to at least three of the items on the scale used for the key measurement (the Symptom Check List, see below). The final sample included 19 291 women. Recruitment, sample size and dropouts are illustrated in Figure 2.

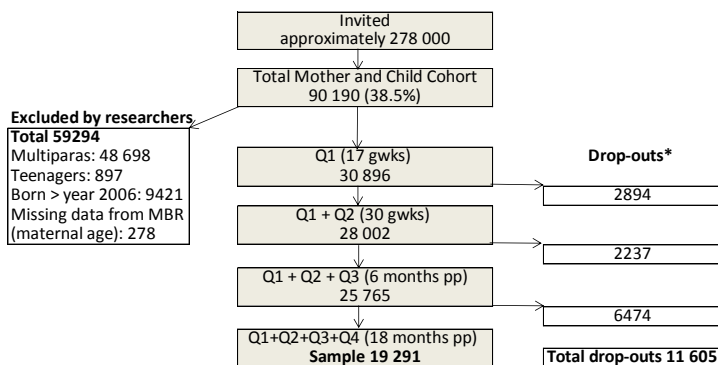


Figure 2. Recruitment, sample and drop outs Paper II

Q = Questionnaire

Gwks=gestational weeks

pp=postpartum

**Drop-outs= non-responders to Q + responders with incomplete SCL5 (less than 3 of the 5 items)*

The samples used for Papers III and IV included women recruited between 1999 and 2008, aged 25 years and over. For Paper III the included women had responded to all three questionnaires used in the study; in gestation weeks 17 and 30, and at six months postpartum. In addition, the questions on birth experience had to be answered. The final sample for this study included 30 065 women. For Paper IV the included women had responded to all four questionnaires used in the study; in gestation weeks 17 and 30 and at six and 36 months postpartum, including responding to three of the five items on the scale used for the key measurement (Satisfaction With Life Scale, see below). The sample was also restricted to include only those who had complete data from the MBRN on parity and maternal age. The recruitment, samples, and dropouts are illustrated in Figure 3. The final study sample for Paper IV included 18 565 women.

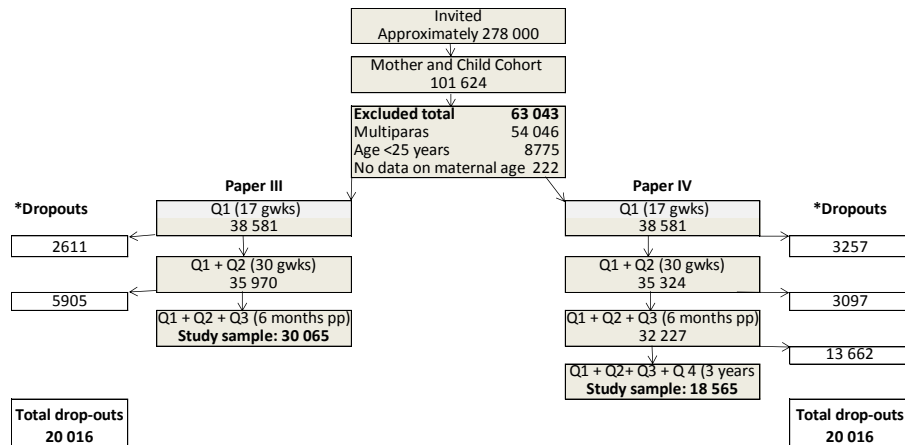


Figure 3. Recruitment, sample and drop outs Papers III and IV

Q = Questionnaire

Gwks = gestational weeks

pp = postpartum

**Drop-outs = Paper 3: non-responders to Q2-3 (n=5905) or to Birth experience in Q3 (n= 2277)*

Paper 4: non-responders to Q2-4 (n=18 130) or to SWLS in Q1-Q4 (n=1886)

The characteristics of the study samples in Papers II-IV are presented in Table 2 including comparisons between the sub-samples giving birth in 2003 and all primiparous women in the same age groups. The data on representativity is discussed later in this thesis.

Table 2 Characteristics of the study samples from the MoBa-cohort (Paper I-VI) and, for representativeness, comparisons between the sub-samples giving birth in 2003 and all primiparous women in the same age groups.

Demographic and social factors	Paper II (n=19 291)				Paper III (n=30 065)				Paper IV (n=18 565)				Women ≥25 years in the study samples giving birth in 2003				Women in the Norwegian birth cohort of 2003										
	Age 20-24		Age ≥32		Age 25-31		Age ≥32		Age 25-31		Age 32-37		Age ≥38		Sub sample Paper II		Sub sample Paper III		Sub sample Paper IV		Norway						
	n=3106	%	n=11 801	%	n=4384	%	n=21 226	%	n=8839	%	n=13107	%	n=4827	%	n=631	%	n=3683	%	n=3549	%	n=2429	%	n=22 272	%	n=16 760	%	
Age (years)*																											
20-24																											
25-29																											
30-34																											
35-39																											
≥40																											
Smoking*	18.3		7.9		9.3		8.4		7.6		8		7.1		8.2		12.8		10.8		8		16.8		13.9		
Single status*	8		2.3		5.1		2.9		4.9		2.1		3.9		10		3.4		2.7		2.8		7.6		5.7		
Native language other than Norwegian	3.4		4.7		7		5.9		8		4.9		7.5		5.7												
Unemployed	5		1.9		2.1		1.7		1.6		1.8		1.8		2.5												
Income (NKR)																											
<200 000	31.3		12.8		7.4		11.2		6		11.1		5.8		6.5												
200 000-399 999	60.4		63.8		53.4		55.5		43.7		58		46.2		45.8												
≥400 000	8.3		23.4		39.2		29.1		46		26		42.8		40.3												
Pregavid BMI, mean (kg/m ²)	24.7		24.6		25.3		23.6		24.1		23.7		24.1		24.5												
IVF present pregnancy*	0.4		2.5		8.1		2.6		8.9		2.5		7.9		12.8		3.4		3.8		3.6		3.8		4.9		
Labour*																											
Mode of delivery																											
Instrumental vaginal	12.1		15.8		18.2		17		19.4		17.2		19		19.5		15.2		16.8		16.8		15.7		16.1		
Elective cesarean	2.2		3		5.7		3.1		6		3.1		5.8		11.1		4.7		3.8		4.2		4.7		5.3		
Emergency cesarean	9.2		10		14.6		9.7		13.5		9.4		12.9		19		11.5		11.4		11.2		11.5		12.5		
Unspecified cesarean	1.1		1.5		1.8		1.9		2.9		1.8		2.3		4		2.2		1.2		1.2		2.2		2.5		
Prematurity***	5.8		6.2		7.1		5.5		6.4		5.8		6.5		8.9		8.3		6.5		6.5		8.3		8.8		
Neonatal transfer	10.3		10.4		11.8		9.2		10.8		9.2		10.5		13.6		11.9		10.8		10.3		11.9		12.5		

* Data from the Norwegian Medical Birth Register

*** Prematurity: 22-36 weeks of pregnancy

DATA COLLECTION

Paper I

The data in the medical birth registers in Sweden and Norway are based on the medical records used in antenatal, intrapartum, and postpartum care. The registers cover 98-99 percent of all births in the two countries. Starting with the first antenatal visit, the standardized notification form comprises information collected prospectively including demographic variables, data on maternal health, chronic diseases, reproductive history and complications during pregnancy. Information about delivery includes; maternal and perinatal outcomes, including complications and interventions, and information on the infant including prematurity, gestational age and birth defects [168, 169]. The two registers are very similar, although some variables differ leading to some difference in the adjustment of confounders in the Swedish and Norwegian data in Paper I.

Papers II-IV

The data used in the studies were retrieved from questionnaires used at five separate time points during the data collection (Figure 4); gestation weeks 17 and 30 in pregnancy, six months postpartum (Papers II-IV), 18 months postpartum (Paper II), and 36 months postpartum (Paper IV).

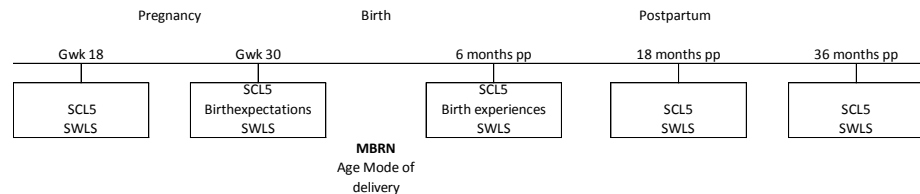


Figure 4. Data collection points MoBa.

Gwk=gestational week

pp=postpartum

The first questionnaire, completed at gestation week 17, provided information on socio-demographic background (education, civil status, native language, income of mother, unemployment, and smoking history), reproductive background (previous pregnancies and In Vitro Fertilization (IVF), health during pregnancy, previous history of depression, weight and height, and included psychological instruments to measure psychological distress (SCL5), satisfaction with life (SWLS), and relationship satisfaction (RSS). The second questionnaire, completed in gestational week 30,

provided information about psychological distress, worry levels for the upcoming birth and desire, if any, for a cesarean section, satisfaction with life, marital status, and relationship satisfaction. The questionnaire completed six months after the birth provided information on psychological distress, experience of childbirth, satisfaction with life, marital status, and relationship satisfaction (RSS).

VARIABLES

Independent variables

Age

Age is the independent variable in all four papers of this thesis, and was defined as maternal age at the time of giving birth. By having a sufficiently large sample of women we were able to decide more freely which cut-off point to use for advanced maternal age. Previous studies have either used the historical age of 35 years as a cut-off or a lower age in order to obtain a sufficiently large sample of woman at an advanced age. Our strategies differ somewhat and are described below. Table 3 shows the age cut-offs in the respective studies.

Table 3. Age cut-offs in the respective studies.

	Paper I	Paper II	Paper III	Paper IV
Young age		20-24		
Reference group	25-29	25-31	25-31	25-31
Advanced age	30-34	≥32	≥32	32-37
Very advanced age	35-39, and ≥40			≥38

Paper I

Age was a continuous variable in the Swedish data set but not in the Norwegian, where it had been categorized into five-year intervals. Consequently, we had to adopt the same intervals in this specific study. As one of the aims in this thesis was to study a potential increase of risk in any of the outcome factors at and under 30 years of age, we defined the reference group as maternal age 25-29 years and compared the outcomes in this group with those in the three groups of women of advanced age; 30-34 years, 35-39 years, and ≥40 years respectively.

Papers II-VI

In order to find a reasonable cut-off for advanced maternal age it was decided that for Papers II-IV the decision about age cut-off would be based on data from the entire Norwegian birth cohort from 2003, retrieved from the Medical Birth Register. Using the breakpoints for the lower quartile (24/25 years) and upper quartile (31/32 years), young age was defined as 20-24 years, advanced age as ≥ 32 years, and very advanced age as ≥ 38 years.

In order not to overlap our research with a different thesis focusing on young mothers, our agreement with the MoBa administration included the use of data on women aged ≥ 25 years for Papers II-IV, with the addition of women aged 20-24 years for Paper II. This was in line with another reason for excluding the youngest women, also from the reference group; that being the fact that they constitute a selected group with higher risk of psychological distress [115]. Consequently, the comparison group was women 25-31 years of age.

Confounding variables

Confounding variables are a challenge in this project and the question is whether it is maternal age itself that causes the differences in the dependent variables or whether there are other factors that count for the relationship [173]. We followed the strategy to avoid adjusting for the natural process of ageing and restricted the confounders to be the available socio-demographic factors in all the studies (with the exception of Paper I).

The data in Paper I include data from women over a relatively wide time period and the year of birth was adjusted in this study. Civil status was also adjusted for (Sweden: living with the baby's father vs. not; Norway: married or cohabiting vs. not), as was chronic hypertension and diabetes. In addition, due to availability, Swedish data was adjusted for country of birth, smoking, and BMI (Body Mass Index).

In Papers II-IV, the potential confounders were primarily restricted to sociodemographic factors. Data in these studies were adjusted for education, single marital status, native language other than Norwegian, and smoking. In Papers II and IV data was also adjusted for time, mother's income and employment status, and in Paper IV for financial problems (at 36 months after the birth). To explore the data and to

explain the differences between women of advanced or very advanced age and the reference group, data was also adjusted for cesarean and instrumental delivery, prematurity, and neonatal transfer to neonatal intensive care unit in Paper II, and previous history of depression, relationship satisfaction, and maternal and infant health problems three years postpartum in Paper IV.

Independent variables and confounders with response alternatives for the respective papers, divided into reference and other categories are illustrated in Table 4, which also includes sources of data.

Table 4. Independent variables and confounders with response alternatives for the respective paper, divided into reference and other categories, as well as source of data

	Reference	Category(ies)	Source	Paper
<i>Age</i>				
	25-29 years	30-34, 35-39, ≥40 years	MBRS, MBRN	I-IV
	25-31 years	20-24, 25-31, ≥32 years	MBRS, MBRN	I
	25-31 years	≥32 years	MBRN	II
	25-31 years	≥32 years	MBRN	III
	25-31 years	32-37, ≥38 years	MBRN	IV
<i>Reproductive background</i>				
IVF	No	Yes	MBRN	II-IV
<i>Socio-demographic background:</i>				
Civil status	Living with the baby's father Married or cohabiting	Not living with the baby's father Not married or cohabiting	MBRS	I
	Married or cohabiting	Not married or cohabiting	MBRN	I
	Continuous variable	Not married or cohabiting	MoBa ^{1,2,3,4,5}	II-IV
Year of birth	Nordic (Sweden, Norway, Denmark, Finland, Iceland)	Other than Nordic	MBRS, MBRN	I
Country of birth	Nordic (Sweden, Norway, Denmark, Finland, Iceland)	Other than Nordic	MBRS	I
Native language	Norwegian	Other than Norwegian	MoBa ¹	II-IV
Education	University degree ≤4 years	9-year secondary school, 1-2 year high school, 3-year high school, University degree ≤4 years	MoBa ¹	II-IV
Mother's income	200-399 999 NKR	No income or <150-199 999 NKR, 400-≥500 000 NKR	MoBa ¹	II-IV
Financial problems	No financial problems	Financial problems	MoBa ⁵	IV
Unemployment	Employed	Unemployed	MoBa ¹	II-IV
Smoking, self-reported in survey	Not smoking	Smoking	MoBa ^{1,5}	II-IV
Smoking, reported to midwife	Not smoking	Smoking	MBRS, MBRN	I-IV
<i>Physical and mental health</i>				
Chronic hypertension	No chronic hypertension	Chronic hypertension	MBRS, MBRN	I
Diabetes	No diabetes	Diabetes	MBRS, MBRN	I
Previous depression	No previous depression	Depression before pregnancy	MoBa ¹	II, IV
Mother's physical health	Good physical health (good/very good)	Poor physical health (poor/very poor)	MoBa ⁵	IV
3 years postpartum	No serious health problems	Serious health problems	MoBa ⁵	IV
Infant health problems	Normal (18.5-24.9)	Underweight (<18.5), overweight (25.0-29.9), obesity (≥30)	MBRS, MBRN	I
3 years postpartum	Satisfied (scores 4-6)	Dissatisfied (scores <4)	MoBa ¹	II-IV
BMI	No worry for the birth	Worry for the birth	MoBa ²	IV
	No wish for cesarean	Wish for cesarean	MoBa ²	III
<i>Relationship satisfaction (RSS)</i>				
Worry for the birth	No worry for the birth	Worry for the birth	MoBa ²	III
Wish cesarean	No wish for cesarean	Wish for cesarean	MoBa ²	III

Relationship satisfaction (RSS)	Satisfied (scores 4-6) No worry for the birth No wish for cesarean	Dissatisfied (scores <4) Worry for the birth Wish for cesarean		
Worry for the birth	No	Yes	MoBa ²	IV
Wish cesarean	No	Yes	MoBa ²	III
<i>Labour</i>				
Vacuum extraction	No	Yes	MBRN	II-IV
Forceps	No	Yes	MBRN	II-IV
Cesarean	No	Yes	MBRN	II-IV
<i>Infant outcomes</i>				
Neonatal transfer	No	Yes	MBRN	II-IV

MoBa¹ = Questionnaire approximately gwk 17

MoBa² = Questionnaire approximately gwk 30

MoBa³ = Questionnaire 6 months postpartum

MoBa⁴ = Questionnaire 18 months postpartum

MoBa⁵ = Questionnaire 36 months postpartum

MBRS = Medical Birth Register of Sweden

MBRN = Medical Birth register of Norway

Dependent variables

Adverse pregnancy outcomes (Paper I)

Adverse pregnancy outcomes in this study were defined as follows: very preterm birth: 22-31 gestational weeks, moderate preterm birth: 32-36 gestational weeks, small for gestational age (SGA): >2 standard deviations under normal weight for the 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 of delivery.

Psychological distress (Paper II)

Psychological distress was investigated in pregnancy at gestational weeks 17 and 30 and six and 18 months postpartum. It was measured using a shortened, five-item version of the widely used Hopkins Symptom Check List [174]. This scale measures symptoms of depression (three items), and anxiousness (two items). The respondent was asked if she had been bothered by any of the following during the previous weeks: feeling fearful, nervousness or shakiness inside, feeling hopeless about the future, feeling blue, or worrying too much about things. Each item was scored on a four point scale (1 = not bothered, 2 = a little bit bothered, 3 = quite bothered and 4 = very bothered) with a total score ranging from 5 to 20. A mean value was calculated and then a cut-off score of ≥ 1.75 was set for psychological distress. The SCL5 has shown high correlation ($r = 0.91$) with the original global SCL25, which is a validated measurement scale of psychological distress and a Cronbach's Alpha between 0.85 and 0.87 has been reported [95, 175]. A cut-off score of ≥ 2 for distress is recommended in the general population [95], but the scale has not been validated in the context of childbearing. To capture a similar population that has been reported using the well-known Edinburgh Postnatal Depression Scale [48, 109, 176], and to make the results comparable to relevant studies, we chose to set the cut-off score at ≥ 1.75 . This decision was also guided by the fact that it was not our aim to study the prevalence of psychological distress, but rather to investigate possible differences related to maternal age. As our aim was to find the associations between psychological distress and age and not the diagnosis depression, we set the cut-off of SCL5 (≥ 1.75) on the basis of literature on prevalence of depressive symptoms during pregnancy and postpartum in Scandinavian settings, measured by, for example, the EPDS. Table 5 illustrates the prevalence of psychological distress if we were to use the cut-off score recommended

in the general population and also different cut-offs of the EPDS in pregnancy and postpartum.

Table 5. Prevalence of psychological distress using SCL5 with cut-offs 1.75 and 2.0 respectively and EPDS with different cut-offs reported in pregnancy and postpartum [48, 110, 177, 178]

Time point	SCL 5 cut-off 1.75	SCL 5 cut-off 2.0	EPDS cut-off 9	EPDS off 10	cut- off 12	EPDS cut- off 12
Gestational weeks 17	11.5	4.5				
Approximately week 16						13.7*
Gestational weeks 32	11	3.8				
6 weeks postpartum			14*	8.9**, 10.1***		
2 months postpartum						11.1*
6 months postpartum	7.1	2.5				
1 year postpartum						13.7*
18 months postpartum	11.3	4.2				

* Rubertsson 2005

**Eberhard Gran 2001, 2004

***Glavin 2009

Birth experience (Paper III)

Birth experience was investigated six months after the birth using the question: ‘Did the birth go as you had expected?’ The response alternatives were trichotomized into; 1 = better (no, it was better), 2 = worse (no, it was worse), and 3 = as expected/mixed feelings (yes, as expected + neither better nor worse).

Satisfaction with life (Paper IV)

Satisfaction with life was measured by the widely used five-item version of the Satisfaction With Life Scale (SWLS) [150, 179, 180]. The responder was asked to assess the following statements; ‘My life is largely what I wanted it to be’, ‘My life is very good’, ‘I am satisfied with my life’, ‘I have achieved so far what is important for me in my life’, and ‘If I could start all over, there is very little I would do differently’. Each item was scored on a one to seven point scale (1 = totally disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = agree and 7 = totally agree, and a total score was calculated. The possible range of scores is from five (low satisfaction), to 35 (high satisfaction [179, 181]. The reliability and validity of the SWLS is well-established [179, 180]. Internal consistence, measured by Cronbach’s alphas, varies between 0.89 and 0.91; in the total MoBa cohort it was 0.89 in gestational week 17, 0.89 in gestational week 30, 0.89 at six months postpartum and 0.91 at three years postpartum [158].

ANALYSES

For all four papers, descriptive statistics and epidemiological methods were used. For each of the samples in Papers II-IV, differences in proportions and means between the age groups were calculated, in addition to the differences between a sub sample giving birth in 2003 and all Norwegian primiparous women. χ^2 -tests and Student's t-tests respectively were used for the calculations.

In all the papers, subgroup analyses and analyses of possible interactions were performed. An interaction effect can be defined as two component causes acting in the same sufficient cause [173]. All analyses were conducted using IBM SPSS Statistics software, versions 19 and/or 20 (SPSS, Inc., Chicago, IL).

Paper I

To investigate the association between maternal age and perinatal outcomes we used regression analyses and estimated the crude and adjusted odds ratios (aORs) with 95% confidence intervals in the two national samples.

To compare the risks associated with advanced maternal age with those related to smoking, being overweight and obesity, we used the Swedish population only (due to availability of data). As a first step, we estimated the association of each pregnancy outcome, with maternal age, smoking habits, and BMI, and adjusted for five risk factors: year of birth, civil status, country of birth, diabetes, and chronic hypertension. When investigating if the effect of age was similar regardless of whether the woman was a smoker or not, and regardless of BMI, we used 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 in a stepwise model. The Wald test was used to assess the effect of each factor and the interaction, and p-values of <0.05 were defined as statistically significant. Goodness-of-fit for each model was tested by the Hosmer and Lemeshow test [182], and p-values of >0.05 were regarded as adequately-fitted models. To detect influential points, which may distort the outcome and accuracy of the regression analysis, we calculated the Cooke's distance, and values of >1 were interpreted as high [183]. To estimate the attributable effect of advanced maternal age, compared with smoking, being overweight, and obesity respectively, we calculated the population rate of each outcome in a low-risk group of women corresponding to the

reference levels on 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 could be explained by advanced maternal age (30-34 years; 35-39 years; ≥ 40 years; and ≥ 30 years), smoking, being overweight, and obesity (and \geq overweight), based on the differences between the adjusted rates and the absolute risk in the low-risk group. To address the issue of multiple hypothesis testing a stricter threshold at $p < 0.001$ was used.

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. To compare the aORs between 1990-1999 and 2000-2010 we calculated the difference between the estimated $\ln(\text{aOR})$ divided by the pooled SE $\ln(\text{aOR})$ for the respective outcome. Two-sided p-values were calculated based on the standard normal distribution.

Paper II

The associations between age and the depended variable (psychological distress) as well as potential confounders and explanatory factors were tested in bivariate analyses. Multivariable logistic regression models based on the methods of generalized estimation equations (GEE) were used to adjust for independent factors divided into the following blocks: 1) time point, 2) sociodemographic factors, 3) operative delivery, and 4) infant outcome. By using GEE, we accurately dealt with the problem of possible correlation between repeated observations from the same individual and thereby obtained more precise variation estimates in the regression models [184].

We used a binary logistic model and the variance-covariance for all models was assumed to be block diagonal but unstructured within a block defined by subjects.

To study whether the effect of age was modified by any of the independent factors, we tested if there were interactions between age and the following factors after adjusting for all other factors: time, education, marital status, native language other than Norwegian, mother's income, unemployment, smoking, emergency cesarean, instrumental vaginal delivery, neonatal transfer, prematurity, and previous depression. All tests were two-sided. The results are presented as crude and adjusted odds ratios (OR) with their 95% Wald confidence intervals (CI) [173]. Imputations on the SCL

scale were made if a maximum of two items on the scale were missing. We used a single-imputation method, Missing Values Analysis (MVA) - Expectation Maximization algorithm (EM). As predictors for imputations, valid data on the remaining items on the scale were used. We replaced missing values on the scale in 1.42% (270), 1.44% (274), 1.02% (195), and 0.84% (160) of cases in the Questionnaire (Q)1-Q4, respectively and thus kept an additional 899 women for the analyses.

Paper III

The associations between maternal age and feelings about the upcoming labour and memory of the childbirth experience, and between maternal age and potential confounders, were tested in bivariate analyses. Multiple logistic regression analyses were performed and statistically significant confounders were adjusted for. In a final analysis of risk factors for a 'worse than expected' experience of childbirth we constructed an interaction variable between maternal age and mode of delivery and performed subgroup analyses by mode of delivery; spontaneous vaginal birth, instrumental vaginal birth, emergency cesarean delivery, and elective cesarean delivery. We also divided the women of advanced age into two groups: 32-37 years and ≥ 38 years, and performed separate analyses.

Paper IV

Associations between SWL in gestational weeks 17 and 30, and at six months and three years after the birth, and potential confounders tested by bivariate analyses using generalized linear models (GLM), and only the statistically significant confounders were retained. Multivariate logistic regression models based on the methods of generalized estimation equations (GEE) were then used to assess the association between maternal age and satisfaction with life with adjustment for 1) time of measurement and 2) socio-demographic factors. The results are presented as crude and adjusted mean differences with 95% confidence intervals (CI) [173]. P-values of <0.05 were defined as statistically significant.

To study whether the effect of age was modified by any of the independent factors, we tested if there were interactions between age and the following factors after adjusting for all other factors: time, marital status, education, financial problems,

smoking, native language other than Norwegian, relationship satisfaction, previous depression, maternal, and infant health problems.

Imputations on the SWL scale were made if a maximum of two of the five items on the scale were missing by using the MVA-EM algorithm [185]. As predictors, data on the remaining items on the scale were used. Through imputation, 484 women could still remain in the study. Imputation was also performed on the Relationship Satisfaction Scale if a maximum of two of the five responses were missing, leading to 472 women remaining for analysis.

ETHICAL CONSIDERATIONS

Paper I

Approval for use of the Swedish data was obtained from the Regional Research Ethics Committee Stockholm Ref no 2012/843-31/1. No ethical approval from the Norwegian Regional Committees for Medical and Health Research Ethics (REC) was required for the use of the data from the Norwegian Medical Birth register since the data constituted register data from central registers where personal identification numbers and other unique characteristics were removed (information is available on the following link: https://helseforskning.etikkom.no/ikbViewer/page/reglerogrutiner/soknadsplikt/sokerikkerk?p_dim=34999&_ikbLanguageCode=us).

Papers II-IV

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 study is covered by a contract between the project leader and the Norwegian Institute of Public Health, Ref. no. 10-1380, which also includes access to the Norwegian Birth Register. The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian Data Inspectorate (S-97045).

All the participants of the Mother and Child Cohort Study were informed about the purpose of the study in the letter of invitation and signed a written consent, stating that the data provided in the questionnaires could be used for research purposes and also that the data were to be linked to the Medical Birth Register. The participants were free

to withdraw from the study at any time and data already included in data analyses could be deleted (<http://www.fhi.no/dokumenter/6d6187a561.pdf>). The collected data was handled and stored in accordance with the directives of the Norwegian Data Inspectorate. Some participants may have found certain questions in the questionnaires intrusive and in this particular study both the question of psychological distress and the questions of birth expectations and experience may have contributed to distress. Such consideration was taken by researchers and during discussions in ethical committees it was found that benefits for society would compensate for the disadvantages for the individual. The MoBa is obliged to inform the participants about the use of data, and the outcome of the research. This information is available through newsletters and on MoBa's website. In addition, news from MoBa is presented in newspapers and other media (<http://www.fhi.no/dokumenter/6d6187a561.pdf>).

RESULTS

ADVERSE PREGNANCY OUTCOMES RELATED TO ADVANCED MATERNAL AGE IN COMPARISON TO SMOKING AND BEING OVERWEIGHT (PAPER I)

In this study we investigated associations between advanced maternal age and adverse pregnancy outcomes and we compared the risks associated with advanced maternal age with those related to smoking, being overweight, and obesity. We found that the risk of very preterm birth, moderately preterm birth, small for gestational age, low Apgar score, stillbirth, and neonatal death all increase with maternal age. In both populations, there was an increased risk from the age of 30-34 years for the following outcomes: very preterm birth, SGA, low Apgar score, and fetal death. In this age group in Sweden, the risk of neonatal death also increased, and in the Norwegian sample moderately preterm birth increased. For most of the outcomes, the adjusted OR increased more sharply from age 35-39 years (Figure 5).

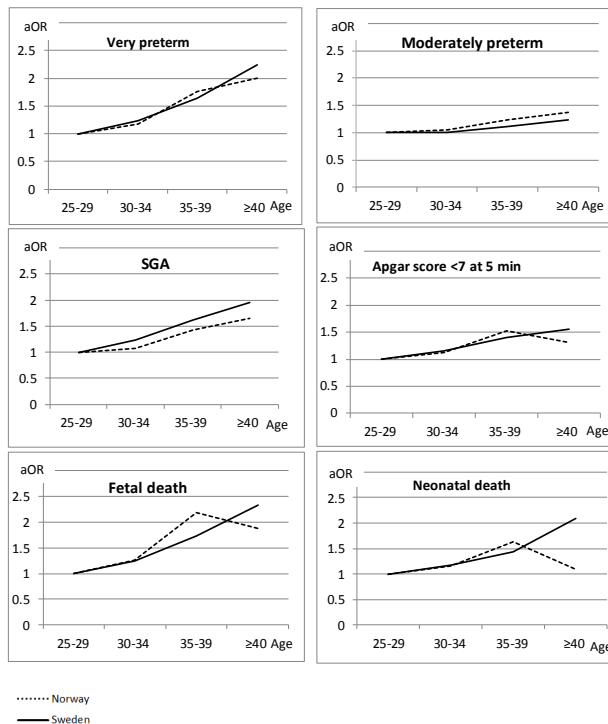


Figure 5. Adjusted Odds Ratios for very preterm birth (22-32 gwks), moderately preterm birth (32-36 gwks), small for gestational age (SGA), Apgar score <7 at 5 minutes, fetal death (from gwk 22), and neonatal death (0-28 days after birth) in nulliparous women singleton pregnancies in Sweden and Norway 1990-2010, by maternal age. Reference (=1): women aged 25-29 (data from Table I, Paper I).

The adjusted Odds Ratio (aOR) for each outcome increased with age in a similar way in Sweden and Norway. Exceptions were the aOR for fetal and neonatal deaths in the oldest age group of ≥ 40 years in the Norwegian sample, where observations were too few to allow valid conclusions.

We investigated the effects of advanced maternal age, smoking and BMI respectively for each outcome in the Swedish sample. We found no statistically significant interactions between maternal age and smoking, maternal age and BMI, or between all three lifestyle factors. Advanced maternal age, smoking, being 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 being overweight was not associated with SGA. Goodness of fit was low in the SGA model ($p < 0.001$), and also in the moderately preterm model ($p = 0.04$). We found no statistically significant differences between the aORs 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 (aORs 1.24; 95% CI 1.17-1.32 vs. aOR 1.05; 95% CI 1.00-1.11). Data are presented in Table 6.

The risks associated with advanced maternal age compared with those related to smoking, being overweight and obesity are shown in Table 7. The rates of the respective outcome in a low-risk group of 162 464 women (25-29 years, nonsmokers and normal BMI) was compared with women of advanced age, smokers, and women who were overweight or obese. The adjusted rates for adverse outcomes were generally lower than the population rates. When estimating additional cases associated with each risk factor compared with the low-risk group we found that maternal age of ≥ 30 years was associated with a larger number of additional cases of very preterm birth (693) and infants with SGA (2749) than smoking (very preterm birth: 158; SGA: 1739) and being overweight/obesity (very preterm birth: 470; SGA: -81), but with the same numbers of fetal deaths (251) as being overweight/obesity (251). Of the three lifestyle factors, being overweight/obesity was associated with the largest number of additional cases of moderately preterm births (1255), infants with low Apgar score (883), and neonatal deaths (92).

Table 6. Adverse pregnancy outcomes in relation to maternal age, smoking and Body Mass Index
 Main effects expressed as adjusted Odds Ratio (aOR) with 95% Confidence Interval (CI) obtained by logistic regression models for each pregnancy outcome, Adjusted for year of birth, civil status, country of birth, chronic hypertension and diabetes. Population rates in "low-risk women": non-smokers of normal weight and aged 25-29 years. Statistically significant differences ($p < 0.001$) indicated in bold.

	All		Very preterm 22-31 gwks		Moderately preterm* 32-36 gwks		SGA		Apgar <7 at 5 min		Fetal death [†]		Neonatal death [†]	
	n	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%
Low-risk women	162464	0.62		4.79	2.58	1.16		0.21	0.14					
Maternal age														
25-29 years	342012	0.8	reference	5.2	reference	3.1	reference	1.4	reference	0.3	reference	0.2	reference	
30-34 years	222883	1.0	1.24 (1.16-1.32)	5.2	1.01 (0.98-1.03)	3.6	1.24 (1.20-1.28)	1.6	1.16 (1.11-1.22)	0.4	1.24 (1.13-1.37)	0.2	1.18 (1.04-1.35)	
35-39 years	67859	1.4	1.64 (1.51-1.78)	5.9	1.13 (1.09-1.17)	4.8	1.62 (1.55-1.69)	2.1	1.40 (1.31-1.49)	0.6	1.73 (1.52-1.96)	0.3	1.43 (1.19-1.72)	
≥40 years	11430	2.0	2.24 (1.93-2.61)	6.4	1.24 (1.14-1.35)	6.0	1.96 (1.80-2.13)	2.3	1.56 (1.36-1.78)	0.9	2.33 (1.85-2.95)	0.4	2.09 (1.48-2.95)	
Smoking[‡]														
Not smoking	548848	0.8	reference	5.1	reference	3.1	reference	1.5	reference	0.3	reference	0.2	reference	
Smoking	56663	1.2	1.45 (1.33-1.57)	5.8	1.13 (1.09-1.18)	6.8	2.19 (2.10-2.27)	1.6	1.07 (0.99-1.15)	0.5	1.55 (1.37-1.77)	0.3	1.30 (1.08-1.55)	
Missing	38673	2.5	1.52 (1.29-1.78)	7.8	1.13 (1.05-1.22)	4.0	1.17 (1.06-1.28)	2.2	1.06 (0.91-1.22)	0.9	1.15 (0.86-1.54)	0.5	1.24 (0.87-1.78)	
BMI[§]														
Underweight	11091	0.8	1.04 (0.83-1.29)	6.0	1.27 (1.17-1.37)	5.9	1.72 (1.58-1.87)	1.1	0.82 (0.68-0.99)	0.3	1.06 (0.75-1.51)	0.1	0.85 (0.50-1.44)	
Normal weight	339345	0.7	reference	4.9	reference	3.3	reference	1.3	reference	0.3	reference	0.2	reference	
Overweight	106319	1.0	1.35 (1.25-1.45)	5.5	1.13 (1.10-1.17)	3.2	0.94 (0.90-0.98)	1.9	1.39 (1.32-1.47)	0.4	1.56 (1.39-1.74)	0.2	1.29 (1.10-1.52)	
Obese	38985	1.6	1.99 (1.81-2.18)	6.5	1.33 (1.28-1.37)	3.7	1.08 (1.02-1.14)	2.6	1.90 (1.77-2.04)	0.7	2.48 (2.16-2.85)	0.3	1.91 (1.55-2.35)	
Missing	148444	1.3	1.16 (1.07-1.25)	5.8	1.04 (1.00-1.07)	3.9	1.03 (0.99-1.07)	1.6	1.16 (1.09-1.24)	0.5	1.27 (1.12-1.44)	0.3	1.20 (1.02-1.41)	
Interactions: Age*Smoking			0.85		0.14		0.21		0.49		0.81		0.13	
Age*BMI			0.11		0.07		0.68		0.06		0.18		0.65	
Age*BMI*Smoking			0.99		0.92		0.42		0.47		1.00		1.00	
Goodness of fit[¶]			p=0.39		p=0.04		p<0.001		p=0.41		p=0.42		p=0.42	

SGA, small for gestational age; aOR adjusted odds ratio; CI, confidence interval. * Very preterm births excluded. † 0-27 days after birth. ‡ Smoking at antenatal care booking in early pregnancy.

§ Underweight <18.5 kg/m²; Normal weight: 18.5-24.9 kg/m²; Overweight: 25-29.9 kg/m²; Obese ≥30 kg/m². ¶ Hosmer and Lemeshow test

Table 7 Estimated additional cases of adverse outcomes caused by advanced maternal age, smoking, overweight and obesity from 1990 to 2010, compared with a low-risk group of women who were nonsmokers, normal weight and 25-29 years old

	n	aAR [†] %	Very preterm 22-31 Weeks			Moderately preterm 32-36 Weeks			SGA ¹			Apgar <7 at 5 minutes			Fetal death [*]			Neor		
			Diff [‡] % units	additional cases [§] All	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	Diff [‡] % units	adjusted Absolute Risk [†] %	
Low risk	162464	0.62			4.79			2.58			1.16			0.21			0.14			
Maternal age																				
30-34 years	222883	0.77	0.15	334	4.84	0.05	111	3.20	0.62	1381	1.35	0.19	423	0.26	0.05	111	0.16			
35-39 years	67859	1.02	0.40	271	5.36	0.57	387	4.18	1.60	1085	1.62	0.46	312	0.37	0.16	108	0.20			
>40 years	11430	1.39	0.77	88	5.89	1.1	126	5.06	2.48	283	1.81	0.65	74	0.49	0.28	32	0.29			
>30 years	302172			693			624			2749			809			251				
Smoking																				
	56663	0.90	0.28	158	5.41	0.62	351	5.65	3.07	1739	1.24	0.08	45	0.33	0.12	67	0.18			
Overweight	106319	0.84	0.22	233	5.41	0.62	659	2.43	-0.15	-159	1.61	0.45	478	0.33	0.12	127	0.18			
Obesity	38985	1.23	0.61	237	6.32	1.53	596	2.79	0.21	78	2.20	1.04	405	0.53	0.32	124	0.27			
≥Overweight	145304			470			1255			-81			883			251				

One infant may have more one than one diagnosis.

SGA: small for gestational age.

[‡] From 22 weeks of gestation.

[†] 0-27 days after birth.

[‡] Diff: attributable difference between aARs

[§] Add. Cases: additional cases; nNumber of additional cases caused by the increased risk related to maternal age, smoking, overweight and obesity.

^{||} Non-smokers of normal weight and aged 25-29 years.

PSYCHOLOGICAL ASPECTS IN PREGNANCY AND AFTER BIRTH (PAPERS II-IV)

In this thesis three different measures of psychological aspect were investigated in relation to maternal age; psychological distress, experience of birth in relation to expectations, and satisfaction with life. Figures 6 to 8 illustrate the distribution of the respective outcome in relation to maternal age.

Figure 6 shows that the youngest women reported the highest scores of distress at all the time points (gwks 17 and 30 and six and 18 months after birth) and that women aged 25-31 had the lowest scores. A slight increase was seen in women aged 32 years and above.

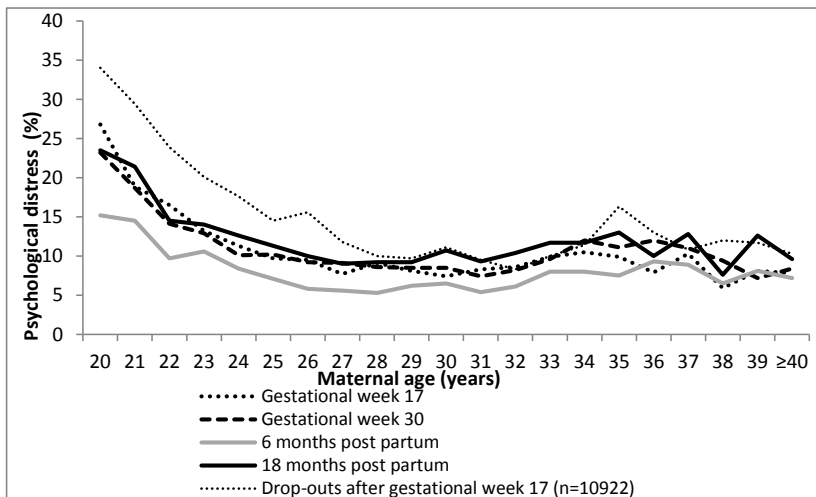


Figure 6. Psychological distress (SCL5 >1.75) in relation to maternal age at 17 and 30 weeks of gestation and at six and 18 months after birth in the study sample of 19291 nulliparous women, and in 10922 drop-outs after gestational week 17 (with baseline data on SCL5).

The women's response to the question; 'Did the birth go as you had expected' when asked six months after the birth is shown in Figure 7. That the birth experience was 'worse than expected' increased slightly with age from 25 years and there was a corresponding decrease with age in the response 'better than expected'.

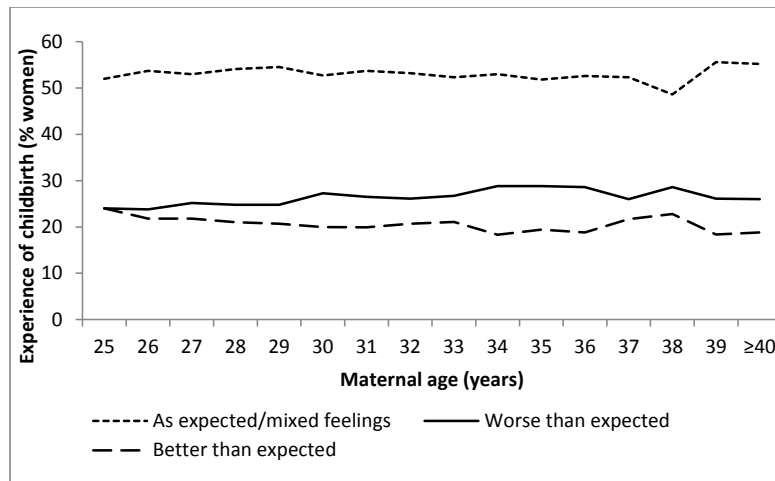


Figure 7. Experience of childbirth ‘as expected or mixed feelings’, ‘better than expected’ and ‘worse than expected’ as remembered at 6 months postpartum by primiparous women of different age (n=30 065).

Figure 8 illustrates the distribution of feelings about the upcoming birth when asked during pregnancy. Women aged 32 years and above reported a slightly increased level of worry about giving birth compared to the reference group (aOR 1.13; 95% CI 1.06-1.21), and when given the possibility to choose they would more often prefer to have a caesarean delivery (aOR 1.84; 95% CI 1.61-2.11).

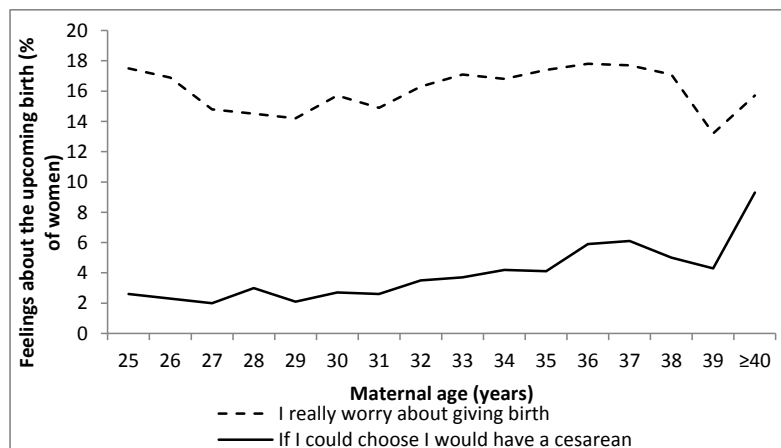


Figure 8. Nulliparous women's feelings about the upcoming birth in relation to maternal age when asked in gestational week 30 (n=30 065).

Figure 9 illustrates the distribution of the SWLS mean scores by maternal age in gestational weeks 17 and 30, and at six months and three years after the birth. During the first three time points, SWL increased from the age of 25 years to 28 years, and then decreased more or less continuously to ≥ 40 years. At three years after birth, the decrease started somewhat younger, from around age of 27 years, and the decrease with age was steeper. The mean SWL scores looked rather similar at the first three time points, but were much lower three years after the birth.

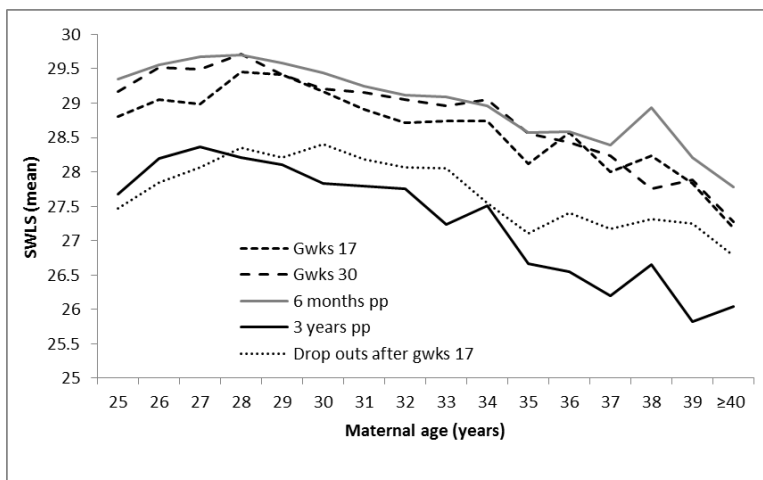


Figure 9. Satisfaction with life (SWLS, mean score) in gestational week 17 and 30 and at six months and three years after birth in relation to maternal age in the study sample (n=18 565), and at gestational week 17 in the drop-outs (n=5891).

Figures 6 and 9 also shows that women who withdrew from the study after having filled in the first questionnaire constituted women with higher rates of psychological distress and lower satisfaction with life.

Psychological distress in relation to advanced maternal age (Paper II)

Paper II investigated the association between advanced maternal age and psychological distress in primiparous women, from mid pregnancy to 18 months postpartum. Table 8 shows the crude and adjusted odds ratios for psychological distress in the various age groups, the women of advanced age (≥ 32 years), the young (20-24 years), and the reference group (25-32 years).

Table 8. Psychological distress (SCL5 ≥ 1.75) in gestational weeks 17 and 30, and at six and 18 months after the birth in primiparous women aged 20-24, 25-31 and ≥ 32 years (n=192 91). Crude and adjusted odds ratios (OR) and 95% Confidence Interval (CI)

Age	n	Psychological distress in gestational week 17 (%)	Crude OR	Adj ¹		Adj ²		Adj ³		Adj ⁴		Adj ⁵		
				CI	95%	CI	95%	CI	95%	CI	95%	CI	95%	CI
20-24	3106	15.3	1.81	(1.66-1.97)	1.80	(1.65-1.95)	1.25	(1.14-1.37)	1.25	(1.14-1.38)	1.26	(1.14-1.39)		
25-31	11801	8.5	1		1		1		1		1			
≥ 32	4384	9.2	1.17	(1.07-1.27)	1.16	(1.06-1.26)	1.14	(1.04-1.25)	1.14	(1.04-1.24)	1.14	(1.04-1.25)		
Interaction effect of age and unemployment														
Unemployed														
20-24	156	28.8										1.98	(1.49-2.63)	
25-31	230	17.4										1.94	(1.49-2.52)	
≥ 32	91	12.1										1.15	(0.74-1.81)	
Employed														
20-24	2950	14.6										1.27	(1.15-1.41)	
25-31	11571	8.3										1		
≥ 32	4291	9.1										1.16	(1.06-1.28)	
Interaction effect of age and a history of depression														
History of depression														
20-24	97	42.7											5.73	(4.60-7.14)
25-31	216	33.3											5.75	(5.01-6.59)
≥ 32	124	35.5											7.00	(5.84-8.38)
No history of depression														
20-24	2879	13.2											1.34	(1.21-1.49)
25-31	11153	7.0											1	
≥ 32	4035	6.9											1.03	(0.93-8.38)

¹ Adjusted for time point

² Adjusted for ¹ and Sociodemographic variables: (education, single status, native language, mother's income (NKR), unemployment and smoking)

³ Adjusted for ¹ and ² and Operative delivery: (emergency caesarean section, instrumental vaginal delivery)

⁴ Adjusted for ¹ and ² and ³ and Infant outcome: (neonatal transfer, prematurity)

⁵ Adjusted for ¹ and ² and ³ and ⁴

The women of advanced age had slightly increased odds for psychological distress, at all time-points, and the odds ratios remained almost unchanged when adjusting for socio-demographic background. The higher risk in the youngest women, in contrast to the women of advanced age, decreased when adjustments were made for socio-demographic variables. We entered also operative delivery (emergency caesarean section, instrumental vaginal delivery) and infant outcome (neonatal transfer, prematurity) into the model, but the figures remained stable for all ages. Interactions between age and the factors described in Table 8 showed that unemployment interacted with age ($p=0.042$), and most strongly in the women aged 20-24 and 25-31 years. Women of advanced age were less affected by unemployment. However, having had one or more episodes of depression prior to pregnancy also interacted with age ($p=0.008$) and the highest risk was observed in the oldest women who had seven fold odds for distress. All women with a history of depression were at higher risk than those without such a background. In the absence of previous depression, the oldest women were not at higher risk than the reference group, which is further illustrated in Figure 10.

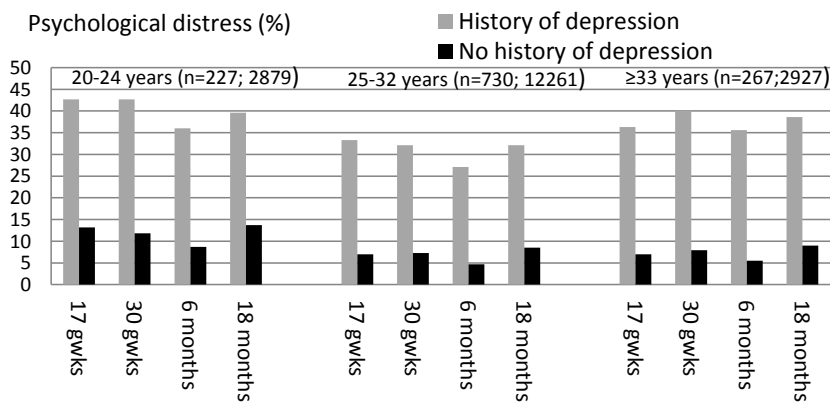


Figure 10. Psychological distress in primiparous women aged 20-24, 25-31 and ≥ 32 years with or without a history of depression, in gestational weeks 17 and 30, and six and 18 months postpartum.

Association between age and experience of birth in relation to expectations (Paper III)

The association between advanced maternal age and birth experience in relation to expectations was investigated, using data on expectations from the mid-pregnancy questionnaire and retrospective assessment of experiences at six months postpartum.

Table 9. Memory of childbirth in relation to expectations in primiparous women of advanced age (≥32 years) compared with the reference group (25-31 years). All women and subgroups of women by mode of delivery*. Total sample = 30,065 women. Regression analyses presented as Crude and Adjusted Odds Ratio (OR) with 95 % Confidence Intervals (CI).

Maternal age, yrs	Total	As expected/mixed feelings		Worse than expected		Better than expected	
		n	%	n	%	n	%
25-31	21 226	11 349	53.5	5376	25.3	1	1
≥32	8839	4652	52.6	2411	27.2	1.09 (1.03-1.16)	1.09 (0.90-1.03) 0.97 (0.90-1.03)
All women							
25-31	14 583	8268	56.7	2342	16.1	1	1
≥32	5192	2872	55.3	913	17.6	1.12 (1.03-1.23)	1.12 (0.95-1.10) 1.02 (0.95-1.10)
Subgroups of women by mode of delivery							
<i>Women with a spontaneous vaginal birth</i>							
25-31	3583	1668	46.6	1632	45.5	1	1
≥32	1696	825	48.6	731	43.1	0.91 (0.80-1.02)	0.91 (0.80-1.02) 1.01 (0.81-1.26)
<i>Women with instrumental vaginal delivery</i>							
25-31	2059	812	39.4	1135	55.1	1	1
≥32	1193	498	41.7	603	50.5	0.87 (0.75-1.01)	0.87 (0.74-1.01) 1.36 (1.01-1.85)
<i>Women with emergency cesarean delivery</i>							
25-31	665	477	71.7	66	9.9	1	1
≥32	532	364	68.4	44	8.3	0.87 (0.58-1.31)	0.85 (0.56-1.30) 1.38 (1.03-1.84)

Table 9 shows the crude and adjusted odds ratios for the birth experience in relation to expectations in the women of advanced age (≥ 32 years) and the reference group (25-32 years). In women aged 32 years and above, 27% reported a childbirth experience that was worse than expected compared to 25% of women aged 25-31 years. When adjusting for mode of delivery the effect of age was no longer statistically significant. The table also shows four subgroups of women with the same mode of delivery. The prevalence of a birth experience worse than expected was highest in women who delivered with an emergency cesarean, followed by women who delivered with an instrumental vaginal delivery. Women who delivered with a spontaneous vaginal birth had a lower prevalence of a birth experience worse than expected. However, the age related risk of a birth experience worse than expected only differed in women who had a spontaneous vaginal birth, where the oldest were at the highest risk.

Satisfaction with life in relation to maternal age (Paper IV)

Paper IV investigated the association between advanced maternal age and satisfaction with life, from mid pregnancy to 36 months postpartum. Table 10 shows the crude and adjusted mean differences between the women of advanced age (32-37 years), very advanced age (≥ 38 years), and the reference group (25-31 years).

Table 10. Satisfaction with life by maternal age group
Mean SWLS in gestational weeks 17 and 30, and at six months and three years after the birth. Analysed by GEE¹ adjusted for timepoint (Adj²) and sociodemographic variables (Adj³) with 95% Confidence Intervals (CI). Nulliparous women aged 25-31 (reference), 32-37 years and ≥ 38 years (n=18 565).

Age	n	SWLS		SWLS		Mean difference	CI 95%	Adj ²	CI 95%	Adj ^{2,3}	CI 95%
		SWLS gwk 17 Mean	SWLS gwk 30 Mean	SWLS 6 months pp Mean	SWLS 3 years pp Mean						
25-31	13107	29.11	29.4	29.52	28.05	0		0		0	
32-37	4827	28.58	28.84	28.9	27.21	-0.6	(-0.77 - -0.51)	-0.63	(-0.76 - -0.50)	-0.7	(-0.83 - -0.58)
≥ 38	631	27.73	27.6	28.31	26.22	-1.6	(-1.92 - -1.21)	-1.56	(-1.92 - -1.20)	-1.32	(-1.65 - -0.99)

¹Generalised Estimated Equation

²Adjustment for time point

³Adjustment for sociodemographic variables: education, single status, native language other than Norwegian, financial problems, unemployment and smoking.

Satisfaction with life was slightly lower in women of advanced age and in women of very advanced age compared to the reference group. These differences remained after

the adjustments were made for time and socio-demographic factors. When entering relationship satisfaction into the model, the mean differences between the reference group and women of advanced age (-0.5; 95% CI -0.62 – -0.38) and very advanced age (-1.18; 95% CI -1.49 – -0.86) were slightly reduced. The following factors also affected the results but only marginally: previous depression, the child's overall health, and maternal overall health.

Interactions between age and all co-variates were investigated and age interacted with time ($p < 0.001$), and the decrease with time was most obvious in women of advanced age.

DISCUSSION

This thesis confirms that advanced maternal age increases the risk of very preterm and moderately preterm birth, small for gestational age, low Apgar score, stillbirth and neonatal death, and that these risks may increase before the age of 35 years. Advanced maternal age was an independent risk factor in relation to smoking and being overweight and the combination of the three factors was associated with a substantially increased risk of adverse pregnancy outcomes. Also, first time mothers of advanced age reported more psychological distress over the age span from gestational weeks 17 and 30 to six and 18 months postpartum as compared to the reference group, a slightly more negative experience of the birth in relation to their antenatal expectations, and a slightly lower degree of satisfaction with life from gestational weeks 17 and 30 to six and 36 months postpartum.

Medical aspects

Previous studies of adverse pregnancy outcomes in relation to maternal age have usually defined “advanced” age as 35 years and older. The findings in Paper I suggest that this definition may need to be reconsidered since the risks of several severe outcomes, including fetal death, may increase already in the age group 30-34 years. Even if the risk estimates were small for the individual woman in this study, the consequences for society may be substantial when large numbers of women have their first baby in their early 30s. Much attention has been paid to medical risks associated with lifestyle factors such as smoking [61, 70] and being overweight/obesity [61, 73], and the findings of this thesis underlines that advanced maternal age should be regarded as a comparable, possibly modifiable, life style factor associated with adverse pregnancy outcomes. Our findings differ from other research that concludes that being overweight/obesity has a higher impact than advanced maternal age [61]. This could be explained by different definitions of advanced age as well as by the reference group. The U-distribution seen in some of the outcomes, with a higher prevalence among the youngest and oldest women, needs to be considered since a reference group consisting of the youngest women could underestimate the effect of ageing.

The reasons why advanced age has negative effects on pregnancy outcomes are not fully understood, but may be related to the aging processes in the uterus and placenta [61, 63, 65, 186, 187]. Neonatal death and low Apgar score may have different causes, including complications during labour and ageing processes in the myometrium, the latter being one of the suggested explanations of the higher rates of uterine dysfunction in older nulliparous women [188, 189]. Smoking may have negative effects on the uterine environment by increasing the risk of placental complications, fetal growth restriction and preterm birth [70], and being overweight or obesity may also increase the risk of adverse pregnancy outcomes, such as gestational hypertension, gestational diabetes, cesarean delivery, and stillbirth [190]. These associations are probably related to metabolic and inflammatory disorders documented in obese and overweight persons [191, 192]. From the analyses we conducted we found no interaction between age and smoking or between age and being overweight/obesity, meaning that the associations are independent and the multiplied 'effect' on adverse pregnancy outcomes could be considerable.

Psychological aspects

Women of advanced age were more worried during pregnancy than younger women when asked approximately 10 weeks prior to the delivery. A similar finding has been reported previously in some research [118, 143], but not in others [193]. These women also wished to have a cesarean section more often than younger women, and such a wish has been associated with fear of childbirth [194-196]. Advanced-age first-time mothers also reported a higher level of psychological distress, but subgroup analyses revealed that this was only the case in women with a history of depression whereas women without such a history did not differ from the reference group. These findings could have clinical implications in the form of paying special attention to older nulliparous women with history of depression, since these women may need extra support during the childbearing period.

Even though young women were not the focus of this thesis, Paper II included women aged 20-24 years, and findings showed that, as expected and reported by research [115-117], these women had the highest level of psychological distress. In contrast to the older women, the distress in the younger women was largely explained by socioeconomic factors, such as unemployment.

Experience of childbirth

A slightly higher risk of experiencing childbirth as worse than expected was found in women of advanced age, but when controlling for mode of delivery this difference in relation to age disappeared. We first interpreted this finding as a consequence of the higher prevalence of operative deliveries in the older women [136]. However, further analyses showed that the older women with an operative delivery had a more positive birth experience than younger women with an operative delivery. This might have to do with expectations during pregnancy. Compared with younger first-time mothers, the older first-time mothers seemed to be better prepared to manage an operative delivery. This interpretation is supported by the fact that women of advanced age are more often prepared for childbirth and aware of the potential risks [148, 197].

Further analyses also showed that women of advanced age with a spontaneous vaginal birth reported a more negative experience in relation to their antenatal expectations, compared with the younger women with a spontaneous birth. Using available data we could not investigate this further, but one explanation could be a higher frequency of prolonged labour in the older women [188], although defined as normal, due to decreased uterine function [67, 68]. The older women might also have had excessively optimistic feelings about the upcoming birth as reported in a Swedish survey [118].

Satisfaction with life

Satisfaction with life decreased from pregnancy to three years after the birth, and this was seen more clearly in older women than in younger women. One explanation could be that SWL decreases with age regardless of childbirth, but this interpretation is contradicted by findings from a nationwide Norwegian sample where SWL was highest in older women. Dissatisfaction with partner relationship and a history of depression are both factors that are more prevalent in older first-time mothers [21] and associated with low SWL [158, 198] and there could be other contributing factors since the effect of age was slightly reduced when adjusting for these in the statistical analyses [21, 158, 198]. Still, symptoms of biological ageing, such as fatigue and sleeping problems [21], obstetric complications [2, 5, 6], and infant health problems [5, 71, 199], could have contributed to the findings although adjustment for many of these factors only slightly reduced the age effect.

Changes over time

In Papers II and IV the outcomes were measured twice during pregnancy and twice after the birth. Psychological distress increased and satisfaction with life decreased over time, and was most obvious in the oldest women, suggesting that pregnancy and motherhood become increasingly challenging over time. One exception was the measurements at six months after the birth when psychological distress was least common and satisfaction with life was at its highest level, regardless of age. These findings are supported by other studies of postpartum depressive symptoms [161, 177, 178]. At six months postpartum, the woman may have adapted to her new role as a mother and feel confident in caring for the child. Mercer [81] described this as a turning point when women had ‘found their own way’. In a country like Norway a mother at this stage will most likely still be on parental leave and not yet confronted with the challenge of combining motherhood and work outside the home [200]. After the six months measurement, psychological distress increased at 18 months in all the age groups, and at three years after birth all age groups reported the lowest SWL scores, and women of advanced age had the lowest of these. At this time, in general, women will have returned to work, suggesting that the lower SWL scores reflect the day-to-day struggle to combine the demands of parenthood and occupational work [81, 200].

Women in this study reported high levels of satisfaction with life compared with other studies and, to our knowledge, the scores at six months after birth are among the highest ever reported [158]. However, at three years the SWL scores were almost the same as in a population based Norwegian sample of non-pregnant and pregnant women [201]. Notably, SWL declined with age in the childbearing women at all four time points, but increased with age in the total population.

The transition into motherhood is a life-changing event and the findings of this thesis contrast with the view that older first-time mothers are better equipped to deal with this new situation than younger women in their 20s, because of greater personal maturity and life experience. Women of advanced age are faced with other difficulties than younger women, and the unpredictability associated with childbirth and motherhood is one such factor. This may be more difficult to handle after having lived an independent life with a high degree of control for a longer period of time than younger women.

METHODOLOGICAL CONSIDERATIONS

The strength of these studies is their large sample sizes. When rare conditions are investigated, especially perinatal deaths, large samples are necessary [2]. The interpretations must be done in light of the observational design and we cannot draw conclusions about causality. However, the longitudinal design is strong and by using the statistical approach of GEE analyses, full advantage was taken of the design (Papers II-IV). GEE would accurately deal with the problem that repeated observations for the same individual are often correlated, which if ignored leads to smaller standard errors and increases type I errors and the risk of an incorrect conclusion [184].

Age and Age cut-off

In this thesis advanced maternal age is defined as the age of 30 and above (Paper I) and 32 and above (Papers II-IV). This is a lower cut-off than many other definitions of advanced maternal age. The decision for the age cut off in Paper I was based on the fact that we investigated whether there was an increase in risk before the commonly used cut off age of 35 years. For Papers II-IV the decision of age categorization was based on data outside our own data set and based on the age cut-off on the lower limit of the upper quartile for the entire Norwegian birth cohort in 2003; the control group was correspondingly defined as women 25-31 years.

Comparisons between studies can be challenging when different age cut-offs are used. These studies may contribute to a future discussion in order to reach a consensus about what is an 'old' mother. However, most importantly, this study saw rates of serious infant complications appearing already at the maternal age of 30-34. Also, the overview of the respective outcomes over the entire reproductive life span, though excluding the youngest women, supported what has previously been suggested that the consequences of age are a continuum rather than a threshold effect [8].

The focus of this thesis is on women of advanced age even though it would have been valuable to include the entire age span in all papers to put them into context. In one of the papers (Paper II) even women aged 20-24 years were included, however for three papers (Papers I, III and IV) we included only women aged 25 years and above. However, due to our agreement with the Mother and Child Cohort board, we only had

permission to use data on women who no longer belonged to the 'youngest' group in order to avoid overlapping research with other studies. Additionally, teenage mothers have been described extensively in previous publications. However, the findings from Paper II suggest that the problems related to teenage pregnancies may also exist in higher ages and include women aged 20-24 years. We therefore suggest that in studies of advanced maternal age, reference groups such as ours are appropriate.

Selection of women

When interpreting the research findings one must bear in mind the selection of women into late motherhood. Anxiety and depression may have caused some of the older women to postpone their pregnancy rather than a postponed pregnancy causing anxiety and depression. Women may also have postponed their pregnancy due to fear of childbirth, since women of advanced age reported higher levels of worry about the upcoming birth as well as a more frequent wish for a cesarean birth than younger women (Paper III). Women who were less happy and less satisfied with life might have had greater difficulties finding a partner, [157, 202, 203] also explaining entering into motherhood at an advanced age. A previous study found that women of advanced age (32–37 years) and very advanced age (≥ 38 years) differed from younger women regarding a wide range of background characteristics and that the differences were most pronounced in the oldest women [21]. The women of advanced and very advanced age constituted a heterogeneous group characterized not only by high income and education, but also by a low level of education, unemployment, single marital status, unplanned pregnancies and unsatisfactory relationships with partners. Problems related to physical ageing were more common, such as infertility and physical health problems, as well as fatigue and sleeping problems [21]. Similar findings on older first-time fathers have been reported [25]. A Swedish panel study showed that women and men who postponed their first pregnancy constituted a selected group with different intentions and opportunities for childbearing compared with younger women (Schytt, Nilsen & Bernhardt 2013, in progress). Certain personality traits have also been identified in older mothers including resilience, hardiness and less dependence on others, implying maturity, problem-solving skills, stable partnerships and financial security [2].

When interpreting the findings of Papers II-IV one also needs to take into account the women who dropped out of the study, as they constituted a more disadvantaged group

with more psychological distress and lower satisfaction with life scores. By including these women, the measurements of psychological distress would have been higher and the satisfaction with life scores lower.

Reliability and validity

The accuracy of estimation is an overall goal of an epidemiologic study [173] and reliability and validity are important quality indicators. Reliability refers to the precision of the measurement and is important for the validity of a measurement and for the interpreting of the results. In this thesis two psychological instruments were used, the SCL5 in Paper II and SWLS in Paper IV. The scales are validated, even if the SCL5 is not validated in the context of childbearing. The measurement of birth experience in Paper III, however, is based on a single question and could be threatened by lack of precision.

Selection bias

Selection bias may occur when the relationship between exposure and outcome is different between the study sample and the entire population to which one wishes to compare [173]. Records in the medical birth registers of Norway and Sweden are mandatory and selection bias will most likely not affect the study on medical outcomes (Paper I). The studies on psychological outcomes (Papers II-IV), however, may be affected by the relatively low response rate in the MoBa cohort where the final sample had a low response rate of 38.7% (<http://www.fhi.no/dokumenter/6d6187a561.pdf>). We lack information regarding why women did not participate. The questionnaires in the MoBa are comprehensive and there were no personal benefits for the women taking part. In addition, the sampling was to some extent opportunistic, depending on available funding and the participation of local hospitals at various times during the recruitment period. Only facilities with more than 100 births per year were targeted (<http://www.fhi.no/dokumenter/6d6187a561.pdf>). However, the selection to the MoBa sample has been described and suggests that although some prevalence estimates are biased, the association measurements between exposures and outcomes are not [171]. A socioeconomic gradient may have specially affected the prevalence estimates of psychological measures and the questions used in this study may have been assessed as sensitive for some women

To assess the representivity, we compared the background characteristics and pregnancy outcomes of a sub-group of women who gave birth in 2003 with women aged ≥ 25 years in the total 2003 year birth cohort in Norway (Table 2). The mean age in our sample was higher than in the entire birth population. Furthermore, the following characteristics were under-represented in the study samples; women aged 20-24 years (relevant in Paper 2) and women aged 25-29 years, smokers, single marital status, IVF in present pregnancy, cesarean delivery, premature birth, and infant transfer to neonatal intensive care unit. However, there was nearly no underrepresentation of women in the oldest age groups. Women in the sample did not differ from the national birth cohort regarding the frequency of vacuum and forceps deliveries.

We have revealed that the women who withdrew from the study after having filled in the first questionnaire constituted a selected group with higher rates of psychological distress and lower rates of satisfaction with life. This means that the study results probably underestimate these factors and that in the target population there will be a higher prevalence of symptoms of anxiety and depression and lower scores in relation to satisfaction with life.

The questionnaires in the MoBa studies were distributed only in the Norwegian language, which implies that only women who could understand and answer in Norwegian were included. As a consequence it is possible that the results cannot be generalized to women representing cultures that differ substantially from the Norwegian [154, 204].

Information bias

Variables from the MBR of Sweden and Norway

Information bias may occur when there are errors in the measurements of the required information [173], referred to as misclassification. Even though data from the Medical Birth Registers of Sweden and Norway are of high quality, missing data, incorrect information, and previous misclassification due to data transformation problems might be an issue [169, 205]. An evaluation of the MBRS found that information regarding gestation duration, birth weight, and infant survival were fairly reliable but the rate of stillbirths was slightly underestimated. Information regarding smoking was relatively reliable (4.2 - 9.0 per cent missing) and a calculation of the BMI was possible for about 65 % of women [205]. Missing data will obviously affect

all estimates of prevalence, but will usually have little impact on risk estimates if the lack of information is random [205]. In order not to lose participants in the analyses in Paper I we constructed a missing group and calculated the OR's for the outcome even for this group, which was in most cases increased compared with the reference group. For the data from the Norwegian Medical Birth register several of the variables have been validated and found to be satisfactory [169, 206]. For both registers, the form is completed by midwives or doctors after the birth, and all records of the birth registers are matched with those of the Central Person Registry, resulting in mutual updating of the files. Additionally the Birth Registers also receive a notification form for all infants transferred to neonatal care unit [169, 205]. According to the studies in this thesis, the possible information bias is probably not prominent and will not threaten the validity of the studies.

Variables from the MoBa

The measurement of psychological distress was based on a shortened version of the Hopkins Symptom Check List, the SCL5, which was not validated in the context of childbearing. This could lead to a misclassification. However we were not aiming at the diagnosis depression or anxiety and this did not threaten the validity of the study. The measures of birth expectations and experience were based on not validated single-item questions. In addition, the question on birth experience was based on the women's expectations, which we have limited information on. This might have introduced information biases as the expectations will differ among the women. The SWL measurement was performed with a validated instrument and so probably does not suffer from misclassification. It applies for the three MoBa studies (Papers II-IV) that even some potential misclassification; we were aiming at illuminating a possible age difference and threat of misclassification was not a serious one.

Other study limitations

The context for this study is for Papers II-IV from Norway, women giving birth between 1999 and 2009, and for Paper I data from all births occurring in Norway and Sweden between 1990 and 2010. Changes may have occurred, and these would be most relevant for Paper I. however, we adjusted for year of birth in this paper and in the Swedish data set we compared outcomes from 1990-1999 with those from 2000-2010 and found that they were fairly similar.

Paper I: The analyses were adjusted for different variables in the two samples; nevertheless, the risk estimates were relatively similar to other population-based studies. One limitation was that the SGA model did not fit well with the data which implies that this should be interpreted with caution.

Papers II-IV: In this thesis we have investigated the age differences regarding three different psychological measures even if we may not have captured the constructs in their total breadth.

Paper IV: We lack information of SWL before pregnancy, but such information would have been very difficult to obtain since one would not know beforehand who will become pregnant or not. This makes it difficult to answer the question of whether the declines in SWL over time are absolute or if they represent an adaptation to the childbirth.

GENERAL CONCLUSIONS

Paper I: It was confirmed that advanced age is associated with an increased risk of adverse pregnancy outcomes. The risk was increased already by the age of 30-35 years, and although the individual risk is small, it may be significant for society due to the large number of women who give birth at this age.

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

Paper II: Primiparous women of 32 years and beyond had a slightly increased risk of psychological distress during pregnancy and the first 18 months of motherhood compared with women aged 25-31 years.

Paper III: Primiparous women of 32 years and above were at a slightly increased risk of experiencing childbirth as 'worse than expected'. In pregnancy they were also more often worried about the upcoming birth and if they could choose, a higher proportion of them would prefer a cesarean delivery.

Paper IV: First-time mothers of advanced age (32-37 years) and very advanced age (38 years and above) reported a slightly lower degree of satisfaction with life compared with women aged 25-31 years and the age-related association was greatest when the child was three years of age.

Overall, findings from this thesis suggest that the postponement of childbirth phenomenon in high-income countries may increase the risk of adverse pregnancy outcomes at an earlier age than has previously been reported, and that it may have marginal negative effects on women's emotional wellbeing and satisfaction with life. On the basis of the studies included in this thesis we *cannot* confirm that from the perspective of these aspects it would be more advantageous to have the first child at an advanced maternal age. On the contrary, our findings suggest that childbearing affects life more positively if occurring before women reach their thirties.

CLINICAL IMPLICATIONS

The clinical implication of this study is that the postponement of childbirth needs to be taken more seriously. Although the risk for the individual is small; it may be significant for society due to the large number of women giving birth at this age.

Knowledge about the associations between age and the psychological aspects is important for midwives and doctors in their roles as facilitators for women and couples and caregivers should be extra alert to women with a previous history of depression.

Society and young people should be provided with adequate information about possible risks associated with the postponement of parenthood. The postponement of childbirth should feature to a larger extent on the agendas of communities, legislators, and politicians.

FUTURE RESEARCH

Interventions aiming at testing models of information should be tested and evaluated.

Investigate the effects of postponement on women's health, in relation to birth of subsequent children.

Investigate the combined risk of women and men of advanced age.

Psychological aspects of advanced age in the immigrant population as many immigrants are excluded due to language restrictions in the MoBa Cohort Study.

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ERRATA

In Paper 3 an error in table 2 was detected after the paper was published. Two subheadings are both saying 'Women with instrumental vaginal delivery' and the second of those should be replaced with 'Women with emergency cesarean delivery'. A comment is posted in the biomed central pregnancy and childbirth.

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APPENDIX

The following websites include actual MoBa documents:

The questionnaires:

http://www.fhi.no/eway/default.aspx?pid=240&trg=MainContent_6894&Main_6664=6894:0:25,7372:1:0:0:::0:0&MainContent_6894=6706:0:25,7375:1:0:0:::0:0

The letter of information:

<http://www.fhi.no/dokumenter/b73f096b9c.pdf>

The revised protocol including consent form:

<http://www.fhi.no/dokumenter/3972b9ec5c.pdf>

Paper I

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Adverse Pregnancy Outcomes Related to Advanced Maternal Age Compared With Smoking and Being Overweight

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Précis For the individual, the increased absolute risk for adverse pregnancy outcomes at or beyond age 30 is small, but on a population level the number of increased adverse pregnancies may be substantial.

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Abstract (243 words)

Objective To investigate the association between advanced maternal age and adverse pregnancy outcomes, and to compare the risks related to advanced maternal age with those related to smoking and being overweight or obese.

Methods A population-based register study including all nulliparous women aged 25 years and older with singleton pregnancies at 22 weeks of gestation or greater who gave birth in Sweden and Norway from 1990 to 2010; 955,804 women were analyzed. In each national sample, adjusted odds ratios (aOR) of very preterm birth, moderately preterm birth, small for gestational age, low Apgar score, fetal death and neonatal death, in women aged 30-34 years (n=319,057), 35-39, years (n=94,789) and 40 years or older (n=15,413) were compared with those of women aged 25-29 years (n=526,545). In the Swedish sample, the number of additional cases of each outcome associated with maternal age 30 years or older, smoking, and overweight or obesity, respectively, was estimated in relation to a low-risk group of nonsmokers of normal weight, aged 25-29 years.

Results The aOR of all outcomes increased by maternal age in a similar way in Sweden and Norway; and the risk of fetal death was increased even in the 30-34 year-old age group (Sweden n=826; aOR 1.24; 95% CI 1.13-1.37, Norway n=472; aOR 1.26; 95% CI 1.12-1.41). Maternal age 30 years or older was associated with the same number of additional cases of fetal deaths (n=251) as overweight or obesity (n=251).

Conclusion For the individual woman, the absolute risk for each of the outcomes was small, but for society it may be significant due to the large number of women who give birth after the age of 30.

Introduction

Many women in high-income countries plan to have their first baby after the age of 30, and this postponement of childbirth compared with the previous generation has caused concern among healthcare providers due to the risk of infertility and adverse pregnancy outcomes (1). Along with increasing demands for assisted reproductive techniques, advanced maternal age has been associated with preterm birth (2), fetal growth restriction leading to infants small for gestational age (SGA)(2), chromosomal abnormality (3), low Apgar score (4), stillbirth (5), and neonatal death (6). Advanced maternal age is often defined as 35 years or older, and in this study the question posed was whether the risk of some of the most serious pregnancy outcomes commenced earlier.

Several of the outcomes mentioned are also associated smoking and overweight or obesity. Smoking increases the risk of preterm birth (7), SGA(8), stillbirth (5), and neonatal death (7); and overweight or obesity during pregnancy is associated with preterm birth (9), low Apgar score (4), stillbirth (5), and neonatal death (10). The relative significance of the respective lifestyle factors during pregnancy is less explored, except regarding the risk of stillbirth. A systematic review reported that maternal overweight and obesity contributed to around 8000 stillbirths (≥ 22 weeks' gestation) annually across all high-income countries; and that advanced maternal age (>35 years) and smoking contributed to 4200 and 2800 stillbirths respectively (5). In this study we investigated whether advanced maternal age was a risk factor comparable to smoking and overweight or obesity, regarding the outcomes listed below.

The specific aims of the study were:

(1) To investigate associations between advanced maternal age and very preterm birth, moderately preterm birth, SGA, low Apgar score, stillbirth and neonatal death in nulliparous

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women aged 30 years and older with a singleton pregnancy, compared with women aged 25-29 years, who gave birth in Sweden and Norway during 1990-2010.

- (2) To compare the risks associated with advanced maternal age with those related to smoking, and being overweight or obese in the Swedish sample.

Materials and methods

For the first aim of the study we obtained data from the Swedish and Norwegian Medical Birth Registers, and for the second aim we used Swedish data only. The Swedish and Norwegian Medical Birth Registers include information from the standardized medical records used by all antenatal clinics and delivery units and cover $\geq 98\%$ of all births in the respective country. Several variables used in the present study have previously been validated with satisfactory results, such as maternal age, gestational age and infant survival (11-14).

To study a potential increase of risk in any of the outcome factors at a younger age than 35 years, which is a commonly used cutoff for advanced maternal age, 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 respectively. For simplicity, the three age groups of 30 years and older are referred to as advanced maternal age in this study. In contrast to our Norwegian dataset, in which maternal age was given as a five-year interval for each individual, the Swedish data included information about the exact maternal age, which allowed calculation of the mean age within each of the four age groups. These were: 27.0 years (SD ± 1.4); 31.6 (SD ± 1.37), 36.4 (SD ± 1.33) and 41.3 (SD ± 1.59).

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

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was collected on the same occasion, and BMI was defined as underweight $<18.5 \text{ kg/m}^2$; normal weight: $18.5\text{-}24.9 \text{ kg/m}^2$; overweight: $25\text{-}29.9 \text{ kg/m}^2$; obese: $\geq 30 \text{ kg/m}^2$. 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.

In addition, adjustment was made for the following factors: 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.

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): >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.

To investigate the association between maternal age and each outcome, we estimated the crude and adjusted odds ratios with 95% confidence intervals in the two national samples (Table 1).

For the second aim of the study 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 five risk factors: year of birth, civil status, country of birth, diabetes, and chronic hypertension. 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

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BMI) by adding each of the interactions, one at a time, to the model in the first step, which included eight factors. The Wald test was used to assess the effect of each factor and the interaction; p-values <0.05 were defined as statistically significant. Goodness-of-fit for each model was tested by the Hosmer and Lemeshow test (15), and p-values >0.05 were regarded as adequate-fitted models. To detect influential points, which may distort the outcome and accuracy of the regression analysis, we calculated the Cooke's distance, and values >1 were interpreted as high (16). No such points were found.

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 (in Table 2) for the respective outcomes related to each of the three risk factors in the estimated models. The absolute population rates for each outcome are presented along with these relative adjusted rates. 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 \geq overweight), based on the differences between the adjusted rates and the absolute risk in the low-risk group. For example, the rate of fetal death among the 162,464 infants in the low-risk group was 0.21%, corresponding to 341 cases during the years 1990-2010. Among woman aged ≥ 40 years, the adjusted risk of fetal death was 2.33-fold higher compared with woman aged 25-29 years, corresponding to an estimated absolute ratio of 0.49% ($2.33 \times 0.21\%$). The difference in risk attributable to age is therefore 0.28 percentage units, which implies that if all the 11,430 woman over the age of 40 had given birth at the age of 25-29, and if the relationship between maternal age and fetal death were completely causal, the number of fetal deaths could have been reduced by 32 cases ($0.28\% \times 11430$).

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To address the issue of multiple hypothesis testing a stricter threshold at $p < 0.001$ was used. We found that all the statistically significant findings at level $p < 0.05$ were also significant at $p < 0.001$ (indicated as footnotes Table 1 and 2).

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. To compare the aORs between 1990-1999 and 2000-2010 we calculated the difference between the estimated $\ln(\text{aOR})$ divided by the pooled $\text{SE} \ln(\text{aOR})$ for the respective outcome. Two-sided p-values were calculated based on the standard normal distribution.

The analyses were conducted using SPSS, version 20 (SPSS, Inc., Chicago, IL, USA). The study was approved by the appropriate Regional Committees for Ethics in Medical Research in Sweden and Norway.

Results

The adjusted Odds Ratio (aOR) for each outcome increased by maternal age in a similar way in Sweden and Norway (Table 1). . Exceptions were the aOR for fetal and neonatal deaths in the oldest age group of ≥ 40 years in the Norwegian sample, where observations were too few (28 and 8 respectively) to allow valid conclusions.

In both populations, there was an increased risk in the 30-34 year old age group 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. Table 2 presents the adjusted associations of advanced maternal age, smoking and BMI for each outcome in the Swedish sample. We found no statistically significant interactions between maternal age and smoking,

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maternal age and BMI, or between all three lifestyle factors. 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. Goodness of fit was low in the SGA model ($p<0.001$), and also in the moderately preterm model ($p=0.04$).

When comparing the aOR for adverse pregnancy outcomes in 1990-1999 with those of 2000-2010 we found statistically significant reductions in the following outcomes and age groups: very preterm birth (30-34 years: $p<0.05$), moderately preterm birth (30-34 years: $p<0.01$, 35-39 years: $p<0.001$, ≥ 40 years: $p<0.01$), SGA (30-34 years: $p<0.05$, 35-39 years: $p<0.05$), and Apgar score (35-39 years: $p<0.05$). Although the aORs were lower in 2000-2010, the increased risks in relation to maternal age were still statistically significant, except regarding moderately preterm birth ([details available on request](#)). No statistically significant differences in the aORs were found between the two time periods regarding fetal death and neonatal death, or in the aORs for adverse outcomes in relation to smoking, overweight or obesity.

Table 3 shows the *rates* of the respective outcome in a low-risk group of 162,464 women with none of the three lifestyle factors, and in women of advanced age, in smokers and in women who were overweight or obese. The adjusted rates were generally lower than the population rates (see Table 2). The estimated additional cases associated with each risk factor compared with the low-risk group are indicated in bold. Maternal age ≥ 30 years was associated with a larger number of additional cases of very preterm birth (693) and infants with SGA (2749) than smoking (very preterm birth: 158; SGA: 1739) and overweight or obesity (very preterm birth: 470; SGA: -81), and with the same numbers of fetal deaths (251)

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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 (1255), infants with low Apgar score (883), and neonatal deaths (92).

Discussion

Based on independent nationwide samples of nulliparous women from two high-income countries, this study confirms that the risk of very preterm birth, moderately preterm birth, small for gestational age, low Apgar score, stillbirth, and neonatal death all increase with advancing maternal age. The estimated risks related to advancing age were approximately the same in both countries, despite the adjustment for slightly different variables (no adjustment for smoking, BMI and country of birth in the Norwegian sample). The study shows that risks may increase before the age of ≥ 35 years, which is the commonly used definition of advanced maternal age. For the individual woman aged 30-34, the absolute risks for very preterm birth, SGA, low Apgar score and fetal death respectively were small, but for society they may be significant due to the large number of women who give birth in this age range.

Compared with the low-risk group of normal-weight non-smokers aged 25-29 years, we found that higher maternal age was associated with a larger number of additional fetal deaths than overweight plus obesity. In contrast, Flenady and colleagues reported in a systematic review of stillbirths that maternal overweight or obesity had a higher impact than advanced maternal age (5). This difference in findings could be related to the different definitions of advanced maternal age (≥ 30 versus ≥ 35 years). The choice of age cutoff, as well as the definition of the reference group, is crucial when investigating effects of maternal aging. If, for example, women ≥ 35 years are compared with women < 35 years, the effect of aging may be underestimated because of the U-shaped distribution of some of the adverse pregnancy

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outcomes, such as the rates of preterm birth, low Apgar score and neonatal mortality, which are higher in teenagers than in women in their 20s (17).

Estimations of additional cases of adverse pregnancy outcomes related to advanced maternal age, smoking or overweight or obesity, are dependent on the prevalence of these factors, and the findings are therefore influenced by lifestyle changes in the study population, such as the reduction of smoking in high-income countries (18), the size of the obesity epidemic (19) and the phenomenon of childbirth postponement (1). In this study, data in Table 3 were from a country with a low rate of smokers, and comparatively few women who were obese.

The reasons why advanced maternal age has negative effects on pregnancy outcomes are not fully understood. The odds ratios for very preterm birth, SGA and fetal death in this study indicate factors in the uterine environment, such as aging processes in the uterus and placenta. Placental pathology has been discussed in relation to the increased risk of stillbirth in older women (20), and this is estimated to explain one in four stillbirths (21). Sclerotic lesions in the myometrical arteries could cause underperfusion, and such lesions increase by age (20). Placental pathology may also contribute to SGA and preterm birth (22), and the placental dysfunction syndrome, including preeclampsia, SGA, placental abruption, and preterm birth (23), is associated with advanced maternal age (24). Neonatal death and low Apgar score may be due to many different causes including complications during labor. Aging processes in the myometrium may explain the higher rates of uterine dysfunction in older nulliparas (25, 26), and different theories have been presented, such as hormonal effects on the uterus (27), decreased number of oxytocin receptors (28, 29), and up-regulation of ATP-sensitive (K_{ATP}) channels in the myometrium by increasing age (30).

Similarly to advanced maternal age, smoking may have negative effects on the uterine environment by increasing the risk of placental complications, fetal growth restriction and

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preterm birth (7), and the biological effects might be related to the vasoconstrictive effect of nicotine and the reduced prostacyclin synthesis (31-33). Overweight or obesity may also increase the risk of adverse pregnancy outcomes, such as gestational hypertension, gestational diabetes, cesarean delivery and stillbirth (34). The biological mechanisms underlying these associations are probably related to the metabolic and inflammatory disorders seen in obese persons, and also documented in overweight pregnant women (35, 36).

We found no interaction between advanced maternal age, smoking and BMI and, if the effects were causal and independent, the multiplied effect on adverse pregnancy outcomes would be considerable.

The findings of this study should be interpreted in light of the observational design, which does not allow definite conclusions about causality. Analyses were not adjusted for smoking and BMI in the Norwegian dataset, and information about education was missing. For the second aim of the study, differences in women's socioeconomic background were therefore only controlled for indirectly by the variables civil status, country of birth, and smoking, which is more prevalent in women with a low level of education in Sweden (18). Nevertheless, the risk estimates were relatively similar to those of other population-based studies, although comparisons are difficult due to varying definitions of advanced maternal age and reference groups. However, the systematic review of stillbirth previously referred to (5) allowed comparison with our Swedish findings (Table 2), and the risks associated with all three lifestyle factors were fairly similar.

Another limitation of our study was that the SGA model did not fit well with the data and should therefore be interpreted with some caution. One explanation could be lack of differentiation between severe and moderate SGA. Severe SGA is more related to fetal growth restriction and advanced maternal age, whereas moderate SGA may be a mixture of growth restriction and biologically small infants (8).

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Strengths of this study were the size and quality of the two datasets retrieved from the Swedish and Norwegian Medical Birth Registers. Analyses from two independent populations strengthened the validity of the findings related to the risk of adverse pregnancy outcomes due to advanced maternal age. The definition of the reference group as an age group when pregnancy outcomes are more or less optimal (25-29 years), made it possible to discover an increased risk for some of the outcomes already at the age of 30-34 years.

This study confirms that advanced maternal age is associated with an increased risk of adverse pregnancy outcomes. It also shows that the risk may increase by the age of 30-35 years, and although the individual risk is small, it may be significant for society due to the large number of women who give birth at this age.

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

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Table 1. 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

†Pregnancy outcomes by maternal age	Sweden (n=644184)				Norway (n=311620)			
	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*								
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	1073	0.3	reference	756	0.4	reference	reference
25-29 years	826	0.4	1.23 (1.13-1.35)	472	0.5	1.20 (1.07-1.35)	1.26 (1.12-1.41)
30-34 years	392	0.6	1.85 (1.64-2.07)	222	0.8	2.02 (1.74-2.35)	2.18 (1.87-1.54)
35-39 years	100	0.9	2.80 (2.28-3.45)	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	357	0.2	reference	reference
30-34 years	474	0.2	1.12 (1.00-1.26)	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)	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)	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.

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Table 2. Adverse pregnancy outcomes in relation to maternal age, smoking and Body Mass Index

Main effects expressed as adjusted Odds Ratio (aOR) with 95% Confidence Interval (CI) obtained by logistic regression models for each pregnancy outcome, adjusted for year of birth, civil status, country of birth, chronic hypertension and diabetes.

Population rates in "low-risk women": non-smokers of normal weight and aged 25-29 years.

Statistically significant differences (p<0.001) indicated in bold

	All		Very preterm 22-31 gwks		Moderately preterm* 32-36 gwks		SGA		Apgar <7 at 5 min		Fetal death†		Neonatal death‡	
	n	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%
Low-risk women	162464	0.62		4.79		2.58		1.16		0.21		0.14		
Maternal age														
25-29 years	342012	0.8	reference	5.2	reference	3.1	reference	1.4	reference	0.3	reference	0.2	reference	
30-34 years	222883	1.0	1.24 (1.16-1.32)	5.2	1.01 (0.98-1.03)	3.6	1.24 (1.20-1.28)	1.6	1.16 (1.11-1.22)	0.4	1.24 (1.13-1.37)	0.2	1.18 (1.04-1.35)	
35-39 years	67859	1.4	1.64 (1.51-1.78)	5.9	1.13 (1.09-1.17)	4.8	1.62 (1.55-1.69)	2.1	1.40 (1.31-1.49)	0.6	1.73 (1.52-1.96)	0.3	1.43 (1.19-1.72)	
≥40 years	11430	2.0	2.24 (1.93-2.61)	6.4	1.24 (1.14-1.35)	6.0	1.96 (1.80-2.13)	2.3	1.56 (1.36-1.78)	0.9	2.33 (1.85-2.95)	0.4	2.09 (1.48-2.95)	
Smoking§														
Not smoking	548848	0.8	reference	5.1	reference	3.1	reference	1.5	reference	0.3	reference	0.2	reference	
Smoking	56663	1.2	1.45 (1.33-1.57)	5.8	1.13 (1.09-1.18)	6.8	2.19 (2.10-2.27)	1.6	1.07 (0.99-1.15)	0.5	1.55 (1.37-1.77)	0.3	1.30 (1.08-1.55)	
Missing	38673	2.5	1.52 (1.29-1.78)	7.8	1.13 (1.05-1.22)	4.0	1.17 (1.06-1.28)	2.2	1.06 (0.91-1.22)	0.9	1.15 (0.86-1.54)	0.5	1.24 (0.87-1.78)	
BMI 														
Underweight	11091	0.8	1.04 (0.83-1.29)	6.0	1.27 (1.17-1.37)	5.9	1.72 (1.58-1.87)	1.1	0.82 (0.68-0.99)	0.3	1.06 (0.75-1.51)	0.1	0.85 (0.50-1.44)	
Normal weight	339345	0.7	reference	4.9	reference	3.3	reference	1.3	reference	0.3	reference	0.2	reference	
Overweight	106319	1.0	1.35 (1.25-1.45)	5.5	1.13 (1.10-1.17)	3.2	0.94 (0.90-0.98)	1.9	1.39 (1.32-1.47)	0.4	1.56 (1.39-1.74)	0.2	1.29 (1.10-1.52)	
Obese	38985	1.6	1.99 (1.81-2.18)	6.5	1.33 (1.28-1.37)	3.7	1.08 (1.02-1.14)	2.6	1.90 (1.77-2.04)	0.7	2.48 (2.16-2.85)	0.3	1.91 (1.55-2.35)	
Missing	148444	1.3	1.16 (1.07-1.25)	5.8	1.04 (1.00-1.07)	3.9	1.03 (0.99-1.07)	1.6	1.16 (1.09-1.24)	0.5	1.27 (1.12-1.44)	0.3	1.20 (1.02-1.41)	
Interactions														
Age*Smoking			0.85		0.14		0.21		0.49		0.81		0.13	

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Age* BMI	0.11	0.07	0.68	0.06	0.18	0.65
Age* BMI* Smoking	0.99	0.92	0.42	0.47	1.00	1.00
Goodness of fit[¶]	p=0.39	p=0.04	p<0.001	p=0.41	p=0.42	p=0.42

SGA, small for gestational age; aOR adjusted odds ratio; CI, confidence interval.

* Very preterm births excluded

† From 22 weeks of gestation.

‡ 0-27 days after birth

§ Smoking at antenatal care booking in early pregnancy

|| Underweight <18.5 kg/m²; Normal weight: 18.5-24.9 kg/m²; Overweight: 25-29.9 kg/m²; Obese ≥30 kg/m²

[¶] Hosmer and Lemeshow test.

Table 3 Estimated additional cases of adverse outcomes caused by advanced maternal age, smoking, overweight and obesity from 1990 to 2010, compared with a low-risk group of women who were nonsmokers, normal weight and 25-29 years old

	n	aAR [†] %	Very preterm 22-31 Weeks			Moderately preterm 32-36 Weeks			SGA [‡] Apgar <7 at 5 minutes			Fetal death [*]			Net		
			Diff [‡]	additional cases [§]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]	Diff [‡]	adjusted Absolute Risk [†]
			All	All	All	All	All	All	All	All	All	All	All	All	All	All	
Low risk	162464	0.62		4.79	2.58	1.16	0.21										
Maternal age																	
30-34 years	222883	0.77	0.15	4.84	3.20	0.62	1.35	0.19	423	0.26	0.05	111	0.16				
35-39 years	67859	1.02	0.40	5.36	4.18	1.60	1.62	0.46	312	0.37	0.16	108	0.20				
>40 years	11430	1.39	0.77	5.89	5.06	2.48	1.81	0.65	74	0.49	0.28	32	0.29				
>30 years	302172		693	624	2749	809	251										
Smoking																	
	56663	0.90	0.28	5.41	5.65	3.07	1.24	0.08	45	0.33	0.12	67	0.18				
Overweight	106319	0.84	0.22	5.41	2.43	-0.15	1.61	0.45	478	0.33	0.12	127	0.18				
Obesity	38985	1.23	0.61	6.32	2.79	0.21	2.20	1.04	405	0.53	0.32	124	0.27				
≥Overweight	145304		470	1255	-81	883	251										

One infant may have more than one diagnosis.

SGA: small for gestational age.

[‡] From 22 weeks of gestation.

[†] 0-27 days after birth.

[‡] Diff: attributable difference between aARs

[§] Add. Cases: additional cases: nNumber of additional cases caused by the increased risk related to maternal age, smoking, overweight and obesity.

^{||} Non-smokers of normal weight and aged 25-29 years.

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Paper II

Associations between advanced maternal age and psychological distress in primiparous women, from early pregnancy to 18 months postpartum

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Objective To investigate if advanced maternal age at first birth increases the risk of psychological distress during pregnancy at 17 and 30 weeks of gestation and at 6 and 18 months after birth.

Design National cohort study.

Setting Norway.

Sample A total of 19 291 nulliparous women recruited between 1999 and 2008 from hospitals and maternity units.

Methods Questionnaire data were obtained from the longitudinal Norwegian Mother and Child Cohort Study, and register data from the national Medical Birth Register. Advanced maternal age was defined as ≥ 32 years and a reference group of women aged 25–31 years was used for comparisons. The distribution of psychological distress from 20 to ≥ 40 years was investigated, and the prevalence of psychological distress at the four time-points was estimated. Logistic regression analyses based on generalised estimation equations were used to

investigate associations between advanced maternal age and psychological distress.

Main outcome measures Psychological distress measured by SCL-5.

Results Women of advanced age had slightly higher scores of psychological distress over the period than the reference group, also after controlling for obstetric and infant variables. The youngest women had the highest scores. A history of depression increased the risk of distress in all women. With no history of depression, women of advanced age were not at higher risk. Changes over time were similar between groups and lowest at 6 months.

Conclusion Women of 32 years and beyond had slightly increased risk of psychological distress during pregnancy and the first 18 months of motherhood compared with women aged 25–31 years.

Keywords Maternal age, postpartum, postponement of childbirth, pregnancy, psychological distress.

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Introduction

Maternal age at first childbirth has increased dramatically during the last few decades in most high-income countries.^{1,2} In Norway, the average age of women having their first baby was 23 years in 1975, and 28 years in 2011.³ The postponement of childbearing has been high on the medical research agenda for many years because of the increased risk of infertility⁴ and medical complications such as caesarean section,⁵ intrauterine growth restriction and low birthweight,⁶ perinatal morbidity^{6,7} and perinatal mortal-

ity.^{6,8} In contrast to the considerable attention paid to the physical consequences of delaying childbirth, relatively little attention has been paid to exploring the psychological well-being of older first-time mothers.⁹

Findings presented in studies of emotional wellbeing in older mothers are inconclusive.¹⁰ In some studies, women of advanced age were not at an increased risk of depressive symptoms either during pregnancy^{11–13} or during the first year of motherhood^{12,14} compared with younger women. In contrast, other studies found a higher prevalence of worries during pregnancy¹¹ and depression postnatally^{15–17} in

older women. An Australian study reported that first-time mothers older than 35 years were more depressed at 1 month but not at 4 months after the birth, compared with women aged 24–34 years.¹⁸ Another study reported that the risk of psychotic illness immediately following the first birth increased more than two-fold in women over 35 years of age compared with younger women.¹⁹ In addition, some medical complications that are more prevalent in older primiparous women, such as emergency caesarean delivery and preterm birth, increase the risk of depression and anxiety.^{20,21} Although some of these findings seem to indicate that higher maternal age may increase the risk of psychological distress, it has also been suggested that postponing childbirth may be beneficial from a psychological point of view because of the woman's more stable socio-economic situation²² and increased personal maturity.⁷

The principal aim of the present study was to investigate if advanced maternal age at first birth increases the risk of psychological distress during pregnancy in gestational weeks 17 and 30, and at 6 and 18 months after the birth. By investigating the distribution of psychological distress over the age span, from 20 to ≥ 40 years, at all the four time-points, information was also obtained about younger women.

Methods

Data were drawn from the longitudinal population-based Norwegian Mother and Child Cohort Study (MoBa), carried out by the Norwegian Institute of Public Health. The MoBa study investigates sociodemographic, physical, genetic and mental health exposure variables and outcomes in mothers and children. The method has been described in detail in previous publications.^{23,24} Norwegian-speaking women were recruited in the period between 1999 and 2008 from all Norwegian hospitals and maternity units with more than 100 births annually. A postal invitation was sent out after the women had registered for a routine ultrasound examination at approximately 17 weeks of gestation. The invitation included an informed consent form and the first of six questionnaires. The current study is based on version 4 of the quality assured data files. In the present study, data from four of the questionnaires were used: gestational weeks 17 (Q1) and 30 (Q2), and 6 months (Q3) and 18 months (Q4) after the birth. A letter of reminder was sent out after 2–3 weeks to women with unreturned questionnaires. The first questionnaire obtained information about sociodemographic background (education, civil status, native language, mothers' income (NKR), unemployment and smoking), reproductive background (previous pregnancies), weight and height and history of depression (the woman was asked to tick a box if she had suffered from depression before the current preg-

nancy). In addition, the questionnaire included an instrument of psychological distress (see description below). The same questions regarding psychological distress were included in all the questionnaires. Data on maternal age, parity, mode of delivery, infant outcome (neonatal transfer, prematurity), smoking, civil status and *in vitro* fertilisation treatment were retrieved from the Norwegian Medical Birth Register, which covers all births and includes information from the standardised medical records used by all antenatal clinics and delivery units in Norway.²⁵

Participants

For the present study, only first-time mothers who had responded to all four questionnaires, including the questions about psychological distress, and who had complete data from the Medical Birth Register on parity and age were included. We also excluded women recruited after year 2006 because they, at the time of conducting the present study, had not yet filled in the follow-up questionnaire at 18 months after birth. Teenagers were excluded because they constituted a selected group and were beyond the scope of this paper. First-time mother was defined as a woman who had not given birth previously; neither to a live infant nor to a stillborn after 21 weeks of pregnancy.²⁶

The flow-chart (Figure 1) shows the initial MoBa sample and the final study sample, which was 19 291 women, after exclusions of the drop-outs. The 11 605 drop-outs (37.6%) included women who had responded to Q1 but not to one or more of the subsequent questionnaires (Q2–Q4), and 684 women who filled in fewer than three items on the scale measuring psychological distress (see below). To determine the representativeness of the study sample it was compared with all women aged ≥ 20 years who gave birth

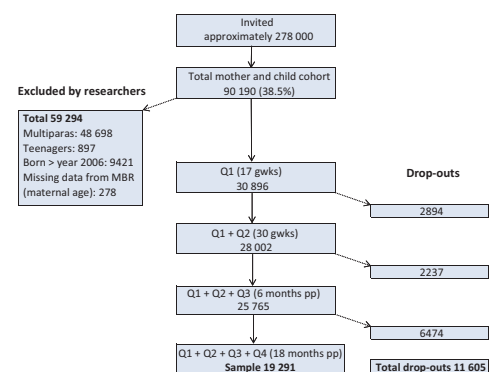


Figure 1. Recruitment, sample and dropouts. Q, Questionnaire; gwks, gestational weeks; pp, post partum. Drop-outs: non-responders to Q + responders with incomplete SCL-5 (less than 3 of the 5 items).

to their first child in Norway in 2003. Psychological distress was investigated also in the drop-outs who had responded to the questionnaire in week 17 of gestation but not thereafter.

Outcome variable

Psychological distress was measured using a shortened version of the widely used Symptom Check List (SCL-25),²⁷ i.e. the Hopkins Symptom Checklist (SCL-5), which is a five-item self-report scale including two dimensions: depressiveness (three items) and anxiousness (two items). The responder was asked if she had been bothered by any of the following during the last 2 weeks: 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 four-point scale (1 = not bothered, 2 = a little bit bothered, 3 = quite bothered and 4 = very bothered) with a total score ranging from 5 to 20. A mean value is then calculated. The SCL-5 has shown high correlation ($r = 0.91$) with the original global SCL-25, which is a valid measure of psychological distress.²⁸ A Cronbach's Alpha between 0.85 and 0.87^{29,30} has been reported. A cut-off score of ≥ 2.0 for psychological distress is recommended in a general population,³⁰ but the scale has not been validated in the context of childbearing. This cut-off would have defined a smaller proportion of our sample as suffering from psychological distress than has been reported in studies of depressive symptoms in relation to childbirth, as measured by the Edinburgh Postnatal Depression Scale (EPDS).^{15,31–36} Although the SCL-5 and EPDS are different tools, we chose to take these findings into consideration, setting a lower SCL-5 cut-off at ≥ 1.75 to capture a similar proportion of psychologically distressed women as in the EPDS-based surveys of depression. This decision was also justified by the fact that it was not our aim to study the prevalence of psychological distress as such, but rather possible differences related to maternal age, including the mean value for each age group, as well as differences over time. In women for whom a maximum of two items on the scale were missing, imputation was used on the remaining items.

Explanatory variable

Age was defined as maternal age at the time of giving birth. There is no consensus as what should be defined as a young and old first-time mother, and maternal age is often presented in intervals of 5 years.^{1,6,37} The young may, for example, be defined as teenagers³⁸ or as mothers <25 years old^{11,18} and the 'old' as those over 25 years,³⁹ 30 years⁴⁰ or 35 years⁵ of age. These definitions seem mainly to be guided by the size of the study sample. We decided to base the decision about age cut-off on data from the entire Norwegian birth cohort from 2003, retrieved from the Medical

Birth Register. Using the breakpoints for the lower (24/25 years) and upper (31/32 years) quartiles, young age was defined 20–24 years and advanced age as ≥ 32 years. The comparison group was defined as women aged 25–31 years.

Confounders

To avoid adjusting for the natural process of ageing, potential confounders were restricted to the following socioeconomic factors: education, single status, native language other than Norwegian, mother's income (NKR), unemployment and smoking. To explain differences between women of advanced age and the reference group, we entered also operative delivery (caesarean section, instrumental delivery) and infant outcome (neonatal transfer, prematurity) into the models.

Statistical analyses

Differences in proportions and means between the age groups and between a subsample giving birth in 2003 and all Norwegian primiparous women in 2003 (women in the sample excluded), were calculated by chi-square test and Student's *t* test, respectively.

The associations between age and psychological distress as well as potential confounders and explanatory factors were first tested in bivariate analyses. Multivariable logistic regression models based on the methods of generalised estimation equations were then used to adjust for independent factors divided into blocks, which were entered in the following order: (1) time point, (2) sociodemographic factors, (3) operative delivery and (4) infant outcome. Generalised estimation equations would accurately deal with the problem that repeated observations for the same individual are often correlated. If the intra-cluster correlation is ignored, this may lead to imprecise variation estimates from the regression models, leading to incorrect statistical and biological conclusions. Such correlation violates the assumption of independence necessary for more traditional repeated-measures analysis and leads to bias in regression parameters.⁴¹ We used a binary logistic model and the variance-covariance for all models was assumed to be block diagonal but unstructured within a block defined by subjects. Finally, to study whether the effect of age differed across any of the independent factors, we tested the interactions between age and each factor, one at a time, after adjusting for all other factors. All tests were two-sided. The results are presented as crude and adjusted odds ratios (OR) with their 95% Wald confidence intervals (CI).⁴² Imputations on the SCL scale were made if a maximum of two items on the scale were missing. We used a single-imputation method, Missing Values Analysis—Expectation Maximisation algorithm⁴³ as suggested by researchers who validated the scale in Norway (K. Tambs, pers. comm.) and previously used on the SCL-5 scale in the MoBa. As

predictors for imputations, valid data on the remaining items on the scale were used. We replaced missing values on the scale in 1.42%, 1.44%, 1.02% and 0.84% of cases in the Q1–Q4, respectively. The analyses were conducted using SPSS, version 20 (SPSS, Inc., Chicago, IL, USA). The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian data Inspectorate (S-97 045).

Results

When comparing only those women who gave birth in year 2003 in our sample with the total Norwegian birth cohort of primiparas during the same year we found that the following characteristics were under-represented in our sample: age 20–24 years, smokers, single status, caesarean delivery, premature birth and infant transfer to neonatal intensive care unit (Table 1).

When comparing the oldest age group in our sample with the reference group we found that the following characteristics were more common: high mean pregravid BMI ($P < 0.001$), smoking ($P < 0.001$), single status ($P < 0.001$), native language other than Norwegian ($P < 0.001$), high income ($P < 0.001$) and depression before pregnancy ($P < 0.001$). The oldest women also had higher rates of IVF ($P < 0.001$), caesarean delivery ($P < 0.001$) and premature birth ($P < 0.05$), and their babies were more often transferred to neonatal intensive care ($P < 0.05$). The following characteristics were more prevalent in the youngest women compared with the reference group regarding: smoking ($P < 0.001$), single status ($P < 0.001$), unemployment ($P < 0.001$), low income ($P < 0.001$), depression before pregnancy ($P = 0.001$), and Norwegian speaking background ($P = 0.01$). They also had higher rates of spontaneous vaginal birth ($P < 0.001$).

The prevalence of psychological distress in the total sample was 9.7% in week 17 of gestation, 9.9% in week 30 of gestation, 7.1% at 6 months and 11.0% at 18 months after the birth. Figure 2 presents psychological distress by maternal age, and shows that the youngest women had the highest scores on all occasions and women in the reference group had the lowest. Women of 32 years and beyond had slightly higher rates than the reference group. A figure based on the mean SCL-5 values resulted in an almost identical pattern (not shown). Figure 2 also reveals that the women who withdrew from the study after having filled in the first questionnaire constituted a selected group with higher rates of psychological distress. The proportion of these drop-outs was 14.1% in the youngest group, 10.1% in the reference group and 10.3% in the oldest group. The proportions of drop-outs with psychological distress were 26.7%, 14.5% and 13.6% in the respective group.

Figure 3 shows psychological distress by time of measurement. On all occasions the prevalence was slightly higher in women of advanced age than in the reference group, and almost twice as high in the youngest group (see Table 2 for crude OR and 95% CI). Across the time period the pattern was similar in all groups, suggesting that the effect of time was similar regardless of age. Compared with early pregnancy, the prevalence in the total sample was similar in late pregnancy (OR 1.0; 95% CI 1.0–1.1), had dropped by 6 months postpartum (OR 0.7; 95% CI 0.7–0.8), and increased at 18 months (OR 1.2; 95% CI 1.1–1.2).

Table 2 shows the crude and adjusted odds ratios for psychological distress in young and older women, and in the reference group (25–31 years), one model for each block of variables. As previously shown in Figure 3, women of advanced age had slightly increased odds for psychological distress, independent of time, and the odds ratios remained almost unchanged when adjusting for sociodemographic background. To further understand what lies behind the increased risk of distress, we entered also operative delivery (emergency caesarean section, instrumental vaginal delivery) and infant outcome (neonatal transfer, prematurity) into the model, but the figures remained stable. The higher risk in the youngest women, also independent of time, decreased from 1.81 to 1.25 when entering sociodemographic variables into the model, but then remained unchanged when adding operative delivery and infant outcome.

Interactions between age and all factors described in Table 2 were then tested. Unemployment interacted with age ($P = 0.042$), and most strongly in the women aged 20–24 and 25–31 years who had a two-fold risk of psychological distress when compared with women who were employed in the reference group. Psychological distress in women of advanced age was less affected by unemployment. Having had one or more episodes of depression before pregnancy also interacted with age ($P = 0.008$). All women with a history of depression were at higher risk of distress than those without such background, and the highest risk was observed in the oldest women who had a seven-fold odds for psychological distress. Without a previous depression, the oldest were not at a higher risk than the reference group.

Discussion

In this national sample the prevalence of psychological distress was slightly higher in older first-time mothers than in a reference group aged 25–31 years, when measured in weeks 17 and 30 of gestation, and at 6 and 18 months after the birth. This finding contrasts with the view that postponing childbirth is beneficial from a psychological point

Table 1. Background characteristics of the age groups, the total study sample, a sub-sample giving birth in 2003, and all primiparous women aged ≥ 20 years in Norway in 2003

	Age 20–24 <i>n</i> = 3106 (%)	Age 25–31 <i>n</i> = 11 801 (%)	Age ≥ 32 <i>n</i> = 4384 (%)	Total study sample <i>n</i> = 19 291 (%)	Sub-sample giving birth in 2003 <i>n</i> = 3693 (%)	Primiparous women in the Norwegian birth cohort of 2003 <i>n</i> = 22 272 (%)	<i>P</i> value (sub-sample vs national birth cohort 2003)
Demographic and social factors							
Age (years)*							
20–24				16.1	17.1	24.7	<0.0001
25–29				44.8	45.8	40.7	
30–34				30.5	29.5	26.5	
35–39				7.8	7	7.2	
≥ 40				0.9	0.6	0.9	
Pregravid BMI, mean (kg/m ²)	24.7	24.6	25.3	24.8			
Smoking*	18.3	7.9	9.3	10.5	12.8	16.8	<0.0001
Single status*	8	2.3	5.1	3.6	3.4	7.6	<0.0001
Native language other than Norwegian	3.4	4.7	7	5	4.4		
Unemployed	5	1.9	2.1	2.5			
Income (NKR)							
<200 000	31.3	12.8	7.4	13.6			
200 000–399 999	60.4	63.8	53.4	57.3			
$\geq 400 000$	8.3	23.4	39.2	23.2			
Psychological and reproductive health							
Depression before pregnancy	7.3	5.5	8	6.3			
IVF present pregnancy*	0.4	2.5	8.1	3.5	3.4	3.8	0.13
Labour*							
Mode of delivery							
Unassisted vaginal delivery	75.6	70.1	60	68.7	69	66.4	<0.0001
Instrumental vaginal delivery	12.1	15.8	18.2	15.8	15.6	15.2	
Elective caesarean section	2.2	3	5.7	3.5	3.3	4.7	
Emergency caesarean section	9.2	10	14.6	10.9	10.8	11.5	
Unspecified caesarean section	1.1	1.5	1.8	1.5	1.3	2.2	
Prematurity	5.8	6.2	7.1	6.3	6.5	8.3	<0.0001
Neonatal transfer	10.3	10.4	11.8	9.9	10.2	11.9	0.001

BMI, body mass index; IVF, *in vitro* fertilisation; NKR, Norwegian krone.

*Data from the Norwegian Medical Birth Register.

of view, as suggested by some authors.^{7,22} However, advanced age at first pregnancy only increased psychological distress in women who reported having suffered from depression before pregnancy.

Although the youngest group was not the major focus of our study and teenagers were excluded, the inclusion of women aged 20–24 years in our study contributed to a more comprehensive view of the distribution of psychologi-

cal distress in primiparous women, and it became obvious that the increase in older women was much less pronounced than in the youngest group. The slightly U-shaped pattern of psychological distress over the age span may be explained by socioeconomic disadvantage, such as unemployment, on the left hand side of the distribution and history of depression on the other side. Other factors may also be important, such as timing of pregnancy. In both the youngest and the

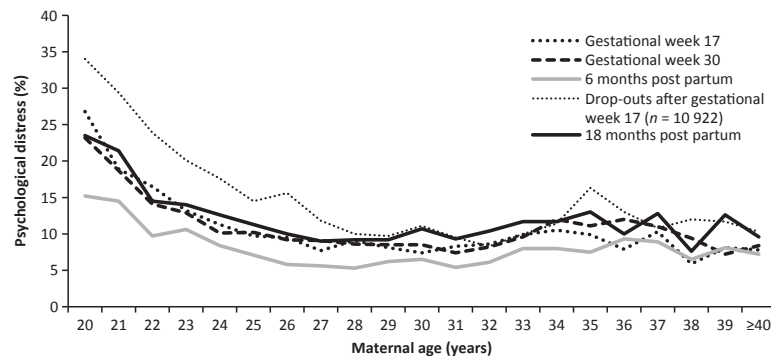


Figure 2. Psychological distress (SCL-5 > 1.75) in relation to maternal age at 17 and 30 weeks of gestation and at 6 and 18 months after birth in the study sample of 19 291 women expecting their first baby, and in 10 922 drop-outs after week 17 of gestation (with baseline data on SCL-5).

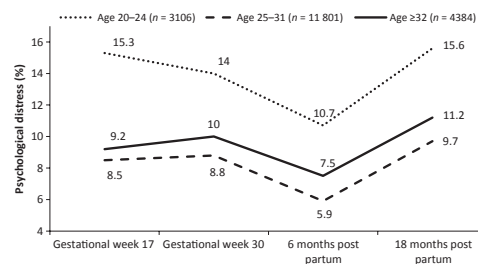


Figure 3. Psychological distress (SCL-5 ≥ 1.75) in primiparous women aged 20–24, 25–31 and ≥32, in weeks 17 and 30 of gestation and 6 and 18 months after the birth ($n = 19\ 291$).

oldest groups the timing may not have been optimal. A recent study of 2500 US women⁴⁴ found that mistiming of the first birth accounted for the curvilinear relationship between age and psychological distress. Deviating from life course expectations and violating social age norms, may result in an identity discrepancy, which as such is associated with mental health problems. Further, older women may have more accumulated trauma and physical health problems.^{20,21,45} However, we cannot rule out the possibility that anxiety or depression caused some of the older women to postpone their pregnancy, rather than the other way around.

Sociodemographic factors, particularly unemployment, contributed to psychological distress in the young primiparas, a finding also reported by others.^{31,46} This was not the case in the oldest group suggesting that these women felt more secure about their position in the workforce, probably because of higher education and income.

In all age groups, and regardless of history of depression, psychological distress was least common at 6 months after

the birth. This finding is supported by other studies^{12,34} and has been interpreted as a period when the mother has adapted to the new role as a mother, and in a country like Norway she will still be on parental leave and not yet confronted with the challenge of combining motherhood and work outside home.

Women in the oldest group had been more exposed to events associated with psychological problems, such as caesarean delivery and instrumental vaginal delivery,²⁰ prematurity,²¹ and infant transfer to neonatal care.²⁰ Adding these factors into the analysis did not change the odds of psychological distress in the oldest women with a history of depression, suggesting that medical complications were of less importance. However, this conclusion does not take into account the women who dropped out of the study and who constituted a selected group with more complications, including caesarean delivery (17.8% versus 15.9%) and preterm birth (8.9% versus 6.3%). The age-related adverse obstetric and neonatal outcomes may therefore still have contributed to our findings. We can only speculate as to whether other age-related factors may have been important, such as fatigue, high blood pressure and diabetes, or psychosocial factors, such as unrealistic expectations and the unpredictability of life as a parent.

A limitation of our study was that psychological distress was not measured by an instrument validated for the study population and our choice of cut-off could be questioned for being too low. However, the cut-off at SCL-5 ≥ 1.75 was set to adapt to the prevalence of depressive symptoms during pregnancy and postpartum in Scandinavian settings, measured by, for example the EPDS,⁴⁷ and not depression as a clinical diagnosis. Clinically, the measurement of depressive symptoms has been important and screening

Table 2. Prevalence of psychological distress (SCL-5 ≥ 1.75) in gestational week 17, and OR for psychological distress longitudinally during pregnancy and 18 months after the birth (gestational weeks 17 and 30, and 6 and 18 months after the birth) in primiparous women aged 20–24, 25–31 and ≥ 32 years ($n = 19\ 291$)

Age	<i>n</i>	Psychological distress in gestational week 17 (%)	Crude OR	95% CI	Adj OR*	95% CI	Adj OR**	95% CI	Adj OR***	95% CI	Adj OR****	95% CI	Adj OR*****	95% CI
20–24	3106	15.3	1.81	(1.66–1.97)	1.80 (1.65–1.95)	1.25 (1.14–1.37)	1.25 (1.14–1.38)	1.26 (1.14–1.39)						
25–31	11 801	8.5	1		1	1	1	1						
≥ 32	4384	9.2	1.17	(1.07–1.27)	1.16 (1.06–1.26)	1.14 (1.04–1.25)	1.14 (1.04–1.24)	1.14 (1.04–1.25)						
Interaction effect of age and unemployment														
Unemployed														
20–24	156	28.8											1.98 (1.49–2.63)	
25–31	230	17.4											1.94 (1.49–2.52)	
≥ 32	91	12.1											1.15 (0.74–1.81)	
Employed														
20–24	2950	14.6											1.27 (1.15–1.41)	
25–31	11 571	8.3											1	
≥ 32	4291	9.1											1.16 (1.06–1.28)	
Interaction effect of age and a history of depression														
History of depression														
20–24	97	42.7											5.73 (4.60–7.14)	
25–31	216	33.3											5.75 (5.01–6.59)	
≥ 32	124	35.5											7.00 (5.84–8.38)	
No history of depression														
20–24	2879	13.2											1.34 (1.21–1.49)	
25–31	11 153	7.0											1	
≥ 32	4035	6.9											1.03 (0.93–8.38)	

Crude and adjusted odds ratios (OR) and 95% Confidence Interval (CI).
 *Adjusted for time point.
 **Adjusted for * and Sociodemographic variables: education, single status, native language, mother's income (NKR), unemployment and smoking.
 ***Adjusted for * and ** and Operative delivery: emergency caesarean section, instrumental vaginal delivery.
 ****Adjusted for *, ** and *** and Infant outcome: neonatal transfer, prematurity.
 *****Adjusted for *, **, *** and ****.

tools are being introduced in many antenatal clinics to identify women at risk of depression to provide adequate preventive support. A review by Gavin et al.⁴⁸ reported a prevalence of major perinatal depression of 3–5% whereas minor depression was estimated to be 9–13%, which is similar to our figures.

Our choice of cut-off identified approximately 10% who were psychologically distressed, but the analysis of drop-outs after the first questionnaire suggests that this could be an underestimate of the rate in the total population of nulliparous women, particularly in the youngest and oldest groups. In addition, women with sociodemographic and some obstetric risk factors for depression were under-represented in our sample compared with the national birth cohort, and these risk factors are more prevalent in young^{31,46} and older^{20,21} women.

Another limitation was that information about 'history of depression' was based on self-reports on a single-item question. Still, our findings show that a single question about history of depression identifies women who are at increased risk of being distressed during pregnancy and postpartum.

Clinical implications

It is well established that caregivers need to pay extra attention to the needs of pregnant teenagers.^{48,49} With the growing tendency to postpone childbirth in high-income countries the definition of a young and old first-time mother has changed and new groups of women are now exposed to psychological distress during pregnancy and early parenthood. Caregivers should be extra alert to women with a previous history of depression, regardless of age, and also to first-time mothers in their twenties without a job, who may need extra attention and support.

Disclosure of interests

There is no conflict of interest.

Contribution to authorship

VAA analysed the data, contributed to the interpretation of findings and wrote the first draft of the manuscript. UW was the principal investigator and contributed with the idea, the interpretation of the results and with writing the manuscript. AH contributed to interpretation of results and by commenting on the manuscript. SR contributed in the analyses, and commented on the manuscript. HP contributed to the data analyses and writing of the manuscript. ES contributed to the planning of the study, to the data analyses, the interpretation of the results and the writing of the manuscript. All authors have approved the final version of the manuscript.

Details of ethics approval

The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian data Inspectorate (S-97 045).

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Paper III

RESEARCH ARTICLE

Open Access

Experience of childbirth in first-time mothers of advanced age – a Norwegian population-based study

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Abstract

Background: Delaying the first childbirth to an advanced age has increased significantly during the last decades, but little is known about older first time mothers' experience of childbirth. This study investigates the associations between advanced maternal age in primiparous women and the postnatal assessment of childbirth.

Methods: The study was based on the National Norwegian Mother and Child Cohort Study (MoBa) conducted by the Norwegian Institute of Public Health. Data on 30 065 nulliparous women recruited in the second trimester 1999–2008 were used. Three questionnaires were completed: around gestational week 17 and 30, and at 6 months postpartum. Medical data were retrieved from the national Medical Birth Register. Advanced age was defined as ≥ 32 years and the reference group as 25–31 years. Descriptive and multiple logistic regression analyses were conducted.

Results: Primiparous women aged 32 years and above expressed more worry about the upcoming birth than the younger women (adjusted OR 1.13; 95% CI 1.06-1.21), and 6 months after the birth they had a slightly higher risk of having experienced childbirth as 'worse than expected' (adjusted OR 1.09; 95% CI 1.02-1.16). The difference in birth experience was explained by mode of delivery. Comparisons within subgroups defined by the same mode of delivery showed that the risk of a more negative birth experience in the older women only applied to those with a spontaneous vaginal birth (adjusted OR 1.12; 95% CI 1.02-1.22). In women delivered by cesarean section, the older more often than younger women rated childbirth as 'better than expected' (elective cesarean delivery: adjusted OR 1.36; 95% CI 1.01-1.85, emergency cesarean delivery: adjusted OR 1.38; 95% CI 1.03-1.84).

Conclusion: Postponing childbirth to ≥ 32 years of age only marginally affected the experience of childbirth. Older women seemed to manage better than younger with having an operative delivery.

Keywords: Experience of childbirth, Maternal age, Primiparous, Postponement of childbirth

Background

Delaying the first childbirth to an advanced reproductive age has increased significantly among women during the last decades [1]. Whereas the higher rates of medical complications in first-time mothers of advanced age are well described [1-5], less is known about their experience of childbirth. The significance of women's negative experience of childbirth is illustrated by its association

with severe psychological problems such as postpartum depressive symptoms [6-8] and post-traumatic stress disorder [9], and also with mother-infant bonding [10]. A negative experience may even affect future reproduction with fewer subsequent births or a longer interval to next birth [11,12], which is particularly problematic at an age when fecundity is in decline [13].

Several factors that may influence the childbirth experience are more prevalent in women of advanced age, such as instrumental vaginal delivery [2,4], emergency cesarean delivery [14], premature birth [2], and social background factors such as being single and unemployed [15,16]. Women's feelings for the upcoming birth may

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also affect the childbirth experience [7,15,17-19], and these may vary by age but in what direction remains unclear. On the one hand, women of advanced age are more likely to worry for the up-coming birth [20] and to prefer a cesarean delivery [21]. On the other hand, a nationwide Swedish study showed that primiparous women of advanced age (≥ 35 years) had more positive feelings about the upcoming birth compared to a reference group aged 26–29 [22], but postnatally, these women rated their overall experience as more negative than the younger women.

In this study we used data from the Norwegian Mother and Child Cohort to further investigate the association between advanced maternal age in primiparous women and the postnatal assessment of the birth experience.

Methods

Data were drawn from the population-based Norwegian Mother and Child Cohort Study (MoBa), carried out by the Department of Public Health. The MoBa study investigates socio-demographic, physical, genetic, and mental health exposure variables and outcomes in mothers and their children. The method has been described in detail in previous publications [23,24]. Norwegian-speaking women were recruited during 1999–2008 from all Norwegian hospitals and maternity units with more than 100 births annually. A postal invitation, which included an informed consent form (for participation, follow ups and data linkage to the Norwegian Medical Birth Register) and the first of six questionnaires, was sent out after the women had registered for a routine ultrasound examination at approximately 17 weeks of gestation. The current study is based on version 6 of the quality-assured data files, released in 2011. Data from three of the questionnaires were used and these were completed around gestational weeks 17 and 30, and 6 months after the birth. A letter of reminder was sent out after 2–3 weeks in cases of unreturned questionnaires. The first questionnaire (Q1) obtained information about socio-demographic background (education, civil status, native language, income, unemployment and smoking) and reproductive background (previous pregnancies, in-vitro-fertilization (IVF)). The second questionnaire (Q2) asked about worry about the upcoming birth and wish for a cesarean delivery, and the third (Q3) about the experience of childbirth. Data on maternal age, parity, mode of delivery and infant outcomes (prematurity, neonatal transfer) were retrieved from the Norwegian Medical Birth Register, which covers all births and includes information from the standardized medical records used by all antenatal clinics and delivery units in Norway [25].

For the present study, only nulliparous women who had completed all the three questionnaires, including the question about childbirth experience, and who had

complete data from the Medical Birth Register on parity and age were included. Nulliparity was defined as women who had not given birth; either to a live or still-born infant after 21 weeks of pregnancy [26]. Representativeness of the sample was assessed by comparison of a sub-sample giving birth in 2003 with all primiparous women in the entire Norwegian birth cohort (data from the Medical Birth Register) from the same year, which was approximately half-way through data collection. The age distribution of maternal age in Norway has since then been the same.

Age was defined as maternal age at the time of giving birth. The definition of 'advanced' maternal age was also based on data from the entire Norwegian birth cohort from 2003. We chose to define the upper quartile (break-point 31/32 years) as advanced maternal age, i.e. women of 32 years and beyond, and the comparison group as all women between the lower (24/25 years) and upper quartile, i.e. women aged 25–31 years. There is no consensus regarding how to define 'advanced' maternal age [27] and studies therefore use different age cut-off [2,28,29]. As fecundity starts to decline and medical complications increase much earlier than the commonly used 35 years limit [5,30], the 31/32 years limit was considered relevant. We did not include women younger than 25 years in the reference group which would have biased the results since these women constitute a selected group with higher risk of negative exposure [16] and outcome, for instance psychological distress [31].

Negative feelings about the upcoming labour and birth were measured by the statements 'I really worry about giving birth', and 'If I could choose I would have a cesarean delivery'. The response alternatives were dichotomized into agree ('Agree completely' + 'Agree'), and disagree ('Agree somewhat' + 'Disagree somewhat' + 'Disagree' + 'Disagree completely').

The childbirth experience was measured at 6 months after the birth (Q3) using the question: 'Did the birth go as you had expected?' The response alternatives were trichotomized into; 1) better ('No, it was better'), 2) worse ('No, it was worse'), and 3) as expected/mixed feelings ('Yes, as expected' + 'Neither better nor worse').

Statistical analyses

Differences between 1) the age groups and 2) between a sub-sample giving birth in 2003 and all primiparous women aged >25 years in Norway in 2003 were assessed by Student's t-test and chi-square tests, respectively. Associations between maternal age and feelings about the upcoming labour and memory of the childbirth experience, and between maternal age and potential confounders, were tested in bivariate analyses. Multiple logistic regression analyses were performed and statistically significant confounders were adjusted for. To avoid

adjusting for the natural process of ageing, potential confounders were restricted to the following socioeconomic factors: smoking, single status, native language other than Norwegian and education. In a final analysis of risk factors for a 'worse than expected' experience of childbirth we constructed an interaction variable between maternal age and mode of delivery, and also divided the women of advanced age into two groups: 32–37 years and ≥38 years.

The results are presented as crude and adjusted odds ratios (OR) with 95% confidence intervals (CI) [32]. The analyses were conducted using SPSS 19 (SPSS, Inc., Chicago, IL). The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian data Inspectorate (S-97045).

Results

The flow-chart (Figure 1) shows the total MoBa sample and our study group of 30 065 women, which remained after exclusion of multiparas, women younger than 25 years, missing data on age and childbirth experience, and drop-outs after Q1 and Q2. Table 1 shows that when compared with all Norwegian women who gave birth in 2003, the following characteristics were under-represented in the sample: smoking, single status, IVF in present pregnancy, cesarean delivery, premature birth and infant transfer to neonatal intensive care unit. The table also shows that the following characteristics were more common in the older than in the younger women in our study: non-smoking, married or cohabiting, native language other than Norwegian, high income, a higher pre-gravid body mass index, IVF pregnancy, operative

delivery, preterm birth and newborn transfer to neonatal unit.

Figure 2 shows the percentages of women over the total age span from 25 to ≥40 years who agreed to the statements: 'I really worry about giving birth', and 'If I could choose I would have a cesarean delivery'. The adjusted odds ratios for the respective outcome in women of ≥32 years compared with the younger reference group were 1.13 (95% CI 1.06-1.21) and 1.84 (95% CI 1.61-2.11) respectively.

Figure 3 illustrates women's childbirth experience at 6 months postpartum with the response 'worse than expected' increasing slightly by age and a corresponding decrease in the response 'better than expected'. In the age group of ≥32 years, 27% reported the childbirth experience as 'worse than expected' compared with 25% in the reference group, a small but statistically significant difference (Table 2). When adjusting for mode of delivery the effect of age was no longer statistically significant (not shown). Table 2 also shows the four subgroups of women who had undergone the same mode of delivery, with comparisons between those of advanced age and the reference group. The prevalence of a 'worse than expected' experience was highest in women with emergency cesarean delivery regardless of age, followed by women with instrumental vaginal delivery, whereas the prevalence was lower after spontaneous vaginal birth and elective cesarean delivery. However, the age-related risk of a 'worse than expected' experience within each subgroup did not differ statistically, except in women with a spontaneous vaginal delivery where the oldest women were at higher risk (adjusted OR 1.12; 95% CI 1.02-1.22).

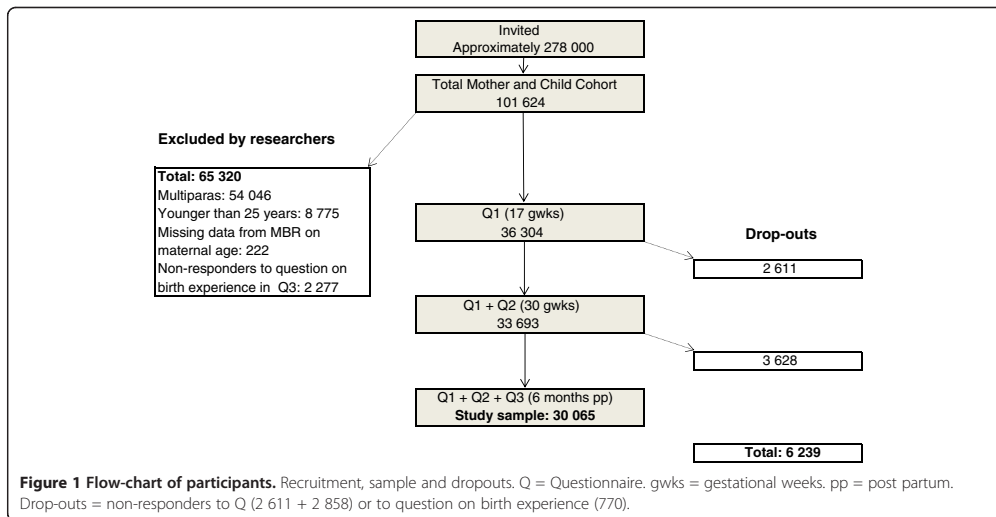


Table 1 Background characteristics of primiparous women aged 25–31 years (reference group) and ≥32 years (advanced age), and for representativeness; comparisons between a sub-sample giving birth in 2003 and all primiparous women aged >25 years in Norway in 2003 (P-value for differences between a sub-sample from 2003 and all Norwegian primiparous women >25 years giving birth in 2003)

	Women in the study			Women ≥ 25 years giving birth in 2003		P-value
	Age 25-31	Age ≥32	All	Sub sample	Norway	
	n=21 226	n=8839	n=30 065	n=3549	n=16 760	
	%	%	%	%	%	
<i>Demographic and social factors</i>						
Age (years)*						0.07
25-29			50.8	55.2	54.0	
30-34			37.6	35.2	35.1	
35-39			10.3	8.8	9.6	
≥40			1.3	0.8	1.2	
Smoking*	8.4	7.6	8.2	10.8	13.9	<0.001
Single status	2.9	4.9	3.5	2.7	5.7	<0.001
Native language other than Norwegian	5.9	8	6.5	4.7		
Unemployed	1.7	1.6	1.7			
Income (NOR)**						
<200 000	11.2	6	8.7			
200 000–399 999	55.5	43.7	51.5			
≥400 000	29.1	46	33.7			
Pregravid BMI, mean (kg/m ²)	23.6	24.1	23.8			
IVF present pregnancy*	2.6	8.9	4.4	3.8	4.9	<0.001
<i>Labour*</i>						
<i>Mode of delivery</i>						
Vacuum	14.2	16	14.8	14.1	13.7	0.54
Forceps	2.8	3.4	3	2.7	2.4	0.27
Elective cesarean delivery	3.1	6	4	3.8	5.3	<0.001
Emergency cesarian delivery	9.7	13.5	10.8	11.4	12.5	0.06
Unspecified cesarean delivery	1.9	2.9	2.2	1.2	2.5	<0.001
Prematurity**	5.5	6.4	5.8	6.5	8.8	<0.001
Neonatal Transfer	9.2	10.8	9.3	10.8	12.5	<0.001

*Data from the Norwegian Medical birth Register.

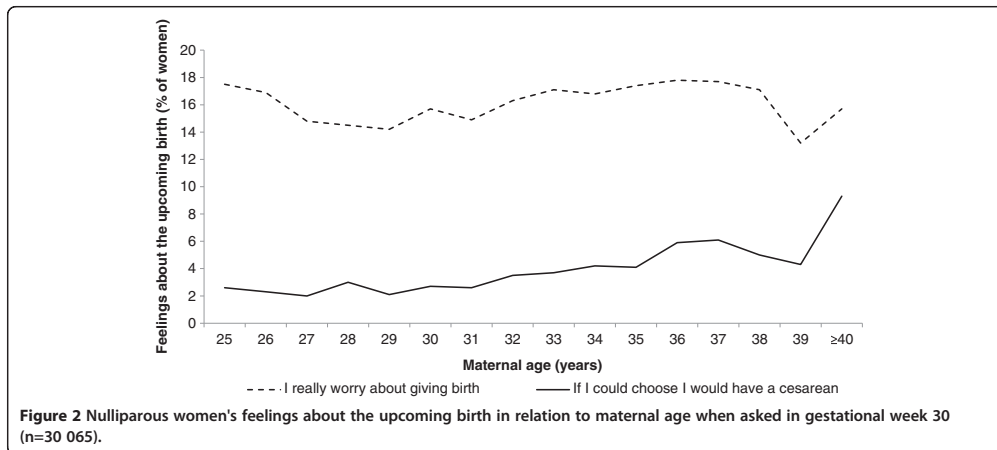
**NKR: NOK/GBP=10.90.

***Prematurity: 22–36 weeks of pregnancy.

One in five women of advanced age (20%) had a 'better than expected' childbirth experience, which was similar to the comparison group (21%) (Table 2). The odds of having a 'better than expected' experience in the sub-groups of women delivered by elective and emergency cesarean were increased in the older women compared with the younger.

To explore possible consequences of the way the question on childbirth experience was phrased, as being related to antenatal feelings, we also adjusted the analyses for *really worrying about the upcoming birth* and *a wish for a cesarean delivery*. The figures in Table 2 then remained almost unchanged (not shown).

As data from Table 2 suggested that older women tend to manage better than younger when exposed to an operative delivery we wanted to explore this issue further, and therefore divided the group of 'advanced' maternal age into two age groups, 32–37 years and ≥38 years (constituting the highest 2.5 percentile, labeled 'very advanced maternal age'). Table 3, in which women aged 25–31 who had a spontaneous vaginal birth constitute the reference (=1) with which all other alternatives are compared, confirms that a 'worse than expected' experience decreased by maternal age and regardless of mode of delivery, even when adjusted for socio-demographic factors.



Discussion

This study showed that primiparous women of advanced age, defined as 32 years and beyond, were at a slightly higher risk of experiencing childbirth as 'worse than expected', compared with women aged 25–31 years. In pregnancy, they were also more often worried about the upcoming birth and if they could choose, they more often wished to have a cesarean delivery.

The association between advanced maternal age and a negative childbirth experience was no longer statistically significant after controlling for mode of delivery. We then assumed that the higher rate of emergency operative deliveries in older women, and the strong association between such deliveries and a negative experience of childbirth [15], explained this finding. However, the age effect in our study was the opposite: when exposed

to an operative delivery, the older women seemed to manage better and reported more positive birth experiences than the younger. This trend was even more apparent when dividing the women into 32–37 years and ≥ 38 years. Reporting a birth experience as 'worse than expected' decreased with age in a dose-response manner, and women ≥38 years had the most positive experience. Older women may have been more aware of their age related risk of having an operative delivery and therefore been mentally more prepared [14,33], besides that the older women in beforehand were more positive to having a caesarean section. They may also have more mature strategies to manage a complicated birth because of earlier life experiences [33] and they may have felt relief after a prolonged [34,35] and complicated birth.

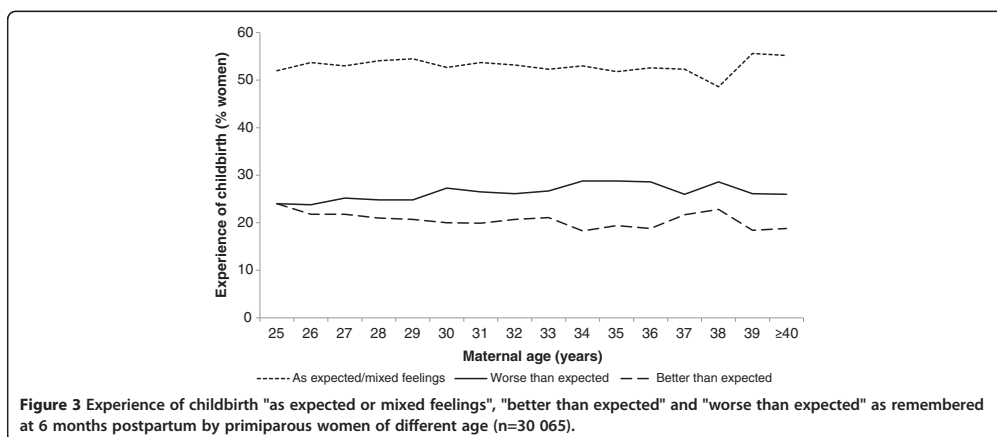


Table 2 Experience of childbirth in relation to expectations in primiparous women of advanced age (≥32 years) compared with the reference group (25–31 years)

Maternal Age, yrs	Total n	As expected/ mixed feelings		Worse than expected				Better than expected							
		n	%	n	%	Crude OR	95% CI	Adj OR*	95% CI	n	%	Crude OR	95% CI	Adj OR*	95% CI
All women															
25-31	21,226	11,349	53.5	5376	25.3	1		1		4501	21.2	1		1	
≥32	8839	4652	52.6	2411	27.2	1.09	(1.03-1.16)	1.09	(1.02-1.16)	1776	20.1	0.96	(0.90-1.03)	0.97	(0.90-1.03)
Subgroups of women by mode of delivery															
<i>Women with a spontaneous vaginal birth</i>															
25-31	14,583	8268	56.7	2342	16.1	1		1		3973	27.2	1		1	
≥32	5192	2872	55.3	913	17.6	1.12	(1.03-1.23)	1.12	(1.02-1.22)	1407	27.1	1.02	(0.95-1.10)	1.02	(0.95-1.10)
<i>Women with instrumental vaginal delivery</i>															
25-31	3583	1668	46.6	1632	45.5	1		1		283	7.9	1		1	
≥32	1696	825	48.6	731	43.1	0.91	(0.80-1.02)	0.9	(0.80-1.02)	140	8.3	1.00	(0.80-1.25)	1.01	(0.81-1.26)
<i>Women with instrumental vaginal delivery</i>															
25-31	2059	812	39.4	1,135	55.1	1		1		112	5.4	1		1	
≥32	1193	498	41.7	603	50.5	0.87	(0.75-1.01)	0.87	(0.74-1.01)	92	7.7	1.34	(1.00-1.80)	1.36	(1.01-1.85)
<i>Women with elective cesarean delivery</i>															
25-31	665	477	71.7	66	9.9	1		1		122	18.8	1		1	
≥32	532	364	68.4	44	8.3	0.87	(0.58-1.31)	0.85	(0.56-1.30)	124	23.3	1.33	(1.00-1.77)	1.38	(1.03-1.84)

All women and subgroups of women by mode of delivery**.

Total sample = 30 065 women. Regression analyses presented as Crude and Adjusted Odds Ratio (OR) with 95% Confidence Intervals (CI).

*Adjusted for smoking, single status, native language other than Norwegian and education.

**Women with unclear mode of delivery or combined (VE and emergency cesarean delivery) excluded (n=562).

On the contrary, women of advanced age managed less well than the younger when having a spontaneous vaginal birth. Processes of biological ageing, such as decreased uterine function [36,37] as well as physical health [15], or prolonged labour [34], may have affected labour negatively, and consequently the childbirth was a difficult experience even if the birth technically was defined as normal, i.e. spontaneous vaginal birth. Additionally, induction of labour, which have previously been reported as a risk factor for a negative birth experience [15], was more prevalent in the women of advanced and very advanced maternal age who had an unassisted vaginal delivery than in the reference group (reference group 11.9%; advanced maternal age 14.3%; very advanced age; 23.4%) (p<0.001).

The higher rate of a 'better than expected' experience of childbirth in older women delivered by elective cesarean section has been reported previously [15]. A wish to have a cesarean delivery was more frequent in women of advanced age than in the reference group, and the fact that their preferences were met may be one explanation to the finding. Older women are also more

often well prepared before childbirth [33], and it may be easier to prepare for a predictable event as an elective cesarean delivery than for labour and a vaginal birth.

These findings partly confirm the results from a previous national Swedish study of 1 302 first-time mothers. In agreement, the Swedish women of advanced age had a more negative birth experience than the younger, but contrary to the Norwegian women in the present study, more positive feelings prior to childbirth [22]. The survey questions were different in the two studies and also the time point for measurement differed; in the Swedish study expectations for the upcoming birth were measured in gestational week 17 and in the Norwegian, in gestational week 30. Optimistic expectations in early pregnancy may have altered towards more pessimistic or realistic after being informed through parental education, and finally facing the unknown. There may also be differences in the maternity care and childbirth preparations between the two countries. Further, from the present cohort, we have previously showed that women of advanced maternal age had an increased risk of psychological distress in terms of anxiety and

Table 3 Memory of childbirth as "worse than expected" in primiparous women aged 32–37 and ≥38 years compared with the reference group aged 25–31 years, in relation to mode of delivery

Maternal age, yrs	n	%	Adjusted OR*	95% CI
Spontaneous vaginal birth				
25-31 years	2342	16.1	1.00	
32-37 years	831	17.7	1.12	1.03-1.23
≥38 years	82	16.7	1.08	0.84-1.39
Instrumental vaginal delivery				
25-31 years	1602	45.3	3.41	3.13-3.70
32-37 years	639	43.3	3.14	2.79-3.52
≥38 years	83	43.2	3.03	2.25-4.08
Emergency cesarean delivery				
25-31 years	1135	55.1	4.89	4.42-5.41
32-37 years	519	51.4	4.29	3.74-4.92
≥38 years	84	45.7	3.75	2.75-5.13
Elective cesarean delivery				
25-31 years	66	9.9	0.48	0.37-0.63
32-37 years	37	8.6	0.44	0.31-0.62
≥38 years	7	7	0.34	0.15-0.74

Regression analyses presented as Adjusted Odds Ratio (OR) with 95% Confidence Intervals (CI).

*Adjusted for smoking, single status, native language other than Norwegian and Education.

depression during pregnancy and postpartum, which may have affected their assessments of childbirth experience [31]. In the smaller Swedish study, the older women were not at such a risk.

The strength of this study was the large sample size and age distribution similar to the national Norwegian birth cohort. Still the sample differed from the national cohort regarding characteristics that could have led to an underestimation of the risk for a negative childbirth experience, such as lower rates of single mothers, smokers, IVF pregnancies, preterm births and newborn transfers to neonatal intensive care unit. A limitation of this study was that data for the feelings for the upcoming birth and birth experience were restricted to responses to single items questions from the MoBa survey and not measured by validated instruments. The fact that the survey question included an assessment of childbirth experience relative to the woman's expectations seemed to be of little importance since the results did not change after adjusting for worrying childbirth and for wishing a cesarean delivery.

Conclusion

We conclude that delaying the first pregnancy to 32 years and older may have a negative effect on women's childbirth experience, but only in cases of spontaneous

vaginal birth. Even if women who are delivered by emergency cesarean section or instrumental vaginal delivery have a much more negative experience than after a spontaneous vaginal birth, older women seem to be better prepared to manage this experience than younger women. Whether primiparous women of advanced age would have a better experience after being informed about the possible risk of a prolonged labour needs further investigation.

Ethics approval

The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian data Inspectorate (S-97045).

Competing interests

The authors declare that they have no competing interests.

Author's contribution

VAA contributed to the planning of the study and analysed the data, contributed to the interpretation of findings and wrote the first draft of the manuscript. UW was the principal investigator and contributed with the idea, the interpretation of the results and with writing the manuscript. SR contributed in the analyses, and commented the manuscript. ES contributed to the planning of the study, to the data analyses, the interpretation of the results and the writing of the manuscript. All authors read and approved the final manuscript.

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Paper IV

Satisfaction with life during pregnancy and early motherhood in first-time mothers of advanced age: a population-based longitudinal study

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Background: The trend to delay motherhood to the age of 30 and beyond is established in most high-income countries but relatively little is known about potential effects on maternal emotional well-being. This study investigates satisfaction with life during pregnancy and the first three years of motherhood in women expecting their first baby at an advanced and very advanced age.

Methods: The study was based on the National Norwegian Mother and Child Cohort Study (MoBa) conducted by the Norwegian Institute of Public Health. Data on 18 565 nulliparous women recruited in the second trimester 1999-2008 were used. Four questionnaires were completed: at around gestational weeks 17 and 30, and at six months and three years after the birth. Medical data were retrieved from the national Medical Birth Register. Advanced age was defined as 32-37 years, very advanced age as ≥ 38 years and the reference group as 25-31 years. The distribution of satisfaction with life from age 24 to ≥ 40 years was investigated, and the mean satisfaction with life at the four time points was estimated. Logistic regression analyses based on generalised estimation equations were used to investigate associations between advanced and very advanced age and satisfaction with life.

Results: Satisfaction with life decreased from around age 28 to age 40 and beyond, when measured in gestational weeks 17 and 30, and at six months and three years after the birth. When comparing women of advanced and very advanced age with the reference group, satisfaction with life was slightly reduced in the two older age groups and most of all in women of very advanced age. Women of very advanced age had the lowest scores at all time points and this was most pronounced at three years after the birth.

Conclusion: First-time mothers of advanced and very advanced age reported a slightly lower degree of satisfaction with life compared with the reference group of younger women, and the age-related effect was greatest when the child was three years of age

Keywords Maternal age, Postponement of childbirth, Satisfaction With Life, Primiparous,

Background

The trend to delay motherhood to the age of 30 and beyond is now well established in most high-income countries (1). In Norway the mean age of first-time mothers increased from 23 years in 1970 to 28 years in 2012 (2). Comprehensive research has documented that this development increases the medical risks for both the mother and the infant (1, 3-6), although little is known about potential effects on maternal emotional well-being. We have previously reported that psychological distress is slightly more common in primiparous women of advanced age than in younger women (7), and in the present study we explored another aspect of well-being: satisfaction with life in a broader sense. Satisfaction with life (SWL) is a well-defined concept which refers to a person's global evaluation of quality of life based on a cognitive judgment (8, 9).

We hypothesised that SWL would be lower in primiparous women of advanced age compared with younger women, not only because of our previous findings regarding psychological distress, but also because of the higher prevalence of adverse pregnancy outcomes, such as caesarean delivery (10), preterm birth (4, 11) and infant health problems (5, 6, 12), and a higher prevalence in older primiparas of some socioeconomic factors (13) which also have been associated with low SWL, namely unemployment (14), financial stressors (15), and partner relationship problems (16).

Some studies have reported that SWL increases during pregnancy (16, 17) but then decreases during the first years of parenthood to pre-pregnancy level, but whether this development varies by age is unclear (18). In contrast to our hypothesis, one could assume that women who expect

their first child at an advanced age are *more* satisfied with life than their younger peers because childbirth may be part of a well-defined life plan including education, career and then parenthood (13), or because women may feel more mature. One study found that SWL increased steadily during a woman's reproductive life (19), whereas others have suggested that SWL is relatively stable over the age span (20, 21), but sensitive to major life events (14-17, 19), such as childbearing (16, 17).

The aim of this study was to investigate satisfaction with life during pregnancy and the first three years of motherhood in a large population-based sample of first-time mothers, and examine whether advanced maternal age is associated with poorer satisfaction with life.

Methods

Participants and procedures

Selected data were drawn from the Norwegian Mother and Child Cohort Study (MoBa), which is a prospective population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health. The MoBa study investigates socio-demographic, physical, genetic, and mental health exposure variables and outcomes in mothers, fathers and their children. The method has been described in detail in previous publications (7, 22, 23). Participants were recruited from all over Norway during the period 1999-2008, and 38.5% of the invited women consented to participate. The final cohort includes 108 000 children, 90 700 mothers and 71 500 fathers. Follow-up is conducted by questionnaires at regular intervals and by linkage to national health registries. The current study is based on version 6 of the quality-assured data files, released in

2011. Informed consent was obtained from each MoBa participant upon recruitment. A postal invitation, which included an informed consent form and the first of six questionnaires, was sent out after the women had registered for a routine ultrasound examination at approximately 17 weeks of gestation. Data from four of the questionnaires were used and these were completed around gestational weeks 17 and 30, and at six months and three years after the birth. A letter of reminder was sent out after 2-3 weeks in cases of unreturned questionnaires. The first questionnaire (Q1) obtained information about socio-demographic background (education, marital status, native language, income, unemployment and smoking), mother's health during pregnancy, relationship satisfaction (a shortened version of the Relationship Satisfaction Scale) (24, 25) and previous depression. In addition, the questionnaire included the Satisfaction With Life Scale (SWLS) (9, 26, 27)(see below). The same instrument was included also in the second (Q2), the third (Q3) and the fourth questionnaire (Q4). From Q2 we retrieved data on marital status and relationship satisfaction; from Q3 marital status, relationship satisfaction; and from Q4 socio-demographic variables (marital status, smoking, financial problems), and maternal as well as infant health problems. Data on maternal age, parity, in-vitro fertilisation (IVF), mode of delivery and infant outcomes (prematurity, neonatal transfer) were retrieved from the Norwegian Medical Birth Register, which covers all births in Norway and includes information from the standardised medical records used by all antenatal clinics and delivery units in the country (28).

The present study included nulliparous women who had completed all four questionnaires, including the Satisfaction With Life Scale, and who had complete data from the Medical Birth Register on parity and maternal age. Nulliparity was defined as not having given birth previously; neither to a live nor stillborn infant after 21 weeks of pregnancy (29). For simplicity, the term primiparity is used for women in the study, although nulliparity would have been the correct term

when still pregnant. Representativeness was assessed by comparison of a sub-sample of our study from one year, namely 2003 which was approximately half-way through the data collection, with the entire Norwegian birth cohort of nulliparous women of the same age who gave birth in 2003 (data from the Medical Birth Register).

Outcome measurement

Satisfaction with life was measured by the widely used five-item version of the Satisfaction With Life Scale (9, 26, 27). The responder was asked to assess the following statements: *My life is largely what I wanted it to be*, *My life is very good*, *I am satisfied with my life*, *I have achieved so far what is important for me in my life*, and *If I could start all over again, there is very little I would do differently*. The items were rated on a seven-point Likert scale with the following response alternatives: *totally disagree* (=1), *disagree* (=2), *slightly disagree* (=3), *neither agree nor disagree* (=4), *slightly agree* (=5), *agree* (=6), *totally agree* (=7), and a summated score was calculated. The possible range of scores is from 5 (low satisfaction) to 35 (high satisfaction). Scores less than 9 indicate extremely low satisfaction with life, and scores between 20 and 24 are regarded as average (27, 30). The reliability and validity of the scale is well-established (26, 27). Internal consistence, measured by Cronbach's alphas varies between 0.89 to 0.91; in the total MoBa cohort it was 0.89 in gestational week 17, 0.89 in gestational week 30, 0.89 at six months postpartum and 0.91 at three years postpartum (16). For comparison, we retrieved similar data on SWL from the Norwegian Survey on Living Conditions 2005, including a national Norwegian sample of women (pregnant women not excluded) in the same age groups (25-31 years, 32-37 years and ≥ 38 years) (31).

Explanatory variable

Age was defined as maternal age at the time of giving birth. There is no consensus regarding how to define 'advanced' or 'very advanced' maternal age (32) and studies use different age cut-offs (6, 33, 34). In the present study, age was categorised on the basis of data from the Norwegian birth cohort from 2003, using the break point for the upper quartile (31/32 years) for advanced maternal age and the break point for the lower quartile (24/25 years) for the comparison group. To distinguish the 'oldest', the break point for the highest 2.5 percentile (37/38 years) was used. Consequently, advanced maternal age was defined as 32-37 years, very advanced as ≥ 38 years and the comparison group as 25-31 years.

Confounders

We avoided adjusting for the natural process of ageing and therefore restricted the potential confounders to socio-demographic factors: education, single status, native language, income (Q1), financial problems (Q4), unemployment (Q1) and smoking. To further *explore* the differences between the women of advanced or very advanced age and the reference group, we also tested the following variables in the models: previous depression, relationship satisfaction, maternal and infant health problems three years postpartum.

Statistical analyses

For representativeness, differences in characteristics between the age groups, and between women in the sample who gave birth in 2003 and all Norwegian primiparous from 2003, were

assessed by chi-square tests. Associations between SWL in gestational weeks (gwks) 17 and 30, and at six months and three years after the birth and potential confounders were first tested by bivariate analyses using generalised linear models (GLM), and only the statistically significant confounders were retained. Multivariate logistic regression models based on the methods of generalised estimation equations (GEE) were then used to assess the association between maternal age and satisfaction with life, with adjustment for 1) time of measurement and 2) socio-demographic factors. By using GEE, we accurately dealt with the problem of possible correlation between repeated observations from the same individual and thereby obtained more precise variation estimates in the regression models (35). We used a binary logistic model and the variance-covariance for all models was assumed to be block diagonal, but unstructured within a block defined by subjects. The results are presented as crude and adjusted mean differences with 95% confidence intervals (CI) (36). P-values <0.05 were defined as statistically significant.

To study whether the effect of age was modified by any of the independent factors, we tested if there were interactions between age and the following factors after adjusting for all other factors: time, marital status, education, financial problems, smoking, native language other than Norwegian, relationship satisfaction, previous depression, maternal and infant health problems. Imputations on the Satisfaction With Life Scale were made if a maximum of two of the five items on the scale were missing by using a single imputation method, the Missing Values Analyses-Expectation Maximisation algorithm (37). As predictors, data on the remaining items on the scale were used. By imputation, 484 women could still remain in the study. Imputation was also performed on the Relationship Satisfaction Scale if a maximum of two of the five responses were missing, keeping 472 women for analysis.

The analyses were conducted using IBM SPSS Statistics version 20 (SPSS, Inc., Chicago, IL). The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian Data Inspectorate (S-97045).

Results

The flow chart (Figure 1) shows the initial MoBa sample and the final study group of 18 565 nulliparous women who had completed all the four questionnaires, including the SWLS. The dropouts included women who had responded to Q1 but not to one or more of the subsequent questionnaires (n=18 130), or women who had filled in fewer than three items on the SWLS (n=1886). Of the dropouts, 28% (n=5635) had given birth in 2008 or 2009 and thus not yet received Q4.

Table 1 shows the background characteristics of women in relation to age group. Compared with the reference group, the following characteristics were more common in women of advanced and very advanced age: high body mass index ($p<0.001$), IVF pregnancy ($p<0.001$), instrumental vaginal delivery ($p<0.001$), caesarean section ($p<0.001$), preterm birth ($p<0.001$) and newborn transfer to neonatal clinic ($p<0.001$). They were also more often single ($p<0.001$) and high-income earners ($p<0.001$). Women of very advanced age were more often unemployed ($p=0.032$). Table 1 also shows that the following characteristics were underrepresented in the sub-sample of 2003 compared with women in the Norwegian birth cohort of the same year: being single, smoking, IVF pregnancy, caesarean delivery, preterm birth and neonatal transfer.

Figure 2 shows the distribution of mean SWL scores by maternal age at each time point, i.e. in gestational weeks 17 and 30, and six months and three years after the birth, and also the age distribution of SWL in the dropouts in gestational week 17. During the first three time points, SWL increased from the age of 25 years to 28 years, and then decreased more or less continuously to ≥ 40 years. At three years after birth, the decrease started somewhat earlier, from around 27 years of age, and the decrease by age was steeper. Regardless of age, the mean SWL scores looked rather similar at the first three time points, but were much lower three years after the birth. Figure 2 also shows that women who dropped out after 17 weeks of pregnancy, and specifically the older dropouts, had lower scores than women who participated throughout the study.

Table 2 shows the mean values of SWL in the three age groups from gestational week 17 to three years after the birth, and the crude and adjusted mean differences between the women of advanced and very advanced age respectively and the reference group. SWL was slightly lower in women of advanced age (mean difference -0.64; CI 95% -0.77 – -0.51) and very advanced age (mean difference -1.57; CI 95% -1.92 – -1.21). These differences remained also after the adjustment of time and socio-demographic factors. To explore what lies behind the lower satisfaction with life in the women of advanced and very advanced age, we entered possible explanatory factors, one at the time, into the model presented in Table 2. When adding *relationship satisfaction* into the model, the mean differences between the reference group and women of advanced age (-0.5; 95% CI -0.62 – -0.38) and very advanced age (-1.18; 95% CI -1.49 – -0.86) were slightly reduced. The following factors also affected the results, but only

marginally: *previous depression* (advanced age: -0.57; 95% CI -0.69 – -0.44; very advanced age: -1.41; 95% CI -1.76 – -1.07), the *child's overall health*; (advanced age: -0.63; 95% CI -0.76 – -0.51; very advanced age: -1.56; 95% CI -1.92 – -1.21), and *maternal overall health* (advanced age: -0.62; 95% CI -0.75 – -0.50; very advanced age: -1.57; 95% CI -1.92 – -1.22).

Interactions between age and all co-variates in Table 2 were investigated. Age interacted with time ($p < 0.001$), and the decrease by time was most obvious in women of advanced age. Age also interacted with civil status ($p = 0.003$), with married women of advanced and very advanced age showing lower SWL scores than the younger married women. Age did not interact with relationship satisfaction or any of the other remaining factors.

In order to validate our findings, which were based on women who participated at all four time points, we also analysed data from the larger sample of women who contributed up to the six months postpartum measurement ($n = 32\,227$). The mean values of SWL were almost identical to those in Table 2. SWL declined slightly by age and the mean differences remained practically unchanged over the time period, also after adjusting for time and socio-demographic factors (not shown, available on request).

Figure 3 illustrates the mean SWL scores by age group in gestational weeks 17 and 30, and at six months and three years after birth, as well as in a population-based sample of Norwegian women ($n = 1\,183$). Overall, the level of SWL was higher in the childbearing women in our sample than in women of the same age in the total population, which included all women regardless of

pregnancy, and the peak was at six months after birth. At three years after the birth, the SWL scores had decreased in the new mothers and were almost the same as in the population as a whole. Notably, SWL declined by age in the childbearing women at all four time points, but increased by age in the total population.

Discussion

This study of pregnant and new first-time mothers showed that satisfaction with life decreased more or less continuously from around age 28 to age 40 and beyond, when measured in gestational weeks 17 and 30, and at six months and three years after the birth. When comparing age groups defined as advanced maternal age (32-37 years) and very advanced age (≥ 38 years) with a younger reference group (25-31 years), and taking into account the time of measurement and confounding variables, satisfaction with life was slightly reduced in the two older age groups and most so in women of very advanced age. Women of very advanced age had the lowest SWL scores at all time points and most pronounced at three years after the birth. While SWL increased in the younger women during pregnancy, the opposite occurred in the oldest. These findings suggest that the postponement of childbirth phenomenon in high-income countries may have negative effects on women's experience of life.

One possible explanation of our findings could have been that satisfaction with life decreases by age regardless of childbirth, which would explain the lower SWL score in the oldest age groups already at the first measurement in gestational week 17. This explanation is however contradicted by the findings from the nationwide Norwegian sample of women in general, which showed that SWL was highest in the oldest women, despite the fact that the mean age in the oldest group was 39 years in our sample compared with 42 years in the population as a whole (Figure 3). Still,

women who become pregnant at advanced age may have lower SWL than younger pregnant women for reasons that we could not account for in our study because of lack of sufficient information about background factors that could differ between the age groups. The effect of age was slightly reduced by controlling for relationship dissatisfaction and previous depression, both of which are more prevalent in older nulliparas (7, 13) and also associated with low SWL (16, 38). The lowest SWL scores in our study were reported by the dropouts for which we had data only at 17 weeks gestation suggesting that the SWL scores in our sample would have been lower at the subsequent time points if the dropouts had been included.

Biological ageing is probably the most important explanation of our findings, due to age-related physical health problems such as fatigue and sleeping problems (13), obstetric complications (1, 6, 10), followed by a more negative experience of childbirth (39) and infant health problems (5, 6, 12). We adjusted for both obstetric (caesarean delivery) and infant outcomes (prematurity and transfer of the newborn to neonatal infant care), as well as the following factors: IVF, fatigue and mother's physical health during pregnancy; the mother's physical health and breastfeeding six months after the birth; and the mother's and the baby's overall health three years after the birth. In spite of this adjustment, the age effects were only slightly reduced; but there might still be remaining factors on which we do not have data.

When looking at the mean SWL scores at each time point, we found that the scores were higher during pregnancy and six months after the birth than in Norwegian women in general, suggesting that pregnant women and first-time mothers in Norway are fairly happy. Having children is highly valued in Norwegian society and well supported by the welfare system. The SWL scores declined in all age groups at three years after the birth, and were then rather similar to those in the

female Norwegian population. Similarly, a German panel study which reported that SWL scores increased before pregnancy and peaked just after birth, returned to the baseline level within two years postpartum (17). However, the effect of age on SWL was most pronounced when the child was three years of age. Childrearing seemed to be most bothersome for women in their late thirties, and older mothers may also have a reduced network due to the fact that their contemporaries have finished this period in life. Lack of peer- and family support has been reported in older first time mothers from the present cohort (13) and social support is crucial to the experience of SWL (40). Three years after the birth (when the entitled twelve months of parental leave in Norway are over), most women have started to work, suggesting that the lower SWL scores reflect the day-to-day struggle to combine the demands of parenthood and occupational work (41, 42).

Our choice of age cut-off for advanced and very advanced maternal age differs from that of many other studies, but as fecundity starts to decline and medical complications increase much earlier than the more commonly used 35 years limit (3, 43), the 31/32 years and 37/38 years limits were considered relevant. The non-data driven approach for age cut-off makes the decision even more valid. The strength of this study is the large population-based sample of nulliparous women including data from four time points collected over a period of 3.5 years. To our knowledge, the study is the first to investigate longitudinally the association between satisfaction with life and advanced maternal age. A limitation of the study is that women with some socioeconomic characteristics are under-represented, leading to a slight overestimation of SWL in the sample. Another limitation is the lack of SWL information before pregnancy.

Conclusion

First-time mothers of advanced and very advanced age reported a slightly lower degree of satisfaction with life compared with the reference group of younger women, and the age-related effect was greatest when the child was three years of age.

Ethics approval

The study was approved by the appropriate Regional Committees for Ethics in Medical Research and the Norwegian Data Inspectorate (S-97045). The Norwegian Mother and Child Cohort Study is supported by the Norwegian Ministry of Health, and the Ministry of Education and Research, NIH/NIEHS (contract no N0-ES 75558), NIH/NINDS (grant no.1 UO1 NS 047537-01, grant no 2 UO1 NS 047537-06A1), and the Norwegian Research Council/FUGE (grant no. 151918/S10).

Competing interests

The authors declare that they have no competing interests.

Author's contribution

VAA contributed to the planning of the study and analysed the data, contributed to the interpretation of findings and wrote the first draft of the manuscript. UW was the principal investigator, and contributed with the idea, the interpretation of the results and the writing of the manuscript. SR contributed in the analyses, and commented on the manuscript. BE contributed to the data analyses and the interpretation of the results. ES contributed to the planning of the study, the data analyses, the interpretation of the results and the writing of the manuscript. All authors have read and approved the final manuscript.

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Tables and figures:

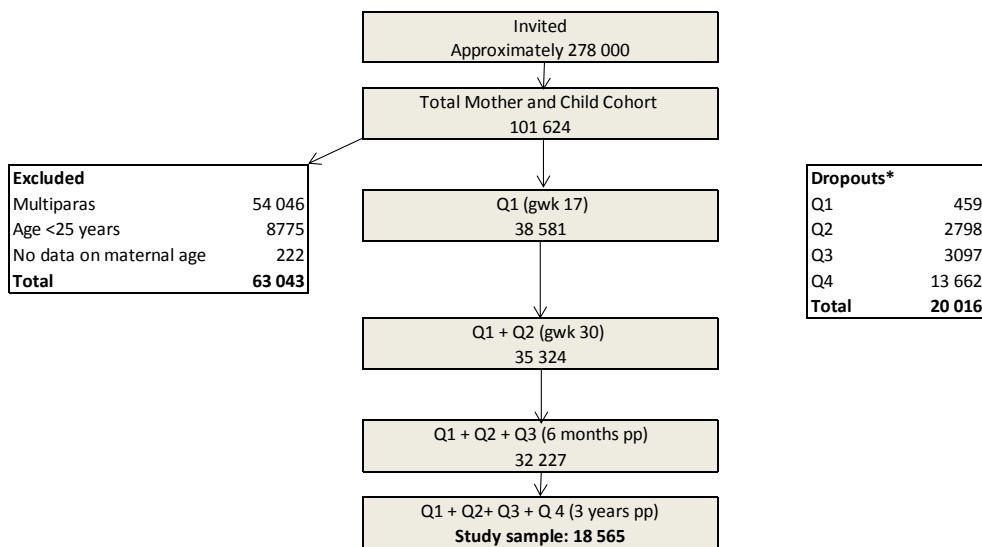


Figure 1. Flow chart of women with complete data on principal outcome SWLS (n= 18 565)

Q = Questionnaire

gwk = gestational week

pp = post partum

*Dropouts = non-responders to Q2-4 (18 130) or to SWLS in Q1-Q4 (n=1886)

**Medical Birth Register

Table 1. Background characteristics and pregnancy outcomes in primiparous women aged 25-31 years (reference group), 32-37 years (advanced age), and ≥38 years (very advanced age), and comparison of women aged ≥25 who gave birth in 2003 in the study and in Norway in total.

	Study group (n=18 565)			Women ≥25 years giving birth in 2003		P-value
	Age 25-31 (n=13107) %	Age 32-37 (n=4827) %	Age ≥38 (n=631) %	Sub-sample of the study (n=2429) %	Norwegian sample (n=16760) %	
<i>Sociodemographic background</i>						
Maternal age (years)*						0.005
25-29				55.7	54.0	
30-34				34.5	35.1	
35-39				9	9.6	
≥40				0.8	1.2	
Single status	2.1	3.9	10	2.8	5.7	<0.001
Native language other than Norwegian	4.9	7.5	5.7			
Unemployed	1.8	1.8	2.5			
Income (NOR)**						
<200 000	11.1	5.8	6.5			
200 000-399 999	58	46.2	45.8			
≥400 000	26	42.8	40.3			
Pregravid BMI, (kg/m ²)						
Underweight <18.5	2.8	1.9	2.1			
Normal weight 18.5-24.9	68.2	65.4	59.6			
Overweight 25-29.9	18.9	21	22.7			
Obesity ≥30	7.7	8.6	11.6			
Smoking*	8	7.1	8.2	8	13.9	<0.001
<i>Obstetric and infant outcomes</i>						
IVF present pregnancy*	2.5	7.9	12.8	3.6	4.9	<0.001
Mode of delivery						
Vacuum extraction	14.4	15.7	15.7	14.3	13.7	0.36
Forceps	2.8	3.3	3.8	2.5	22.4	0.32
Elective caesarean delivery	3.1	5.8	11.1	4.2	5.3	<0.001
Emergency caesarean delivery	9.4	12.9	19	11.2	12.5	0.03
Unspecified caesarean delivery	1.8	2.3	4	1.2	2.5	<0.001
Unassisted vaginal delivery	69	60.6	47.4	67.1	63.6	
<i>Infant outcomes</i>						
Preterm***	5.8	6.5	8.9	6.5	8.8	<0.001
Neonatal transfer	9.2	10.5	13.6	10.3	12.5	<0.001

* Data from the Norwegian Medical Birth Register

**NKR: NOK/GBP = 10.90

*** Preterm: 22-36 weeks of pregnancy

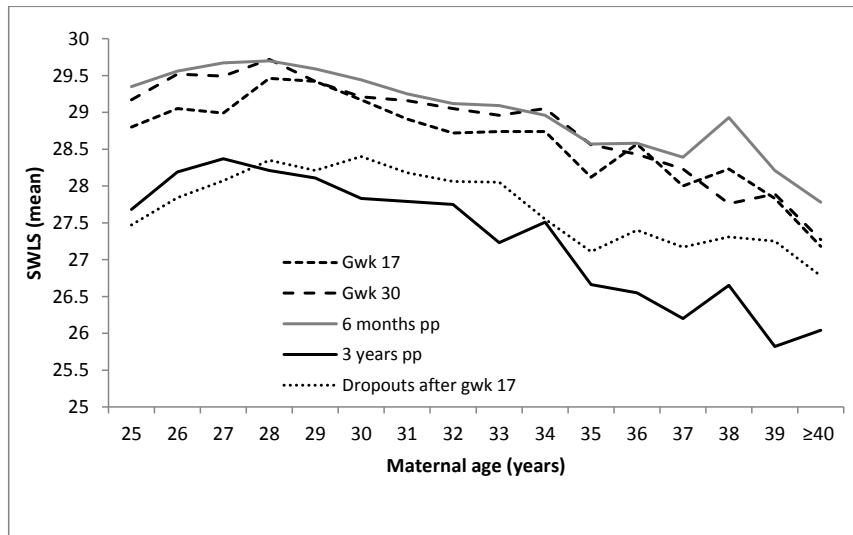


Figure 2 Satisfaction with life (SWLS, mean score) in gestational weeks 17 and 30 and at 6 months and 3 years after the birth in relation to maternal age in the study sample (n=18 565), and at gestational week 17 in the dropouts (n=5891).

Table 2. Satisfaction with life by maternal age group.

Mean SWLS in gestational weeks 17 and 30, and at 6 months and 3 years after the birth analysed by GEE¹ adjusted for timepoint (Adj²) and sociodemographic variables (Adj³) with 95% Confidence Intervals (CI). Nulliparous women aged 25-31 (reference), 32-37 years and ≥38 years (n=18 565).

Age	n	SWLS		SWLS		Mean difference	CI 95%	Adj ²	CI 95%	Adj ^{2,3}	CI 95%
		gwk 17	gwk 30	6 months pp	3 years pp						
25-31	13107	29.11	29.4	29.52	28.05	0		0		0	
32-37	4827	28.58	28.84	28.9	27.21	-0.6	(-0.77 – -0.51)	-0.63	(-0.76 – -0.50)	-0.7	(-0.83 – -0.58)
>38	631	27.73	27.6	28.31	26.22	-1.6	(-1.92 – -1.21)	-1.56	(-1.92 – -1.20)	-1.32	(-1.65 – -0.99)

¹Generalised Estimated Equation

²Adjustment for time point

³Adjustment for sociodemographic variables: education, single status, native language other than Norwegian, financial problems, unemployment and smoking.

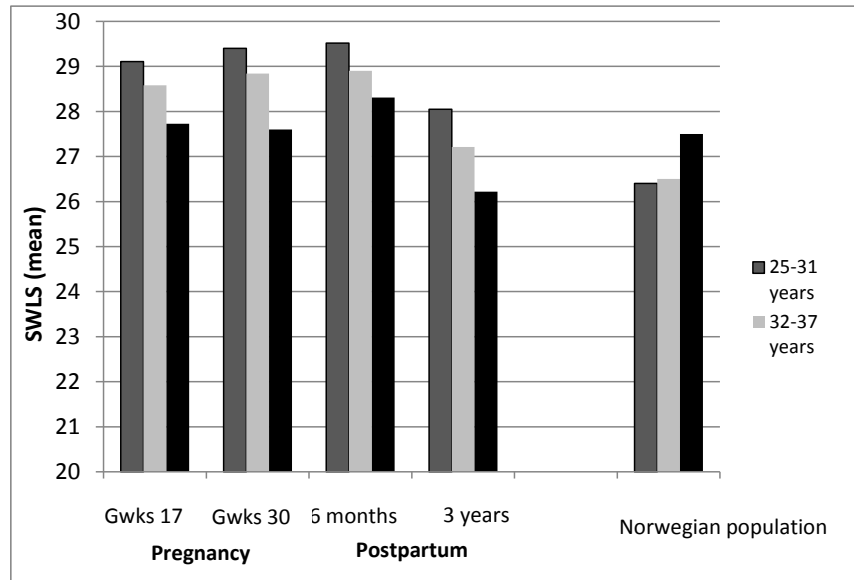


Figure 3. Satisfaction with life (SWLS, mean score) in nulliparous women by age group in gestational weeks 17 and 30, and at 6 months and 3 years after the birth (n=18 565), and in a population-based sample of Norwegian women (non pregnant/pregnant) (n=1183).

