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Health Behavioural and Social Risks in Obstetrics

Effect on Pregnancy Outcome

Doctoral dissertation

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ABSTRACT

Prior studies on pregnancy and social (unmarried status, unemployment, non-attendance at antenatal care) and health behavioural (induced abortions, overweight, young maternal age) risks have shown associations with adverse pregnancy outcomes, such as preterm birth, foetal growth restriction and perinatal deaths. The magnitude of these risks has been different depending on the society and accessibility of maternity care. Also differences in representativeness of populations and in controlling of confounding factors have made the literature inconclusive. In Finland maternity care is exceptionally easy to access and linked with the possibility to receive maternity benefits. Thus, it is attended by virtually the entire pregnant population, which may reduce the effect of adverse social circumstances.

The subjects of the present study belong to the pregnant population treated at Kuopio University Hospital in 1989-2001. The study population consisted of mothers with singletons and births with major malformations were excluded. The total number of participants in different studies varied from 23,613 to 26,967. Of the pregnancies 8235 were outside marriage, in 5976 pregnancies either or both parents were unemployed,185 mothers were under 18 years old, 3388 mothers were overweight and 1880 obese, 2719 women had a history of induced abortion and 477 women had under-attended antenatal care. Maternal risk factors were assessed by comprehensive self-administered questionnaires at 20 weeks of pregnancy, and the data were complemented by interview. Information on pregnancy complications, pregnancy outcome and the neonatal period was electronically filed as a part of clinical work. Odds ratios (OR: s) with 95 % confidence intervals were calculated by logistic regression to estimate the effect of each variable on pregnancy outcome.

Clinically important risks for adverse pregnancy outcome were found. Compared with married women, unmarried and cohabiting had a slightly increased risk of preterm birth, OR 1.15 (95 % CI 1.03-1.28), of infant admission to the neonatal intensive care unit (NICU) OR 1.15 (95 % CI 1.05-1.27) and of small for gestational age infants (SGA) OR 1.11 (95 % CI 1.02-1.22). The risk of SGA was higher in single women (OR 1.29 [95 % CI 1.09-1.54]). Unemployment of the mother was associated with SGA (OR of 1.26 [95 % CI 1.12-1.42]), especially in families where both parents were unemployed (OR 1.43 [95 % CI 1.18-1.73)). The newborns of obese women (BMI $\geq$30 kg/m^2) had an increased risk of perinatal death (OR 2.19 [95% CI 1.33-3.62]), infant admission to the NICU (OR 1.38 [95 % CI 1.17-1.61)) and low Apgar score (OR 1.64 [95 % CI 1.22-2.28[). Even the infants of overweight women had an increased risk of admission to the NICU (OR of 1.20 [95 % CI 1.06-1.37)) and low Apgar score (OR 1.54 [95 % CI 1.20-1.98]). In all, 1,0 % of the women excluding themselves from maternity care had high risks of preterm birth (OR 3.79 [95 % CI 2.72-5.27)), intrauterine foetal death (OR 3.02 [95 % CI 1.20-7.57]) and low Apgar score (OR 4.50 [95 % CI 2.92-6.96)). Teenage women appeared to have favourable pregnancy outcomes. Accordingly, prior pregnancy terminations were not associated with adverse pregnancy outcomes.

Social and health behavioural risks are notable even in conditions of high-quality maternity care attended by 99% of the pregnant population. Obese women might benefit from preventive measures. The increasing trend of obesity is an important, preventable public health issue also in the field of obstetrics. Weight loss to a BMI under 30 would bring substantial advantages to obstetric outcome. Women who do not attend antenatal care or have other social or behavioural risks deserve close surveillance of the pregnancy and support in issues related to motherhood.

National Library of Medicine Classification: WA 310, WQ 175, WQ 200, WQ 240,

Medical Subject Headings: Adolescence; Finland; Induced abortion; Marital Status; Maternal Age; Maternal Behavior; Maternal Health Services; Maternal Welfare; Mothers; Obesity; Pregnancy/complications; Pregnancy, High-Risk; Pregnancy Outcome; Pregnant Women; Prenatal Care; Questionnaires; Reproductive Behavior; Risk Factors; Social Conditions; Socioeconomic Factors; Unemployment

To my Family

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Kajaani December 16th 2006

Kaisa Raatikainen

ABBREVIATIONS

AGA	appropriate for gestational age
AF	amniotic fluid
BMI	body mass index
BV	bacterial vaginosis
CI	confidence interval
CTG	cardio-tocography
GP	general practitioner
IUD	intrauterine device
IUGR	intrauterine growth retardation
LBW	low birth weight
NICU	neonatal intensive care unit
OR	odds ratio
RR	risk ratio
SD	standard deviation
SGA	small for gestational age

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles:

I Raatikainen K, Heiskanen N, Heinonen S.
Marriage still protects pregnancy. BJOG. 2005 Oct;112(10):1411-6.

II Raatikainen K, Heiskanen N, Heinonen S.
Does unemployment in family affect pregnancy outcome in conditions of high quality maternity care? BMC Public Health. 2006 Feb 24;6(1):46.

III Raatikainen K, Heiskanen N, Verkasalo PK, Heinonen S
Good outcome of teenage pregnancies in high-quality maternity care. Eur J Public Health. 2006 Apr;16(2):157-61. Epub 2005 Sep 1.

IV Raatikainen K, Heiskanen N, Heinonen S.
Transition from an overweight condition to obesity worsens pregnancy outcome in a BMI- dependent manner. Obes Res. 2006 Jan 14(1):165-71

V Raatikainen K, Heiskanen N, Heinonen S.
Induced abortion – not an independent risk factor of pregnancy outcome, but a challenge for health counselling. Ann Epid. 2006 Aug;16(8):587-92. Epub 2006 Apr 18.

VI Raatikainen K, Heiskanen N, Heinonen S.
Under-attending free antenatal care is associated with adverse pregnancy outcomes. Submitted

CONTENTS

1 INTRODUCTION

Health behavioural attitudes and habits and untreated pregnancy pathology, mediate association of low socio-economic status and impaired pregnancy outcomes. Low socio-economic status has for decades been associated with adverse pregnancy outcome: a 50 % increased risk of perinatal death and 50–80 % increased risk of preterm birth (Rutter and Quine. 1990, Lumley. 1997). Some of health behavioural and social risks may also have a direct causal impact on pregnancy outcome, for example, the association of smoking and alcohol use during pregnancy on birth weight (Hannigan and Armant. 2000, Hammoud et al. 2005). The impact of poor maternal health status in the perinatal period on the health of offspring lasting over generations makes it particularly important to reduce the socio-economic inequalities of pregnancy outcome (Barker, et al. 1989).

In Finland 99.8 % (Sipila, et al. 1994) of women attend maternity care, which is easily accessible, free of charge and linked with maternity grant. Additionally, maternity allowances reduce differences in material circumstances of families. Conditions in Finland are exceptional in an international comparison.

Abundant information is collected on health behaviour and social status through the maternity care system, but very little is known about the magnitude of the impact employment, low maternal age, unmarried status, prior pregnancy terminations, obesity and non-attendance at antenatal care have on pregnancy outcome under the current conditions of modern antenatal care and obstetrics.

The aim of the present study was to assess the occurrence of social and health behavioural risks in obstetric population and to investigate the impact these factors have on pregnancy outcome. The study groups were unmarried, unemployed, teenage and overweight pregnant women, women with a history of induced abortion and women under attending antenatal care.

The clinical implications of the present study are in assessing whether some risk groups may require additional surveillance and in assessing whether our maternity care has succeeded in preventing some of the known pregnancy risks linked to social circumstances and health behaviour.

2 REVIEW OF THE LITERATURE

2.1 Social status and perinatal health

European women of low socio-economic status have been reported to have an increased relative risk (RR) of perinatal mortality 1.6-fold and increased risk of perinatal morbidity, specifically low birth weight (1.4-fold), (Rutter and Quine 1990) and preterm birth (1.8-fold)(Lumley 1997) compared with higher socio-economic groups.

Changes in marital relationship, employment, maternal age at birth and health may, however, have influenced the associations. On the other hand, obstetric patterns such as pregnancy desirability and parity have been found to pass over generations, reflecting the socio-economic family context. (Pouta et al. 2005)

Several Finnish epidemiologic studies have shown a clear association between low social class and adverse perinatal health. In 1985, a U-shape association was reported in which the best obstetric outcome in terms of gestational length, premature births and birth weight was in the second highest social group. Low Apgar scores had a linear association with social class, with the lowest social group having a four-fold higher risk of low one-minute Apgar scores. (Hemminki et al. 1990) In 1998, Forssas et al. studied perinatal death according to socioeconomic factors, based on register data from the Finnish Medical Birth Register of 1987 and 1994. They found an increased risk of perinatal death (an odds ratio [OR] of 1.58 to 1.26) in lower social groups defined by maternal occupation. (Forssas et al. 1998a) In 1997-99 the corresponding risk of perinatal death was lower, OR 1.33, but significantly increased in the lowest socioeconomic group compared with the highest. Increased risks were found also for preterm births (OR 1.16) and low birth weight (OR 1.25). (Gissler et al. 2003)

Narrowing the health difference between high and low socioeconomic groups has for decades been regarded as one of the most difficult tasks of health policy. It has consistently been a main goal in international (Marmot 2005) and national (Ministry of Social Affairs and Health (STM) 2006a) health programmes. It is not an issue of public consciousness, however. Particularly socially disadvantaged people are unaware of socio-economic health inequalities (Blaxter 1997). The basis of socioeconomic health differences is unequal distribution of material and cultural resources. The causal chain from low socio-economic position to ill health includes low educational level, insecure and heavy work, poverty, low housing standards, lack of social network and unhealthy habits, specifically smoking, alcohol intake and inadequate nutrition. Thus, health systems cannot prevent all health problems related to low social status (Blaxter 1983, Lahelma E. 2000). The means of narrowing health differences are mainly socio-political and clearly beyond the possibilities of health care.

Publicly offered health education most effectively affects people of low socio-economic status, who do not have a possibility to choose among health services. (Lahelma E. 2000) The causal chain of adverse health can reach over generations. Along with current living conditions, childhood economic circumstances and childhood social status are seen as health inequalities that are also reflected in adulthood (Barker et al. 1993, Rahkonen et al. 1997, Lahelma E. 2000).

2.2 Maternity care

2.2.1 Historical perspective

The basis of Finnish antenatal care was established already by Arvo Ylppö in the 1920s. Antenatal services were made available to all pregnant women and a municipal network on antenatal care services covering the whole country was achieved by a law concerning

antenatal care in 1944. The basis for the maternity care system in health care centres was created by the public health law of 1972 (Hemminki et al. 1992).

One of the purposes of modern antenatal care is to identify pregnancies carrying a risk of poor outcome. The effects of many social and health behavioural risk factors are minor, but together they may represent a clinically significant risk of prematurity, foetal growth restriction or perinatal death. Many health behavioural and social risk factors can and should be noted early enough to make preventive measures possible: preferably before pregnancy or in the beginning of the pregnancy (Sipila et al. 1994).

A recently published survey of maternity- and child-care services in health care centres in Finland showed a trend towards insufficient staff resources. A third of health centres were reported not to have nurses in charge in antenatal care. Furthermore, the recommended number of doctors was present in every third maternity centre only. This trend is most probably increasing the health inequalities of pregnant women and newborn infants, and undermines the situation of socially disadvantaged women through the inability to arrange dedicated support and sufficient preventive measures. (Hakulinen-Viitanen et al. 2005)

2.2.2 Content of the antenatal care

Antenatal care can be divided into five areas: 1) screenings (medical and social risk groups, maternal medical conditions, ultrasound and laboratory foetal screenings), 2) medical care, 3) referral to hospital and social services, 4) health education and 5) psychosocial support.

The content of antenatal care has taken shape over decades. National and international bodies, such as WHO (WHO 2006a), Royal College of Gynaecology in the UK (National Centre for Women's and Childrens' Health 2003), American College of Gynecology in the Us and National Health and Medical research Council in Australia (Australian National Health

and Medical Research Council 2000) have given recommendations and published definitions on prenatal health. As in all health care, only a small proportion of all antenatal care offered is evidence based. An exception of this can be found in UK, where recommendations are graded according to the strength of the evidence on which they are based (National Centre for Women's and Childrens' Health 2003). In 2004, 80 % of the member states of the European Union had national guidelines on antenatal care, but these recommendations were far from uniform. Compared with other EU counties, Finnish antenatal care was found to be thorough, and above average in terms of the number of tests. Indicative of the great variation in recommended antenatal care between countries, only 8 % of (3/37) tests were recommended by all EU countries (blood pressure measurement, blood group and Rhesus factor). On the other hand, four routinely used tests lack strong scientific evidence (vaginal examination of cervix to predict preterm birth, auscultation of foetal heart rate, the oral glucose tolerance test and urinalysis for glucose). (Bernloehr et al. 2005)

Until 1992, the National Board of Health gave orders on the structure and amount of antenatal care in Finland. After the National Board of Health was abolished, the National Research and Development Centre for Welfare and Health (STAKES) have given only recommendations, and local authorities make their own decisions on antenatal services. The latest publication on recommended antenatal screenings and collaboration is relatively old, from 1999 (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999).

The Ministry of Social Affairs and Health started with a nationwide programme of timeframes for access to non-emergency treatment in the beginning of March 2004, but

perinatal care is not currently included in the system (Ministry of Social Affairs and Health ([STM] 2006b).

Most guidelines of antenatal care give a platform for baseline clinical care of pregnancies in healthy women with an uncomplicated single pregnancy, and they concentrate on the type of examinations to be offered and the number and timing of antenatal care visits. (Haertsch et al. 1999, Bernloehr et al. 2005) Very few recommendations exist as regards health behavioural and social risks in antenatal care. In some guidelines social status is recommended to be assessed, and women with health behavioral risks are recommended to be offered support. For example, the Australian guidelines address socially disadvantaged women as a risk group having significantly increased levels of perinatal morbidity. They are considered to need special attention as regards preventive activities, acceptability and accessibility of services, health education programmes, antenatal screenings, family planning and breast feeding (Australian National Health and Medical Research Council 2000). Finnish guidelines of perinatal care do not include recommendations for care of the risk groups of the current study. (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999)

To provide a uniform basis for comparison of perinatal health, STAKES collects statistical data on obstetric care in Finland. The oldest database concerns sterilisation as a birth control method and it has been collected since 1939. Statistics on induced abortions have been compiled since 1950, structural foetal anomalies since 1963, deliveries and newborns since 1987, infertility treatments since 1992 and low birth weight preterm infants since 2004 (STAKES Perinatal Statistics of Finland 2003, STAKES Medical Birth Register 2006). The data are based on clinical records from hospitals and clinics, and are complemented by Statistics Finland (Tilastokeskus 2006) and Population Register Centre (Väestörekisterikeskus 2006). Finnish national register data of perinatal health (STAKES Medical Birth Register

2006) have been used also as a basis for European comparison of perinatal mortality as an indicator of quality of care since it is exceptionally comprehensive, with less than 2% missing information on gestational ages and low gestational age and birth weight limits for registering birth (Graafmans et al. 2001, Macfarlane et al. 2003).

2.2.3 Organization in Finland

The antenatal care model in Finland is general practitioner (GP) - and nurse- or midwife -led and it is offered in health care centers for women with uncomplicated pregnancies. Perinatal care is regionalised and most severe pregnancy pathology is treated by obstetricians in referral centres. Referral pathways are clear and based on national recommendations of antenatal care (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999). Moreover, in-utero transfers of very preterm infants to tertiary referral centres are used, the limit of pregnancy duration varying upon local facilities of neonatal intensive care from 28 to 32 weeks. (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999, Zeitlin et al. 2004)

Good continuity of care is achieved in antenatal and postnatal care in health care centres, but intrapartum services are obstetrician led and offered in public hospitals. Women carry their own pregnancy records, and a structured national maternity record is collected. Deliveries outside hospital and planned home deliveries are exceptional. Antenatal care is readily and easily accessible to all women free of charge. Almost the entire pregnant population (99.8 %) attends antenatal care in the whole country (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999, Hartikainen. 2003). The attendance is encouraged by linking the opportunity to receive a maternity allowance (either

maternity package containing child care items or a cash benefit) to the first visit at a maternity care unit before the 16th week of pregnancy.

Finnish antenatal care consists of an average 17 visits to maternity care units. This number exceeds national recommendations, including 13–17 visits for primiparous and 9–13 visits for multiparous women, with two of the visits scheduled after birth. (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999) In 2001, the average gestational age at the first maternity care visit was 9.7 weeks (STAKES Perinatal Statistics of Finland 2003).

The optimal amount of antenatal care in either low- or high-risk pregnancies is not yet resolved. The results of a recent systematic review suggested that women with low-risk pregnancies, defined as lack of prior adverse obstetric history or clinical conditions requiring treatment, can safely have fewer antenatal care visits than in traditional schedule (Carroli et al. 2001). Child-bearing women's own expectations have been reported to be diverse, some of them wishing for more and some, specifically women over 35 years of age with an unfortunate timing of pregnancy, wanting fewer antenatal care visits (Hildingsson et al. 2002).

2.2.4 Indicators of perinatal health

Most critical pregnancy outcomes can be set as indicators for monitoring perinatal health (Stakesin perhesuunnittelun ja äitiyshuollon asiantuntijaryhmä, Kirsi Viisainen [ed.] 1999, Zeitlin et al. 2003). In Finland, the quality of antenatal care is high as measured traditionally by perinatal mortality, which is among the lowest in Europe (Graafmans et al. 2001, Hemminki et al. 2001). Incidence of suboptimal care leading to fatal pregnancy outcome has

also been suggested as a quality measure in perinatal care. It has also been reported to be in Finland the lowest in Europe (Richardus et al. 2003).

2.2.4.1 Pretem birth

Preterm birth, defined as birth before 37 completed weeks (WHO 2006a), is the main cause of perinatal death and neonatal mortality in western world. The incidence of preterm birth is estimated to be 6 % to 10 % of all births in the western world. (Lumley 2003) In Finland, an overall reduction in preterm births was seen from the 1960s to the 1980s, the percentage fell from 9.1 to 4.8. During the same period of time, the iatrogenic preterm deliveries increased from 0.3 to 1.4 percent. (Olsen et al. 1995) From late the 1980s to 2005 in the incidence of preterm births has remained practically unchanged in Finland, the incidence being lowest (5.6 %) in 1987 and 2005 and highest (6.3 %) in 2000 (STAKES Medical Birth Register 2006). These figures are in contrast with a recent Danish study that reported an increase of 22 % in preterm births from 1995 to 2004, contributing to primiparity, multiple births caused by infertility treatments, increasing maternal age and iatrogenic preterm births. (Langhoff-Roos et al. 2006)

Preterm birth is responsible for between 75 % to 90 % of all the neonatal deaths that are not due to congenital anomalies, and 50 % of childhood neurological disabilities. The risk of adverse outcome increases with decreasing gestational age. About two-thirds of preterm births result from spontaneous preterm labour or preterm premature rupture of the membranes, with the remainder due to medical interventions for maternal or foetal indications. (Papatsonis et al. 2005)

Preterm birth is an extremely heterogeneous index to assess obstetric outcome, because a number of intrinsic pathways, such as impaired placentation, infection and polyhydramnios, result in the same endpoint. (Kurki et al. 1992, Peacock et al. 1995, Goldenberg et al. 2000, Kekki et al. 2004, Papatsonis et al. 2005, Romero et al. 2006) Adverse social circumstances during pregnancy (Berkowitz and Kasl 1983, Peacock et al. 1995, Lumley 1997), psychological distress, unmarried status and adverse life events (Berkowitz and Kasl 1983, Hartikainen-Sorri and Sorri 1989, Hedegaard et al. 1993, Moutquin 2003, Hobel 2004) have also been found to be associated with it. Endocrine disturbances have been suggested as mediating factors (Tambyrajia and Mongelli 2000). In 1997 J.Lumley reappraised 1958 British Perinatal Mortality Survey, which has for a long time been the basis of the understanding that social class is a main contributor to preterm birth. They found that the effect of social class on preterm birth is less severe than has been traditionally thought, only moderate in magnitude (unadjusted OR 1.51–1.79), and has changed very little during the past 25 years. Furthermore, they estimated that adjustments for smoking, young maternal age, maternal size and absence of a partner attenuated the risk, suggesting that these factors may be part of the causal chain leading from social factors to obstetric outcome. (Lumley 1997)

2.2.4.2 Small for gestational age infants

Children are considered small for gestational age (SGA) when their birth weight is below the 10^{th} percentile for gestational age in the population concerned. The definition of SGA is not consistent between studies, and growth curves vary by population, race, maternal age and parity. (Pollack and Divon 1992, Alexander et al. 1996, Heinonen et al. 2001). The concept of SGA was introduced in early 1970s, and it changed the pattern of relying on the weight of an infant as marker of prematurity and as predictor of development (Battaglia 1970).

Intrauterine growth retardation (IUGR) is the main cause of SGA. The other possibilities include being constitutionally small and mistakes in the estimation of gestational age. A child can also be growth restricted relative to the growth potential, but not small (Battaglia 1970). Overall, the causes of SGA can be classified as 1) foetal: chromosomal abnormalities, multiple pregnancies, metabolic disorders, infections and malformations, 2) placental: abnormal cord insertion, abnormal placental site, infarcts and placental tumors, and 3) maternal: nutritional, hypoxic, vascular (pre-eclampsia, hypertension), renal, haematologic, and environmental, specifically smoking, alcohol and drugs. (Battaglia 1970, Pollack and Divon 1992, Hannigan and Armant 2000, Odegard et al. 2000, Hammoud et al. 2005) Additionally, lifestyle and psychosocial differences between families have remained important aetiological factors of intrauterine growth retardation. SGA infants have been born more likely to families with an unemployed father and lower socioeconomic status and a mother with a low level of education (O'Callaghan et al. 1997).

Compared with appropriate for gestational age (AGA) foetuses, SGA foetuses experience a four-fold increase in the risk of serious complications. Intrauterine growth retardation is known to be a major aetiologic factor of increased perinatal morbidity, specifically birth asphyxia, meconium aspiration, pulmonary haemorrhage, impaired thermoregulation, polycytaemia and hypoglycaemia. The incidence of neuro-developmental problems is also from two to four-fold increased. (Doctor et al. 2001, Lindqvist and Molin. 2005) Furthermore, mortality in perinatal period is higher in SGA than AGA infants. Approximately 30 % of perinatal deaths are attributable to SGA (Battaglia 1970, Williams et al. 1982, Lindqvist and Molin 2005) .

The consequences of being born as SGA will extend to adulthood. They have a higher incidence of hypertension, stroke, diabetes and hypercholesterolaemia than AGA infants. It has been suggested that pathogenesis of cardiovascular disease is programmed during foetal growth. The possible confounding of low social class as an aetiology for both SGA and future cardiovascular disease has been studied, but no such bias has been found as the cardiovascular diseases of adults who were born SGA were not explained by their lower social class. (Barker et al. 1993).

2.2.4.3 Low Apgar score

In 1952, Virginia Apgar introduced the Apgar score as means of evaluating the physical condition of newborns. The system is still in worldwide use. Five easily evaluated characteristics are scored 0-2: heart rate, respiratory effort, muscle tone, irritability and color. The total score of 7 or higher indicates that the infant's condition is good (Committee on Obstetric Practice, ACOG. et al. 2006). The score is assessed at the age of one and five minutes, the latter one being regarded as a better predictor of survival than the score at one minute (Drage et al. 1964).

Casey et al conducted a large retrospective ten years cohort analysis in 2001, and found that Apgar score remains as relevant for the prediction of neonatal survival today as it was 50 years ago. Term infants (37 completed pregnancy weeks or more) having five minute Apgar of 0–3 had 1460 times the risk of neonatal death than infants with Apgar of 7–10. The predictive value was not as good for preterm infants (26–36 weeks of pregnancy), who were found to have a 59-fold higher risk of neonatal death in those with a five-minute Apgar of 0–3 than in those with a five-minute Apgar of 7–10. (Casey et al. 2001)

2.2.4.4 Perinatal death

The definition of perinatal death varies substantially in the US and in European countries, making the comparison difficult (Graafmans et al. 2001). The definition consists of a summation of the number of intrauterine deaths of foetuses over 20–28 weeks of gestational age, or in some countries foetuses weighing over 500g, and the number of newborns died during the first week – 28 days after birth. Definition used in Finland is uniform with the WHO definition: death of foetuses of 22 completed pregnancy weeks (foetal death) +early neonatal deaths until the age of 7 completed days after birth. This definition includes virtually all deaths attributed to obstetric events. (WHO 2006b)

The differences between published perinatal mortality rates in different countries partly reflect these differences between the criteria involved (Graafmans et al. 2001). The worldwide perinatal mortality rate is 4.7 %. The corresponding rate for the US is 0.7 %, for Western Europe 0.6 % and for Eastern Europe 2.1 %. In Finland it is among the lowest in the world, 0.6%. (WHO. 2006b) Furthermore, Finish perinatal mortality rate has been reported to be the lowest in Western Europe, regardless of the criteria used, and after adjustments made to calculate uniform rates (Graafmans et al. 2001, Richardus et al. 2003).

Worldwide, perinatal mortality is an important indicator of maternal care and of maternal health and nutrition. It also reflects the quality of obstetric and paediatric care available. (WHO. 2006b) A ten-fold difference in perinatal mortality is seen between the least developed countries and developed countries. In the western world, where perinatal mortality is very low, it has lost its importance as a true measure of quality in antenatal care, because the changes in mortality are already too small to be accurately measured (UpToDate 2006).

According to Finnish Medical Birth Register, a declining trend in perinatal mortality has been shown in the 1990s: from 7.8 per 1000 newborns in 1989 to 5.5 per 1000 newborns in 2000. (STAKES Medical Birth Register 2006) The main contributor to this decline has been reported to be the improving survival of infants weighing less than 1500g, and declining incidence of stillbirths in these very low birth weight infants. This change is most likely due to improved antenatal and neonatal care. (Forssas et al. 1998b)

The causes of foetal death are classified as 1) foetal malformations (17 %), 2) placental or umbilical cord pathology (62 %) 3) intrauterine infections (2 %) 4) trauma (1 %) 5) tumors and maternal diseases (3 %). The cause of foetal death is not resolvable in autopsy and/or laboratory tests in 15–30 % (Pitkin 1987, Incerpi et al. 1998, Horn et al. 2004). The main causes of neonatal death are associated with prematurity and low birth weight in 23 % and congenital malformations and chromosomal abnormalities in 20 %. Other important causes are pregnancy complications (5.6 %), placental complications (5.4 %), bacterial sepsis (3.5 %), intrauterine and birth hypoxia (3.1 %), haemorrhage (2.6 %) and necrotising enterocolitis (1.9 %) (UpToDate 2006). The most important risk factor of perinatal death has been reported to be previous stillbirth or neonatal death in a Finnish cohort study comparing obstetric outcome in 1960s (1.5-fold risk) and in the 1980s (3-fold risk). (Sipila et al. 1994)

In previous Finnish studies on the same subject, socioeconomic differences were clear in the early 1990s and also regional differences were found. Perinatal mortality in Kuopio district was found to be at an average level compared with the whole country (0.72 %). Perinatal mortality was higher than in cities on average (0.67 %), but the difference was not statistically significant. (Forssas et al. 1998a) In a study of unexplained foetal deaths several associations between social and lifestyle risks were found: high pre-pregnancy weight, low socioeconomic

status, fewer than four antenatal visits, primiparity or parity over three and maternal age over 40 years (Huang et al. 2000).

2.2.4.5 Need for neonatal intensive care

Treatment in neonatal intensive care units (NICU) makes possible the survival of very preterm and very low birth weight infants. The incidence of infants treated in NICU depends on the definition of intensive care and on the regionalisation of perinatal care (Zeitlin et al. 2004). In national records (STAKES Medical Birth Register 2006) treatment in intensive care ward has been separated from treatment in the observation ward. In Kuopio University Hospital statistics of these two units are not separated. During the 1990s, the trend for treatment in the NICU was increasing in whole country: from 3.5 % in intensive care and 4.2 % in observational care in 1991 to 5.1% and 6.2 % in 2000. (STAKES Medical Birth Register 2006)

2.3 Definition and magnitude of social and behavioural risks in pregnancy

Socio-economic elements associated with adverse pregnancy outcomes include not only social class, but also general working conditions, lifestyle, family status and psychosocial state together with current stressful life events.

2.3.1 Unmarried status as pregnancy risk

Pregnancy outside of marriage has been reported to be associated with higher incidence of preterm birth (OR 1.1–2.0), LBW infants (OR 1.3–5.7) and SGA infants (OR 1.2–2.4). The rates of foetal and neonatal death of children of unmarried women have also been reported to be higher, at ORs of 1.3–2.5. The risks of single mothers have been reported to be higher than

those in cohabiting women. (Hartikainen-Sorri and Sorri 1989, Peacock et al. 1995, Arntzen et al. 1996, Hanke et al. 1998, Bird et al. 2000, Zeitlin et al. 2002, Luo et al. 2004) Accordingly, conflicting results have been published, showing no increased risks in pregnancies of unmarried women. (MacDonald, et al. 1992)

It has been suggested that the additional risks of extramarital pregnancies are higher in societies where pregnancies outside marriage are uncommon. In a recent French study, a cut-off point of 20 % of births to unmarried mothers was suggested to divide societies into those with high risks of adverse pregnancy outcomes outside marriage and into those with no excess risks of pregnancies outside marriage (Zeitlin et al. 2002). A number of recent studies have suggested that the effect of marital status on pregnancy outcomes is becoming less important or totally disappearing, as marital practices change in the direction of more cohabiting unions instead of marriages (MacDonald et al. 1992, Vagero et al. 1999, Gissler et al. 2003). Furthermore, the effect of unmarried status on birth weight and perinatal deaths has been reported to have decreased in the past decades in Finland from relative risk of 1.82 in the 1960s to 1.29 in 1985. (Sipila et al. 1994)

2.3.2 Unemployment – individual or community level risk for perinatal health?

Unemployment in general is associated with a 30 % increased risk of morbidity and a 1.5-2.5-fold increased mortality (Mathers and Schofield 1998). In a review of 69 Medline database articles between 1980 and 1990, it was concluded that there is epidemiologic evidence that unemployment causes illness. Unemployed persons use more general health services, have more physical and mental health problems, have higher rates of overall mortality and death of cardiovascular disease, and even have a higher suicide rate than their employed peers (Jin et al. 1995). Additionally, a lower level of psychological well-being has been found (Bartley

1994). Furthermore, wives of unemployed men have been reported to share the ill health brought about by unemployment (Bartley 1994). Moreover, children in families with both parents being unemployed in Nordic countries have been reported to have a 1.35-fold higher prevalence of chronic illness, 1.67-fold higher prevalence of psychosomatic symptoms and 1.47-fold higher prevalence of low self-reported well being (Reinhardt Pedersen and Madsen 2002).

The influence on pregnancy outcome that unemployment in the family has is still controversial. Some investigators have shown associations of mothers' unemployment with a 1.2–1.8-fold increased risk of preterm delivery (Murphy et al. 1984, Hanke et al. 2001). Both parents' unemployment has been reported to be associated with a doubled risk of very preterm birth (Ancel et al. 1999). Furthermore, a 1.2-fold increased risk of low birth weight and a 1.3-fold increased perinatal mortality has been found in children of unemployed women (Murphy et al. 1984).

Other studies have shown no association: lifestyle variables, principally smoking, were the explanatory factor also in an Australian study of unemployment and preterm birth (Najman et al. 1989). The findings are consistent with those of the study of Henriksen et al., who first before adjustments found a crude OR of 1.5 (95 % CI 1.2–1.9) for SGA in unemployed women, but after large scale adjustments for socio-demographic variables and obstetric history, no significant association remained. (Henriksen et al. 1994). The effect of unemployment on reproductive health may also be on community level. During high unemployment, low birth weight has also been seen as the consequence of a societal level effect, in addition to individual effects, in unemployed families (Catalano, et al. 1999).

Only a few studies have involved investigation of the effect of unemployment of the father on pregnancy. Changes in maternal health behaviour have been found, including delayed

attendance to antenatal care, not attending classes for preparation for labor, not knowing the date of the last menstrual period, and smoking throughout pregnancy. Interestingly no association with low birth weight or preterm delivery was found. (Golding et al. 1986) Stein *et al.* found an association between paternal unemployment and low birth weight, which was mediated by low income (Stein et al. 1987).

In most studies in this field women are categorised as employed or non-employed (Murphy et al. 1984, Wildschut et al. 1997, Reinhardt Pedersen and Madsen. 2002). The situation is rather different in Finland, and unemployed status should be clearly separated from that of housewives, who are not entitled to unemployment benefits when they are not actively seeking a job.

Unemployment has been reported to be one of the most important predictors of alcohol use during pregnancy, along with young age, low educational level and single status (Leonardson and Loudenburg 2003). On the other hand, alcohol use was found not to be associated with unemployment in women in general in Finland in the 1990s during a major economic recession (Luoto et al. 1998).

2.3.3 Possible biological or social threats of pregnancies in teenage

The definition of young maternal age varies between studies, and several studies compare pregnancy outcome in different age groups of teenage mothers. The youngest teenage parturients under 15–17 years of age in different studies have been reported to have the highest risks of adverse preterm birth and low birth weight (Parker et al. 1994, Fraser et al. 1995, Amini et al. 1996, Olausson et al. 2001, Chandra et al. 2002). For women under 18 years old pregnancies have been reported to be associated with a 1.3 to 1.8-fold increased risk of pre-term birth (Meis et al. 1995a, Meis et al. 1995b, Olausson et al. 1997, Jolly et al. 2000)

a 1.2 to 1.9-fold increased risk of foetal growth restriction (SGA), a 1.3 to 1.7-fold increased risk of low birth weight infants (Fraser et al. 1995, Lao and Ho 1997, van der Klis et al. 2002), and a 1.2 to 1.8-fold increased risk of perinatal mortality (Olausson et al. 1999, van der Klis et al. 2002). In other studies, however, no increased risk has been reported in this age group (Satin et al. 1994, Amini et al. 1996, Hemminki and Gissle. 1996, Reichman and Pagnini 1997, Scanlon et al. 2000, Smith and Pell 2001). Furthermore, teenage parturients have been reported to have normal vaginal deliveries more often than adults, with half the risk of adults (OR 0.45–0.47) for operative vaginal delivery and emergency- and elective caesarean section (Jolly, et al. 2000).

There is controversy over whether the risks associated with teenage motherhood are attributable to biological factors, lifestyles or socioeconomic conditions (Satin et al. 1994, Amini et al. 1996, Reichman and Pagnini 1997). In this context, lifestyle includes maternal health behaviour, poor diet, smoking and alcohol use. It has been suggested that the adverse pregnancy outcomes in young women may be attributable to the lower than average social status of these women, not to young age per se (Seidman et al. 1990, Hemminki and Gissler 1996).

Chlamydia infections are common (14–29 %) in teenage girls (Burstein et al. 1998). In addition, changing or multiple partners are more common in teenagers than in adults. Also, a higher incidence of chorio-amnionitis has been reported, which may be the result of shorter cervical length typical of adolescence (Stevens-Simon et al. 2000, Stevens-Simon et al. 2002).

Furthermore, late booking and poor attendance has been reported at some perinatal clinics among teenagers (Fraser et al. 1995, Amini et al. 1996, Jolly et al. 2000, Chandra et al. 2002, van der Klis et al. 2002). This is not the case, however, in Finland: in 2001, the average number of maternity care visits during pregnancy was 17.3 in all pregnant women and as high

as 16.9 in teenagers. The average time of the first maternity care visit was at 9.7 weeks of pregnancy in all pregnant women and at 10.9 weeks of pregnancy in teenagers (STAKES Perinatal Statistics of Finland 2003).

2.3.4 Obesity – severe threat of future perinatal health

More than 20 % of all pregnant women in Finland are overweight. (Vehkaoja et al. 2006). During pregnancy overweight has been reported to increase maternal morbidity (Table 1.). The deliveries of obese women have been reported to be more often induced, and the mode of delivery more often caesarean section (Table 1.). A possible increase in the preterm birth rate is still controversial. Some studies show a 1.2-fold increased incidence (Table 1), whilst others have not (Kumari 2001, Sebire et al. 2001).

Furthermore, maternal overweight has been reported to be an independent risk factor associated with foetal death, showing a progressively increasing risk with increasing maternal weight. The effect of maternal weight on perinatal deaths has been investigated in only a few studies so far, and the causes of increased mortality are as yet undefined. Unexplained intrauterine deaths and foetal deaths due to placental dysfunction have, however, been reported to be overly presented as causes of foetal deaths in obese women. (Kristensen et al. 2005)

Moreover, obese and overweight women have been reported to have a higher risk of birth defects, including spina bifida (3.5-fold), omphalocele (3.3-fold), heart defects (2-fold) and multiple anomalies than women with BMI 18.5–24.9 (Watkins et al. 2003).

The results of earlier studies of gestational weight gain and pregnancy complications are controversial (Edwards et al. 1996, Stephansson et al. 2001), although excessive weight gain predisposes women to obesity-related problems after pregnancy. In a large review of

recommended pregnancy weight gain, excessive weight gain was associated with an almost doubled risk of large-for-gestational-age (LGA) infants and an increased risk of caesarean section related to BMI. (Abrams et al. 2000). A recent study showed a 1.8-fold increased risk of meconium aspiration, 1.5-fold increased risk of hypoglycaemia and 1.3-fold increased risk of low five-minute Apgar scores and doubled risk of being LGA among newborns when mother had excessive weight gain over 18 kg during pregnancy (Stotland et al. 2006). In a Finnish study, women with excessive weight gain of more than 20 kg had higher, but not significantly increased rates of caesarean sections and instrumental deliveries (Ekblad and Grenman 1992). A cohort study from the US showed, on the other hand, that obese women gain less weight than normal weight women. High weight gain was not associated with pregnancy complications, but weight gain under 3 kg increased the risk of SGA among normal weight and obese women (Edwards et al. 1996). A study of Swedish Medical Birth Register found no association between weight gain and risk of stillbirth (Stephansson et al. 2001)

Table 1. Results of earlier studies on overweight and obesity during pregnancy: pregnancy risk factors and outcomes							
	Bianco et al. 1989	Baeten et al. 2001	Sebire et al. 2001	Cedergren 2004	Usha Kiran et al.2004	Kristensen et al. 2005	Pooled Unadjusted OR (95 % CI)
n	11 926	96 801	287 213	621 221	8350	25 476	
Population	Hospital based data, 20-34 years old	Population based register data	Population based, maternity units	Population based register data	Population based data	Hospital based data	
Country	Israel	USA	UK	Sweden	UK	Denmark	
Pregnancy risks %							
Chronic hypertension	5.4		8.3				2.41 (2.33-2.49)
Gestational diabetes	14.2	3.8	2.2				2.39 (2.27-2.51)
Diabetes	7.3		0.6				1.83 (1.66-2.03)
Labour induction			20.8	13.7	36.0		2.01 (1.98-2.03)
Pre-eclampsia	13.9	10.6	1.1	2.9			1.95 (1.89-2.01)
Caesarean section	31.3	26.4	17.6	17.7	27.0		1.77 (1.75-1.79)
Pregnancy outcome %							
Preterm birth	10.1	6.1	6.6	5.6			1.23 (1.21-1.26)
LGA or >4000g*	18.2	15.5*	14.6	7.8	14.8*		2.50 (2.46-2.54)
Shoulder dystocia	1.6			0.3	1.5		1.93 (1.68-2.20)
Admission to NICU	13.1		5.8		3.8		1.12 (1.08-1.15)
Foetal death	0.5		0.58	0.53		1.2	1.81 (1.68-1.94)
Perinatal death				0.69		1.9	1.59 (1.46-1.74)
NICU = neonatal intensive care unit; LGA= large for gestational age, birth weight over 90th percentile							

2.3.5 Effect of prior induced abortions to future reproductive health

Overall, the effect of prior pregnancy terminations on subsequent pregnancy outcome remains controversial in the published literature. In a large systematic review of 71 MEDLINE publications on long-term consequences of induced abortion, including all studies of over 100 subjects between 1966 and 2002 this problem was assessed in detail. The strongest association was found with preterm birth. Typical of the inconsistency of published data on this subject, a 1.4-2.0-fold increased risk of preterm birth or low birth weight was found in 12 of the reviewed studies, and in the other seven, no association was found. (Thorp et al. 2003) A British study of 3000 women with prior induced abortion in 1980-81 was not included in the review, showing 1.35-fold increased risk of preterm delivery. (Pickering and Forbes 1985) Finnish data on this subject were included in a study of 10 European countries. No increased risk of preterm birth after induced abortion was found in Finland or countries with similar abortion rates. (Ancel et al. 2004)

Also, association with intrauterine growth retardation (OR 1.7) (Moreau et al. 2005) has been reported. However, other studies have found no association between prior pregnancy induced abortions and SGA. (Pickering and Forbes 1985, Henriet and Kaminski 2001).

Furthermore, placenta previa or late pregnancy bleeding has been reported to be more common in women with prior induced abortions (Ananth et al. 1997, Hendricks et al. 1999, Thorp et al. 2003, Moreau et al. 2005). On the other hand, other studies have found no association between placentation and previous abortions (Zhou et al. 2001). Ectopic pregnancies after induced abortions have also been studied. In the review by Thorp *et al.* (Thorp et al. 2003) the outcome was controversial. There was an association in nine studies, one of them even showing a dose-response-related effect: a 1.4-fold higher risk in women

with one prior induced abortion, and 1.9-fold with several prior induced abortions (Tharaux-Deneux et al. 1998). There was no association in seven studies.

2.3.6 Attendance depends on the accessibility of antenatal services

Antenatal care has been shown to have some unquestionable benefits to maternal health and pregnancy outcome (Villar and Bergsjo 1997, Villar and Khan-Neelofur 2000, Carroli et al. 2001, Vintzileos et al. 2002, Kunzel and Misselwitz 2003, National Centre for Women's and Childrens' Health 2003). The outcome of pregnancies among women giving birth at home and without any antenatal care for religious reasons has been reported to be associated with a three-fold higher risk of perinatal mortality and a hundred-fold higher risk of maternal mortality than the state-wide rates of the US (Kaunitz et al. 1984). An inverse association between the number of antenatal visits and adverse obstetric outcome has also been found. (Petrou et al. 2003) Pregnancy outcome in women under-attending antenatal care has been looked at only in few previous studies (Table 2.).

Most pertinent studies in this field, however, concentrate on the risk profile of women booking late or not booking at all to antenatal care. They have shown that the most common barriers to attendance at antenatal care in modern Western society are lack of insurance, low income, low educational level, low social class, unmarried status, ethnic origin of the woman, difficulties in obtaining appointments and long distances (McCaw-Binns et al. 1995, Delvaux, et al. 2001, Kupek et al. 2002). In the US accessibility to prenatal care has been reported to be worse overall, and late attendance is more common than in Europe, 21 % vs. 4 % (Buekens et al. 1993). Social inequality in access to perinatal health services has been acknowledged as crucial issue as regards health outcomes in a study of perinatal health indicators in Europe (Zeitlin et al. 2003).

Table 2. Pregnancy risk factors and relative risks (OR, 95 % CI) of adverse pregnancy outcomes of women with insufficient antenatal care

Pregnancy risk factors					
Study	McCaw-Binns *et al.*, 1995	Blondel *et al.*, 1998	Delvaux *et al.*, 2001	Kupek *et al.*, 2002	Herbst *et al.*, 2003
n, population	10,382 two months national cohort, register data	85,066 6 months hospital based cohort, clinical records (20 clinics)	21,722 Case-control, postpartum interview	17,765 two months cohort of nine maternity units, clinical records	8065 one month cohort of six hospitals, clinical records
Country	Jamaica	France	Ten European countries	England and Wales	USA
Inadequate antenatal care	4 %	1.1 %	5.9 %	7 %	10.2 %
Age < 18	1.7 (1.2–2.2)[2]	2.8 (1.2–6.6)[1]	3.7 (2.7–5.1)	2.5 (2.0–3.0)	NA
Unmarried	1.6 (1.1–2.2)	9.3 (6.0–14.3)[1]	3.1 (2.5–3.9)	NA	NA
Multiparous (> 4)	1.5 (0.9–2.4)	34.9 (15.7–77.8)[1]	4.3 (3.1–6.0)	NA	2.26 (1.76–2.90)
Unplanned pregnancy	2.8 (1.6–4.7)	NA	4.0 (3.3–4.7)	NA	NA
No health insurance	NA	7.6 (2.2–26.8)[1]	2.7 (2.1–3.4)	NA	7.67 (5.96–9.86)
Smoking	2.5 (1.8–3.4)	NA	NA	1.6 (1.4–1.9)[1]	NA
Alcohol consumption	0.7 (0.5–0.9)	NA	NA	NA	NA

Pregnancy outcome				
	Kaunitz *et al.*, 1984	Gissler *et al.*, 1994[3]	Blondel *et al.*, 1998	Herbst *et al.*, 2003
n, population	344 Register based study (religional minority, national obstetric statistics)	57,108 One year national cohort, register data	85,066 6 months hospital based cohort, clinical records (20 clinics)	8065 one month cohort of six hospitals, clinical records
Country	USA	Finland	France	USA
Preterm birth	NA	2.21 (1.95–2.51)[1]	5.8 (3.2–10.5)[1]	3.23 (2.62–3.99)
Low birth weight	NA	2.05 (1.74–2.41)[1]	2.6 (1.5–4.4)[1]	2.20 (1.72–2.79)
Admission to NICU	NA	1.56 (1.24–1.98)[1]	2.8 (1.9–4.1)	NA
Foetal death	3.6 (1.8–6.3)	NA	NA	NA
Perinatal death	2.7 (1.6–4.2)	1.87 (1.34–2.62)[1]	NA	NA
Neonatal death				3.63 (2.23–5.91)

[1] OR adjusted for confounding factors found in the study; [2] age under 20 years; NA = not applicable; [3] number of visits relative to gestational length

2.4 Accumulation of risks – complex interplay between independent and mediated factors

The key message of socioeconomic health research is the lower an individual's social status is, the worse health is. Health is determined by four aspects. One aspect is individual characteristics, for example, age and sex. These factors are both biological and social as regards social position and lifespan. Another aspect is lifestyle and health behaviour. A third aspect is social networks and support, which alter health behaviour and ability to maintain health. A fourth aspect is material and mental resources, specifically income, living conditions and education. (Lahelma E. 2000)

An individual's social position can not be defined by a single measure. The usual measures used in studies on this field are maternal and paternal education, employment and occupation, family income, place of residence, marital status and public financing of medical care. There is no uniform pattern in defining confounding factors. Each of these same measures has been used also as confounding factor in some analyses (Parker et al. 1994). Some studies have controlled for example smoking or marital status as a confounder, whereas others have not, (Parker et al. 1994, Hemminki and Gissler 1996) because they have judged these factors to be intermediate in the causal pathway between poor socioeconomic status and poor pregnancy outcome. Herewith, by definition, distinguishing confounding factors from mediating factors between social risk factors and ill health is difficult, if not impossible (Wilkinson and Pickett 2005)

Nevertheless, In a British study surveying 1988 health statistics low birth weight associated with low social status regardless of the indicator used. Associations with preterm delivery and SGA were found for at least one indicator of low socio-economic status. (Parker et al. 1994)

Furthermore, birth weight has been suggested to be a more sensitive indicator of the influence social circumstances has on pregnancy outcome than perinatal death. The effects on the incidence of SGA, preterm birth, perinatal death and low Apgar score have been reported to be less consistent. (Ericson et al. 1989, Seidman et al. 1990, Parker et al. 1994) The strongest mediating social factors to birth weight have been reported to be single motherhood, occupation and type of housing (Ericson et al. 1989).

Unmarried status may reflect other risk factors rather than being an independent risk factor and several mediating factors have been suggested. In general, married adults are in better health than unmarried adults. For example, unmarried women have a 1.5-fold higher mortality than married women (Waldron et al. 1996, Johnson et al. 2000). The mechanisms concerned can be divided into 1) selection: women who are in better health initially are more likely to marry, and 2) Protection of health: in particular, women who are not employed are in better health when married (Waldron, et al. 1996) Marriage increases social support and a stable marital situation is less likely to produce emotional stress than being single. In fact, the adverse impact of stress on pregnancy outcome has been well documented in previous studies (Hedegaard et al. 1993, Kurki et al. 2000, Tambyrajia and Mongelli 2000). On the other hand, the effect of stress related to unmarried status may be ameliorated by society's acceptance of births outside marriage (Zeitlin et al. 2002). In previous studies, at least some of the risks have been suggested to be the result of inadequate access to maternity care (Blondel and Marshall 1998, Zeitlin et al. 2002).

Another hypothesis is that marriage protects health by reducing risky sexual behaviour and infections during pregnancy. Specifically, unmarried status has been reported to be associated with a 2.5–1.9-fold increased risk of bacterial vaginosis (BV) (Kalinka et al. 2003), although sexual activity per se has not been found to increase the risk of bacterial vaginosis or preterm

birth (Kurki and Ylikorkala 1993). Protection is mediated also by increasing healthy behaviour via social behaviour and attitudes among traditional married families (Rutter and Quine 1990, Waldron et al. 1996). A limitation in studies concerning marital status and pregnancy outcome is that they are usually based on registration data that lack detailed description of confounding factors such as maternal illnesses, smoking, weight, alcohol consumption and employment (Holt et al. 1997, Bird et al. 2000).

Unemployment is a marker of socioeconomic status, and also is associated with stress, poor physical or mental health and chemical exposures like alcohol or cigarette smoke. Mediating factors of health consequences of unemployment are postulated to be psychosocial (Rutter and Quine 1990). Moreover, selection cannot be ruled out as a partial explanation: people who are unhealthy may be selected for low status occupations and thus be prone to become unemployed, so called healthy worker effect. (Bartley 1994, Mathers and Schofield 1998) Furthermore, the effect unemployment has on pregnancy has been suggested to vary according to frequency of unemployment. During high unemployment, adverse pregnancy outcomes may also be seen as societal effects in addition to the individual effects in unemployed families. (Catalano et al. 1999)

Teenage girls from lower socioeconomic background have a 1.3–1.6-fold higher risk of becoming pregnant (Vikat et al. 2002). The socioeconomic background probably also affects health attitudes during pregnancy. The complex interplay between socioeconomic circumstances, selection and protection, and pregnancy outcome is evident also in teenage pregnancies. (Vikat et al. 2002) Furthermore, most pregnancies (74–87 %) of adolescent girls are unintended. The corresponding figures for adults of different ages are 29–60 % (Vikat et al. 2002, Finer and Henshaw 2006). Unintended pregnancy as such increases the risk of adverse outcomes through increased stress levels that have been reported to be associated

with preterm birth through endocrine disturbances (Tambyrajia and Mongelli 2000) and through risky health behaviour, multiple partners and infections. (Finer and Henshaw 2006)

Overweight is a multi-factorial trait, since both environmental and genetic factors are known to contribute to its development. It has been estimated that up to 40–80 % of the variation in body weight is due to genetic factors. In refining the phenotype, the mechanisms of body weight regulation, adiposity, adipocyte metabolism and feeding behaviour have to be taken into account (Spiegelman and Flier 2001, Bray and Champagne 2005, Pagotto et al. 2005). Environmental factors reflect the individuals' health attitudes, since in developed countries, obesity is inversely associated with socioeconomic status among women. (Ball and Crawford. 2005)

The reasons for choosing to terminate a pregnancy are various, reflecting health attitudes and influenced by chronic illness, lack of social support, low socio-economic status and lack of resources. Unintended pregnancies have been reported to be highly over-presented among the lowest income group. The strongest determinants for choosing induced abortion have been reported to be marital status (single women have an 18–38-fold higher risk), age (increasing risk for both under 20 years old and over 35-years old) and parity (2-15-fold risk, growing with increasing parity compared with primiparous women) (Skjeldestad et al. 1994) However, even in the studies showing a positive association it is not clear whether or not there is a common risk factor or real biological causality.

The most common barriers to attendance at antenatal care in modern Western society are lack of insurance, low income, low educational level, low social class, unmarried status, ethnic origin of the woman, difficulties in obtaining appointments and long distances. (McCaw-Binns et al. 1995, Kupek et al. 2002). Because non-attendance is rare in Finland, the underlying causes are probably individual. Low social class probably plays a role also in our

conditions through attitudes and mental resources, but hardly through difficulties in accessibility or financial difficulties.

2.5 Trends in risk behavior and social reform

The social class of parturients in Finland has improved during decades. According to a cohort studied in northern Finland, comparing births of 1966 and 1985–86, in the 1960s 25 % of parturients belonged into the lowest social group, whereas only 14 % did so in the 1980s. High educational level has also become significantly more prevalent among parturients, from 4–5 % in the 1960s to 23–25 % in the 1980s. (Sipila et al. 1994) During the 1990s, diminishing social inequality in perinatal health was reported, based on the Medical Birth Register data, showing that differences in preterm births between high and low socioeconomic groups halved from 1991–93 to 1997–1999, the risk of LBW decreased from 1.5-fold to 1.3-fold and perinatal mortality decreased from 1.8-fold to 1.3 fold. (Gissler et al. 2003)

Cohabiting relationships have become more common and non-marital childbearing is no longer stigmatised in Western countries (Kiernan 1999, Bird, et al. 2000, Zeitlin et al. 2002). In the US, in 1995, 69 % of women giving birth were married, 12 % cohabiting and 19 % single, divorced, or widowed (Bird et al. 2000). In Europe differences in marital practices are still wide, with the rate of extramarital pregnancy ranging from over 40% in Scandinavia to under 10 % in Greece and Italy (Kiernan 1999). The trend towards being unmarried during pregnancy is increasing. In 1989 22.9 % and in 2001 39.2 % of pregnancies in Kuopio district were outside marriage; and a comparable change has taken place in all Western countries (MacDonald et al. 1992, Kiernan 1999, Luo et al. 2004)

Figure 1. Live births outside marriage as % of all births: trends in Europe and in Finland (Eurostat yearbook 1999)

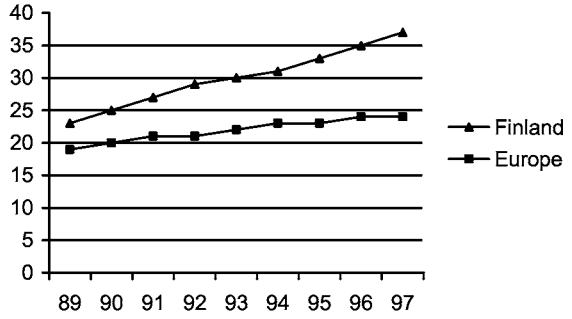
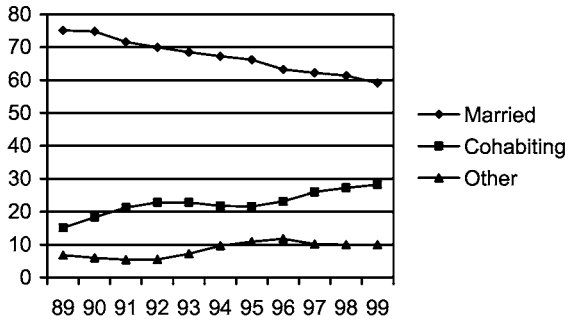


Figure 2. Trends in marital status in Finland (STAKES 2000)



The unemployment rate of women in childbearing age in the Kuopio district varied between 3.0 % and 15.1 % from 1990 to 2000, whereas the equivalent figures for Finland varied between 3.2 % and 16.6 %. The economical depression that was experienced in Finland in early 1990s can readily be seen in the numbers of unemployed women. (STAKES 2000)

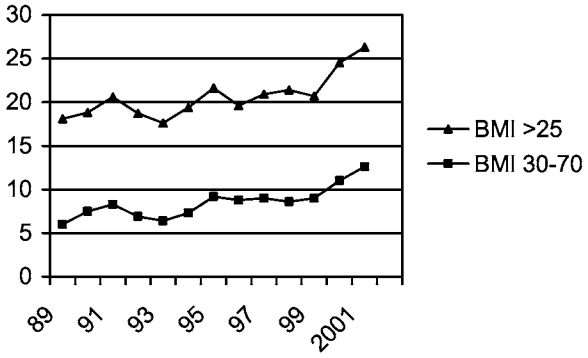
Teenage pregnancy and induced abortion rates more than halved from 1970s to 1990s in Finland. However, the favourable development stopped in mid 1990s. From 1994 to 1997 the teenage pregnancy rate remained at the same level, and the abortion rate slightly increased. (STAKES Perinatal Statistics of Finland 2003, Tilastokeskus 2006) The socio-demographic differences in the occurrence of teenage pregnancies have been found to persist over time

regardless of the overall decrease in the number of teenage pregnancies: adolescents of low socioeconomic background still have a higher risk of becoming pregnant. (Vikat et al. 2002)

Teenage birth rates (births per 1000 adolescent 15–19 years) differ greatly between countries. The teenage birth rate in Finland varied from 11.9 births per 1000 women in 1989 to 9.1 in 1997. (STAKES. 2000) In the 1990s, the rate was high in the US, 54/1000, as compared with the rates in Canada, 42/1000, and the UK, 28/1000. The corresponding rate in Sweden and Denmark was 8/1000, in France 10/1000, in Germany 12/1000 and in Norway 14/1000. Japan had the lowest teenage birth rate in industrialised countries, 4/1000. (Singh and Darroch 2000, STAKES Perinatal Statistics in the Nordic Countries 2005)

An increasing trend of obesity has been reported. In 1987, 17.9 % of parturients were overweight (BMI >25 kg/m^2), whereas the corresponding number was 27.8 % in 2002 (Vehkaoja et al. 2006). A similar increase in the prevalence of maternal obesity has been reported in other European countries and in the US (Cnattingius et al. 1998, Lu et al. 2001).

Figure 3. Trends in BMI among pregnant women in Kuopio University hospital



At the same time the proportion of pregnant women older than 35 years rose from 13.9 % to 18.4% and the mean maternal age at delivery from 29.1 years in 1990 to 29.9 years in 2000

(STAKES Perinatal Statistics of Finland 2003), possibly contributing to the increased incidence of obesity during pregnancy.

The overall rate of induced abortions is low compared with other countries, i.e. 157/1000 live births, whereas the same ratio in Sweden is 304/1000, in Italy 260/1000, in the Czech Republic 503/1000 and in the USA 230/1000 (Thorp et al. 2003). The highest ratio worldwide has been reported in Russia (1888/1000). The reliability of registering the actual numbers varies between countries (Thorp et al. 2003). Since in Finland induced abortion is legal and virtually all pregnancy terminations are performed at public hospitals, all cases are reported to the Register on Induced Abortions, and the data can be considered highly reliable. Recently, the proportion of medically induced abortions, using misoprostol and mifepristone, has grown from 3 % in 1999 to nearly 30 % in 2003. During the study period of the present study (1989–2001), however, the method used to induce abortions was mainly surgical vacuum aspiration or curettage in the first trimester and medical induction in the second trimester. Of all induced abortions, 94% were performed in the first trimester of pregnancy. The main reason for induced abortion are social in 73.7–85.8 %, medical (maternal disease or medication) in 0.1–1.1 %, ethical (criminal issues) in 0–0.1 %, age under 17 in 3.7–7.5 %, age over 40 in 3.9–7.7 %, more than four previous children in 1.6–2.0 %, foetal malformation in 1.5-2.2 % and limited ability to take care of children in 0 % of cases. (STAKES Perinatal Statistics of Finland 2003)

The use of maternity services in Finland has increased from 92 % in 1966 to nearly full attendance to 99.8 % in 1985 (Sipila et al. 1994). Over the last three decades the attendance has, however, remained practically unchanged: in 1977 0.04 % of women had no antenatal care visits, and 1.4 % had 1-5 visits. (Lääkintöhallituksen vuosikirja 1974-80 1980)

3 AIMS OF THE STUDY

The aims of this study were:

1) To assess the risk factors and outcome of pregnancy in the growing numbers of births outside marriage in the 1990s.
2) To assess the effects of unemployment in the family on obstetric risk factors and pregnancy outcome.
3) To assess the relationship of young age (under 18 years) of the mother with pregnancy risk factors and adverse pregnancy outcomes.
4) To assess the impact of pre-pregnancy overweight on pregnancy and delivery complications and outcome.
5) To assess the effects of prior induced abortions on obstetric risk factors and pregnancy outcome.
6) To assess the outcome of pregnancies when antenatal care has been inadequate.

4 MATERIAL AND METHODS

4.1 Kuopio University Hospital Birth Register

This study uses information of Kuopio University Hospital Birth Register, which is a computerised database containing information on maternal characteristics, pregnancy characteristics, pregnancy complications and outcome and information of the newborn until age of seven days for all treated pregnancies proceeding beyond 22nd week of pregnancy. Data collection was started in April 1989 and was completed in the end of year 2001, before beginning of this thesis work. In addition to information required for the national Medical Birth Register (STAKES Medical Birth Register 2006), the database includes a large quantity of information used for clinical purposes.

The validity of the data has manually been checked for some specific pregnancy complications, such as perinatal deaths, velamentous umbilical insertions, umbilical cord knots and placental abruptions (Heinonen et al. 1996, Airas and Heinonen 2002, Toivonen et al. 2002).

4.1.1 Data collection

Information on maternal characteristics was based on data from self-administered questionnaires at approximately 20 weeks of pregnancy, returned to maternity centers by 22 weeks of pregnancy and added manually to the database (Appendix). These data were complemented by information from the women's maternity case notes that they carry with them, and by nurse interviews at visits or at delivery in Kuopio University Hospital. The questionnaire consists of 75 items, concerning marital status, employment, previous operations, illnesses, obstetric history, contraceptive use, smoking, alcohol consumption and

paternal characteristics. Information on maternal age and civil status was updated from the patient register of Kuopio University Hospital and analysed at birth. Information on pregnancy complications, pregnancy outcome and the neonatal period was collected in real time, during delivery and neonatal care from clinical records and electronically filed in a systematic manner as a part of clinical work by the nurses and midwives taking care of delivery and neonatal care. The Institutional Review Board has approved the study. The childbearing women gave informed consent at the time of data collection. The ethical committee has approved the database and given permission for using it for research purposes. The data were processed anonymously.

4.1.2 Study population

The total pregnant population had 27,776 deliveries during the study period. Exclusion criteria were: 1) multiple pregnancies (n = 484–548 in different studies) and 2) major foetal structural anomalies (n = 256–275 in different studies), because such pregnancies carry an unusually high risk of adverse outcome. In each study, cases with unknown status of risk factor of interest were excluded. The numbers in different studies varied from 23,614 to 26,967 pregnancies. The numbers of subjects included in the analyses of each study are shown in Table 3.

Delivery outside hospital was rare (n = 20, 0.07 % of all deliveries). The neonatal period in these cases was treated in Kuopio University Hospital.

Table 3. Number of deliveries in different studies[a]				
Study	Study groups	*n*	Reference group	*n*
I	1. all unmarried	8235	married	17138
	2. subgroup, cohabiting	6147		
	3. subgroup, single	2088		
II[b]	1. mother unemployed	3388	employed	18963
	2. father unemployed	1551		
	3. both parents unemployed	1037		
III	teenagers under 18 years	185	adults	26 782
IV	1. overweight	3388	normal weight	20 333
	2. obese	1880		
V	1. one induced abortion	2364	no induced abortions	24 248
	2. two or more abortions	355		
VI	1. 1–5 visits at antenatal care	207	6–18 visits at antenatal care	23 137
	2. no visits at antenatal care	270		

[a]single births without major anomalies; [b]until year 1999

4.2 Definitions

4.2.1 Maternal risk factors

The incidences of maternal socio-demographic risk factors in the obstetric cohort are shown in Table 4 (on page 59). Teenage was defined as age under 18 years at birth. Women aged over 35 years at birth were considered old parturients. Unmarried status was defined as any civilian status other than marriage (including cohabiting, single, widowed and divorced women). Unemployment status was asked in the questionnaire as *yes/ no*. Housewives were grouped with employed women, because they were recorded separately concerning the quality

of work in the questionnaire. Changes in employment status during the course of pregnancy were not recorded and are, therefore, not available in the database. Educational attainment was divided into three categories: high, average and low, according to the women's own evaluation.

Health behaviour and diseases as pregnancy risk factors were asked in the questionnaire: The woman was considered a smoker when she smoked 5 cigarettes or more per day during pregnancy (Spira et al. 1977, Wisborg et al. 1996). Changes in the smoking habit were not recorded to the database. Alcohol use was recorded as *yes/ no* in the questionnaire before pregnancy and at 20 weeks of pregnancy. Illicit drug use was marginal in Kuopio district during the study period, and it was not asked. Overweight was defined, according to international limits, as BMI (body mass index, kg/m^2 analysed as integers 26–70) over 25, calculated from reported pre-pregnancy weight, and obesity as BMI at or over 30. Underweight condition was defined as BMI less than 20. Low weight gain was defined as less than 7000 g gain during pregnancy. Maternal diabetes was defined as insulin-treated diabetes during pregnancy. Chronic hypertension was self reported as a multiple choice concerning maternall illnesses in the questionnaire. Other chronic diseases were conditions requiring regular medication that has possible effect on pregnancy, specifically, thyroid disease, arthritis, epilepsy and heart and kidney diseases.

Obstetric history of women was recorded as follows. Parity was handled as separate dichotomous variables: primiparity and grand multiparity (defined having over 7 previous deliveries). Previous miscarriage was defined as the loss of pregnancy before 22 weeks gestational age. Intrauterine foetal death was considered when foetal death occurred after 22 weeks of pregnancy. Prior induced abortion was defined as the medical or surgical abortion of

a viable foetus. IUD as a preventive method was also considered as a risk factor. Prior caesarean section or other major surgery scarring the uterus was recorded.

4.2.2 Pregnancy characteristics and complications

Estimation of gestational age was based on the date of the last menstrual period unless there was discordance of more than seven days with first trimester ultrasound measurement at 10-13 weeks of gestation, or more than 14 days with second trimester ultrasound measurements. Approximately 95 % of pregnant women underwent ultrasound examination, as published earlier (Heinonen et al. 2001).A gestational age of 42+0 weeks or more was used as the definition for prolonged pregnancies. Pre-eclampsia was defined as repeated blood pressure measurement exceeding 149/90 mmHg in at least two separate measurements four hours apart with proteinuria exceeding 0.5 g/day. Low haemoglobin was defined as under 100 g/l in the third trimester of pregnancy. Chorio-amnionitis was registered when this obstetric diagnosis was set during the hospital stay. Rh-immunisation was recorded also based on registered diagnosis.

The delivery inductions were performed using prostaglandins (Cytotec®, Prostin®) or intravenous oxytocin, or by amniotomy. Meconium staining of the amniotic fluid during delivery was marked in the delivery reports and to the database by midwives. The mode of delivery was registered to the database as spontaneous, instrumental (vacuum extraction, or in exceptional cases forceps), or caesarean section.

4.2.3 Pregnancy outcome

The following definitions for adverse pregnancy outcomes were used: Infants were considered small for gestational age (SGA) when the age- and sex-adjusted birth weight was

below the tenth percentile according to the normal tables for our population (Heinonen, et al. 2001). Low birth weight (LBW) was defined as a birth weight less than 2500 g. Preterm birth occurred when the delivery was before 37 weeks of gestation. Iatrogenic preterm deliveries were included in this category. Information on spontaneous preterm deliveries was not collected separately. Apgar scores were given mainly by midwifes in uncomplicated deliveries and by paediatricians, when consulted, and were considered low when the scores were less than 7 at the age of one minute and at the age of five minutes. The pH limit used for foetal acidosis was 7.15 at birth in the umbilical vein. Abnormal CTG was recorded to the database by obstetricians. The admission rate to the neonatal intensive care unit (NICU) was recorded as infants requiring more than 24 hours surveillance. Neonates needing only observation are also treated in the NICU in our hospital.

Foetal death was defined as intrauterine death of a foetus after the full 22 gestational weeks or birth weight of 500 g or more. Early neonatal death was considered as death during the first seven days after birth. Perinatal death is by definition the combination of foetal- and early neonatal death.

4.3 Statistical analyses

4.3.1 Univariate models

Statistical differences between the subjects and the reference group in the maternal demographic and obstetric background factors, maternal health behaviour and diseases were evaluated by using Chi-square tests. A value of $p<0.05$ was considered statistically significant. Fisher's exact test was applied when the minimal estimated expected value was less than five. Continuous variables were analysed by using two-tailed, pooled *t* tests.

Unadjusted odds ratios for each pregnancy outcome were calculated by using Microsoft Excel, without any control for confounding factors. These results have been published in the original articles I, II, V and VI. They were not included in the analyses of publications III and IV.

4.3.2 Multivariate models

Possible confounding variables were identified from background data on a purely statistical basis. Significant or nearly significant effects ($p < 0.1$) of lifestyle variables concerned in this study on pregnancy outcomes were assessed in multiple logistic regression analyses (BMDP, and in analyses conducted after 2004, SAS for Windows, SAS release 8 statistical package). All independent variables were modelled as categorical terms and were entered simultaneously to the model. The logistic regression analyses were performed separately for each outcome. Confidence intervals were evaluated at 95 %.

5 RESULTS

5.1 Maternal background factors

5.1.1 Demographic risk factors

Maternal demographic risk factors, specifically age under 18 or over 35 years, unemployment and unmarried status were significantly more prevalent in most of the study settings than in the reference population in each study. Whether or not an individual had several simultaneous demographic risks was not investigated in this study. Table 4 shows the distribution of demographic risk factors in the obstetric cohort after exclusions and in each study group.

Table 4. Demographic risk factors: prevalences in different studies								
Population in different studies	Risk factor							
	Age < 18 years		**Age > 35 years**		**Unmarried**		**Unemployed**	
	n	%	n	%	n	%	n	%
Unmarried mothers[I]	157	1.9***	836	10.2***	-	-	2022	24.6***
Unemployed mothers[II]	43	1.3***	269	7.9***	1453	43.1***		
Teenage mothers[III]	-	-	-	-	157	84.9***	65	37.6***
Overweight mothers (BMI 26-29 kg/ m^2)[IV]	9	0.3***	552	16.3***	1078	31.8*	613	18.1*
Obese mothers (BMI 30-70 kg/ m^2)[IV]	3	0.2**	299	15.9***	617	32.8	417	22.2***
Mothers with one induced abortion[V]	14	0.6	281	11.9	1240	52.5***	592	25.0***
Mothers not attending antenatal care[VI]	5	1.9*	38	14.1	125	46.3***	45	16.7*

*p<0.05, **p<0.01, ***p<0.001 statistically significant difference compared with the reference population [I]married, [II]employed, [III]adults, [IV]normal weight, [V]no induced abortions, [VI]average attendance of 6-18 visits

5.1.2 Obstetric risk factors

Prior obstetric history as a maternal risk factor in the analyzed obstetric population and in different study groups is shown in Table 5. Also in this aspect, mothers in different study groups varied significantly from their references for most variables. Grand multiparity was found to be a rarity. Teenage mothers were a very different group as regards obstetric history, due to their short fertile period. Interestingly, however already 8.1 % of them had a history of induced abortion. Overweight women had overall the most adverse obstetric history. Women not-attending antenatal care had no statistically significant differences in their obstetric history compared with women attending antenatal care as recommended.

Table 5. Obstetric background: prevalences in different studies												
Population in different studies	Risk factor											
	Primiparity		**Grand multiparity**		**Prior miscarriage**		**Prior fetal death[a]**		**Prior induced abortion**		**Prior uterine surgery**	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	n	%
Unmarried mothers[I]	4614	56.0***	1	0.01 NA	1080	13.1***	107[a]	3.0***	1186	14.4***	638	7.8***
Unemployed mothers[II]	1976	41.7	2	0.06***	582	17.2	65	1.9	422	12.5***	366	10.8
Teenage mothers[III]	171	92.4***	0	0***	5	2.7***	1	0.5	15	8.1	1	0.5***
Overweight mothers[IV] (BMI 26–29 kg/ m^2)	1117	33.0***	28	0.8***	682	20.1***	93	2.7***	390	11.5**	507	15.0***
Obese mothers[IV] (BMI 30–70 kg/ m^2)	571	30.4***	11	0.6*	373	19.8***	64	3.4***	243	12.9***	289	15.4***
Mothers with one induced abortion[V]	891	37.7***	0	0**	544	23.0***	60	2.5***	-	-	274	11.6
Mothers not attending antenatal care[VI]	118	43.7	1	0.4	45	16.7	4	1.5	21	7.8	NA	

*[a] of parous women; *p<0.05, **p<0.01, ***p<0.001 compared with reference population of each study [I]married, [II]employed, [III]adults at or over 18 years, [IV]normal weight, [V]no induced abortions, [VI]average attendance of 6–18 visits; NA = not applicable*

5.1.3 Health behaviour and chronic diseases

Current diseases and health behaviour during pregnancy are shown in Table 6. Smoking and overweight were more prevalent in most of the study groups than in general. Women not-attending antenatal care were as regards health behaviour and illnesses very similar with general obstetric population. Overweight women were found to have the poorest health of all women studied. Unemployed women and women with a history of pregnancy termination had the least favourable health habits.

5.2 Pregnancy and delivery complications

The significant differences of pregnancy characteristics and complications in different study populations of single pregnancies without major structural anomalies compared with the reference population of each study are listed in Table 7.

Table 6. Health behaviour and chronic diseases: prevalences in different study populations

Population in different studies	Risk factor											
	History of infertility		**BMI >25**		**Smoking during pregnancy**[a]		**Using alcohol during pregnancy**		**Diabetes**		**Essential hypertension**		**Other chronic diseases**[b]	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Unmarried mothers[I]	295	3.6***	1686	20.5	939	11.4***	302	3.7	241	2.9**	159	1.9	462	5.6*
Unemployed mothers[II]	NA		872	25.7*	320	9.5*	152	4.5*	94	2.8**	73	2.2	209	6.2
Teenage mothers[III]	NA		12	6.9***	35	18.9***	2	1.1	0	0**	2	1.1	12	6.5
Overweight mothers[IV] **(BMI 26-29 kg/ m^2)**	210	6.2			251	7.4***	127	3.8	182	5.4***	100	3.0***	237	7.0***
Obese mothers[IV] **(BMI 30-70 kg/ m^2)**	130	6.9*			144	7.7***	67	3.6	189	10.1***	99	5.3***	197	10.5***
Mothers with one induced abortion[V]	85	3.9***	547	24.2***	269	11.4***	93	3.9***	61	2.6	56	2.4	174	7.4**
Mothers not attending antenatal care[VI]	16	5.9	47	22.2	23	8.5	10	3.7	5	1.9	3	1.1	12	4.4

*p<0.05, **p<0.01, ***p<0.001 statistically significant difference compared with the reference population in each study [I]married, [II]employed, [III]adults at or over 18 years, [IV]normal weight, [V]no induced abortions, [VI]average attendance of 6-18 visits;NA= not applicable, [a]over 5 cigarettes per day; [b]heart disease, kidney disease, arthritis, thyroid disease, epilepsy; [c]single pregnancies without major structural anomalies

Table 7. Pregnancy and delivery complications: occurrences in different studies														
Population in different studies	Risk factor													
	Pre-eclampsia		**Late pregnancy bleeding/ placental abruption**		**Chorio-amnionitis**		**Labour induction**		**Instrumental delivery, forceps or vacuum**		**Cesarean section**		**Meconium stained amniotic fluid**	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Unmarried mothers[I]	268	3.3	119	1.5	134	1.6*	NA		591	7.2	1470	17.9	NA	
Unemployed mothers[II]	101	3.0	32	0.9	51	1.5	640	18.9***	190	5.6	531	15.7*	385	11.4
Teenage mothers[III]	6	3.2	1	0.5	7	3.8**	29	20.4	13	7.0	24	13.0	14	7.7
Overweight mothers[IV] (BMI 26-29 kg/ m^2)	138	4.1***	41	1.2	57	1.7*	765	27.7***	177	5.2	656	19.4***	422	12.8***
Obese mothers[IV] (BMI 30-70 kg/ m^2)	117	6.2***	25	1.3	41	2.2***	527	34.0***	89	4.7*	462	24.6***	260	14.3***
Mothers with one induced abortion[V]	86	3.6	50	2.1*	49	2.1**	441	23.7**	120	5.1	425	18.0	273	11.8
Mothers not attending antenatal care[VI]	10	3.7	12	4.4***	13	4.8***	NA		NA		63	23.3**	28	11.0

*p<0.05, **p<0.01, ***p<0.001 statistically significant difference compared with the reference population in each study [I]married, [II]employed, [III]adults at or over 18 years, [IV]normal weight, [V]no induced abortions, [VI]average attendance of 6-18 visits;NA= not applicable

5.3 Pregnancy outcomes

Unadjusted ORs of pregnancy outcomes are documented in the original publications. Independent associations were considered when logistic regression analysis controlling for possible confounding factors showed a 95 % confidence interval over 1 and when inversely associated, less than 1. The independent associations are shown in the end of this chapter and in Figure 4 and Tables 8 and 9. Overall, the relative risks changed little in the multivariate analyses.

5.3.1 Small for gestational age infants

SGA was found in 2592 of the singletons without major structural anomalies. The occurrence of SGA was statistically significantly increased in some study groups compared with their references: 12.1 % in unmarried, 11.6 % in cohabiting women and 13.3 % in single women. In families where mother was unemployed, 10.8 % of infants were SGA, 9.2 % when father was unemployed and 14.0 % when both parents were unemployed. Of infants of teenage women 14.0 % were SGA. On the other hand, the amount of SGA was lower among overweight (7.1 %) and obese women (8.0 %) than in normal weight women.

These associations were partly explained by confounding factors. The independent associations are summarised in Figure 4 and Table 9 (on page 69-70). In the logistic regression analysis the association of unmarried status and SGA changed from a moderately increased (unadjusted OR 1.48) to a slightly (1.1-fold) increased risk. The subgroup of cohabiting women was found to have a similarly, 1.1-fold increased risk of SGA.

In unemployed women, only a small attenuation in the ORs for SGA were seen in the multivariate analyses, more markedly in the group where both parents were unemployed

(unadjusted OR 1.69, adjusted OR 1.43). An additional logistic regression analysis on SGA in unemployed families was performed for this thesis, because low weight gain and anaemia, which were overly represented in unemployed families, were not included in the original analyses. As a result, in families where mother was unemployed the OR decreased from 1.26 to 1.18 (95 % CI 1.02–1.36), remained unchanged when the father was unemployed, and increased from 1.43 to 1.75 (95 % CI 1.42–2.16) when both parents were unemployed. Prior induced abortions had no effect on the occurrence of SGA.

5.3.2 Preterm delivery

The occurrence of preterm birth was 6.2 % in the studied pregnant population of singletons without major foetal anomalies. The percentage was significantly higher than average in most study groups: 6.7 in unmarried women, 6.5 in overweight women, 7.9 in obese women, 7.4 in women with prior abortions and 25.2 in women not attending antenatal care.

However, in logistic regression analyses after controlling for confounding factors most of these associations were not significant. However, the women not attending antenatal care had a 3.79-fold higher risk of preterm delivery independently of confounding risk factors. Unmarried status was also found to independently increase the risk for preterm birth 1.15-fold; the risk of preterm birth was similarly1.15-fold higher in cohabiting women, and 1.29-fold higher in single women than in married women. The excess numbers of preterm births in the different study groups are listed in Table 8.

5.3.3. Low Apgar score

The incidence of Apgar scores under 7 at the age of five minutes was 1.9 % (*n*= 517) among the newborns. A low Apgar score at five minutes was found to be more common among newborns of the teenage mothers (3.2 %) and overweight (2.5 %) and obese mothers (2.6 %), and much more common in newborns of mothers who did not attend antenatal care (11.0 %). After controlling for confounders, the newborns of the overweight women were found to have a 1.54-fold higher risk and obese women a 1.64-fold higher risk for low Apgar scores. Not attending antenatal care was associated with a 4.5-fold higher risk of low Apgar scores.The excess of children with poor Apgar scores in the obstetric groups compared with their references, calculated per 10 000 births, are listed in Table 8.

5.3.4 Admission to neonatal intensive care unit

In all, 8.2 % of the infants (*n* = 2197) needed surveillance in NICU. Infants of unmarried women had a significant excess incidence of needing NICU treatment (9.2 %), and the excess risk was nearly the same for cohabiting (9.0 %) and single women (9.8 %). In multivariate logistic regression analyses, a 1.15-fold higher risk for NICU treatment was found in unmarried and cohabiting women.

Teenage women had no excess of NICU-treated infants (5.4 %) compared with the reference population. Maternal overweight (9.7 %) and obesity (12 %) were independently associated with 1.20-fold and 1.38-fold increased risk of infant treatment in the NICU, respectively.

5.3.5 Perinatal death

Perinatal death occurred in 0.6 % (115 intrauterine foetal deaths and 54 neonatal deaths) of the singletons without major foetal anomalies. In the entire obstetric population, the incidence was 0.8 %. When compared with the reference group in each study, the incidence of perinatal death was significantly increased in obese women (1.1 %) and in women not attending antenatal care (5.2 %). When adjusting for confounding factors, obese women were found to have a 2.19-fold higher risk of prenatal death. For women not attending antenatal care, the adjusted OR was calculated for the original publication separated as foetal and early neonatal deaths. Multivariate analyses showed a 3-fold higher risk of foetal death and 5.9-fold higher risk of neonatal death.

5.3.6 Adjusted risks

In this study 2592 infants were born SGA, 1663 preterm, 2197 were admitted to NICU, 517 had Apgar score under 7 at the age of five minutes and 169 infants died perinatally. Table 8 lists the excess cases of adverse outcomes calculated per 10,000 births. One case can be listed attributable to several social or health behavioural risks, for which reason the excess of cases cannot be summated.

Table 8. Estimate of excess cases of adverse obstetric outcomes compared with reference population in each study, calculated per population of 10,000 single births

	SGA	Preterm delivery	Apgar score <7 at age of 5 minutes	Admission to NICU	Foetal death	Perinatal death
Cases / 10,000 births	960	620	190	820	40	60
Unemployed mothers 13.6 %	15					
Both parents unemployed 4.2 %	17					
Overweight mothers 13.2 %	-32	3	7	29		2
Obese mothers 7.3 %	-11	11	5	33	2	3
Teenage mothers 0.7 %	3					
Unmarried mothers 32.5 %	75	15		52		
Mothers with prior induced abortions 10.1 %		11				
Mothers not attending antenatal care 1.0 %		15	9		2	4

NICU = neonatal intensive care unit; SGA =small for gestational age infants

Figure 4. Independent risks of adverse obstetric outcomes in different study populations

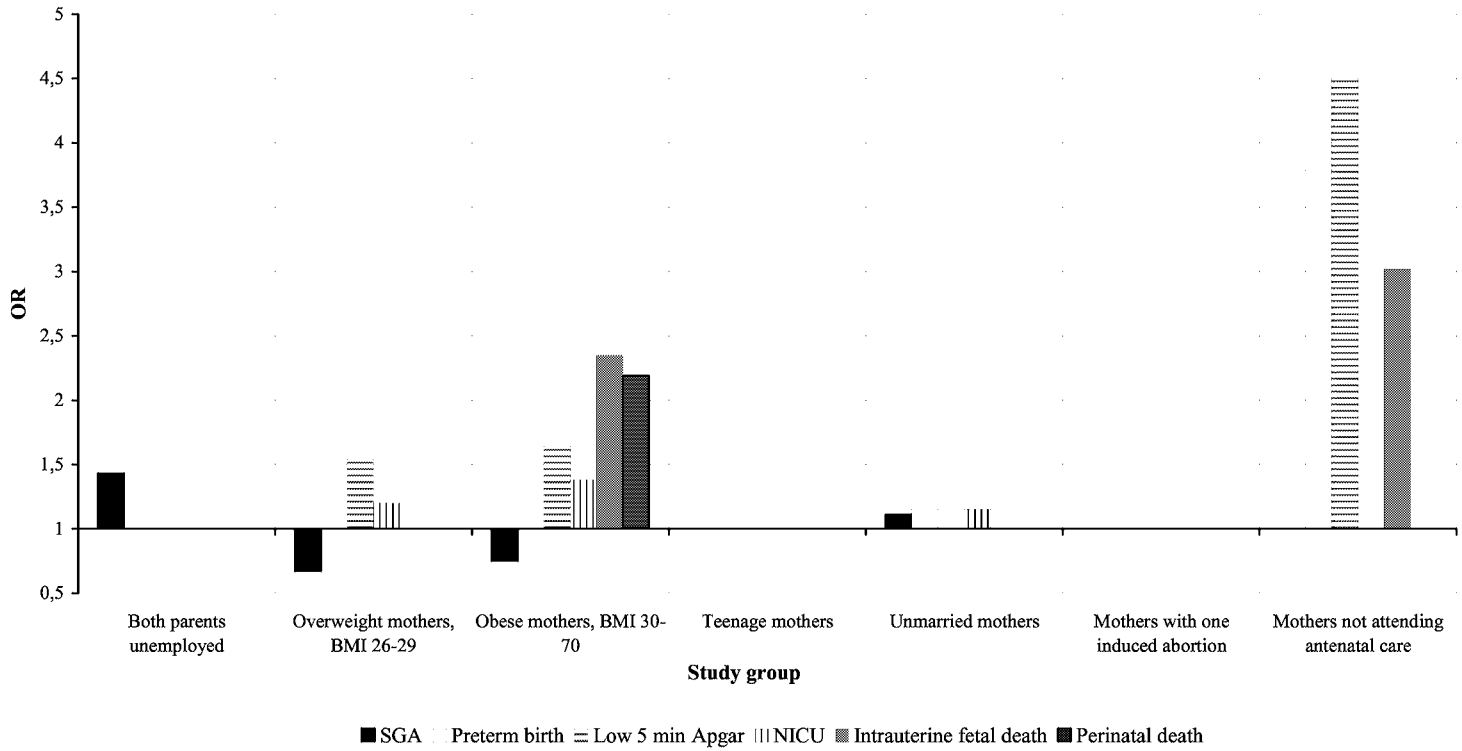


Table 9. Adjusted odds ratios (95 % confidence intervals) of adverse obstetric outcomes in different study populations							
	Both parents unemployed (n = 1037)	Overweight mothers, BMI 26-29 (n = 3388)	Obese mothers, BMI 30-70 (n = 1880)	Teenage mothers (n = 185)	Unmarried mothers (n = 8235)	Mothers with one induced abortion (n = 2719)	Mothers not attending antenatal care (n = 270)
Small for gestational age infants	**1.43 (1.18–1.73)**	**0.67 (0.58–0.77)**	**0.75 (0.63–0.90)**	0.91 (0.59–1.41)	**1.11 (1.02–1.22)**	0.96 (0.83–1.11)	0.79 (0.51–1.22)
Preterm birth	0.99 (0.77–1.29)	1.02 (0.87–1.20)	1.12 (0.92–1.36)	1.14 (0.64–2.02)	**1.15 (1.03-1.28)**	1.13 (0.94–1.35)	**3.79 (2.72–5.27)**
Low 5-min Apgar score	0.79 (0.58–1.08)	**1.54 (1.20–1.98)**	**1.64 (1.22–2.28)**	1.53 (0.62–3.78)	1.01 (0.83–1.24)	1.12 (0.81–1.55)	**4.50 (2.92 – 6.96)**
Infant admission to neonatal intensive care	1.0 (0.78–1.27)	**1.20 (1.06–1.37)**	**1.38 (1.17–1.61)**	0.61 (0.32–1.16)	**1.15 (1.05–1.27)**	0.98 (0.83–1.16)	0.99 (0.65–1.53)
Perinatal death	NA	1.54 (0.98–2.42)	**2.19 (1.33–3.62)**	NA	0.98 (0.69–1.39)	0.97 (0.53–1.78)	NA
Intrauterine foetal death	1.0 (0.36–2.79)	1.54 (0.88–2.68)	**2.35 (1.28–4.32)**	NA	0.93 (0.61–1.42)	NA	**3.02 (1.20–7.57)**

6 DISCUSSION

6.1 Importance of the present study

Public health strategies aiming to improve perinatal health are based mainly on identifying population groups having adverse pregnancy outcomes. Low socio-economic status and adverse maternal health behaviour are classically recognised as pregnancy risks, and the effect of antenatal care has been reported to be highest in socially disadvantaged pregnant patients. Additionally, the effect of perinatal health extends across generations, and the consequences of decisions made today are still seen after decades. However, changes in society, population heath, attitudes, health consciousness and maternity benefits may have changed the significance of these factors in obstetrics. Easily accessible and antenatal care with almost universal attendance presumably limits or removes the effects on social status and health behaviour have on pregnancy outcome. Therefore, the aim of this study was to identify social and health behavioural risk groups needing tailored antenatal care.

6.2 General aspects of the study

This study was made up of a large cohort of pregnant women having 27,776 deliveries during twelve years (1989–2001) at Kuopio University Hospital. Virtually all (99.9 %) deliveries took place in the hospital, providing the database with full coverage of the population coming from all socio-economic groups. On the other hand, the population in Kuopio District may differ from the average Finnish obstetric population as regards social background, because Kuopio is a university town with a higher educational level and more students with lower income. Furthermore, a possible source of bias is that our hospital serves as a tertiary referral centre, and some adverse outcomes may be overly presented. Overall, the estimation of the effect of referral on the results is difficult, because the database used in the current study does

not contain comprehensive information on patient referral. Four central and two local hospitals in Kuopio University Hospital district refer obstetric patients also to other university clinics according to the clinical indications. Also in rare cases patients of Kuopio University Hospital are referred to other tertiary centres. Furthermore, the local hospitals served as obstetric clinics during weekdays only during this study, and referred all obstetric patients to Kuopio University Hospital during weekends.

Patient referral concerns particularly preterm births, because in the entire database the incidence of preterm infants was 25–28 % higher than nationally. The numbers of perinatal deaths were similarly higher than in national records, although the trend decreased during the 1990s. On the other hand, foetal deaths (0.5 %) and NICU treatments (7.2 %) were at the national level. Nevertheless, the referral indications are clinical and do not vary according to the social status of women, nor according to the variables in the interest of our study. Thus, a representative sample of all social classes was available.

The reason for exclusion of multiple births and major structural anomalies was to decrease confounding and to produce risk estimates relevant to clinical practice for singleton pregnancies. Because multiple and anomalic pregnancies are often complicated, our sample size is not sufficient for controlling this source of confounding in analyses. On the other hand, this exclusion made the comparison of occurrence of different outcomes with national records more difficult.

Most studies in this field are register-based studies that lack pertinent details in maternal health behaviour and obstetric history. Accordingly, using the Birth register of Kuopio University Hospital provided us with a comprehensive database with the details of maternal risks and obstetric history, since the questionnaire used was broad, having 75 items, and the

missing data were complemented by nurse interviews and clinical records. The use of this data enabled adjustments for possible confounding factors, to find the independent risks.

Distinguishing confounding factors from mediating factors as regards social risks and adverse pregnancy outcomes is difficult, because a purely statistical viewpoint was applied in choosing the variables for the logistic regression analyses. This procedure allows interpretation of independent risks, but unadjusted risks may still provide a more accurate picture of the magnitude of the actual risks in the study groups.

Moreover, underreporting of smoking, alcohol use or prior adverse obstetric history cannot be totally ruled out, which is a common problem in this type of study. Also, manual entering of data to the database is as a source of possible inaccuracy.

6.3 Marriage protects pregnancy

The trend towards being unmarried during pregnancy is increasing: 22.9% of pregnancies were outside marriage in 1989 and 39.2 % in 2001. Cohabiting unions have also become more common during pregnancy, from 14.2 % in 1989 to 30.1 % in 2001. Other marital statuses, i.e., being single, widowed or divorced, have increased from 6.8 % to 13.4 % during the same period of time (STAKES Perinatal Statistics of Finland 2003). In our study population the percentages were in accordance with national records. Overall, cohabiting unions were as common in Finland as in other Scandinavian countries and in the US, and up to three fold as common as in southern Europe. A comparable change in cohabiting unions has taken place in all Western countries. (Kiernan 1999, Bird et al. 2000).

Pregnancy outside marriage has been reported to be associated with higher risks of small-for-gestational-age infants, preterm birth and foetal and neonatal death (Arntzen et al. 1996,

Hanke, et al. 1998, Luo, et al. 2004). The risks have been suggested to be lower in societies where pregnancies outside marriage are common. A prevalence of 20 % has been suggested as a cut-off level over which the risk decreases (Zeitlin et al. 2002).

In the present study, unmarried women had risks such as primiparity, unemployment, smoking, chronic illnesses and chorioamnionitis more often than married women. The risks of adverse pregnancy outcomes remained significantly increased, although smaller after controlling for confounding maternal characteristics in logistic regression analysis (OR of 1.17 for low birth weight, 1.15 for preterm birth, 1.11 for SGA and 1.15 for admission to the NICU). In subgroup analyses of cohabiting women and single women, elevated risks for the same outcomes were found. Single women had a 28 % higher incidence of preterm birth than unmarried women overall (adjusted OR 1.29), and cohabiting women had slightly lower incidences of adverse outcomes (e.g. a 12 % lower incidence of preterm delivery) than unmarried women overall, but the independent risks were similar.

Surprisingly, the risks were on the same order of magnitude as reported in the 1950s in the UK and in the 1980s in Scotland, although secularisation in the trend in marital status could have diminished the protective effect of marriage (Lumley 1997). Our results suggest that women who are married at the time of delivery have a more stable family situation than cohabiting women. If the present trend of extramarital childbearing continues, this phenomenon may become less marked, and the number of cases of adverse outcomes attributable to this risk may not increase to the same degree.

The excess numbers of SGA children (75/10,000 births), preterm deliveries (15/10,000 births) and infants requiring admission to NICU (52/10,000 births) were relatively high due to the high incidence of extramarital childbearing, increasing the clinical significance of the risks of pregnancy outside marriage (Table 8. on page 68).

In summary, in the 1990s marriage seemed to have a small, but significant protective effect on pregnancy outcome also when pregnancies outside marriage were common.

6.4 Risks of unemployment

Economical depression was experienced in Finland in the early 1990s. The unemployment rate of women at childbearing age in Kuopio district varied between 3.0 % and 15.1 % during 1998-2001, whereas the equivalent figures for Finland varied between 3.2 % and 16.6 % (STAKES 2000). The effects of high unemployment at the society level may have altered the effect of unemployment on pregnancy outcome, which may reduce the possibility to generalise these results over low unemployment periods. (Catalano et al. 1999)

The 1.3-1.4-fold increased risk of foetal growth restriction (SGA) found in this study translated to 32 extra cases of SGA infants in an obstetric population of 10,000 pregnancies. Free-of-charge antenatal care did not fully overcome the excess risks brought about by unemployment. However, in the present study we did not find any increased risk of preterm birth, which has been reported in earlier British (Murphy et al. 1984) and Polish (Hanke et al. 2001) studies and in a study of 17 European countries (Ancel et al. 1999), nor any increased risk of perinatal mortality, also found in prior studies (Murphy et al. 1984). The risk of SGA was found to be, however, on the same level as reported earlier in Denmark (Henriksen et al. 1994).

The risk factors associated with unemployed status were unmarried status, prior pregnancy terminations, overweight, low weight gain, anaemia, smoking and alcohol consumption. After controlling these numerous risk factors, the relative risks of SGA changed little in the logistic regression analyses. Furthermore, nutrition did not explain this association, because the

increased risk of SGA remained after an additional analysis controlling for anaemia and low weight gain. This finding suggests that the unemployed pregnant population is heterogeneous as regards health behaviour, and individual risk assessment is therefore needed.

In summary, unemployed women had a higher incidence of foetal growth restriction, even when confounding factors were controlled for. Psychosocial and health behavioural factors not measured in this study may explain the association. In families where both parents were unemployed, the risk of foetal growth restriction was higher than in families with one unemployed parent.

6.5 Good outcome of pregnancies in teenage

Delivery in teenage is relatively rare in Finland compared with the US (which has an up to five-fold higher teenage birth rate), the UK (three-fold higher), and comparable with Sweden and Denmark (Singh and Darroch 2000, STAKES Perinatal Statistics in the Nordic Countries 2005)

Teenage pregnancies have been reported to be associated with foetal growth restriction, pre-term birth, low birth weight and neonatal mortality. These could be due to biological immaturity, lifestyle factors, lower socio-economic status or inadequate attendance to maternity care (Fraser et al. 1995, Olausson et al. 1997, Jolly et al. 2000, Stevens-Simon et al. 2000). Teenage mothers under 16 years of age have been reported to have higher risks than those who have almost reached adulthood. (Amini et al. 1996, Olausson et al. 2001)

In the present study primiparity, smoking, unemployment, anaemia and chorio-amnionitis were found to be risk factors in teenage pregnancies. Taking into account the very short fertile period of teenage parturients, the 8.1 % prevalence of prior induced abortion was high compared with 10.1 % in the entire pregnant population. This is indicative of general

problems in family planning. The incidence of SGA was increased compared with all adults before adjustment (14.1 % vs. 9.6 % in adults). On the other hand, when compared with the incidence of SGA in primiparous adult women (13.5 %), no excess risk of SGA was found. In multivariate logistic regression analyses, the obstetric outcome of teenage pregnancies was as good as adults. The number of operative deliveries was even lower in teenagers than adults, as reported earlier (Jolly, et al. 2000), leading to a protective effect on future pregnancies.

The relatively small number (n = 185) of teenage pregnancies makes the interpretation of the data more difficult, and some results conflicted with findings from previous studies. However, our results of similarly good pregnancy outcome in teenagers and adult mothers are in accordance with earlier Finnish studies (Hemminki and Gissler 1996). This makes the hypothesis of biological immaturity as an explanation to previously reported adverse pregnancy outcomes in teenagers less likely, because adjustment for confounding factors removed the excess risk.

Explanations for our results of good pregnancy outcome of teenage mothers different from earlier reported are: 1) Age: most teenage mothers in Finland are relatively near to adulthood, as our study population included only 5% of teenage mothers under 16 years; 2) Study protocol: compared with earlier studies of teenage parturients of corresponding age (Fraser et al. 1995, van der Klis et al. 2002) we made broader adjustments for confounding in logistic regression analyses; 3) Better accessibility to antenatal care than in earlier reports (Jolly et al. 2000, van der Klis et al. 2002): in our country, antenatal care is attended also by teenage women, regardless of their economical status, providing screening of infections and other possible risk factors for premature birth.

In summary, our data suggest that the increased risk of adverse pregnancy outcomes in teenagers reported in earlier studies can probably be recognised and treated, if teenage

mothers attend antenatal care. Nevertheless, pregnant teenagers have social risk factors, and their need of extra social support is emphasised by the high incidence of unmarried status and unemployment.

6.6 The risks of obesity are preventable

Overweight is becoming more common, existing already in 20.5 % of all pregnancies in our study population (1989–2001). Overweight and obesity therefore represent a major public health issue also during pregnancy (Sebire et al. 2001, Vehkaoja et al. 2006).

The results of the most pertinent earlier studies on this subject are listed in Table 1 on page 37. Our results are in harmony with earlier findings as regards the quality and magnitude of the risks associated with overweight and obesity. Also, the incidences of pregnancy complications and adverse outcomes are comparable with international results. (Bianco et al. 1998, Baeten et al. 2001, Sebire et al. 2001, Cedergren 2004, Kristensen et al. 2005, Usha Kiran et al. 2005)

The new and main finding of the present study was that even modest weight loss and keeping the BMI under 30 would likely bring substantial benefits for pregnancy outcome. The risk of perinatal death increased from 1.5-fold to 2.2-fold in the transition from overweight to obesity. Normal weight women were younger, in better health before pregnancy and had a more favourable prior obstetric history and health behaviour than overweight women. Pregnancies of overweight and obese women were complicated by chorio-amnionitis 1.3–1.7-times more often, pre-eclampsia 1.6–2.4 more often and meconium stained amniotic fluid on delivery 24–40 % more often than pregnancies in women with a normal weight, Moreover, overweight and obese women needed delivery inductions 45–78 % more often and caesarean sections 27–39 % more often.

In the present study, SGA was found to be less common in infants of overweight and obese mothers than of normal weight mothers at OR: s of 0.7–0.8. However, there were probably unrecognised cases of intrauterine growth restriction (IUGR) due to placental dysfunction as consequence of overly presented hypertension and smoking among obese mothers. Since maternal obesity increases foetal weight, the newborns may have suffered from IUGR even they were not small for gestational age. We did not, however, confirm this hypothesis by studying the ponderal index of newborns, nor did we have systematic ultrasound follow up of foetal growth of obese women. This under-recognition of the growth restricted foetuses is important, because SGA-foetuses unidentified as such before birth have been reported to have four-fold increased risk of serious foetal complications (Lindqvist and Molin 2005).

In summary, infants of overweight and obese women in Finland have similarly increased risks of perinatal death, low Apgar scores and admissions to the NICU as reported in other countries. The adverse outcomes increase with increasing BMI. Thus, even modest pre-pregnancy weight loss to a BMI under 30 would likely bring substantial benefits to pregnancy outcome.

6.7 Impact of a history of induced abortion on pregnancy outcome

In terms of world statistics, the rate of induced abortions is low in Finland, half that in Sweden and 70 % of that in the USA (Thorp et al. 2003). Underreporting is a common problem in studies concerning pregnancy terminations. From the statistic database of induced abortions we know that during the study period the percentage of pregnant women having a history of induced abortion varied from 12.5 % to 14.5 % in all of Finland, and the rate in Kuopio district was only 83 % of that in Finland during the study period (STAKES Perinatal Statistics of Finland 2003). As many as 10.1 % of mothers in our study population reported a

history of induced abortion. These figures suggest relatively low underreporting rate. This is possibly due to double checking of this information from clinical records available at the time of collecting the data. The abortion history was asked in both the questionnaire and interview, which has been reported to reduce underreporting (Fu et al. 1998).

The prior literature is divided regarding the association of induced abortions with adverse pregnancy outcomes. Preterm births, abnormal placentation, miscarriages and ectopic pregnancies have been reported to be associated with prior induced abortions (Tharaux-Deneux et al. 1998, Johnson et al. 2003, Ancel et al. 2004). The effect has been suggested to increase with the number of prior induced abortions. On the other hand a number of studies have shown no risk increases. After multivariate logistic regression analysis we found no evidence of adverse pregnancy outcomes. This inconsistency is probably due to the fact that by using our database including numerous confounding factors, maternal health behaviour was found to explain the association of induced abortions with adverse pregnancy outcomes in logistic regression analyses.

Induced abortions were associated with several known health behavioural pregnancy risk factors, specifically maternal age over 35 years, unemployment, unmarried status, low educational level, smoking, alcohol consumption, overweight and chronic illnesses. Late pregnancy bleeding complicated pregnancies of these women significantly more often than the pregnancies of women without prior induced abortions (2.1 % vs.1.6 %). Whether this is true causality or due to shared risks, for example trauma, cannot be determined based on the current study. Earlier studies have shown an association of placental ablations with smoking and using alcohol, which were more common in our study in mothers with prior induced abortions than on the average (Tikkanen et al. 2006).

In summary, in women with prior induced abortions, the accumulation of pregnancy risk factors plays an important role, and individual risk assessment and health education based on risk factors and their number are thus needed.

6.8 Non-attendance at antenatal care

Attendance and time of the first visit at antenatal care clinics varies according to availability of services. The most common barriers to attendance of antenatal care clinics in modern Western society are lack of insurance, low income, low educational level, low social class, unmarried status, ethnic origin of the woman, difficulties in obtaining appointments and long distances. (McCaw-Binns et al. 1995, Delvaux et al. 2001, Kupek et al. 2002)

Comparison with the results of prior studies (Table 2 on page 40) also suggests that when a high frequency of women receive inadequate antenatal care, the magnitude of associated risk may be diluted: The smaller the proportion of women excluding themselves from antenatal care, the greater the differences in health-behavioural and socio-demographic risk factors and the worse the pregnancy outcome. (Blondel and Marshall 1998, Herbst et al. 2003) Compared with a prior Finnish study (Gissler and Hemminki 1994), the risks of prematurity, NICU-treatments and perinatal death were higher in our study, probably because we did not adjust the number of antenatal visits according to gestational age. Interestingly, in a study of a religionous minority without antenatal care of any kind or any professional care of labour, foetal and neonatal mortality were at the same level as in our study. This may be due to otherwise healthy habits and safe environment for pregnancy of the women in the minority (Kaunitz et al. 1984).

In the present study, the overall pregnancy outcome of women with insufficient antenatal care was poor. The high amount of preterm births (39.6 %) in the group of women having

only 1-5 visits at antenatal care is partly the explanation for few visits. However, the outcome was very similar as in the group of women totally lacking antenatal care. Since non-attendance was so rare, the number of extra cases of adverse outcome attributable to this phenomenon remained relatively low. Nonetheless, the relative risks of foetal- and neonatal deaths, low Apgar scores and low birth weight were as high as 3–4.5-fold in mothers having insufficient antenatal care compared with mothers with average attendance at antenatal care. Under- or non-attendance was strongly associated with particular risk factors, specifically unmarried status, lower educational level, young maternal age, grand multiparity, smoking and alcohol use. Furthermore, chorio-amnionitis and placental abruption were more common complications among women having insufficient antenatal care than in women attending antenatal care regularly. In our study the significantly higher incidence of placental abruptions in the study groups than in the reference group (4.4 %–6.3 % vs. 0.7 %) suggests trauma as an aetiology, as proposed by Grossman 2004 (Grossman 2004) This kind of health behaviour in the family and possible abuse both indicate further close surveillance of the newborn.

In summary, women excluding themselves from antenatal care had a high risk of intrauterine foetal death, preterm birth and infant admission to the NICU, even though they had hospital deliveries.

6.9 Suggestions for preventive measures and future research

Based on the results of the current study, social situation and health behaviours need to be assessed in maternity care. When an accumulation of risk behaviour and social risks is found, special attention should be addressed on screening of infections and recognising signs of foetal growth restriction and the threat of preterm delivery. Women with a cluster of social and health behavioural risks may benefit from more substantial social support and preventive

measures than is offered now. These social and health behaviour risks are mainly determined by social policy and education rather than health care policy. Social support can be partially implemented also in primary health care, but the possibilities of "the third sector", civil organisations, peer support, or other local resources might be worth investigating.

Teenage pregnant women can be supported by the information that they may have even less complicated deliveries than adults. However, careful screening of genital infections, clinical examinations to find a possible threat of prematurity and detecting foetal growth restriction must be emphasised. Our results highlight teenage pregnancy as more of a social than biological problem, at least in older teen-agers.

In theory, the adverse effects of overweight on pregnancy outcome are preventable by normalising weight before pregnancy. Women with pre-pregnant BMI over 30 should be referred to specialised maternity units for surveillance of their high-risk pregnancies. After delivery, weight-loss groups or lifestyle interventions by the general practitioner might be beneficial.

When counselling women who are terminating their pregnancy, they can be told that there are probably no harmful consequences on their future pregnancy outcomes. However, the previously mentioned recommendations on clustered health behavioural risks are valid also for them.

Women who have excluded themselves from prenatal services may have the need for support after pregnancy due to adverse health attitudes and possible abuse or mental problems.

The role of domestic violence as an aetiological factor needs future research. Other possible explanations that require future research are psychiatric disorders and ideological reasons for

refusing antenatal care (naturalism, avoidance of technology, religion). Moreover, it would be interesting to investigate the health and mental development of children born to women who excluded themselves from maternity care.

The emphasis of health research policy in the EU is oriented strongly towards preventive medicine, and epidemiological, environmental and public health research is given a high priority (Saracci et al. 1998). In the future, intervention studies are needed in this field. Intervention studies for the promotion of mental health might work as a basic model. Promising interventions have been reported from the European Comissions mental health programme. They have been carried out in local communities, home visiting programmes and school programmes (Olds 2002, Wahlbeck and Taipale 2006)

7 CONCLUSIONS

In the present study, most women had favourable pregnancy outcomes. However, clinically important risk increases in adverse pregnancy outcomes were found in multivariate analyses:

Unmarried or cohabiting women had moderately elevated risks of 1.15–1.29-fold for preterm birth, 1.15-fold for infants admission to the NICU and 1.11-fold for SGA infants compared with married women. Single, divorced and widowed women had the highest risks. The risk increases were of a similar magnitude as reported in the 1950s and 1980s despite the secularisation in marital practises.

Unemployment was associated with a moderate 1.26–1.43-fold higher risk of SGA. The risk was highest (1.43-fold) in families where both parents were unemployed. Free-of-charge antenatal care did not offset the excess risk of foetal growth retardation, although no excess risk of preterm birth or perinatal death was found in these women.

Teenage women had favourable pregnancy outcomes, even though 92 % of them were primiparous. They had significantly more behavioural and social risk factors such as smoking, unmarried status and unemployment. Their pregnancies were more often complicated by anaemia and chorio-amnionitis, but they were essentially in better health in terms of chronic illnesses, as could be suspected, than their adult counterparts.

Normal weight women were younger, in better health before pregnancy and had a more favourable prior obstetric history and health behaviour than overweight women. Pregnancies of overweight women were more often complicated by chorio-amnionitis, pre-eclampsia and meconium-stained amniotic fluid. Also delivery inductions and caesarean sections were needed more often. The risk of perinatal death increased with increasing maternal BMI. Perinatal mortality was 2.2-fold higher in obese women than in mothers with a normal BMI.

Infants of obese women also had a moderately increased risk of a low Apgar score and admission to the NICU.

Prior pregnancy terminations were not independently associated with adverse pregnancy outcomes, even though the incidence of coexistent adverse health behaviour was high.

The offspring of the small minority of women (1.0 %) excluding themselves totally from maternity care services had high risks of preterm birth (3.8-fold), intrauterine death (3.0-fold) and low Apgar scores (4.5-fold). In settings with a high frequency of non-attendance these risks have been reported to be less marked. Even though the relative risks in this group of women were high, the absolute number of adverse outcomes attributable to non-attendance was low because of the low number of women not attending antenatal care.

Our study confirms that social and health behavioural risks are still remarkable even under conditions of high-quality maternity care attended by virtually entire pregnant population. The problem with many health behavioural and social risk factors is that they should be identified early enough for preventive measures, preferably before pregnancy or in the beginning of the pregnancy. Furthermore, health care alone is not sufficient, but also socio-political interventions are needed.

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ORIGINAL PUBLICATIONS

I

Marriage still protects pregnancy.

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Marriage still protects pregnancy

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Objective To assess the risk factors and outcome of pregnancy outside marriage in the 1990s, in conditions of a high percentage of extramarital pregnancies and high standard maternity care, used by the entire pregnant population.

Design Hospital-based cohort study.

Setting A university-teaching hospital in Finland.

Population The 25,373 singleton pregnancies of known marital and cohabiting status.

Methods Odds ratios (ORs) with 95% confidence intervals were calculated to estimate the effect of extramarital childbearing on pregnancy outcome. Multiple logistic regression analyses were conducted to control for confounding maternal risk factors.

Main outcome measures Small-for-gestational age (SGA) infants, preterm birth (less than 37 completed weeks), low birthweight (LBW; under 2500 g).

Results Of the study population, 67.5% were married and 32.5% were unmarried; 24.2% of all mothers were cohabiting. Unmarried status was strongly associated with social disadvantage and particular risk factors, specifically unemployment, smoking and previous pregnancy terminations, which in turn had an impact on obstetric outcome. There were significantly more SGA infants among unmarried mothers ($P < 0.001$), with an absolute difference of 45%; more preterm deliveries ($P = 0.001$), with an absolute difference of 17.5%; and more LBW infants ($P < 0.001$), with an absolute difference of 26%. The differences in adverse pregnancy outcomes between study groups (i) all unmarried women, (ii) cohabiting women and (iii) single women, remained significant after multivariate analysis at adjusted ORs of 1.11, 1.11 and 1.07 for SGA, 1.17, 1.15 and 1.21 for LBW and 1.15, 1.15 and 1.29 for the preterm births, respectively.

Conclusion Even in the 1990s when cohabitation was already common, pregnancy outside marriage was associated with an overall 20% increase of adverse outcomes, and free maternity care did not overcome the difference.

INTRODUCTION

Pregnancy outside marriage has been reported to be associated with higher risks of preterm birth,[1–4] low birthweight (LBW) infant[1,2,5] and small-for-gestational-age (SGA) infant.[1,2,6,7] The rates of fetal and neonatal death of children of unmarried women have also been reported to be higher.[2,8] Preterm birth is one of the main causes of perinatal death and neonatal mortality.[3] Birthweight is the most important determinant of perinatal outcome, and intrauterine growth restriction is a major cause of perinatal mortality and morbidity.[9]

Society in Western countries is changing: cohabitation is becoming more common and non-marital childbearing is no longer stigmatising.[4,5,10] In our study population, 67.5% of women were married, 24.2% were cohabiting and 8.2% were single, widowed or divorced. Corresponding figures in the United States have been reported to be 53% married, 35% cohabiting and 11.9% single during pregnancy.[2] In Europe differences in marital practices are still wide, with the rate of extramarital pregnancy ranging from over 40% in Scandinavia to under 10% in Greece and Italy.[10] The trend towards being unmarried during pregnancy is increasing: in 1989 22.9% and in 2001 39.2% of pregnancies in our study population were outside marriage; and a comparable change has taken place in all Western countries.[10,11] It has been suggested that the additional risks of extramarital pregnancies are higher in societies where pregnancies outside marriage are uncommon; in a recent French study a cutoff point of 20% of births to unmarried mothers was suggested to divide societies into those with high risks of adverse pregnancy outcomes outside marriage and those with no excess risks of pregnancies outside marriage.[4]

Unmarried status may reflect other risk factors rather than being an independent risk factor. Very little is known about the mechanisms or background leading to adverse pregnancy outcome in unmarried women. Socio-economic conditions may be related to maternal health behaviour[12] and emotional stress and lack of social support may also impair the outcome of pregnancies outside marriage.[13] In previous studies at least some of the risks have been

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suggested to be the result of inadequate access to maternity care.[4,11,14] However, in Finland maternity care is provided free of charge and is used virtually by the entire pregnant population, up to 99.7%.[15] The opportunity to receive maternity care during pregnancy is not affected by the economic situation of a woman; this asset should lower the risks associated with unmarried status during pregnancy.

The aim of this study was to assess the effect of marriage on pregnancy outcome in a society with a high percentage of pregnancies outside marriage and in conditions of high standard maternity care, covering the whole pregnant population. Our hypothesis was that after controlling for confounding factors in multivariate analysis, little or no difference in pregnancy outcomes between study groups would remain.

METHODS

We reviewed the total population who gave birth at Kuopio University Hospital between January 1989 and December 2001. Our hospital-based database includes information on maternal characteristics, pregnancy complications, pregnancy outcome and neonatal period. The data are based on interview, on clinical records and on information from a self-administered questionnaire at 20 weeks of pregnancy, and were collected by midwives in maternity care throughout pregnancy. All visits to Kuopio University Hospital during pregnancy were recorded. The data concerned 8235 unmarried women and 17,138 married women, who were used as the reference population. The information on marital status was missing in 235 (0.9%) cases. Multiple pregnancies (n = 548) and major fetal structural anomalies (n = 275) were excluded from the cohort before statistical analyses to eliminate confounding factors, because such pregnancies carry an unusually high risk of adverse outcome, and the effect of marital status on such pregnancies would be difficult to distinguish. The study population is ethnically homogeneous.

Marital status was recorded as married, cohabiting, widowed, divorced or single. The study group 'unmarried' (n = 8235) consisted of all women other than married and was divided into two subgroups: 'cohabiting' (n = 6147) and 'single' (n = 2088) consisting of women living alone (single, widowed or divorced). The following definitions were used to record pregnancy outcome: preterm birth, delivery before 37 weeks of gestation; prolonged gravidity, delivery after 42 weeks of gestation; pre-eclampsia, repeated blood pressure measurement exceeding 149/90 mmHg with proteinuria exceeding 0.5 g/day; and LBW, birthweight less than 2500 g. Infants were considered SGA when the age- and sex-adjusted birthweight was below the 10th centile according to the normal tables for our population. Grand multiparity was defined as having over seven previous deliveries. The mother was considered to be a smoker when she had over five cigarettes per day during pregnancy. Alcohol use was recorded at interview; the mother either used or did not use alcohol before pregnancy and at 20 weeks of pregnancy. Illicit drug use was marginal in Kuopio in the 1990s. Low haemoglobin was defined as under 100 g/L in the third trimester of pregnancy. The pH limit used for fetal acidosis was 7.15 at birth. Overweight

Table 1. Reproductive risk factors of unmarried women compared with married women.

Risk factors	Married, n = 17,138	Percentage, 67.5	Unmarried, n = 8235	Percentage, 32.5	P
Under 18 years old	12	0.07	157	1.91	<0.001
Over 36 years old	2127	12.4	836	10.2	<0.001
Primiparity	5652	33.0	4614	56.0	<0.001
Second pregnancy in 12 months	1397	12.2[a]	526	14.5[a]	<0.001
Time since previous delivery >6 years	1765	15.4[a]	686	18.9[a]	<0.001
>7 deliveries	98	0.6	1	0.01	NA
Prior termination miscarriage	3286	19.2	1080	13.1	<0.001
Prior termination	1405	8.2	1186	14.4	<0.001
Prior fetal demise	414	3.6[a]	107	3.0[a]	<0.001
Prior caesarean or scarred uterus	2103	12.3	638	7.8	<0.001
IUD before pregnancy	1795	10.5	784	9.5	0.02
Pregravid BMI > 25 kg/m^2	3533	20.6	1686	20.5	0.79
Unemployed	2308	13.5	2022	24.6	<0.001
Smoking > 5/day before pregnancy	1831	10.7	2681	32.6	<0.001
Smoking > 5/day during pregnancy	590	3.4	939	11.4	<0.001
Alcohol consumption before pregnancy	6346	37.0	3650	44.3	<0.001
Alcohol consumption during pregnancy	576	3.4	302	3.7	0.21
Maternal diabetes	410	2.4	241	2.9	0.01
Maternal pregravid hypertension	340	2.0	159	1.9	0.63
History of infertility	1196	7.0	295	3.6	<0.001
Maternal chronic illness	1074	6.3	462	5.6	0.04

BMI = body mass index; IUD = intrauterine device.
[a] Percentage of parous women.

Table 2. Pregnancy and delivery characteristics of unmarried women compared with married women.

Characteristic	Married, n = 17,138	Percentage, 67.5	Unmarried, n = 8235	Percentage, 32.5	P
Prolonged gravidity (>42 weeks)	811	4.8	407	5.0	0.47
Late pregnancy bleeding	282	1.7	119	1.5	0.23
Low haemoglobin (<100 g/L)	252	1.5	133	1.7	0.36
Chorioamnionitis	219	1.3	134	1.6	0.03
Obstetric cholestasis	106	0.62	52	0.63	0.90
Placenta praevia	65	0.4	35	0.4	0.59
Pre-eclampsia	520	3.0	268	3.3	0.34
Rh immunisation	26	0.2	5	0.1	0.03

was defined as BMI over 25 kg/m^2, calculated at the first visit to maternity care, at 10 weeks of pregnancy. If a subject had two abnormalities, such as a LBW infant and preterm delivery, each was considered an independent outcome and the mother was included in both categories.

Statistical differences between subjects and controls were evaluated by using χ^2 tests (dichotomous variables), and Fisher's Exact Test was applied when the minimal estimated expected value was less than five. A value of $P < 0.05$ was considered statistically significant. Continuous variables were analysed by using two-tailed, pooled t tests. Possible confounding variables were identified from background data, obstetric risk factors and health behaviour. Multivariate analysis of significant or nearly significant effects ($P < 0.1$) of independent lifestyle variables considered in this study (maternal age over 35 or under 17, primiparity, grand multiparity, smoking during or before pregnancy, alcohol consumption before pregnancy, history of infertility, unemployment, previous miscarriages or fetal death, previous induced abortions, short time or long time since previous pregnancy or using an IUD before the current pregnancy, having surgical scars in the uterus, maternal diabetes or chronic illness) on dependent outcomes was based on multiple logistic regression analysis (BMDP Statistical Software, Los Angeles, California). The variables were entered simultaneously and the analysis was performed stepwise. All independent variables were modeled as categorical terms as shown in Tables 1 and 2. Confidence intervals were evaluated at 95%.

RESULTS

Of the women pregnant and giving birth at Kuopio University Hospital between January 1989 and December 2001, 32.5% were unmarried during pregnancy. Of these, 74.6% were cohabiting and 25.3% were single, divorced or widowed. The mean maternal age [SD] in married women was 29.7 [4.9] years *versus* 27.6 [5.8] years in the unmarried women ($P < 0.001$). The mean birthweight [SD] of newborns who were delivered at term (after 37 gestational weeks) were 3558 [600] g (married) *versus* 3463 [604.5] g ($P < 0.001$).

Table 1 shows the distribution of maternal risk factors. Unmarried women were more often primiparous. They were more likely to have social risk factors, specifically adolescent age, unemployment or second pregnancy in 12 months ($P < 0.001$). They were more likely to have had prior pregnancy terminations, to have smoked before and during pregnancy and to have used alcohol before pregnancy ($P < 0.001$). In addition, pregnancy-related diabetes was more common in unmarried women than in the reference

Table 3. Pregnancy outcomes of unmarried women compared with married women.

Outcome	Married, n = 17,138	Percentage, 67.5	Unmarried, n = 8235	Percentage, 32.5	P	Adjusted OR	95% CI
SGA (<90th centile)	1456	8.5	992	12.1	<0.001	1.11	1.02–1.22
LBW (<2500 g)	702	4.1	424	5.2	<0.001	1.17	1.03–1.32
Preterm delivery (<37 weeks)	958	5.7	545	6.7	0.001	1.15	1.03–1.28
Low Apgar score (<7) 1 min	780	4.6	458	5.6	<0.001	1.07	0.94–1.21
Low Apgar score (<7) 5 min	290	1.7	151	1.8	0.42	1.01	0.83–1.24
Fetal venous pH < 7.15 at birth	181	1.2	95	1.3	0.45	0.74	0.57–0.97
Abnormal FHR during delivery	2517	16.4	1428	20.0	<0.001	0.98	0.91–1.06
Caesarean	2719	15.9	1470	17.9	<0.001	1.06	0.98–1.15
Forceps or vacuum	865	5.1	591	7.2	<0.001	1.10	0.98–1.22
Admission to neonatal unit	1303	7.6	760	9.2	<0.001	1.15	1.05–1.27
Fetal death	62	0.4	28	0.3	0.78	0.93	0.61–1.42
Perinatal death	91	0.5	45	0.6	0.87	0.98	0.69–1.39

SGA = small for gestational age; FHR = fetal heart rate; OR = odds ratio; CI = confidence interval.
OR adjusted for age, parity, smoking alcohol consumption, infertility, abortions, previous fetal deaths and miscarriages, time since previous pregnancy and maternal illness.

Table 4. Pregnancy outcomes in unmarried, cohabiting and single women compared with married women.

Outcome	Group	%	*P*	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
SGA	Married	8.5			
	Unmarried	12.1	<0.001	1.48 (1.35–1.61)	1.11 (1.02–1.22)
	Cohabiting	11.6	<0.001	1.42 (1.29–1.56)	1.11 (1.02–1.24)
	Single	13.3	<0.001	1.65 (1.44–1.89)	1.07 (0.93–1.23)
LBW (<2500 g)	Married	4.1			
	Unmarried	5.2	<0.001	1.27 (1.12–1.44)	1.17 (1.03–1.32)
	Cohabiting	4.6	<0.20	1.12 (0.97–1.29)	1.15 (1.02–1.31)
	Single	6.9	<0.001	1.72 (1.44–2.09)	1.21 (1.01–1.46)
Preterm delivery (<37 weeks)	Married	5.7			
	Unmarried	6.7	<0.001	1.20 (1.07–1.33)	1.15 (1.03–1.28)
	Cohabiting	6.0	NS	1.08 (0.96–1.22)	1.15 (1.03–1.28)
	Single	8.6	<0.001	1.55 (1.31–1.83)	1.29 (1.09–1.54)
Admission to neonatal unit	Married	7.6			
	Unmarried	9.2	<0.001	1.24 (1.13–1.36)	1.15 (1.05–1.27)
	Cohabiting	9.0	<0.001	1.21 (1.09–1.34)	1.15 (1.05–1.27)
	Single	9.8	<0.001	1.32 (1.13–1.54)	1.15 (0.99–1.35)

SGA = small for gestational age.

* OR adjusted for parity, smoking, alcohol consumption, infertility, abortions previous fetal deaths and miscarriages, time since previous pregnancy and maternal illness.

population. However, unmarried women had more favourable obstetric histories; previous miscarriage, fetal demise, history of infertility or surgical scarring of the uterus were less likely in unmarried women, and married women more commonly had chronic illnesses complicating the pregnancy.

Table 2 summarises the frequencies of various pregnancy and delivery complications. The incidence of chorioamnionitis was statistically different between married and unmarried women, in favour of married women, with an absolute difference of 23%. The incidence of Rh immunisation was significantly higher in married women than in unmarried woman.

Table 3 shows comparison of pregnancy outcomes among unmarried and married women and the results of multivariate analyses controlling for the obstetric risk factors investigated in this study. Significant differences were found between the study groups. Unmarried women had more preterm deliveries ($P = 0.001$), with an absolute difference of 17.5%, at an adjusted odds ratio (OR) of 1.15; more SGA infants ($P < 0.001$), with an absolute difference of 45%, at an adjusted OR of 1.11; and more LBW infants ($P < 0.001$), with an absolute difference of 26%, at an OR of 1.17. During the neonatal period low Apgar scores at the age of 1 minute and admission to a neonatal care unit were more common among unmarried women than among married women, but in multivariate analysis only the admission rate to a neonatal care unit remained statistically significantly worse ($P < 0.001$), at an adjusted OR of 1.15. Fetal and perinatal death rates were similar in married and unmarried women.

Table 4 shows comparison of the subgroups of cohabiting mothers ($n = 6147$) and single mothers ($n = 2088$), and all unmarried mothers ($n = 8137$), *versus* married women. Unadjusted ORs of the major adverse outcomes of interest are shown (univariate model): An increasing trend in the risks of SGA (ORs 1.42, 1.48 and 1.65), LBW (ORs 1.12, 1.27 and 1.72), preterm delivery (ORs 1.08, 1.20 and 1.55) and admission to a neonatal intensive care unit (ORs 1.21, 1.24 and 1.32) were seen in the groups of cohabiting mothers, all unmarried mothers and single mothers, respectively. The differences were statistically significant ($P < 0.001$) in all variables concerned between the married and all unmarried women, and between the married and single mothers. Between the married women and cohabiting women the differences were smaller, showing statistical significance only in the numbers of SGA infants and admission to neonatal care ($P < 0.001$).

In logistic regression analyses the ORs for adverse pregnancy outcomes remained significant, although smaller after adjusting for confounding factors; ORs for SGA being 1.11, 1.11 and 1.07 in cohabiting, all unmarried and single women, respectively; ORs for LBW 1.15, 1.17 and 1.21, respectively; ORs for preterm birth 1.15, 1.15 and 1.29, respectively; and ORs for admission to neonatal care unit 1.15, 1.15 and 1.15, respectively.

DISCUSSION

We studied the effect of maternal unmarried status on pregnancy outcome, and found that even in the 1990s pregnancy outside marriage was associated with markedly elevated risks of adverse pregnancy outcomes. The elevated risks of LBW (OR 1.27), preterm birth (OR 1.20), SGA infants (OR 1.48) and need of neonatal intensive care (OR 1.24) experienced in births outside marriage were evident. The increased risks remained statistically significant, although smaller after controlling for confounding maternal characteristics in multivariate analysis, at an OR of 1.17 for LBW, with an OR of 1.15 for preterm birth, at an OR of

1.11 for SGA and an OR of 1.15 for neonatal intensive care. In subgroup analyses of cohabiting women and single women the similar elevated risks were found, although single women had higher risks than unmarried women overall, and cohabiting women had slightly lower risks.

The number of pregnancies outside marriage was comparable to that in the United States and most European countries. Our findings are in contrast to those of a number of recent studies that have suggested that the effect of marital status on pregnancy outcomes is becoming less important or is disappearing as marital practices change in the direction of more cohabiting unions instead of marriages.[4,5,16–19] Our results, however, are consistent with those in several previous studies on maternal characteristics and health behaviour. It has often been reported that unmarried women are younger, more often primiparous, more often unemployed and smoke more than married women.[1,5,6,10,12,18] In the present study, there was evidence of variation in pregnancy risks because of behavioural differences between unmarried women and the reference obstetric population. Hence, marital status in itself may have minor effects on pregnancy outcome in such cases. On the other hand, the observed lower incidence of unfavourable obstetric history and chronic maternal illness would act to offset the adverse effect of unmarried status, so that the effects found may be underestimated rather than over-estimated.

Today we are in a situation in which the elevated risks of adverse outcomes of pregnancies outside marriage have been reported in numerous studies, but because most of them reflect a situation in which marriage is still the norm, and because the increase in non-marital childbearing is occurring now, the additional risks of extramarital childbearing should be questioned. More specifically, pregnancy outside marriage has been reported to be associated with more SGA infants,[1,2,6,7] more preterm births,[1–3,11] LBW,[1,2] elevated neonatal death rate[2] and even an elevated postneonatal death rate.[20]

A limitation in studies concerning marital status and pregnancy outcome is that they are usually based on registration data that lack detailed description of maternal illnesses, smoking, weight, alcohol consumption, employment etc., which cannot consequently be used to adjust the results.[1,5] In addition, in the registers marital status is usually defined in terms of married, unmarried, widowed or divorced and cohabitation cannot be distinguished in the unmarried group. On the other hand, if the above maternal characteristics have been taken into account, the sample size is often small. The strength of the present study is that we had an opportunity to assess the effects of maternal behaviour and pre-pregnancy health on the pregnancy, because the Kuopio University Hospital birth registry contains comprehensive data on these variables. A possible limitation of this data from a tertiary level perinatal centre of this area is that some adverse outcomes may be overly present. Furthermore, some women change their marital status during pregnancy and in this study we could not study the effect of the change. However, women who got married during pregnancy have likely been classified as cohabiting and this classification bias would rather lower than magnify the adverse effects found.

Unmarried status may reflect other causative factors leading to poor reproductive health. Several mediating factors have been suggested. In general, married adults are in better health than unmarried adults. The mechanisms concerned can be divided into (i) selection, women who are in better health initially are more likely to marry; and (ii) protection, in particular, women who are not employed are in better health.[21] The economic situation of unmarried women, especially single ones, is likely to be worse than that of married women. An economic recession was experienced in Finland in the 1990s. At that time the unemployment rate was high among pregnant women, and low income among unmarried women and unemployed women may lead to ill health.

Another hypothesis is that marriage protects health by reducing risky sexual behaviour and increasing healthy behaviour via social behaviour and attitudes among traditional married families.[21,22] Infections during pregnancy, specifically bacterial vaginosis and chorioamnionitis, have also been reported to be more common in unmarried than in married women,[12] which reflects health behaviour and health consciousness. Herewith, the number of sexual partners in the last years and the time spent with the current partner would be of interest in explaining the association of unmarried status with obstetric infections. Health consciousness is negatively related to being less well educated and more often unemployed and is seen in more smoking, alcohol consumption, pregnancy terminations and untreated infections and poorer attendance at prenatal classes.

On the other hand, marriage increases social support and a stable marital situation is less likely to produce emotional stress than being single. In fact, the adverse impact of stress on pregnancy outcome has been well documented in previous studies.[13,23] The effect of stress related to unmarried status may be ameliorated by society's acceptance of births outside marriage.[4] Thus, the influences of stress and social support are valid explanations as regards the pregnancy outcomes revealed in this study, as the higher pregnancy risks experienced by unmarried women remained significant after controlling for maternal health and social profile. Furthermore, the increasing trend in adverse outcomes from cohabiting to single mothers emphasises this conclusion.

CONCLUSIONS

We conclude that even in the era of modern maternity care, pregnancy outside marriage is associated with notable, overall 20%, excess risks, and preventive measures could be taken to address this problem. The excess risks

concern both health behaviour, which is important from a preventive point of view, and pregnancy outcome, specifically the risk of preterm birth (OR 1.15), LBW (1.17), SGA (1.11) and neonatal intensive care (OR 1.15) (after controlling for maternal risk profile). Elevated pregnancy risks were experienced also by cohabiting women, and the risks were highest in single, divorced and widowed women. Thus, secularisation in marital practice has not changed the protective effect of marriage on pregnancy outcome.

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Does unemployment in family affect pregnancy outcome in conditions of high quality maternity care?

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Abstract

Background: The influence of unemployment in the family on pregnancy outcome is controversial. Only a few studies have involved investigation of the effect of unemployment of the father on pregnancy. The objective of this study was to assess the effects of unemployment of one or both parents on obstetric outcome in conditions of free antenatal care attended by the entire pregnant population.

Methods: The data of 24 939 pregnancies included maternal risk factors, pregnancy characteristics and outcome, and was based on a self administered questionnaire at 20 weeks of pregnancy and on clinical records.

Results: Unemployment was associated with adolescent maternal age, unmarried status and overweight, anemia, smoking, alcohol consumption and prior pregnancy terminations. Multivariate logistic regression analysis indicated that after controlling for these maternal risk factors small differences only were found in pregnancy outcomes between unemployed and employed families. Unemployed women had significantly more often small-for-gestational-age (SGA) infants, at an OR of 1.26 (95% CI: 1.12 – 1.42) whereas, in families where both parents were unemployed, the risk of SGA was even higher at an OR of 1.43 (95% CI: 1.18 – 1.73). Otherwise, pregnancy outcome was comparable in the groups studied.

Conclusion: Free antenatal care was unable to fully overcome the adverse pregnancy outcomes associated with unemployment, SGA risk being highest when both parents are unemployed.

Background

Unemployment is strongly associated with an increased risk of morbidity and mortality. Unemployed persons use more general health services, have more physical and mental health problems and even have a higher suicide rate than their employed counterparts. Lower levels of psychological well-being have been systematically found in all studies – at all ages and in both sexes [1,2].

The topic of unemployment and pregnancy outcome is of interest for several reasons, since it is a marker of socioeconomic status, a potential marker of stress, an indicator of poor physical or mental health, a proxy for chemical exposures like alcohol or cigarette smoke etc.

Much controversy exists in the literature with regard to the influence of unemployment in the family on pregnancy

outcome. Some investigators have shown associations with preterm delivery [3-5], low birth weight [5] and a higher perinatal mortality rate [5], whereas others have shown opposite results [6-8]. However, there appears to be consensus that unemployment in pregnancy shows a strong association with social disadvantage, low income, being unmarried and having unfavorable health behaviors. The correlation between unemployment and ill health has been explained as a result of both exposure to these factors and selection of unhealthy persons to be unemployed. The relationship is complex and causation cannot easily be proved [9].

Only a few studies have involved investigation of the effect of unemployment of the father on pregnancy. These studies have shown a change in maternal health behavior, but interestingly no association with low birth weight or preterm delivery [10]. In Finland maternity care is provided free of charge and is used by virtually the entire (99.7%) pregnant population, the first visit at maternity care takes places at average of 9.7 weeks of pregnancy and the average number of visits to maternity care during pregnancy is 17.3 [11]. The opportunity to receive maternity care during pregnancy is not affected by the economic situation of a family and this kind of antenatal care is rare even in European countries, in other Scandinavian countries maternity care is comparable to Finland.

The aim of this study was to assess the effects of unemployment of one or both parents on obstetric risk factors and pregnancy outcome in conditions of free, high standard maternity care, used by almost the entire pregnant population, to gain more understanding of whether the poor pregnancy outcomes associated with unemployment in family are avoidable in these conditions.

Methods

We investigated the total population at Kuopio University Hospital who gave birth between January 1989 and December 1999, a total of 25 679 pregnancies. Kuopio University Hospital is a university teaching hospital and the only hospital in Kuopio District offering obstetric care. Of the study population, 0.76% did not attend antenatal care of any kind before they were in birth. Unemployment rate of women in childbearing age in Kuopio district varied during the period of time concerned between 3.0% and 15.1%, whereas the equivalent figures for Finland varied between 3.2% and 16.6%. Economical depression that was experienced in Finland in early 1990's can readily be seen in the actual numbers of women unemployed [12]. Data from 3388 women unemployed during pregnancy, (study group I), 1551 women whose partner was unemployed during pregnancy (study group II) and 1037 women who were unemployed and whose partner was also unemployed during pregnancy (study group III). The reference population (no parental unemployment) consisted of 18 963 women. Multiple pregnancies (n = 484, 1.88% of all pregnancies) and major fetal structural anomalies (31 in study group I, 16 in study group II, 13 in study group III and 196 in the reference group, totaling 1.0% of all viable pregnancies) were excluded since these pregnancies carry an unusually high risk of adverse outcome, and the effect of unemployment on these pregnancies would be difficult to distinguish. After exclusions, a total of 24 939 pregnancies were analyzed.

Our database included information on maternal characteristics, based on information from a self-administered questionnaire at 20 weeks of pregnancy and completed by nurse interviews at visits to Kuopio University Hospital. The Institutional Review Board has accepted the study and childbearing women have given informed consent at the time of data collection and patient data has been processed anonymously. The questionnaire consisted of over 50 questions concerning marital status, employment data, paternal characteristics, previous operations, illnesses and obstetric history, contraceptive use and smoking and alcohol consumption. The information on pregnancy complications, pregnancy outcome and neonatal period was based on clinical records, collected to the database by the team who took care of the delivery and neonatal care. Unemployment status is clearly distinguishable from that of housewives, who are not entitled to unemployment benefits when they are not actively seeking a job: a multiple choice question concerning profession included separate options for both housewives and unemployed women. Unmarried women were classified according their unemployment status. The estimation of gestational age was based on menstrual history and ascertained by measuring fetal crowd rump length by ultrasound at 10 to 12 weeks of pregnancy.

The following definitions were used: preterm birth, delivery before 37 weeks of gestation; prolonged gravidity, delivery after 42 weeks of gestation; pre-eclampsia, repeated blood pressure measurement exceeding 149/90 mmHg with proteinuria exceeding 0.5 g/ day. Infants were considered small for gestational age (SGA) when the age- and sex-specific birth weight was below the tenth percentile according to the normal tables for our population [13]. Grand multiparity was defined having over 7 previous deliveries. Mother was considered a smoker when she smoked more than 5 cigarettes per day during pregnancy. Low hemoglobin was defined as hemoglobin under 100 g/l. The pH limit used for fetal acidosis was 7.15 at birth. Overweight was defined as pre-gravid BMI > 25 (weight in kg divided by the square of the height in m). If a subject had two abnormalities, such as SGA and preterm delivery, each was considered an independent outcome and the subject was included in both categories.

Table 1: Maternal Risk Factors in study groups I-III compared with the reference group

Risk factor	Reference (n = 18963) %	I Mother unemployed (n = 3388) %	P	II Father unemployed (n = 1551) %	P	III Both parents unemployed (n = 1037) %	P
Age < 18 years	0.4	1.3	0.001	1.81	0.001	2.51	0.001
Age > 35 years	12.9	7.9	0.001	8.90	0.001	5.79	0.001
Unmarried	27.4	43.1	0.001	45.0	0.001	58.0	0.001
Primiparity	40.3	41.7	0.12	45.8	0.001	49.8	0.001
Previous miscarriage	17.2	17.2	0.92	14.8	0.015	13.8	0.005
Prior termination	9.3	12.5	0.001	13.0	0.001	15.4	0.001
➢ 7 deliveries	0.5	0.06	0.001	0.4	0.59	0	0.01
IUD before pregnancy	9.02	7.29	0.001	6.25	0.001	6.56	0.006
Surgically scarred uterus	10.6	10.8	0.75	10.1	0.54	7.8	0.004
Second pregnancy in 12 months	6.9	7.5	0.24	8.6	0.014	8.3	0.089
Previous delivery > 6 y	9.7	9.1	0.30	8.1	0.040	8.8	0.35
Prior fetal demise	2.1	1.9	0.51	1.9	0.67	3.2	0.018
Low weight gain	6.8	9.1	0.001	7.6	0.34	9.0	0.02
Overweight	23.7	25.7	0.01	24.4	0.51	26.3	0.053
Smoking	4.2	9.5	0.001	10.4	0.001	17.9	0.001
Alcohol consumption	3.2	4.5	0.001	3.4	0.76	2.7	0.36
Chronical illness	5.7	6.2	0.26	5.5	0.83	6.3	0.42
Diabetes	2.0	2.8	0.003	2.2	0.58	2.9	0.044
Pregravid hypertension	1.9	2.2	0.24	2.0	0.69	2.1	0.54

IUD = intrauterine device

Statistical differences between subjects and controls were evaluated by using Chi-square tests (dichotomous variables), and Fisher's exact test was applied when the minimal estimated expected value was less than five. $P < 0.05$ was considered statistically significant. Continuous variables were analyzed by using two-tailed, pooled *t* tests. Possible confounding variables were identified from background data, obstetric risk factors, and health behaviors. Multivariate analysis of significant or nearly significant effects ($p < 0.1$) of lifestyle variables concerned in this study (maternal age over 35 or under 17, being single mother, primiparity, smoking during pregnancy, history of infertility, previous miscarriages, previous induced abortions, short time or long time since previous pregnancy or using IUD before this pregnancy) was based on multiple logistic regression analysis (BMDP Statistical Software Inc., Los Angeles, CA). Confidence intervals were evaluated at 95%.

Results

In 13.6 % of single pregnancies without major structural anomalies the mother was unemployed, in 6.2% the father and in 4.2% of pregnancies studied both parents were unemployed. Compared with the reference group, the women in groups I-III were younger: the mean maternal age (± standard deviation) in the reference group was 29.4 ± 5.2 y, vs. 27.5 ± 5.3 y in study group I, mother unemployed, ($p < 0.05$), 27.6 ± 5.5 years in study group II, father unemployed, ($p < 0.05$) and 25.3 ± 5.5 years in study group III, both parents unemployed, ($p < 0.05$). Pregnancies with major anomalies were excluded before statistical analyzes. The percentage of anomalies did not vary statistically significantly between study groups.

Table 1 shows the distribution of maternal risk factors. Adolescent age was more common and age over 35 years less common in unemployed women than in the reference group. Pregnancy outside marriage was also highly prevalent among unemployed families: 27% in the reference group, 43% when mother was unemployed and 58% when both parents were unemployed. Unemployed women were more likely to have had prior pregnancy terminations, to smoke and to use alcohol during pregnancy. Pregravid overweight (BMI > 25) and maternal diabetes were also more common (vs. the reference) in study groups I (mother unemployed) and III (both parents unemployed).

Table 2 summarizes the frequencies of various pregnancy and delivery complications. Only a few differences were recorded between the groups. Low hemoglobin during pregnancy was statistically more common in study groups I (mother unemployed) and III (both parents unemployed). No difference was found in the incidence of chorio amnionitis.

Table 3 shows pregnancy outcomes in the study groups I-III, before (Unadjusted OR) and after (Adjusted OR) multivariable analyses controlling for pregnancy risk factors found significant in this study ($p < 0.1$). SGA rate was

Table 2: Pregnancy and Delivery Characteristics in study groups I–III compared with the reference group

Characteristic	Reference (n = 18961) %	I Mother unemployed (n = 3388) %	P	II Father unemployed (n = 1551) %	P	III Both parents unemployed (n = 1037) %	P
Prolonged gravidity	4.9	5.3	0.38	4.1	0.12	5.1	0.79
Low hemoglobin	1.4	1.9	0.01	1.8	0.14	2.1	0.040
Meconium stained AF	10.5	11.4	0.11	10.4	0.99	11.1	0.51
Amnionitis	1.5	1.5	0.88	1.5	0.86	1.3	0.46
Pre-eclampsia	3.3	3.0	0.32	4.1	0.11	3.0	0.58
Inducted delivery	15.9	18.9	0.001	17.9	0.039	17.1	0.32

AF = amniotic fluid

found to be 22.7% higher in study group I (mother unemployed) than in the reference group, and 59.1% higher in study group III (both parents unemployed), respectively. The incidence of SGA was not increased in the study group II (father unemployed). The odds ratios changed only little in the multivariable analyses. On the other hand, the incidences of low Apgar scores, fetal acidosis at delivery, preterm delivery, admission rates to a neonatal unit, or fetal or neonatal death did not vary between the groups.

The mean birth weight (± SD) among newborns who were delivered at term (after 37 gestational weeks) was significantly lower ($p < 0.05$) in study groups I (mother unemployed) and III (both parents unemployed) (3612 g ± 490 g [reference] vs. 3580 ± 502 g and 3497 ± 506 g, respectively). In study group II (father unemployed) there was no difference in birth weight (3590 g ± 493 g) compared with the reference group. After adjusting for smoking the birth weights remained significantly lower ($p < 0.02$ and $p < 0.0001$) in study groups I and III (3622 g ± 485 g [reference] vs. 3601 g ± 495 g and 3605 g ± 496 g, respectively). In study group II there was no difference in birth weight (3525 g ± 508 g) compared with the reference group.

Table 4 provides direct comparison between families where the mother is unemployed and families, where both parents are unemployed. The main finding is that the risk of SGA is statistically significantly higher, OR 1.35 (1.10–1.65) in families where also father is unemployed.

Discussion

We studied the impact of unemployment of one or both parents on the risk factors and outcome of pregnancy in conditions of free maternity care used by the entire pregnant population and found that there were marked differences between families with different employment status. The incidence of fetal growth restriction (SGA) was found to be higher in unemployed women and in families where both parents were unemployed, but not when only the father was unemployed.

We found marked differences in the pregnancy risk factors, unemployment showing a strong association with adolescent age during pregnancy, unmarried status during pregnancy and unfavorable health behaviors, specifically overweight, anemia, smoking, alcohol consumption and prior pregnancy terminations. All these are known risk factors of adverse obstetric outcome: smoking is the most important cause of fetal growth restriction [14] and alcohol consumption [15] during pregnancy is known to be associated with fetal growth restriction and anomalies. Anemia in the third trimester does not effect the pregnancy outcome but reflects nutritional status of the pregnant women and may impair the mothers ability to take care of the newborn [16,17]. Maternal adolescent age has been found to be associated with preterm births [18] and unmarried status [19] and prior pregnancy terminations [20] have also been reported to be associated with adverse pregnancy outcomes. By definition, distinguishing confounding factors from mediating factors between unemployment and ill health is difficult, if not impossible[21], and therefore, a pure statistical viewpoint was applied in the present study. However, pregnancy outcome measures in the groups studied were compared both before and after adjusting for these factors, to overcome the difficulty brought about the either confounding or mediating role of known obstetric risks being significantly associated with unemployment. Interestingly, adjusted and unadjusted ORs differed only little from each other in the present study.

Birth weight is the most important determinant of perinatal outcome, and fetal growth restriction remains a high risk factor of morbidity and mortality [22] Overall, the results of the present study revealed a reduction in mean birth weight of 32 g (study group I) to 115 g (study group III) and an increase in the rate of SGA infants among unemployed women, an OR 1.26 and among families with both parents unemployed at an OR of 1.43. Interestingly, the effect of the partner's unemployment on the socioeconomic circumstances in family was seen in obstetric outcome in the number of SGA infants only,

Table 4: Unadjusted Odds Ratios of pregnancy outcome in unemployed women compared to families where both parents are unemployed

Outcome	I Mother unemployed (%)	III Both parents unemployed (%)	Unadjusted OR (95% CI)
SGA	10.8	14.0	1.35 (1.10–1.65)
Preterm delivery	6.2	6.8	1.10 (0.83–1.46)
Admission to neonatal unit	7.5	7.6	1.01 (0.78–1.32)
Low Apgar score (< 7) 1 min	4.9	4.6	0.94 (0.68–1.31)
Low Apgar score (<7) 5 min	1.8	1.5	0.81 (0.46–1.44)
Fetal venous pH < 7.15 at birth	1.2	1.5	1.17 (0.65–2.12)
Abnormal FHR during delivery	14.0	16.5	1.22 (1.01–1.47)
Fetal death	0.5	0.4	0.77 (0.26–2.29)
Neonatal death	0.2	0.4	1.87 (0.55–6.40)

FHR = fetal heart rate

although social disadvantage during pregnancy was clearly observed in their health behavior. The high prevalence of pregnancy risk factors found in this study in the unemployed families is in accordance with social and material deprivation. In addition to the social factors associated with unemployment there are common psychosocial associations, especially psychological stress, depression and low levels of practical support, resulting in adverse obstetric outcome [23] which persisted after adjustment for social and reproductive risk factors. The new and main finding of this study was that the social disadvantage brought about by unemployment was not overweighed by means of free antenatal care provided by the state.

So far, only a few studies on the influence of unemployment on pregnancy outcome have been reported and the results of these studies are controversial. The changes in pregnancy risk factors are consistent with previous observations. Unemployment has been associated with preterm delivery [4] (OR 1.92) and a weakly elevated (not statistically significant) risk of SGA. Unemployment of both parents has been reported to be associated with a double risk of a very preterm birth [3]. A higher proportion of low birth weight and pre-term infants and even a high perinatal mortality rate in unemployed women have been reported [5]. Psychological distress during pregnancy has been found to be associated with preterm delivery [23]. Peacock *et al.* reported that adverse social circumstances were associated with preterm birth, but they found no association between fetal growth retardation and psychosocial factors [24].

A number of investigators have reported conflicting results, with no statistically significant association between unemployment and adverse pregnancy outcome after adjustment for lifestyle variables [6,7,25,26]. Studies concerning the influence of the father being unemployed have revealed no significant excess of low birth weight or preterm delivery. However, major differences in maternal health behavior were found when the father was unemployed, specifically, delayed attendance at antenatal care, not attending classes for preparation for labor, not knowing the date of the last menstrual period, and smoking throughout pregnancy [10]. Stein *et al.* found an association between paternal unemployment and low birth weight, but this effect was statistically accounted for by low income[27]. In an identical manner, Morrison *et al.* investigated the impact of paternal socioeconomic status on pregnancy outcome. Before adjustment for lifestyle variables there seemed to be a connection between very low occupational status of the father and perinatal morbidity, but this diminished after further analysis [7].

On the other hand, in studies on SGA infants, lifestyle and psychosocial differences between families have remained important etiological factors of intrauterine growth retardation. SGA infants have been found to be more likely to have an unemployed father, to be of lower socioeconomic status and their mothers to have a lower level of education [28]. Mediating factors of unemployment's health consequences are postulated to be psychosocial. Explanations can be divided into four types: (1) poverty, (2) stress, lack of social support at work and lowered self-esteem, (3) health-related behavior and health attitudes, and (4) the effect of unemployment on the rest of work career and future socio-economic status. Furthermore, selection cannot be ruled out as a partial explanation: people who are unhealthy may be selected for low status occupations and thus be prone to become unemployed, so called healthy worker effect. [1,29-31].

Classification bias may be an issue in the current study. Data on employment status was obtained at 20 weeks of pregnancy and some women or their partners initially categorized as unemployed subsequently changed their status. Another bias may arise from the fact that in 1990's during economical depression pregnant women may have been more prone to become unemployed than women not planning to reproduce, but this would cause rather

Table 3: Pregnancy outcomes in study groups I–III compared with the reference group

Outcome	Group	%	Unadjusted OR	95% CI	Adjusted OR	95% CI
SGA	Reference	8.8				
	I Mother	10.8	1.26	1.11–1.41	1.26	1.12–1.42
	II Father	9.2	1.06	0.88–1.26	1.06	0.88–1.27
	III Both	14.0	1.69	1.41–2.03	1.43	1.18–1.73
Preterm delivery (< 37 weeks)	Reference	6.4				
	I Mother	6.2	0.98	0.84–1.14	0.97	0.83–1.13
	II Father	5.5	0.87	0.69–1.09	0.86	0.68–1.08
	III Both	6.8	1.08	0.84–1.39	0.99	0.77–1.29
Admission to neonatal unit	Reference	7.3				
	I Mother	7.5	1.03	0.89–1.18	1.03	0.90–1.19
	II Father	7.6	1.04	0.86–1.26	1.05	0.87–1.28
	III Both	7.6	1.04	0.82–1.32	1.0	0.78–1.27
Low Apgar score (< 7) 1 min	Reference	5.1				
	I Mother	4.9	0.97	0.82–1.15	0.95	0.80–1.12
	II Father	5.0	0.98	0.77–1.25	0.97	0.76–1.23
	III Both	4.6	0.91	0.68–1.23	0.79	0.58–1.08
Low Apgar score (<7) 5 min	Reference	1.9				
	I Mother	1.8	0.92	0.70–1.21	0.92	0.69–1.21
	II Father	2.0	1.04	0.72–1.50	1.02	0.70–1.48
	III Both	1.5	0.75	0.44–1.25	0.68	0.40–1.16
Fetal venous pH < 7.15 at birth	Reference	1.0				
	I Mother	1.2	1.20	0.86–1.68	1.20	0.86–1.69
	II Father	1.2	1.12	0.69–1.83	1.12	0.69–1.82
	III Both	1.5	1.41	0.83–2.38	1.03	0.68–1.54
Abnormal FHR during delivery	Reference	15.7				
	I Mother	14.0	0.87	0.79–0.97	0.86	0.77–0.96
	II Father	15.2	0.97	0.84–1.12	0.95	0.82–1.10
	III Both	16.5	1.06	0.90–1.26	0.93	0.79–1.12
Fetal death	Reference	0.4				
	I Mother	0.5	1.29	0.76–2.18	1.30	0.76–2.20
	II Father	0.4	0.99	0.43–2.28	1.04	0.45–2.39
	III Both	0.4	0.99	0.36–2.71	1.0	0.36–2.79
Neonatal death	Reference	0.2		0.40–1.98		
	I Mother	0.2	0.89	0.13–2.29	0.80	0.40–1.96
	II Father	0.1	0.56	0.60–4.64	0.56	0.13–2.30
	III Both	0.4	1.66		1.65	0.58–4.68

*OR adjusted for age, parity, smoking, alcohol consumption, infertility, abortions, previous fetal deaths and miscarriages, time since previous pregnancy and maternal illness

underestimation than overestimation of the effect of unemployment on reproductive health. During high unemployment, adverse pregnancy outcomes may also be seen as societal level effects, in addition to the individual effects in unemployed families.[32] The application of our findings may be limited because of differences in maternity care between countries.

Conclusion

These results confirm those of a number of previous studies and suggest that although free-of-charge maternity care may in part cut across the social gradient, maternal unemployment remains an important public health issue in pregnancy even in the era of modern obstetric care. In summary, analysis of the observed data suggests that

maternal unemployment is associated largely with social disadvantage, which results in increased risks when pregnant or in labor. The results clearly convey the impression that the principal reason for the association between a woman's unemployment and adverse pregnancy outcome is the presence of a series of correlated risk factors. However, correction for confounding factors did not entirely explain the association between unemployment and adverse pregnancy outcome. This was particularly the case for families with both parents unemployed but also when only the pregnant women was unemployed, and therefore effective measures should be considered.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

All authors (K.R., N.H., and S.H.) participated in designing the study, analyzing the results and writing the manuscript, K.R. coordinated the study. All authors read and approved the final manuscript.

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III

Good outcome of teenage pregnancies in high-quality maternity care.

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Good outcome of teenage pregnancies in high-quality maternity care

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Background: Teenage pregnancies have been associated with fetal growth restriction, low birth weight, preterm birth and neonatal mortality. These could be due to biological immaturity, lifestyle factors or inadequate attendance to maternity care. The objective of this study was to assess the relationship between young age of the mother and pregnancy risk factors and adverse pregnancy outcome in conditions of high-quality maternity care used by almost the entire pregnant population. **Methods:** We analysed a population-based database of 26 967 singleton pregnancies during 1989–2001. Only 185 of these mothers were under 18 years old. Data were collected using a self-administered questionnaire at 20 weeks of pregnancy and clinical records of pregnancy, delivery and newborn child. The information covered maternal risk factors, pregnancy characteristics and obstetric outcomes. Odds ratios (ORs) for adverse pregnancy outcomes in teenage compared with older mothers were obtained from multiple logistic regression models. **Results:** Teenage mothers smoked, were unemployed and had anaemia or chorioamnionitis more often than older mothers. On the other hand, they were overweight and had maternal diabetes less often than adults. Teenage mothers had as many instrumented deliveries (OR 0.70; 95% confidence interval 0.39–1.27) but fewer Caesarean sections (0.62; 0.39–0.97) than adults. We found no evidence for increased risk of preterm delivery, fetal growth restriction, low birth weight, or fetal or perinatal death in teenage mothers. **Conclusions:** These results suggest that increased risks for adverse pregnancy outcomes in teenage pregnancies can most probably be overcome by means of high-quality maternity care with complete coverage.

Keywords: outcome, pregnancy in adolescence, prenatal health care

Teenage pregnancies have often been reported to be associated with adverse pregnancy outcomes, specifically with low birth weight, small for gestational age (SGA) infants, prematurity, and higher rates of neonatal and postneonatal mortality.[1–6] Some investigators have found that the youngest teenage mothers (aged less than 16 years) have particularly high risks. There is much controversy over whether the risks associated with teenage motherhood are attributable to biological factors, lifestyles or socioeconomic conditions.[7–10] In this context, the latter would denote maternal health behaviour, poor diet, smoking, alcohol use, inadequate attendance to prenatal care and suffering from emotional stress.

Maternity care is provided free of charge in Finland and is used by virtually the entire pregnant population, up to 99.7%.[11] The opportunity to receive maternity care during pregnancy is similar for everyone, regardless of the economic situation of the mother, and non-attendance leads to the loss of maternity benefits. Routine prenatal health care is given in maternity care units by general practitioners and community midwives. In 2001, the average number of maternity care visits during pregnancy was 17.3 in all pregnant women and 16.9 in teenagers. The average time of the first maternity care visit was 9.7 weeks of pregnancy in all pregnant women and at 10.9 weeks of pregnancy in teenagers.[12]

The aim of this study was to assess the effects of young age (under 18 years) on obstetric risk factors and pregnancy outcome in conditions of free, high standard maternity care, used by almost the entire pregnant population. We expected that the reportedly poor pregnancy outcomes associated with teenage pregnancy would not be observed in conditions of high standard maternity care.

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Materials and methods

We investigated the total population who gave birth at the Kuopio University Hospital between January 1989 and December 2001. Our database includes information obtained using a self-administered questionnaire at 20 weeks of pregnancy and complemented by a nurse at later visits to the Kuopio University Hospital. The questionnaire consisted of over 50 questions about smoking and alcohol consumption, previous operations, illnesses and obstetric history, contraceptive use, employment, marital status and paternal characteristics. The information on pregnancy complications, pregnancy outcomes and neonatal period was based on clinical records, collected to the database by the team who took care of the delivery and neonatal care. The patient data were processed anonymously. Multiple pregnancies ($n = 548$) and pregnancies with major fetal structural anomalies ($n = 261$) were excluded before statistical analyses, because such pregnancies carry an unusually high risk of adverse outcome. The present study includes information on 26 976 pregnancies, of which 185 were pregnancies of teenage mothers under 18 years of age.

The following definitions were used to record pregnancy outcomes: preterm birth, delivery before 37 weeks of gestation; prolonged pregnancy, delivery after 42 weeks of gestation; preeclampsia, twice repeated blood pressure measurements exceeding 149/90 mmHg or 30/14 mmHg increase in blood pressure with proteinuria exceeding 0.5 g/day; and low birth weight, birth weight <2500 g. Infants were considered small for gestational age when the sex- and age-adjusted birth weight was below the tenth percentile according to the normal tables for our population. Smoking during pregnancy was defined as over five cigarettes smoked per day. The limit for low haemoglobin was 100 g/l in the third trimester of pregnancy. The pH limit used for fetal acidosis was 7.15 at birth. Overweight was defined

as a BMI over 25 (weight in kg divided by the square of the height in m), calculated at the first visit to maternity care units. If a subject had two abnormalities, such as infant low birth weight and preterm delivery, each was considered an independent outcome and the subject was included in both categories. Unemployed status was clearly distinguishable from students or housewives not actively seeking a job or receiving unemployment benefits. Otherwise socio-economic status was not controlled, because teenage mothers are usually in a poor economic situation or dependent on their parents and information on the parents' economic situation was not available. Differences in educational level or marital status were not considered relevant and were thus not taken into account.

Statistical differences between subjects and controls were evaluated by using χ^2-tests, and Fisher's exact test was applied when the minimal estimated expected value was less than five. Continuous variables were analysed by using two-tailed, pooled *t*-tests. A *P*-value <0.05 was considered statistically significant. Multivariate analysis of significant or nearly significant effects ($P < 0.1$) of independent variables considered in this study (prepregnancy BMI >25 kg/m^2, unemployment, smoking during pregnancy, primiparity, previous miscarriages, surgically scarred uterus, diabetes, anaemia, and prior use of intrauterine device) on dependent outcomes was based on multiple logistic regression analysis (BMDP Statistical Software Inc., Los Angeles, CA). The variables were entered simultaneously. All independent variables were modelled as categorical terms as shown in tables 1 and 2. Confidence intervals (CIs) were evaluated at 95%.[13]

Results

Table 1 shows the distribution of maternal risk factors in teenage and adult women. Teenage mothers were healthier: a pre-gravid overweight condition was seen in only 6.9% of the teenage mothers, which was much less frequent than the 20.7% observed

Table 1 Maternal risk factors

Risk factors	Adult (*n* = 26 782)		Teenage (*n* = 185)		*P*-value
	n	%	*n*	%	
Pre-gravid overweight	5256	20.7	12	6.9	<0.001
Smoking >5 cigarettes per day	1572	5.9	35	18.9	<0.001
Alcohol consumption	909	3.4	2	1.1	0.08
Unemployed	4302	16.9	65	37.6	<0.001
Maternal diabetes	705	2.6	0	0	0.007
Maternal pre-gravid hypertension	528	2.0	2	1.1	0.17
Primiparity	10 942	40.9	171	92.4	<0.001
Previous miscarriage	1040	3.9	5	2.7	<0.001
Prior fetal demise	524	2.0	1	0.54	0.54
Prior termination	2704	10.1	15	8.1	0.53
Prior Caesarean or surgically scarred uterus	2888	10.8	1	0.5	<0.001
IUD	2691	10.1	7	3.8	0.005

BMI = body mass index, IUD = intrauterine device

Table 2 Pregnancy characteristics

Characteristic	Adult (*n* = 26 782)		Teenage (*n* = 185)		*P*-value
	n	%	*n*	%	
Low haemoglobin (<100 g/l)	402	1.6	10	5.7	<0.001
Obstetric cholestasis	172	0.6	1	0.5	0.36
Rh immunization	40	0.2	0	0	0.76
Preeclampsia	855	3.2	6	3.2	0.96
Late pregnancy bleeding	450	1.7	1	0.5	0.13
Chorioamnionitis	385	1.4	7	3.8	0.008
Prolonged gravidity	1266	4.8	8	4.5	0.83
Induced delivery	4557	21.4	29	20.4	0.77
Meconium-stained amniotic fluid	2902	11.1	14	7.7	0.14
Bloody amniotic fluid	566	2.11	1	0.54	0.08

Rh = Rhesus

Table 3 Relative risk of adverse pregnancy outcomes in teenage compared with adult mothers

Outcome	Adult (n = 26782)		Teenage (n = 185)		Unadjusted P-value	Adjusted OR	95% CI
	n	%	n	%			
Abnormal FHR during delivery	4179	17.6	32	18.7	0.69	0.71	0.47–1.07
Caesarean section	4478	16.7	24	13.0	0.17	0.62	0.39–0.97
Forceps or vacuum	1525	5.7	13	7.0	0.44	0.70	0.39–1.27
Fetal venous pH <7.15 at birth	293	1.2	1	0.5	0.25	0.28	0.04–2.20
Low Apgar score (<7) 1 min	1352	5.1	14	7.6	0.11	1.28	0.71–2.27
Low Apgar score (<7) 5 min	511	1.9	6	3.2	0.18	1.53	0.62–3.78
Low birth weight (<2500 g)	1276	4.8	12	6.5	0.27	0.87	0.44–1.72
SGA (<90th percentile)	2566	9.6	26	14.0	0.04	0.91	0.59–1.41
Admission to neonatal unit	2187	8.2	10	5.4	0.17	0.61	0.32–1.16
Preterm delivery (<37 weeks)	1649	6.3	14	7.9	0.39	1.14	0.64–2.02
Fetal death	115	0.4	0	0	0.45	NA	
Perinatal death	169	0.6	0	0	0.31	NA	

OR adjusted for: BMI >25 kg/m^2 before pregnancy, unemployment, smoking during pregnancy, primiparity, previous miscarriages, surgically scarred uterus, diabetes, anaemia, use of an IUD, amnionitis
FHR = fetal heart rate; IUD = intrauterine device

in the adult mothers ($P < 0.001$). Along with obesity, maternal diabetes was much more common in adults, 2.6% versus 0% in teenage ($P = 0.007$). On the other hand, the underweight condition was more common, 37.7% versus 17.1% in teenagers (not shown). Teenage women smoked significantly more often than the adults, 5.9% versus 18.9% ($P < 0.001$). Unemployment was clearly more common in the group of teenage women than in the adults, 37.6% versus 16.9% ($P < 0.001$). Teenage mothers had a healthier reproductive history compared with adults, with 2.7% versus 3.9% ($P < 0.001$) previous miscarriages, and 0.5% versus 10.8% prior uterine scars, e.g. from Caesarean section ($P < 0.001$).

Table 2 summarises the frequencies of various pregnancy and delivery complications. The study groups were very similar in this regard and the teenagers experienced practically the same amount of pregnancy and delivery complications as the adults. Only low haemoglobin in the third trimester of pregnancy ($P < 0.001$) and chorioamnionitis ($P = 0.008$) were found more often in teenage mothers than in the reference population.

Table 3 shows pregnancy outcomes in the study groups after controlling for the obstetric risk factors investigated in this study. Small differences in risk estimates were seen between the groups in low Apgar scores, preterm delivery and low birth weight, in favour of the adult mothers, but none of these differences reached statistical significance. Teenage mothers underwent normal vaginal delivery at least as well as the adults: Caesarean section was carried out less often among teenage than adult mothers [odds ratio (OR) 0.62; 95% CI 0.39–0.97] and there was no statistically significant difference in the frequency of vacuum- or forceps-assisted deliveries between the study groups (OR 0.70; 95% CI 0.39–1.27). The mean birth weights (±SD, not shown in the tables) of new-borns delivered at term (after 37 gestational weeks) were 3512 ± 622 g in adult and 3356 ± 574 g in teenage mothers ($P < 0.001$).

Discussion

Overall, many maternal risk factors were more common in teenage than in older women. The unemployment rate in pregnant teenagers (37.6%) was much higher than the unemployment rate in adult women in the present study (16.9%), or the rate that has previously been described for all teenage women in Finland (11.8%).[14] Also, smoking during pregnancy was more common in teenage women. On the other hand, the prevalence of overweight and diabetes was lower in teenage than in older women. Generally, the maternal risk profile in teenage pregnancies was found to be similar to the risk profiles in other studies.[3,5,8,15,16]

Teenage women were found to have a higher incidence of chorioamnionitis, which may be the result of several causes such as physiological immaturity of the cervix, specifically alkalinity of vaginal pH, prominence of the squamocellular junction and shorter cervical length.[17] In addition, serially monogamous relationships are more common in teenagers than in adults and thus sexually transmitted diseases such as chlamydia infection are more common in teenage mothers.[17] Accordingly, anaemia during the third trimester of pregnancy was significantly more common in the teenage mothers, suggesting a poorer nutritional status in young mothers, as reported in a number of previous studies.[4,5] However, only anaemia in the first or second trimester has been found to impair pregnancy outcome in previous studies.[18,19]

In our study population no excess risk of adverse pregnancy outcome in teenage mothers was found after controlling for the confounding factors in logistic regression. So far, studies concerning teenage pregnancy outcomes have had somewhat differing results. Some studies have suggested increased risks for poor pregnancy outcome, especially preterm birth [relative risk (RR) from 1.28 to 1.79],[3–5,20–24] but also for SGA infants (RR 1.3–1.89),[3,5,15,16] low birth weight infants (RR 1.29–1.7)[1–3,5,7,8,16,17] and fetal or perinatal death (RR 1.2–1.77).[5,6,22,25] In other studies, however, no risk increases have been reported.[7,9,10,19] Teenagers have also been reported to undergo normal vaginal delivery more often than adults and to have a lower proportion of Caesarean deliveries or instrumented vaginal deliveries.[2,4,5,8,10,15,16]

There are several possible explanations for the reported differences concerning obstetric outcome of teenage pregnancies. First, the age group 'teenagers' varies between studies from

under 17 to under 20 years of age. In the present study, only nine teenage mothers were less than 16 years old and the effects of very young age could thus not be studied separately. However, one may speculate the effects of young age *per se* should be more clear in the youngest age groups.

Secondly, the teenage pregnancy rate varies greatly between countries. The teenage birth rate in Finland is 9.8 births per 1000 women (aged 15–19 years), being similar to the rates in Sweden (7.7) and Denmark (8.3)[12–14] and low compared with the rates in many other countries, e.g. the UK (28.4), Germany (12.5) Canada (24.2) or USA (54.4).[26–28]

Thirdly, there are many differences in maternity care systems worldwide. In some countries maternity care systems are based on insurance[29] and the availability of these services depends on the economic circumstances of the mother, which are likely to be worse in teenage mothers than in adults. In some countries maternity care is provided free of charge and special attention is focused on mothers considered to be at greater psychosocial risk. Poor attendance by teenagers has been reported at some perinatal clinics.[3,7,8,30] Finally, the effects of chance as a (partial) source of controversy about outcomes of teenage pregnancies cannot be ruled out.

Hence our positive results may at least partly stem from the high quality of maternity care system in Finland: free of charge,[31] attended early in the pregnancy,[12] used by almost the entire pregnant population,[31] early, consisting of numerous visits, minimum six antenatal visits for normal multigravidas and eight to 10 visits for primiparous women and an average of 17 visits to maternity care units,[12,32,33] using high technology, and having low rates of maternal and perinatal mortality.[34] Also, the incidence of mortality caused by suboptimal care in Finland has been reported to be the lowest in the Europe.[34]

This study raised some questions that could not be investigated, partly due to the limited number of teenage women, and further studies are required. Presumably, the higher incidence of chorioamnionitis together with inadequate prenatal care in teenage women might explain the excess preterm births found in previous studies. Thus the number of sexual partners prior to teenage pregnancy might be of interest in future studies.

Maternity care is likely to be of importance in screening for biological risks of adolescent pregnancy such as cervical shortness, infections, inadequate nutrition and abuse. The issues of teenage pregnancy concern hundreds of thousands of women and children in Europe yearly and the public health implications of this study are in preventive measures. Maternity care will also be of importance in terms of offering psychosocial support in the difficult and stressful the situation in which teenage mothers find themselves. Emotional stress has been reported to cause endocrine disturbances and preterm delivery[35,36] and relieving this stress could lead to a more favourable outcome. Psychosocial support of teenage mothers may prevent economical, educational and social marginalization and does not underrate the medical attendance needed.[37] Furthermore, as teenage women giving birth are much more often unemployed than other women of their age, their children may need additional support and surveillance.

To conclude, some maternal and pregnancy risk factors were more common in teenage than older women. However, we found no evidence for major impairments of pregnancy outcome among teenage mothers in conditions of high-quality maternity care with complete coverage. This study does not reveal what would have happened without free maternity care and our results may not apply to other populations with a different health care system. In any case, the maternity care system faces a challenge in opposing the adverse pregnancy outcomes either via preventive measures or clinical practice.

Key points

- We studied risk factors and outcome of pregnancies of teenage women who attended high quality maternity care.
- Smoking, unemployment, anaemia and chorioamnionitis were found to be risk factors of teenage pregnancies.
- After multiple logistic regression analyses obstetric outcome of teenage pregnancies was as good as for adults.
- Increased risks of adverse pregnancy outcomes in teenage reported in earlier studies can probably be overcome by means of maternity care.

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IV

Transition from an overweight condition to obesity worsens pregnancy outcome in a BMI- dependent manner.

Raatikainen K, Heiskanen N, Heinonen S.

Obes Res. 2006 Jan 14(1):165-71¤

Descriptive Epidemiology

Transition from Overweight to Obesity Worsens Pregnancy Outcome in a BMI-dependent Manner

Kaisa Raatikainen, Nonna Heiskanen, and Seppo Heinonen

Abstract

RAATIKAINEN, KAISA, NONNA HEISKANEN, AND SEPPO HEINONEN. Transition from overweight to obesity worsens pregnancy outcome in a BMI-dependent manner. *Obesity.* 2006;14:165–171.

Objective: To assess pregnancy outcomes in different BMI groups.

Research Methods and Procedures: We analyzed 25,601 singleton pregnancies from January 1989 to December 2001. Overweight women (prepregnancy BMI = 26 to 29 kg/m^2) represented 13.2% (3388) of the cases, and 7.3% (1880) were obese (BMI $\geq$ 30 kg/m^2). The data were obtained from self-administered questionnaires at 20 weeks of pregnancy, complemented by nurse interviews and clinical records. Multiple logistic regression analysis was used to control for confounding factors.

Results: Overweight and obese women had more previous deliveries, pregnancy terminations, miscarriages, and stillbirths, to have more diabetes and hypertension, and to smoke more often than normal weight women. The pregnancies were more often complicated by preeclampsia or chorioamnionitis ($p < 0.001$). Pregnancy outcomes were impaired in overweight and obese pregnant women, with respective odds ratios (95% confidence index) as follows: low Apgar score at 5 minutes, 1.54 (1.20 to 1.98) and 1.64 (1.22 to 2.28); newborn admission to a neonatal unit, 1.20 (1.06 to 1.37) and 1.38 (1.17 to 1.61); cesarean delivery, 1.22 (1.10 to 1.35) and 1.68 (1.48 to 1.91); fetal death, 1.54 (0.88 to 2.68) and 2.35 (1.28 to 4.32); perinatal death, 1.54 (0.98 to 2.42) and 2.19 (1.33 to 3.62).

Discussion: Obesity, in particular during pregnancy, should be considered as an abnormal situation. An overweight condition increases obstetric risks in a BMI-dependent manner. The risk of perinatal death more than doubles in the transition from an overweight to an obese condition. Modest weight loss could bring substantial advantages to obstetric outcome.

Key words: morbidity, perinatal, obstetrics, pregnancy outcome, pregnancy complications

Introduction

In Finland, in the 1990s, women giving birth became more overweight; i.e., the frequency of a prepregnancy BMI of >25 kg/m^2 rose from 18.8% in 1990 to 24.5% in 2000, and the frequency of obesity (BMI $\geq$ 30 kg/m^2) rose from 7.5% to 11.0%. The same increasing trend in the prevalence of maternal obesity has been reported in other European countries and in the United States (1,2). At the same time, the percentage of pregnant women older than 35 years of age rose from 13.9% to 18.4% (3), and the mean maternal age at delivery rose from 29.1 years in 1990 to 29.9 years in 2000 (3), possibly contributing to the increased incidence of obesity during pregnancy.

Obesity is a known risk factor for several diseases and a major public health issue. It can lead to severe functional impairment and is associated with a considerable proportion of disability pensions (4). An overweight condition during pregnancy has been reported to increase morbidity, specifically hypertension (5–7), diabetes hypertension (5–7), gestational diabetes (2,6–10), and preeclampsia (5–7,10). Deliveries by obese women have been reported to be complicated by higher rates of labor induction (10,11), cesarean section (2,5,6,8,9,12–16), and dystocia resulting from macrosomia (2,6). A possible increase in the preterm birth rate is still controversial; some studies have shown an increased incidence (8), whereas others have not (6,10).

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Furthermore, a maternal overweight condition has been reported to be an independent risk factor associated with fetal death, showing a progressively increasing risk along with increasing maternal weight (8,12,17–19). The effect of maternal weight on perinatal deaths has been studied in only a few studies thus far, and the causes of increased mortality are still undefined (12).

Using a hospital database, we investigated all births from 1989 to 2001. The database includes data on maternal characteristics and pregnancy risk factors, complications, pregnancy outcome, and the neonatal period. We used the extensive database to control for possible confounding factors when calculating odds ratios (ORs)[1] of various obstetric outcomes using logistic regression analysis in studying the effects of maternal overweight and obesity on pregnancy risks.

In Finland, the standard of maternity care is high. It is free of charge and is used by almost the entire (99.3%) pregnant population (20). Maternity care starts early in pregnancy (3), and it consists of numerous visits: a minimum of 6 antenatal visits for normal multigravidas, 8 to 10 visits for primiparous women, and an average of 17 visits to maternity care units (3). Moreover, high technology is involved; there are very low rates of maternal and perinatal mortality (21), and there is a low incidence of mortality resulting from suboptimal care (22). Routine prenatal health care in maternity care units is provided by general practitioners and community midwives. However, treating obese pregnant women, with all of the known risks, is a challenge to maternity care. Our study hypothesis was that being even a minor degree overweight (BMI = 26 to 29 kg/m^2) increases the risk of adverse pregnancy outcomes.

Research Methods and Procedures

We investigated the total population who gave birth at Kuopio University Hospital between January 1989 and December 2001, a total of 26,424 pregnancies. Information on maternal characteristics was based on data from self-administered questionnaires at 20 weeks of pregnancy, complemented by nurse interviews at visits to Kuopio University Hospital. The questionnaire consisted of more than 50 questions concerning marital status, employment, previous operations, illnesses, obstetric history, contraceptive use, smoking, alcohol consumption, and paternal characteristics. Information on pregnancy complications, pregnancy outcome, and the neonatal period was from clinical records. It was added to the database by the team who took care of delivery and neonatal care. The data were processed anonymously. They included 25,601 single pregnancies without major structural anomalies, of which 5268 involved overweight women (BMI = 26 to 70 kg/m^2). Normal weight women (BMI $\leq$ 25 kg/m^2) were used as a reference group. Two subgroups were created: overweight (pre-pregnancy BMI = 26 to 29 kg/m^2) and obese (pre-pregnancy BMI $\geq$ 30 kg/m^2). The women were measured at their first maternity care visit, in most cases before the 10th week of pregnancy, and BMI was calculated as kilograms per meter squared. Information on maternal weight was missing in 5.3% of the recorded pregnancies. Exclusion criteria were 1) multiple pregnancies (n = 548) and 2) major fetal structural anomalies (n = 275), because such pregnancies carry an unusually high risk of adverse outcome, and the effect of maternal weight on these pregnancies would be difficult to distinguish. The study population was ethnically homogeneous.

The following definitions were used: fetal death, intrauterine death of a fetus under 22 weeks of gestational age or 500 grams weight; perinatal death, intrauterine death after 22 weeks of gestation or 500 grams weight or during the first 7 days after birth; preterm birth, delivery before 37 weeks of gestation; prolonged pregnancy, delivery after 42 weeks of gestation; preeclampsia, repeated blood pressure measurement exceeding 149/90 mm Hg with proteinuria exceeding 0.5 g/d; maternal diabetes, insulin-treated diabetes during pregnancy; low birth weight, birth weight <2500 grams. Infants were considered small for gestational age when the age- and sex-adjusted birth weight was below the 10th percentile according to the normal tables for our population. Grand multiparity was defined having more than seven previous deliveries. The woman was considered a smoker when she smoked five cigarettes or more per day during pregnancy. We used a risk factor-based screening procedure for gestational diabetes followed by a 75-gram oral glucose tolerance test as the diagnostic test, using World Health Organization criteria, and up to one-third of all pregnant women, including all overweight and obese women, were tested. Alcohol use was recorded at interview; the pregnant woman either used or did not use alcohol before pregnancy and at 20 weeks of pregnancy. Illicit drug use was marginal in Kuopio in the 1990s. Low hemoglobin was defined as <100 g/liter in the third trimester of pregnancy. The pH limit used for fetal acidosis was 7.15 at birth. If a subject had two abnormalities, such as low birth weight and preterm delivery, each was considered an independent outcome, and the subject was included in both categories.

Statistical differences between the subjects and the reference group were evaluated using χ^2 tests (dichotomous variables), and Fisher's exact test was applied when the minimal estimated expected value was less than five. A value of $p < 0.05$ was considered statistically significant. Continuous variables were analyzed using two-tailed, pooled Student's t tests. Possible confounding variables were identified from background data, obstetric risk factors, and health behavior. Multivariate analysis of significant or nearly significant effects ($p < 0.1$) of lifestyle variables

[1] Nonstandard abbreviations: OR, odds ratio; CI, confidence index.

Table 1. Reproductive risk factors among overweight and obese women vs. normal weight women

Risk factors	Normal weight (n = 20,333) (%)	Overweight (n = 3388) (% p)	Obese (n = 1880) (% p)
Age under 18	0.8	0.3 < 0.001	0.2 < 0.001
Age over 35	10.5	16.3 < 0.001	15.9 < 0.001
Primiparity	42.7	33.0 < 0.001	30.4 < 0.001
More than seven deliveries	0.3	0.8 < 0.001	0.6 < 0.03
Previous miscarriage	16.5	20.1 < 0.001	19.8 < 0.001
Prior fetal death	1.7	2.7 < 0.001	3.4 < 0.001
Prior termination of pregnancy	9.7	11.5 < 0.005	12.9 < 0.001
Prior operations on uterus	9.7	15.0 < 0.001	15.4 < 0.001
Short interpregnancy interval (<12 months)	14.2	16.1 < 0.004	15.2 < 0.36
Long interpregnancy interval (>6 years)	18.0	20.7 < 0.006	21.7 < 0.003
History of infertility	5.7	6.2 < 0.37	6.9 < 0.046
IUD before pregnancy	9.5	12.4 < 0.001	13.8 < 0.001
Smoking >5 cigarettes/d	5.6	7.4 < 0.001	7.7 < 0.001
Alcohol consumption	3.4	3.8 < 0.32	3.6 < 0.72
Chronic disease	5.5	7.0 < 0.001	10.5 < 0.001
Essential hypertension	1.5	3.0 < 0.001	5.3 < 0.001
Maternal diabetes	1.4	5.4 < 0.001	10.1 < 0.001

concerned in this study was based on multiple logistic regression analysis (BMDP Statistical Software, Los Angeles, CA). Confidence intervals were evaluated at 95% (23,24).

Results

Of the women pregnant and giving birth at Kuopio University Hospital between January 1989 and December 2001, 13.2% were overweight (BMI = 26 to 29 kg/m^2), and 7.3% were obese (BMI = 30 to 70 kg/m^2) at the first maternity care visit. Compared with the normal weight women, the overweight and obese women were older: mean age in the normal weight women was 28.7 ± 5.3 vs. 29.7 ± 5.6 (SD) years ($p < 0.001$) in the overweight women and 29.9 ± 5.5 years ($p < 0.001$) in the obese women. The youngest mother in this study was 14 years, and the oldest was 52 years.

Table 1 shows the distribution of maternal risk factors. The maternal risk profile differed statistically significantly ($p < 0.001$) between the study groups in nearly every aspect concerned: overweight and obese women were less often primiparous and more often multiparous. An unfavorable obstetric history, specifically previous pregnancy terminations, miscarriages, and instances of fetal demise, were more common in the overweight and obese women than in the normal weight women. Prior cesarean section had occurred more often among the obese and overweight women, and the pregnancy concerned was more often the second in 12 months or there was an interval of >6 years between the pregnancy concerned and prior pregnancy. Use of an intrauterine device as a contraceptive was more usual in the overweight and obese women; overweight and obese women smoked more often during pregnancy. Furthermore, the overweight and obese women more often had chronic illnesses, and the numbers of diabetic and hypertensive women were greater than in the normal weight women. Age <18 years was less common and age >35 years was more common in overweight and obese women. Only alcohol consumption during pregnancy did not vary between the study groups.

Table 2 summarizes the frequencies of various pregnancy and delivery complications. The differences between study groups were statistically significant in nearly every aspect concerned. Preeclampsia and chorioamnionitis were more frequent in the overweight and obese women than in normal weight women. The amniotic fluid was more often found to be meconium-stained at delivery in obese and overweight women. On the other hand, no difference between the study groups was found in incidence of obstetric cholestasis. Low hemoglobin was less usual in overweight women than in the reference population.

The mean birth weight among newborns who were delivered at term, after 37 weeks of gestation, was 3489 ± 587 grams in the normal weight women, 3618 ± 662 grams in the overweight women, and 3616 ± 736 grams in the obese women. Accordingly, the newborns of overweight and

Table 2. Pregnancy and delivery characteristics in overweight and obese women vs. normal weight women

Characteristic	Normal weight (n = 20,333) (%)	Overweight (n = 3388) (% p)	Obese (n = 1880) (% p)
Prolonged gravidity	4.6	5.7 < 0.007	5.6 < 0.06
Late pregnancy bleeding	1.7	1.2 < 0.06	1.3 < 0.3
Low hemoglobin (<100 g/liter)	1.7	1.2 < 0.005	1.0 < 0.03
Meconium-stained AF	10.3	12.8 < 0.001	14.3 < 0.001
Chorioamnionitis	1.3	1.7 < 0.05	2.2 < 0.001
Obstetric cholestasis	0.6	0.8 < 0.33	0.3 < 0.1
Preeclampsia	2.6	4.1 < 0.001	6.2 < 0.001
Induced delivery	19.1	27.7 < 0.001	34.0 < 0.001

AF, amniotic fluid.

obese mothers weighed 156 and 128 grams more, respectively, than the newborns of normal weight mothers; these differences were statistically significant ($p < 0.001$). The highest birth weight was 5860 grams in the infants of normal weight mothers and 6020 grams in the infants of overweight/obese mothers. The incidence of clavicle fractures did not vary between the study groups, but Erb's paresis was a more common delivery complication in overweight/obese women than in normal weight women ($p < 0.001$).

Table 3 shows the adjusted ORs of adverse pregnancy outcomes in the three subgroups overweight, pooled (overweight and obese), and obese, after controlling for the obstetric risk factors investigated in this study in multiple logistic regression analysis. There was an increasing trend in the risk of adverse pregnancy outcome in the study groups: perinatal death rate, OR = 1.54 in the overweight study group, OR = 1.74 in the pooled study group, and OR = 2.19 in the obese study group; fetal death rate, ORs of 1.54, 1.79, and 2.35, respectively; low Apgar scores at 5 minutes of age, ORs of 1.54, 1.59, and 1.64, respectively; admission to a neonatal unit, ORs of 1.20, 1.26, and 1.38, respectively. The same trend was seen in the determinants of fetal asphyxia: abnormal fetal heart rate during delivery and low fetal venous pH at birth. The cesarean section rate also followed the same pattern, with ORs of 1.22, 1.37, and 1.68, respectively. However, no difference between the study groups was seen in the rates of instrumental delivery. Additionally, preterm delivery (before 37 weeks of gestation) and low birth weight (<2500 grams) seemed to be more common among overweight and obese mothers, but after adjusting for pregnancy risk factors, no statistically significant differences remained. On the other hand, the risk of having small-for-gestational age infants was higher in the normal weight women than in the overweight and obese women. Overall, the differences between unadjusted and adjusted ORs calculated in multivariate logistic regression analyses were small. In these analyses, the most predictive factors for perinatal death were primiparity [p = 0.003, OR = 2.0, 95% confidence index (CI): 1.29 to 3.08], previous miscarriage ($p < 0.001$, OR = 1.90, 95% CI: 1.27 to 2.84), previous stillbirth (p = 0.02, OR = 2.20, 95% CI: 1.29 to 3.08), and long interpregnancy interval (p = 0.01, OR = 1.87, 95% CI: 1.05 to 3.33).

Discussion

An overweight maternal condition exists in >20% of all pregnancies and represents a major public health issue because of the numerous known pregnancy risks and complications. In this study, we found an increasing trend in the risk of severe adverse obstetric outcomes, rising along with increasing maternal BMI. The risk of perinatal death was found to be high among overweight and obese women (OR = 1.54 to 2.19). The risk of fetal death was also found to be markedly increased (OR = 1.54 to 2.35), rising in a BMI-dependent manner. In addition, the risk of low Apgar scores (OR = 1.54 to 1.64) and incidence of the newborn being admitted to a neonatal intensive care unit (OR = 1.26 to 1.38) were high. The most predictive maternal background characteristics regarding perinatal mortality and fetal death were primiparity (OR = 2.0), previous miscarriage (OR = 1.90), previous stillbirth (OR = 2.20), and long interpregnancy interval (OR = 1.87). Maternal morbidity was also found to rise markedly when comparing overweight (BMI = 26 to 29 kg/m^2) vs. obese (BMI ≥ 30 kg/m^2) women: the incidence of maternal diabetes rose by 87%, that of hypertension by 77%, that of chronic diseases by 50%, and that of chorioamnionitis by 29%. At the same time, risky maternal health behavior, specifically smoking and alcohol consumption, and a history of previous pregnancy termination did not increase as much (by only 2.6%

Table 3. Adjusted ORs of adverse pregnancy outcomes in various BMI groups

	BMI group	Proportion (%)	Unadjusted *p*	OR	95% CI
Pre-term delivery	≤25	5.8			
	26 to 29	6.5	0.07	1.02	0.87 to 1.20
	30 to 70	7.9	<0.001	1.12	0.92 to 1.36
	26 to 70	7.0	<0.001	1.06	0.93 to 1.21
Abnormal FHR pattern	≤25	17.1			
	26 to 29	18.5	0.07	1.13	1.02 to 1.25
	30 to 70	19.0	0.06	1.18	1.03 to 1.35
	26 to 70	18.6	0.01	1.15	1.05 to 1.25
Umbilical vein pH < 7.15 at birth	≤25	1.1			
	26 to 29	1.5	0.12	1.36	0.97 to 1.90
	30 to 70	1.6	0.13	1.47	0.96 to 2.24
	26 to 70	1.5	0.04	1.38	1.04 to 1.83
5 minutes Apgar < 7	≤25	1.5			
	26 to 29	2.5	<0.001	1.54	1.20 to 1.98
	30 to 70	2.6	<0.001	1.64	1.22 to 2.28
	26 to 70	2.5	<0.001	1.59	1.28 to 1.97
Instrumental delivery	≤25	5.9			
	26 to 29	5.2	0.11	0.98	0.83 to 1.16
	30 to 70	4.7	0.04	0.96	0.76 to 1.21
	26 to 70	5.1	0.01	0.98	0.85 to 1.13
Cesarean section	≤25	15.2			
	26 to 29	19.4	<0.001	1.22	1.10 to 1.35
	30 to 70	24.6	<0.001	1.68	1.48 to 1.91
	26 to 70	21.2	<0.001	1.37	1.25 to 1.49
SGA (<10th percentile)	≤25	10.2			
	26 to 29	7.1	<0.001	0.67	0.58 to 0.77
	30 to 70	8.0	0.003	0.75	0.63 to 0.90
	26 to 70	7.4	<0.001	0.69	0.62 to 0.78
Low birth weight (<2500 g)	≤25	4.3			
	26 to 29	5.2	0.002	1.04	0.89 to 1.21
	30 to 70	4.7	0.20	0.99	0.82 to 1.19
	26 to 70	6.2	<0.001	1.13	0.90 to 1.41
Admission to neonatal unit	≤25	7.5			
	26 to 29	9.7	<0.001	1.20	1.06 to 1.37
	30 to 70	12.0	<0.001	1.38	1.17 to 1.61
	26 to 70	10.5	<0.001	1.26	1.13 to 1.41
Fetal death	≤25	0.3			
	26 to 29	0.5	0.06	1.54	0.88 to 2.68
	30 to 70	0.7	0.006	2.35	1.28 to 4.32
	26 to 70	0.6	0.004	1.79	1.14 to 2.83
Perinatal death	≤25	0.5			
	26 to 29	0.7	<0.04	1.54	0.98 to 2.42
	30 to 70	1.1	<0.001	2.19	1.33 to 3.62
	26 to 70	0.9	<0.001	1.74	1.20 to 2.52

BMI = 25 kg/m^2, n = 20,333; BMI = pooled, 26 to 70 kg/m^2, n = 5268; BMI = overweight, 26 to 29 kg/m^2, n = 3388; BMI = obese, 30 to 70 kg/m^2, n = 1880.
OR, odds ratio; CI, confidence index; FHR, fetal heart rate; SGA, small for gestational age.

to 12%). Maternal obesity even decreased the risk of anemia during pregnancy, which reflects good nutritional status.

The effect of an overweight condition on adverse pregnancy outcomes did not diminish in logistic regression analyses controlling for the numerous differences in maternal prepregnancy characteristics. We confirmed previously reported results of an overweight condition increasing the risks of maternal diabetes (5–7), preeclampsia (5,7–10), induced deliveries (10,11), prolonged pregnancies (12), and cesarean sections (2,5,6,8,9,12–16). Furthermore, we confirmed the results of previous studies regarding no excess risk of preterm birth (10,11) and a protective effect on fetal growth restriction (10).

The increasing trend toward obesity among pregnant women is costly. Because obesity is, at least in theory, a preventable threat to pregnancy, the excess fetal and perinatal mortality would be amenable to preventive measures. The costs arise from additional hospitalization of mothers as a result of chronic illnesses caused by obesity, an excess incidence of preeclampsia, extra pregnancy screening at maternity clinics, and an increased cesarean section rate, with increased risks of anesthesia complications, wound infections, and dehiscence owing to obesity (13–16). There is also the cost of treatment of infants at neonatal intensive care units as a result of maternal diabetes, birth asphyxia, and dystocia. Moreover, the consequences of being born to an obese mother with diabetes do not end in early childhood, and the offspring of diabetic mothers have been reported to be at an increased risk of diabetes and obesity; this risk does not seem to diminish with time but continues to adulthood (25). To gain more understanding of the mechanisms leading to the increase in fetal and perinatal deaths in obese mothers, further research is needed.

The prevalence of obesity increases in every age and social class, and it is a multifactorial trait, because both environmental and genetic factors are known to contribute to its development. It has been estimated that up to 40% to 80% of the variation in body weight is caused by genetic factors. In refining the phenotype, the mechanisms of body weight regulation, adiposity, and adipocyte metabolism, as well as feeding behavior, have to be taken into account (26–28). Whatever the mechanism, obesity is known to be associated with metabolic abnormalities, such as dyslipidemia, hypertension, insulin resistance, and endothelial dysfunction. During pregnancy, obesity, with its accompanying metabolic alterations, clearly is a risk factor for gestational diabetes, placental insufficiency, pregnancy-related hypertension, and preeclampsia (29,30), and even moderate weight loss would be protective against these complications.

The results of this study imply that maternity care comes too late to make a change in the pregnancies of overweight women. We suggest that obese women (BMI $\geq$ 30 kg/m^2), at least, should be sent to maternity clinics for screening because of their high pregnancy risks and should be carefully monitored during delivery to lower the high risk of adverse pregnancy outcome. The results of a number of earlier studies showed no association between gestational weight gain and pregnancy complications (11,12,19,21), although excessive weight gain predisposes women to obesity-related problems after pregnancy. Thus, preventive measures should be taken with overweight teenagers before their first pregnancy, and delivery wards should have an essential role in identifying women at high risk in their next pregnancy as a result of obesity. Childbearing at a younger age should be encouraged, because it would reduce the number of overweight mothers. Even modest weight loss, aimed at keeping maternal weight under the limit of obesity (BMI $\geq$ 30 kg/m^2), would bring substantial advantages to the obstetric outcome of these women.

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V

Induced abortion – not an independent risk factor of pregnancy outcome, but a challenge for health counselling

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ELSEVIER

Induced Abortion: Not an Independent Risk Factor for Pregnancy Outcome, But a Challenge for Health Counseling

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PURPOSE: Low birth weight (LBW), preterm births, abnormal placentation, and miscarriages have been associated with prior induced abortions. An incidence-related effect has been suggested. The objective of this study is to assess the effects of prior induced abortions on obstetric risk factors and pregnancy outcome in conditions of free high-standard maternity care used by almost the entire pregnant population in Finland.
METHODS: We analyzed a population-based database including 26,976 singleton pregnancies from 1989 to 2001, of which 2364 were among women with one prior induced abortion and 355 women had had at least two prior induced abortions. Data included maternal risk factors, pregnancy characteristics, and obstetric outcome measures and were based on results of a self-administered questionnaire at 20 weeks of pregnancy and clinical records. Odds ratios (ORs) concerning pregnancy outcomes were calculated in multiple logistic regression analysis.
RESULTS: Induced abortions were associated with several known pregnancy risk factors; specifically, maternal age older than 35 years, unemployment, unmarried status, low educational level, smoking, alcohol consumption, overweight condition, and chronic illnesses. Preterm birth (OR, 1.19; 95% confidence interval, 1.01–1.41) in women with one prior abortion (7.3% versus 6.2%) and LBW (OR, 1.54; 95% confidence interval, 1.02–2.32) in women with two or more prior abortions (7.0% versus 4.7%) appeared to be more common, but after logistic regression analysis, we found no evidence of adverse pregnancy outcomes.
CONCLUSIONS: Induced abortion is not an independent risk factor for adverse obstetric outcome. Marked health behavioral pregnancy risks are associated with prior induced abortions. Health counseling of these women is a challenge, but this objective has not yet been achieved.
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KEY WORDS: Induced Abortion, Pregnancy Outcome, Risk Factors, Counseling.

INTRODUCTION

A history of induced abortion is highly prevalent among pregnant women, and any effect on subsequent pregnancy outcome would be of public health interest. The published literature concerning effects of prior induced abortions on subsequent pregnancies is limited, and clear conclusions are lacking; some studies showed elevated pregnancy risks, whereas others did not. The main adverse outcomes associated with prior induced abortions are preterm birth (1–5), miscarriages (6), abnormal placentation (7–10), and certain types of mood disorders (10). However, weaknesses of these studies are the possibility of recall bias and lack of statistical control over confounding factors.

In Finland, the rate of induced abortions is low in terms of world statistics, i.e., 157/1000 live births, whereas ratios are 304/1000 in Sweden, 260/1000 in Italy, 503/1000 in the Czech Republic and 230/1000 in the United States (10). The highest ratio worldwide has been reported to be in Russia (1888/1000), although the reliability of registering the actual numbers varies among countries (10). In Finland, all induced abortions are reported to the Register on Induced Abortions.

In Finland, induced abortion is legal, and virtually all pregnancy terminations are performed at public hospitals. The method used in the first trimester is mainly dilatation and surgical vacuum aspiration or curettage. Recently, the proportion of medically induced abortions, using misoprostol and mifepristone, increased from 3% in 1999 to nearly 30% in 2003. During the study period (1989 to 2001), the method used to induce abortions was surgical in first trimester and medical in the second trimester. Of all induced abortions, 94% were performed in the first trimester of pregnancy. Reasons for induced abortion were social in 85.3%, medical (maternal disease or medication) in 0.52%, ethical (criminal) in 0.1%, age younger than 17 years in 4.88%, age older than 40 years in 5.53%, having more than four children in 1.9%, and fetal defect in 1.45% of cases (11).

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Selected Abbreviations and Acronyms

OR = odds ratio
LBW = low birth weight

The aim of this study is to assess maternal risk factors, pregnancy complications, and outcomes associated with prior induced abortions. We used an extensive hospital-based database of all births from 1989 to 2001 to control for possible confounding factors in logistic regression analysis when studying the effect of prior induced abortions on subsequent obstetric outcome.

METHODS

We investigated the total population that gave birth at Kuopio University Hospital (Kuopio, Finland) between January 1989 and December 2001. Kuopio University Hospital offers practically all obstetric care needed at the Kuopio district; therefore, the population can be considered representative to the Finnish overall obstetric population in Finland. The Institutional Review Board accepted the study, and childbearing women gave informed consent at the time of data collection. Information for maternal characteristics was based on data from self-administered questionnaires at 20 weeks of pregnancy, complemented by nurse interviews at visits to Kuopio University Hospital. In addition, prior clinical records pertinent to gynecologic history were available. The questionnaire consisted of more than 50 questions concerning marital status; employment; previous operations, illnesses, and obstetric history; contraceptive use; smoking and alcohol consumption; and paternal characteristics. Information on pregnancy complications, pregnancy outcome, and the neonatal period was based on clinical records collected by the team involved in delivery and neonatal care. Data were processed anonymously. Women with no reported history of induced abortion were used as a reference group. Exclusion criteria were: i) multiple pregnancies and ii) major fetal structural anomalies because such pregnancies carry an unusually high risk for adverse outcome, and the effect of prior pregnancy terminations on these pregnancies would be difficult to distinguish. The study population was ethnically homogeneous.

The following definitions were used to record pregnancy risk factors and outcomes: preterm birth, delivery before 37 weeks of gestation; prolonged pregnancy, delivery after 42 weeks of gestation; preeclampsia, repeated blood pressure measurement exceeding 149/90 mm Hg with proteinuria with protein exceeding 0.5 g/d; maternal diabetes, insulin-treated diabetes during pregnancy; and low birth weight (LBW), birth weight less than 2500 g. Infants were considered small for gestational age (SGA) when the age- and sex-adjusted birth weight was less than the 10th percentile according to the normal tables for our population. Grand multiparity is defined as having had more than seven previous deliveries. An overweight condition is defined as a body mass index greater than 25 kg/m^2, measured at the first visit to maternity care. The mother was considered a smoker when she smoked five or more cigarettes per day during pregnancy. Alcohol use was recorded at interview; the mother either used or did not use alcohol before pregnancy and at 20 weeks of pregnancy. Low hemoglobin level is defined as less than 100 g/L in the third trimester of pregnancy. The pH limit used for fetal acidosis was 7.15 at birth. If a subject had two abnormalities, such as LBW and preterm delivery, each was considered an independent outcome and the subject was included in both categories.

Statistical differences between study groups and the reference group were evaluated by using chi-square tests (dichotomous variables), and Fisher exact test was applied when the minimal estimated expected value was less than five. $p < 0.05$ is considered statistically significant. Continuous variables were analyzed by using two-tailed pooled *t*-tests. Possible confounding variables were identified from background data, obstetric risk factors, and health behavior. Multivariable analysis of significant or nearly significant effects ($p < 0.1$) of lifestyle variables concerned in this study was based on multiple logistic regression analysis (BMDP Statistical Software Inc., Los Angeles, CA). Multivariable analysis was performed stepwise, leaving only the significantly associated confounders of each outcome to the final models. Confidence intervals were evaluated at 95% (12).

RESULTS

Our data included 26,976 pregnancies, of which 2364 were among women who reported one prior induced abortion (8.77%) and 355 women had had at least two prior induced abortions (1.32%). In these women, maternal demographic characteristics differed from those in the general obstetric population: women with a history of induced abortions more often were unemployed (21.8% versus 16.2%; $p < 0.001$) and their educational level more was often low (31.5% versus 21.2%; $p < 0.001$ and less often high (15.7% versus 25.0%; $p < 0.001$).

Table 1 lists the distribution of maternal risk factors. Women with a history of induced abortions were overweight more often, smoked, and used alcohol more often during pregnancy than women not reporting prior induced abortions. They more often had chronic illnesses in general, but the proportions of women with diabetes or high blood pressure did not vary between study groups. Reproductive history differed between the study groups: women with prior induced abortions more often were parous than women with no history of induced abortion, but none was grand

TABLE 1. Maternal risk factors

	Reference group (n = 24,248)	One termination (n = 2364)		Two or more terminations (n = 355)	
Risk factors	%	%	p	%	p
Age ≤18 years	0.7	0.6	0.54	0.3	.34
Age ≥ 36 years	11.7	11.9	<1	15.5	.03
Primiparous	41.7	37.7	<0.0001	33.2	.001
>7 Deliveries	0.4	0	<0.0001[a]	0	0.22[a]
Second pregnancy in 12 months	14.4	17.6	0.49	23.8	0.003
Time since previous delivery > 6 years	19.1	17.1	<0.025	19.1	0.99
Surgically scarred uterus	10.6	11.6	<0.20	13.0	0.15
Previous miscarriage	16.4	23.0	<0.001	19.4	0.25
Prior fetal demise	1.9	2.5	<0.05	2.3	<0.001
History of infertility	5.4	3.9	<0.001	4.2	0.52
Body mass index > 25 kg/m^2	20.2	24.2	<0.001	24.9	<0.03
Intrauterine device before pregnancy	9.8	11.6	<0.01	13.5	0.02
Smoking > 5/day during pregnancy	5.2	11.4	<0.001	22.0	<0.001
Alcohol consumption during pregnancy	3.3	3.9	<0.01	5.9	0.006
Maternal diabetes	3.8	2.6	0.90	2.3	0.66
Maternal pregravid hypertension	1.9	2.4	<0.20	2.8	0.22
Maternal chronic illness	5.9	7.4	<0.01	7.9	0.11

[a]Fisher exact test.

multiparous. Twenty-three percent of women with one prior induced abortion had experienced previous spontaneous miscarriages (40.2% more than the reference group), and 19.4% of women with two or more induced abortions had experienced previous miscarriages (18.3% more than the reference group). A short time since previous delivery (<1 year) was more common among women reporting two or more prior induced abortions, and a history of infertility treatment was less common in women with one prior induced abortion. Use of an intrauterine device before the index pregnancy also was more common in women with prior induced abortions.

Table 2 lists frequencies of pregnancy and delivery complications. There were very few statistically significant differences between study groups. Late pregnancy bleeding was experienced more often (with an absolute increase of 31.3%) by women with one prior induced abortion (p < 0.01). In women with two or more prior induced abortions, bleeding was 75% more frequent than in the reference group, but the difference did not reach statistical significance. Delivery was induced more often in women who had had previous induced abortions, but the incidence of prolonged pregnancy did not vary between study groups. There was no statistical difference in the incidence of

TABLE 2. Pregnancy and delivery characteristics

	Reference group (n = 24,248)	One pregnancy termination (n = 2364)		Two or more pregnancy terminations (n = 355)	
Characteristic	%	%	p	%	p
Prolonged gravidity	4.8	5.1	0.76	5.1	0.77
Induced delivery	21.2	23.7	<0.01	24.2	0.20
Cesarean	16.5	18.0	<0.10	18.9	0.24
Forceps or vacuum	5.8	5.1	<0.20	5.4	0.73
Preeclampsia	3.1	3.6	<0.20	3.7	0.58
Chorioamnionitis	1.4	2.1	<0.025	0.3	0.03[a]
Late pregnancy bleeding	1.6	2.1	<0.01	2.8	0.08
Low hemoglobin (<100 g/L)	1.6	1.9	0.27	2.4	0.23
Meconium-stained amniotic fluid	11.0	11.8	0.16	13.5	0.14
Obstetric cholestasis	0.7	0.5	0.68	0.6	0.27[a]
Rh immunization	0.18	0.2	0.78[a]	0	0.60[a]

[a]Fisher exact test.

immunization, preeclampsia, or anemia in the third trimester of pregnancy between study groups.

Table 3 lists frequencies of pregnancy outcomes in the study groups. Before adjustment for confounding factors, preterm delivery was statistically significantly more frequent in women with one prior induced abortion (p < 0.05), with an absolute difference of 17.7% compared with women who had no induced abortion. Women with two or more previous induced abortions had a 38.7% excess risk for preterm birth, but the difference was not statistically significant (p = 0.07). LBW was significantly more common in women who had had two or more previous abortions, with an absolute difference of 48.9% (p = 0.038). Abnormal fetal heart

TABLE 3. Pregnancy outcome, univariable model

	Reference group	One pregnancy termination (n = 2364)		Two or more pregnancy terminations (n = 355)	
Outcome	%	%	p	%	p
Abnormal fetal heart rate during delivery	17.4	19.4	<0.025	19.9	0.25
Fetal venous pH < 7.15 at birth	1.2	1.4	0.65	1.3	0.19[a]
Low 1-min Apgar score (<7)	5.0	5.8	<0.20	5.4	0.76
Low 5-min Apgar score (<7)	1.9	2.0	0.96	2.0	0.93
Admission to neonatal unit	8.1	8.0	0.48	9.9	0.24
Low birth weight (<2500 g)	4.7	5.3	<0.20	7.0	0.039
Small for gestational age (<10th percentile)	9.5	10.0	0.27	11.8	0.14
Preterm delivery (<37 weeks)	6.2	7.3	<0.05	8.6	0.066
Fetal death	0.5	0.2	<0.05[a]	0.6	0.27[a]
Perinatal death	0.6	0.6	0.87	0.6	0.27[a]

[a]Fisher exact test.

rate during delivery was found more often in women with one prior induced abortion than in the reference group ($p < 0.025$). No excess risk for fetal or perinatal death was found in the study groups.

Table 4 lists unadjusted and adjusted odds ratios (ORs) of pregnancy outcomes. Multivariable logistic regression analyses were calculated for age younger than 18 or older than 35 years, overweight condition, unmarried status, educational level, unemployment, smoking before and during pregnancy, alcohol consumption before and during pregnancy, history of infertility or miscarriage, primiparity, using an intrauterine device, surgically scarred uterus, diabetes, toxemia, and prolonged gravidity. Overall, ORs changed only a little in the analysis. Before adjustment for confounding factors, risk for preterm birth was increased in women with one prior abortion, but after adjustment, no excess risk remained. Risk for LBW also appeared to be elevated in women with two or more abortions compared with the reference group, but no excess risk remained after controlling for confounding factors. Overall, no excess risk for adverse obstetric outcome was found in this study.

DISCUSSION

We investigated associations between prior induced abortions and maternal risk factors, pregnancy complications, and outcome. Data were from an extensive database, and pregnancy outcomes were assessed in multivariable analysis and controlled for confounding factors. We found a number of differences in health behavior and obstetric history among women with and without prior induced abortions. However, no excess risk for adverse pregnancy outcome was found in logistic regression analysis after controlling for confounding factors.

Women who had had prior induced abortions showed an increased incidence of several known risk factors (13–19) for adverse pregnancy outcome. The demographic profile of women with prior induced abortions differed from that of the general obstetric population, with age older than 35 years, unemployment, and low educational level more common in women with previous induced abortions. These women also had different health behavior versus women in the general obstetric population: maternal smoking was four times more common, there was more alcohol consumption, an overweight condition was more common, and there was a greater proportion of chronic illnesses. Presumably, fertility in women with prior induced abortions was high because they had had 38.5% fewer infertility treatments and had a shorter interpregnancy interval than women in the general obstetric population.

The effect of prior induced abortions on risk for miscarriage in the subsequent pregnancy could not be assessed directly because we investigated only pregnancies proceeding over 22 weeks of gestation. However, in the obstetric history of women who had a prior induced abortion, there was a 40.2% excess of miscarriages and 31.5% excess of cases of fetal demise, which may have been the result of previous procedures, or there may be common risk factors associated with miscarriages and fetal demise. Additional studies are needed to address these pregnancy events in a detailed manner.

Before controlling for confounding factors, there appeared to be increased risk for LBW in women with two or more prior pregnancy terminations (OR, 1.54) and for preterm delivery in women with one prior termination (OR, 1.19). This result is in contrast to a recent study that controlled preterm delivery risk for maternal risk factors and may be explained in part by a small sample size in the subgroup analysis for two prior pregnancy terminations, but not for the entire population (5). However, explanatory factors for these outcomes were advanced maternal age, unmarried status, smoking during pregnancy, preeclampsia, and

TABLE 4. Results of logistic regression analysis: adjusted odds ratios for adverse pregnancy outcomes

Outcome	Unadjusted OR (95% CI) One pregnancy termination ($n = 2364$)	Adjusted OR (95% CI) One pregnancy termination ($n = 2364$)*	Unadjusted OR (95% CI) Two or more pregnancy terminations ($N = 355$)	Adjusted OR (95% CI) Two or more pregnancy terminations ($N = 355$)*
Abnormal fetal heart rate during delivery	1.15 (1.02–1.29)	1.34 (1.01–1.28)	1.14 (0.86–1.50)	1.12 (0.83–1.51)
Fetal venous pH < 7.15 at birth	1.20 (0.82–1.75)	1.13 (0.78–1.65)	1.05 (0.39–2.84)	0.70 (0.22–2.28)
Low 1-min Apgar score (<7)	1.16 (0.97–1.39)	1.14 (0.91–1.35)	1.08 (0.68–1.71)	0.95 (0.58–1.57)
Low 5-min Apgar score (<7)	1.04 (0.77–1.41)	1.12 (0.81–1.55)	1.03 (0.49–2.20)	0.81 (0.33–1.99)
Admission to neonatal unit	0.98 (0.84–1.15)	0.98 (0.83–1.16)	1.23 (0.87–1.76)	1.29 (0.90–1.85)
Low birth weight (<2500 g)	1.13 (0.94–1.37)	1.03 (0.83–1.37)	1.54 (1.02–2.32)	1.26 (0.79–2.00)
Small for gestational age (<90th percentile)	1.06 (0.92–1.22)	0.96 (0.83–1.11)	1.27 (0.92–1.76)	0.99 (0.70–1.40)
Preterm delivery (<37 weeks)	1.19 (1.01–1.41)	1.13 (0.94–1.35)	1.44 (0.98–2.10)	1.35 (0.91–2.02)
Cesarean	1.11 (0.99–1.24)	1.09 (0.96–1.24)	1.17 (0.90–1.53)	1.15 (0.85–1.55)
Perinatal death	0.87 (0.49–1.53)	0.97 (0.53–1.78)	0.89 (0.22–3.59)	0.52 (0.07–3.75)

OR = odds ratio, CI = confidence interval.
*Adjusted for age younger than 18 or older than 35 years, overweight condition, unmarried status, educational level, unemployment, smoking before and during pregnancy, alcohol consumption before and during pregnancy, history of infertility or miscarriage, primiparity, using an intrauterine device, surgically scarred uterus, diabetes, toxemia, and prolonged gravidity.

previous miscarriages because controlling for these factors eliminated the difference.

The current literature concerning the effects of prior induced abortions on subsequent pregnancies does not allow a clear conclusion: some studies showed elevated pregnancy risks, whereas others did not.

Preterm birth and LBW have been the most studied adverse outcomes in subsequent pregnancies after induced abortions. They were reported to be more common after previous induced abortions in a number of studies: In 2002, Thorp et al. (10) included 24 studies in a review article concerning preterm birth and LBW subsequent to induced abortions. The studies were carried out between 1966 and 2001.

In 12 of these studies, there was an association, with relative risks of 1.3 to 2.0. An incidence-related effect, with risk increasing according to number of induced abortions, was found in seven of these studies, and this result also was confirmed in other studies (1, 2, 4, 5). Conversely, in the review by Thorp et al. (10), no association between induced abortions and preterm birth was found in seven studies. Zhou et al. (4) studied the effect of complications in induced abortion on the length of subsequent pregnancies and found no association. Accordingly, Lao and Ho (20) studied induced abortion in relation to subsequent preterm delivery in teenage women and found no association. Meirik et al. (21) looked at delivery subsequent to vacuum aspiration and found no effect. In keeping with the present results, Henriet and Kaminski (2) found no association between induced abortions and adverse outcome after controlling for confounding factors; specifically, smoking and marital status.

Other reproductive effects also were studied: Placenta previa was reported to be more common in women with prior induced abortions (7, 8, 10). Johnson et al. (9) reported that curettage as the surgical method was associated with abnormal placentation, whereas vacuum aspiration was not. Conversely, Zhou et al. (22) found no association between placentation and previous abortions. Ectopic pregnancies after induced abortions also were studied. In the review by Thorp et al. (10), the outcome was controversial: there was an association in nine studies, one of them even showing an incidence-related effect (23), and no association in seven studies. Miscarriages were reported to be more common among women with previous abortions, with an OR of 1.72 (6), but in most studies, no such association was found (4, 10, 24). Mood disorders were associated with induced abortions (10). However, it was not clear whether there was a common risk factor or real causality. The impact of induced abortions on subsequent fertility also was reviewed by Thorp et al. (10). In five studies, there was no association with impairment in fertility, whereas an increase in risk was found in two studies.

A weakness of this study, as with most other studies concerning this issue, is that underreporting cannot be ruled out. From a statistical database concerning pregnancies and abortions in the entire country, we know that in 1998 in Finland, 14.5% of pregnant women had a history of induced abortion, and in 2001, the rate was 12.6%. During the study period, the abortion rate in Kuopio district was only 83% of the rate in all of Finland during the study period (11). These figures point to recall bias: underreporting of prior pregnancy terminations appears to be relatively common, with only 10.1% of pregnant women reporting a history of induced abortion and prior induced abortion denied in 2.6% to 16.1% of cases. Conversely, underreporting in our study was relatively low compared with earlier studies (21% to 27%) (25). A possible explanation for the low underreporting rate in our study is that abortion history was asked in both the questionnaire and interview, and patients knew that their clinical records also were checked (26). We do not know whether underreporting is more common in women with pregnancy complications than in others. Another possible bias arises from differences between women who choose to have an induced abortion and those who choose to deliver even when the pregnancy was unwanted. Women choosing to terminate their pregnancies are known to be younger overall, be of lower socioeconomic status, show more adverse health behavior, have inadequate access to maternity care, and be less able to obtain and use contraceptives regularly. Conversely, strengths of this study are the large sample size and multivariable analysis used to control for appropriate confounding factors.

In conclusion, women who reported a history of one or more induced abortions had markedly different health behavior and sociodemographic and socioeconomic status than women who reported no induced abortions. They showed an excess of several known risk factors for adverse pregnancy outcome, and, as expected, risks for LBW and preterm birth were elevated before adjustment for confounding factors. Health counseling of women undergoing induced abortion thus is a challenge and should include recommendations to stop smoking, reduce alcohol consumption, and lose weight before childbearing, but currently, this objective has not been achieved. The current manner of inducing abortions appears to be safe and does not increase the incidence of infertility or immunization. After controlling for confounding factors, no excess risks remained, and pregnancy outcome among women with prior induced abortions was found to be good.

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VI

Under-attending free antenatal care is associated with adverse pregnancy outcomes.

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Submitted

Under-attending free antenatal care is associated with adverse pregnancy outcomes

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Abstract

Background

Most pertinent studies of inadequate antenatal care concentrate on the risk profile of women booking late or not booking at all to antenatal care. The objective of this study was to assess the outcome of pregnancy when free and easily accessible antenatal care has been either totally lacking or low in number of visits.

Methods

This is a hospital register based cohort study of pregnancies treated in Kuopio University Hospital, Finland, in1989 - 2001. Pregnancy outcomes of women having low numbers (1-5) of antenatal care visits (n=207) and no antenatal care visits (n= 270) were compared with women having 6-18 antenatal visits (n=23 137). Main outcome measures were: Low birth weight, fetal death, neonatal death. Adverse pregnancy outcomes were controlled for confounding factors (adjusted odds ratios, OR: s) in multiple logistic regression models.

Results

Of the analyzed pregnant population, 1.0% had no antenatal care visits and 0.77% had 1-5 visits. Under- or non-attendance associated with social and health behavioral risk factors: unmarried status, lower educational level, young maternal age, smoking and alcohol use. Chorio-amnionitis or placental abruptions were more common complications of pregnancies of women avoiding antenatal care, and pregnancy outcome was impaired. After logistic regression analyses, the OR:s were from one third to half lower than before controlling for confounding: there were significantly more low birth weight infants in under- and non-attenders (OR:s with 95% CI:s: 6.62 (4.50-9.32) and 4.06 (2.94-5.62), respectively) more fetal deaths (OR:s 7.75 (3.65-16.46) and 3.02 (1.20-7.57), respectively) and more neonatal deaths (OR:s 6.16 (4.70-9.32) and 5.92 (2.48-14.17), respectively).

Conclusions

Even when birth takes place in hospital, non- or under-attendance at antenatal care carries a substantially elevated risk of severe adverse pregnancy outcome. Underlying adverse health behavior and possible abuse indicate close surveillance of the newborn.

Background

The optimal amount and content of antenatal care in either low- or high-risk pregnancies is not yet resolved. There is, however, evidence showing some unquestionable benefits of antenatal care (1-5) and overall, the outcome of pregnancies among women giving birth at home and without any antenatal care for religious reasons is known to be severely impaired in the US(6). On the other hand, the results of a recent systematic review suggested that women with low-risk pregnancies can safely have fewer antenatal care visits (2). Child-bearing women's own expectations are diverse, some wishing for more and some, specifically women over 35 years of age or with an unfortunate timing of pregnancy, wanting fewer antenatal care visits (7).

Most pertinent studies in this field concentrating on the risk profile of women booking late or not booking at all to antenatal care have shown that the most common barriers to attendance at antenatal care in modern Western society are lack of insurance, low income, low educational level, low social class, unmarried status, ethnic origin of the woman, difficulties in obtaining appointments and long distances. (8, 9).

In Finland, almost the entire (99.8%) pregnant population attends antenatal care (10) since it is provided by the state free of charge and is easily accessible. Furthermore, the attendance is encouraged by linking the opportunity to receive maternity benefits to the first visit to maternity care units before the 16^{th} week of pregnancy. The average number of 17 antenatal care visits is high (11). This number exceeds national recommendations of 13-17 visits in first pregnancy and 9-13 visits in others, two of the visits scheduled after birth (12). Currently, maternal and perinatal mortality rates (13) and the incidence of suboptimal care are very low (14). Although the content and frequency of antenatal care are thorough

considered, a small minority of women do not attend. The purpose of this study was to assess the outcome of pregnancies when antenatal care has been inadequate - either totally lacking or low in number of visits.

Methods

We investigated an existing clinical database of the total population of 27 776 births at Kuopio University Hospital between 1989 and 2001. Information on maternal characteristics was based on data from self-administered questionnaires at approximately 20 weeks of pregnancy, returned to the hospital by 22 weeks of pregnancy. When any data were missing, they were complemented by interviews with a nurse at the delivery ward. The questionnaire consisted of 75 items, part of them multiple choices, concerning marital status, employment, previous operations, illnesses, obstetric history, contraceptive use, smoking, alcohol consumption and paternal characteristics. Information on pregnancy complications, pregnancy outcome and the neonatal period was collected real timely as part of clinical work from to the database by the nurses and midwives who took care of delivery and neonatal care. The Institutional Review Board accepted the study and childbearing women gave informed consent at the time of data collection. The ethical committee has accepted the database and given permission for using it for research purposes. The data were processed anonymously. Exclusion criteria were: 1) multiple pregnancies ($n = 548$) and 2) major fetal structural anomalies ($n = 275$), because such pregnancies carry an unusually high risk of adverse outcome. Information of the number of antenatal care visits was missing from 77 women. Women who had over 19 visits to antenatal care units were not included in this study. We analyzed 23 614 births, of which 270 were among women who did not attend

antenatal care (non-attenders) and 207 were among women with few antenatal care visits (1-5, under-attenders). Women with an average number (6-18) of antenatal care visits, totaling 23 137, were used as reference group.

Kuopio University Hospital is a tertiary level obstetric referral centre, but it also serves as the only hospital in our district dealing with deliveries. The antenatal care model was general practitioner- and nurse- or midwife-led for women with uncomplicated pregnancies. The appointments were structured and involved clear referral pathways to university hospital obstetricians when complications arose. Antenatal care was readily and easily accessible to all women. Good continuity was achieved in antenatal and postnatal care, whereas intrapartum care was obstetrician-led. Planned home deliveries were exceptional. The women carried their own maternity case notes, and structured, national maternity records were collected. Estimation of gestational age was based on menstrual history and ascertained by measuring fetal crown-rump length by ultrasonography in approximately 95% of cases at 10 to 12 weeks of pregnancy.

The following definitions were used: Young maternal age was defined as age under 18 years at birth. Women aged over 35 years at birth were considered old parturients. Unmarried status was defined as any civilian status other than marriage (including cohabiting, single, widowed and divorced women). Grand multiparity was defined as more than 7 previous deliveries. Prior induced abortion of a viable fetus was separated from miscarriage. An overweight condition was considered when pre-pregnancy body mass index (BMI) was over 25 kg/ m^2.The woman was considered a smoker if she smoked 5 cigarettes or more per day during pregnancy. Alcohol use was recorded as *yes/no.* Chronic illnesses were defined as conditions requiring regular medication that has possible effect on

pregnancy, specifically, thyroid disease, arthritis, epilepsy, cardio-vascular and kidney diseases. Maternal diabetes was defined as insulin-treatment during pregnancy. Chronic hypertension was self reported as a multiple choice concerning maternal illnesses in the questionnaire. Low hemoglobin was defined as under 100 g/l in the third trimester of pregnancy. Educational attainment was divided into three categories: high, average and low, according to the women's own evaluation. Unemployment status was asked in the questionnaire *yes/ no.* Pre-eclampsia was defined as repeated blood pressure measurement exceeding 149/90 mmHg with proteinuria exceeding 0.5 g/day. Gestational age of 42+0 weeks or more was used as definition for prolonged pregnancies. Chorio-amnionitis, placental abruption or placenta previa were registered when these obstetric diagnoses were set during the hospital stay. Meconium staining of amniotic fluid during delivery was marked in the delivery reports and to the database by midwives.

Preterm birth was delivery before 37 weeks of gestation. Infants were considered small for gestational age (SGA) when the age- and sex-adjusted birth weight was below the tenth percentile according to the normal tables for our population (15), and of low birth weight (LBW) when it was less than 2500 g. The mode of delivery was registered to the database as: spontaneous, instrumental or cesarean section. Apgar scores were given mainly by midwifes in uncomplicated deliveries and by pediatricians, when consulted, and were considered low when the scores were less than 7. The pH limit used for fetal acidosis was 7.15 at birth in the umbilical vein. Abnormal CTG was recorded to the database by obstetricians. The admission rate to the neonatal intensive care unit (NICU) was recorded as infants requiring more than 24 hours surveillance. Neonates needing only observation are also treated in the NICU in our hospital.

Fetal death was defined as intrauterine death of a fetus over 22 weeks of gestational age or over 500 g weight and neonatal death as death during the first seven days after birth. If a subject had two abnormalities, such as LBW and preterm delivery, each was considered an independent outcome and the subject was included in both categories.

Statistical differences between the subjects and the reference group were evaluated by using Chi-square tests (dichotomous variables), and Fisher's exact test was applied when the minimal estimated expected value was less than five. A value of $p < 0.05$ was considered statistically significant. Continuous variables were analyzed by using two-tailed, pooled t tests. Possible confounding factors were identified from background data in statistical basis. Multivariable analysis of significant or nearly significant effects ($p < 0.1$) of lifestyle variables concerned in this study was based on multiple logistic regression analysis (SAS for Windows, SAS release 8 statistical package). Logistic regression analysis was performed stepwise, leaving only the significantly associated confounders in the final models. Confidence intervals were evaluated at 95%.

Results

Of the obstetric population of singletons without major anomalies, 270 (1.0%) had no antenatal care visits, 207 (0.77%) had 1-5 visits, and 23 137 (85.8%) had an average number (6-18) of antenatal care visits. The differences between the study groups in incidence of birth outside hospital were statistically significant ($P< 0.025$and $P< 0.001$, respectively), although the numbers were very small: In the group of 6-18 antenatal care visits 14 (0.09%) infants were born outside hospital, in the group of no antenatal care there were 5 (1.85%) and in the group of 1-5 visits one (0.97%). The women in the study groups and in the reference group were of the same age: the mean age (± standard deviation) of the women who had 6-18 antenatal visits being 28.7 ± 5.3 y, *vs.* 28.8 ± 6.5 y (p=0.85) in the non-attenders and 28.13 ± 6.7 y (p = 0.10) in the under-attenders. The youngest mother in this study was 14 y and the oldest 52 y. The study population was ethnically homogeneous.

Non-attenders and under-attenders of antenatal care were statistically significantly more often unmarried, smokers, and less often highly educated (Table 1.). Young age was more common in the group of non-attenders than average. Moreover, grand multiparity was more common in under-attenders than on average, as was alcohol use during pregnancy. Furthermore, the pregnancies of non-attenders and under-attenders of antenatal care were significantly more often ($p< 0.001$) complicated by placental abruption (4.44% and 6.28% vs. 0.70%, respectively) or chorio-amnionitis (4.83% and 9.66% vs. 1.27%, respectively), but no differences were found as regards other pregnancy complications.

The mean birth weight (± standard deviation) of newborns was 3503 ± 617 g in the women with 6-18 antenatal visits, 3014 ± 1033 g in the non-attenders and 2704 ± 1156 g in the under-attenders. Accordingly, the newborns of non-attenders and under-attenders of

antenatal care weighed 489 and 799 g less, respectively, than the newborns of mothers with an average number of antenatal visits, these differences being statistically significant ($p<0.0001$).

Table 2 shows unadjusted odds ratios (OR:s) and the results of logistic regression analyses, the adjusted odds ratios of adverse pregnancy outcome in the study groups. Before multivariable analyses non-attenders and under-attenders statistically significantly more often had low 5-minute Apgar scores, preterm births and low birth weight infants. Additionally, the risk of fetal death was high in both the study groups, as well as was the risk of neonatal death.

After logistic regression analyses based on the maternal and pregnancy characteristics shown in Tables 1 and 2, the OR:s of adverse pregnancy outcomes were lower, being approximately 50% of the unadjusted OR:s as regards fetal and neonatal deaths and one third lower as regards preterm birth, low Apgar scores and low birth weight.

Table 3 summarizes the odds ratios of pregnancy risk factors and outcomes reported in earlier studies concerning inadequate maternity care, compared with the present data. The comparison suggests that when high frequencies of women receive insufficient antenatal care, the magnitude of associating risks is diluted.

Discussion

Regardless of easily accessible and high quality maternity care a small minority of pregnant women chose not to use it. As a result the outcome of their pregnancies was poor, although delivery took place in hospital, in conditions of modern obstetric care. Specifically, the risk of placental abruption, intrauterine infections, preterm birth, low birth weight and even intrauterine fetal death and neonatal death were found to be statistically higher than in the general obstetric population who attended routine antenatal care. Clinically, under-attending antenatal care appeared to be a significant contributor to low birth weight, and this association was chiefly the result of preterm delivery, not to growth restriction.

Only a few studies concerning pregnancy outcome in women under-attending antenatal care have been published (Table 3). Overall, the present study showed similar outcomes as in earlier studies, although the magnitude of risk appears to vary substantially in different settings depending on the antenatal care system and degree of low attendance. Comparison with the results of prior studies also suggests that the magnitude of the risk may be diluted in settings with a high frequency of women receiving inadequate antenatal care. Accordingly, definitions used for inadequate antenatal care vary from late attendance to a reduced total number of visits. Although the risk profile of women in the present study resembles that published earlier (8,9,16-20), socio-demographic and health behavioral risk factors appeared to play a less significant role in our country than elsewhere, probably because the care is offered free of charge and is readily and easily accessible to all women. Interestingly, a substantial proportion (52.5%) of non-attenders and under-attenders were of high or average educational level in the present study.

Surprisingly, factors that have been reported to lead to higher concern and motivation to attend antenatal care were not under-presented in women not attending antenatal care: specifically, history of infertility treatment, miscarriage or fetal demise (7).Furthermore, we found no differences between study groups in a number of the known risk factors associated with adverse health behavior

and the lack of health consciousness during pregnancy, specifically unemployment (21), prior pregnancy terminations (22) and an overweight condition (23). Accordingly, ethnicity of the mother, the nature of the antenatal care provider, health insurance and difficulties in accessibility of antenatal care, which have also been found to be important factors in the etiology of under-attending antenatal care (8), were not relevant in the present study.

Preterm birth is an extremely heterogeneous index by which to assess obstetric outcome, because it combines a number of intrinsic pathways resulting in the same endpoint (24). Efforts to isolate these pathways would benefit from studying the individual components. In that regard, the substantially high incidence of placental abruption found in the present study is partly explained by smoking during pregnancy (25,26), but it also raises a hypothesis of trauma and domestic violence as possible explanations for adverse pregnancy outcome and a reduction in the uptake of services(27). Amnionitis and neonatal deaths have been reported to be associated with a number of underlying risks, such as experienced violence during pregnancy and changing partners (28-30).

Overall, as failure to attend antenatal care is very rare in Finland, the underlying reasons probably varied and it can be assumed that women choosing to self exclude themselves from antenatal care have some serious but still poorly recognized problems, and difficulties in their overall health behavior. This could partly explain the higher numbers of adverse pregnancy outcomes found in this study compared with earlier studies (6,18,31,32).

A strength of the present study is that we had the opportunity to assess the effects of maternal behavior and pre-pregnancy health on pregnancy outcomes, since the Kuopio University Hospital birth registry contains comprehensive data on these variables. A possible limitation of this data from a tertiary level perinatal centre in this area is that some adverse outcomes may be overly present, but this is probably the case particularly in the reference population. Furthermore, estimation of gestational age in pregnancies with a lack of antenatal care may not be as accurate as normally. However, inaccuracy in assessing the risk of prematurity was overcome by the high

percentage of low birth weight infants and the lower mean birth weights found in women lacking in antenatal care. The high amount of preterm births (39.6 %) in the group of women having only 1-5 visits at antenatal care is partly the explanation for few visits. However, the outcome was very much alike in the group of women totally lacking antenatal care. Accordingly, compared with a prior Finnish study (32), the risks of prematurity, NICU-treatments and perinatal death were higher in our study, probably since we did not adjust the number of antenatal visits according to gestational age. Moreover, the background data for women not attending antenatal care was collected at the time of the birth, may have underreporting as a source of error, depending on the pregnancy outcome. Furthermore, by definition, distinguishing confounding factors from mediating factors as regards lack of antenatal care and adverse pregnancy outcomes is difficult, if not impossible, and therefore, a purely statistical viewpoint was applied in choosing the variables for the multivariable analyses. However, pregnancy outcome measures in the groups studied were compared both before and after adjusting for these factors, to overcome the difficulty brought about by either the confounding or mediating roles of the known obstetric risks significantly associated with under-attending antenatal care.

The role of domestic violence as an etiological factor needs future investigation. Other possible explanations that require future research are psychiatric disorders and ideological reasons for refusing antenatal care (naturalism, avoidance of technology, religion). Moreover, it would be interesting to investigate the children of the women who excluded themselves from maternity care.

Conclusions

In conclusion, the results of this study highlight to two things: First, it is important to recognize women under-attending antenatal care during pregnancy as high-risk obstetric patients who need extra surveillance during delivery, support when going home with the newborn, and probably support in responsible health behavior in the future. Second, our results underline the beneficial role

of maternity care not only as regards recognizing and treating pregnancy pathology, but also in terms of a resource of health education and an environment for confidential handling of sensitive issues, such as unwanted pregnancy or domestic violence.

Competing interests

All authors declare that they have no competing interests.

Authors' contributions

All authors (K.R., N.H., and S.H.) participated in designing the study, analyzing the results and writing the manuscript, K.R. coordinated the study. All authors read and approved the final manuscript.

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Table 1. Occurrences of pregnancy risk factors and complications

Risk factor	Reference (6–18 visits) (n = 23137) %	No visits (n = 270) %	1–5 visits (n = 207) %
Age < 18 years	0.63	**1.85 ****	0.97
Age > 35 years	11.03	14.07	12.56
Unmarried	17.48	**30.74 *****	**33.33 *****
Primiparity	40.52	43.70	41.55
Previous miscarriage	9.78	16.67	17.88
Prior termination	9.78	7.78	12.56
>7 deliveries	0.41	0.37	**1.45 ***
Prior foetal demise	1.79	1.48	2.42
Overweight	19.04	22.17	18.93
History of infertility	6.30	5.93	4.35
Smoking	5.88	8.52	**13.04 *****
Alcohol consumption	3.45	3.70	**6.76 ****
Chronic illness	5.13	4.44	5.80
Diabetes	2.25	1.85	1.93
Chronic hypertension	1.28	1.11	0.97
Education			
High	24.74	**18.51 ***	**16.43 ****
Average	45.71	**34.07 *****	**36.23 ****
Low	21.70	22.96	20.77
Unemployed	16.97	16.67	16.43
Prolonged gravidity	3.77	4.44	2.08
Low haemoglobin	1.53	0.74	2.90
Pre-eclampsia	2.76	3.72	3.86
Chorio-amnionitis	1.37	**4.83 *****	**9.66 *****
Placental abruption	0.70	**4.44 *****	**6.28 *****
Placenta previa	0.41	0.37	0.48
Meconium-stained AF	10.56	10.98	13.13
Abnormal FHR during delivery	16.76	19.02	15.20

AF = amniotic fluid; FHR = foetal heart rate;
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 2. Occurrences of pregnancy outcomes (%) in the study groups and relative risks (OR) compared with the reference group

Outcome	Study group[a]	%	Unadjusted OR	95% CI	Adjusted OR*	95% CI
SGA	Reference	9.29				
	0	8.15	0.87	0.56-1.34	0.79	0.51-1.22
	1-5	9.66	1.04	0.66-1.66	0.97	0.60-1.55
Preterm delivery (< 37 weeks)	Reference	6.51				
	0	25.22	4.84	3.57-6.57	3.79	2.72-5.27
	1-5	39.58	8.51	6.39-11.35	6.50	4.71-8.99
Low birth weight (< 2500 g)	Reference	4.73				
	0	21.85	5.63	4.19-7.57	4.06	2.94-5.62
	1-5	33.01	9.86	7.33-13.26	6.62	4.50-9.32
Admission to NICU	Reference	7.76				
	0	9.26	1.21	0.80-1.83	0.99	0.65-1.53
	1-5	8.70	1.13	0.70-1.84	0.87	0.52-1.44
Low Apgar score (< 7) 1 min	Reference	4.83				
	0	18.89	4.59	3.36-6.26	3.42	2.44 -4.79
	1-5	25.60	6.78	4.93-9.31	4.86	3.39-6.95
Low Apgar score (< 7) 5 min	Reference	1.82				
	0	11.11	6.74	4.56-9.98	4.50	2.92 – 6.96
	1-5	14.98	9.50	6.41-14.09	6.39	4.07-10.01
Foetal venous pH < 7.15 at birth	Reference	1.22				
	0	3.70	3.12	1.64-5.93	1.04	0.31-3.37
	1-5	1.93	1.60	0.59-4.33	2.19	0.85-5.64
Caesarean section	Reference	16.22				
	0	23.33	1.57	1.18-2.09	1.27	0.94-1.72
	1-5	21.26	1.39	1.0-1.95	1.05	0.73-1.52
Fetal death	Reference	0.26				
	0	2.59	5.76	2.50-13.27	3.02	1.20-7.57
	1-5	4.83	12.86	6.59-25.07	7.75	3.65-16.46
Neonatal death	Reference	0.25				
	0	2.59	10.41	4.71-23.01	5.92	2.48-14.17
	1-5	2.42	9.68	3.85-24.38	6.16	4.70-9.32

[a]Reference (6-18 visits) n = 23137, 0 visits n= 270, 1-5 visits n= 207
*OR adjusted for:
0 visits: age under 18 y, smoking during pregnancy, educational level, placental abruption, chorio-amnionitis.
1-5 visits: unmarried status, multiparity, smoking during pregnancy, alcohol use during pregnancy, educational level, prolonged gravidity, placental abruption, chorio-amnionitis.
SGA = small for gestational age infant; NICU = neonatal intensive care unit.

Table 3. Pregnancy risk factors and relative risks (OR, 95 % CI) of adverse pregnancy outcomes of women with insufficient antenatal care

Pregnancy risk factors						
Study	McCaw-Binns *et al.*, 1995	Blondel *et al.*, 1998	Delvaux *et al.*, 2001	Kupek *et al.*, 2002	Herbst *et al.*, 2003	Present study[1]
n, population	10 382 two months national cohort, register data	85 066 6 months hospital based cohort, clinical records (20 clinics)	21 722 Case-control, postpartum interview	17 765 two months cohort of nine maternity units, clinical records	8065 one month cohort of six hospitals, clinical records	23 614 twelve years hospital based register data
Country	Jamaica	France	Ten European countries	England and Wales	USA	Finland
Inadequate antenatal care	4 %	1.1 %	5.9 %	7 %	10.2 %	1.8%
Age < 18	1.7 (1.2–2.2)[3]	2.8 (1.2–6.6)[2]	3.7 (2.7–5.1)	2.5 (2.0–3.0)	NA	1.29 (0.60-2.74)
Unmarried	1.6 (1.1–2.2)	9.3 (6.0–14.3)[1]	3.1 (2.5–3.9)	NA	NA	1.88 (1.56-2.25)
Multiparous (> 4)	1.5 (0.9–2.4)	34.9 (15.7–77.8)[2]	4.3 (3.1–6.0)	NA	2.26 (1.76–2.90)	2.03 (0.74-5.54)[4]
Unplanned pregnancy	2.8 (1.6–4.7)	NA	4.0 (3.3–4.7)	NA	NA	NA
No health insurance	NA	7.6 (2.2–26.8)[2]	2.7 (2.1–3.4)	NA	7.67 (5.96–9.86)	NA
Smoking	2.5 (1.8–3.4)	NA	NA	1.6 (1.4–1.9)[2]	NA	1.87(1.39-2.52)
Alcohol consumption	0.7 (0.5–0.9)	NA	NA	NA	NA	1.48(0.98-2.25)

Pregnancy outcome						
Study	Kaunitz *et al.*, 1984	Gissler *et al.*, 1994[4]	Blondel *et al.*, 1998	Herbst *et al.*, 2003	Present study[1]	
n	344	57 108	85 066	8065	23 614	
n, population	Register based study (religional minority, national obstetric statistics)	One year national cohort, register data	6 months hospital based cohort, clinical records (20 clinics)	one month cohort of six hospitals, clinical records	Mothers Under-attending antenatal care	Mothers Not-attending antenatal care
Country	USA	Finland	France	USA	Finland	
Preterm birth	NA	2.21 (1.95–2.51)[2]	5.8 (3.2–10.5)[2]	3.23 (2.62–3.99)	6.50 (4.71-8.99)[2]	3.79 (2.72-5.27)[2]
Low birth weight	NA	2.05 (1.74–2.41)[2]	2.6 (1.5–4.4)[2]	2.20 (1.72–2.79)	6.62 (4.50-9.32)[2]	3.79 (2.72-5.27)[2]
Admission to NICU	NA	1.56 (1.24–1.98)[2]	2.8 (1.9–4.1)	NA	0.87 (0.52-1.44)[2]	0.99 (0.65-1.53)[2]
Fetal death	3.6 (1.8–6.3)	NA	NA	NA	7.75 (3.65-16.46)[2]	3.02 (1.20-7.57)[2]
Perinatal death	2.7 (1.6–4.2)	1.87 (1.34–2.62)[2]	NA	NA	NA	NA
Neonatal death				3.63 (2.23–5.91)	6.16 (4.70-9.32)[2]	5.92 (2.48-14.17)[2]

[1] Pooled, under-attending and non-attending [2] OR adjusted for confounding factors found in the study; [3] age under 20 years; NA = not applicable; [4] over 7 births; [5] number of visits relative to gestational length

KUOPION YLIOPISTOLLINEN SAIRAALA
Naistentautien ja synnytysklinikka

ESITIETOILMOITUS
Palautetaan 22 raskausviikkoon mennessä neuvolaan
Neuvola _____

SYNNYTTÄJÄN sukunimi **etunimet**

_____ _____

henkilötunnus **ammatti**

_____ _____

siviilisääty 1 avioliitossa [] 2 naimaton [] 3 leski [] 4 eronnut []
avoliitossa 0 ei [] 1 on []

opiskelija 0 ei [] 1 on [] **työtön** 0 ei [] 1 on [] **koulutus** 1 perus [] 2 keski [] 3 korkea []

sosioekonominen asema
1 työnantaja [] 2 yksinäisyrittäjä [] 3 toimihenkilö [] 4 työntekijä [] 5 eläkeläinen [] 6 opiskelija []
7 muu (esim perheenemäntä) []

työnlaatu 1 kotityö [] 2 säännöllinen päivätyö [] 3 kaksivuorotyö [] 4 kolmivuorotyö [] 5 yötyö []
työn rasittavuus 1 kotityö [] 2 kevyt istumatyö [] 3 raskas istumatyö [] 4 seisomatyö [] 5 raskas ruumiillinen työ []

LAPSEN ISÄN sukunimi **etunimet**

_____ _____

henkilötunnus **ammatti**

_____ _____

opiskelija 0 ei [] 1 on [] **työtön** 0 ei [] 1 on [] **koulutus** 1 perus [] 2 keski [] 3 korkea []

sosioekonominen asema
1 työnantaja [] 2 yksinäisyrittäjä [] 3 toimihenkilö [] 4 työntekijä [] 5 eläkeläinen [] 6 opiskelija []
7 muu []

työnlaatu 1 kotityö [] 2 säännöllinen päivätyö [] 3 kaksivuorotyö [] 4 kolmivuorotyö [] 5 yötyö []
työn rasittavuus 1 kotityö [] 2 kevyt istumatyö [] 3 raskas istumatyö [] 4 seisomatyö [] 5 raskas ruumiillinen työ []

LAPSEN ISÄN SAIRAUDET

_____

SYNNYTTÄJÄN LÄHISUVUN SAIRAUDET (vanhemmat ja sisarukset)
1 sydäntauti [] 2 verisuonitauti [] 3 diabetes [] 4 tuberkuloosi [] 5 verenpainetauti [] 6 syöpä []
7 psyykkinen sairaus [] 8 kehityshäiriö [] 9 muu []

SYNNYTTÄJÄN AIEMMAT SAIRAUDET
1 angiina [] 2 niveltulehdus [] 3 sydänvika [] 4 munuaistauti [] 5 virtsatietulehdus [] 6 diabetes []
7 tuberkuloosi [] 8 tulirokko [] 9 sukupuolitauti [] 10 epilepsia [] 11 mielenterveyshäiriö []
12 maksasairaus [] 13 kilpirauhassairaus [] 14 verenpainetauti [] 15 sappikivet [] 16 alkoholismi []
17 yliherkkyys [] mille _____
18 muu sairaus [] mikä _____

SYNNYTTÄJÄN AIEMMAT LEIKKAUKSET
1 keisarileikkaus [] 2 gynekologinen leikkaus [] 3 steriliteettileikkaus [] 4 umpilisäke []
5 muu leikkaus [] mikä _____ missä _____

AIKAISEMMAT RASKAUDET JA SYNNYTYKSET TAPAHTUMAJÄRJESTYKSESSÄ

N:o	Vuosi	Sukupuoli 1poika 2 tyttö	Syntymäpaino	Syntyi 1 elävänä 2 kuollena	Epänormaali päättyminen 1 keskenmeno 2 keskeytys 3 kohdunulkoinen	Raskausvii kot	Raskauden kulku	Synnytyksen kulku	Lapsivuodeaika 1säännölli nen 2 epäsäännölli nen	Syntymäpaikka
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

EHKÄISY

Viimeksi käytetty ehkäisymenetelmä
1 e-pillerit [] 2 minipillerit [] 3 kondomi [] 4 kierukka [] 5 vaahdot [] 6 muut [] 7 ei mitään []
ehkäisy lopetettu _____/_____v _____ **raskautta yritetty** _____ **kuukautta**

KUUKAUTISET

Alkamisikä __ vuotta **alkamispäivien väli** _____ - _____ vrk **vuodon kesto** _____ -_____ vrk
säännölliset 0 ei [] 1 on [] **kipuja** 0 ei [] 1 on [] **kirjanpito** 0 ei [] 1 on []
viimeiset kuukautiset alkoivat _____/_____ v_____ **olivat** 1 tavalliset [] 2 niukat []

LAPSETTOMUUS

onko tämä raskaus alkanut 1 ilman lapsettomuushoitoja [] 2 kohdunkaulakihedelmöityksellä (IVF) []
hormonihoidolla: 3 Clomifen [] 4 pistoshormonihoito [] 5 leikkauksen jälkeen []

lapsettomuuden hoitopaikka (nykyinen raskaus) 1 KYS [] 2 Klinikka In-Tiimi [] 3 IAS [] 4 VAS []
5 muu [] _____

oletteko aiemmin saanut lapsettomuushoitoja 1 ei [] 2 kohdunkaulakihedelmöityshoitoja [] 3 hormonihoitoja []

ovatko aikaisemmat hoidot johtaneet raskauteen 0 ei [] 1 on []

tähän raskauteen liittyvä alkionsiirtopäivämäärä ____/____ v _____

NYKYINEN RASKAUS

synnyttäjän paino ennen raskautta _____ kg **pituus** _____ cm

häiriöt alkuraskaudessa 1 pahoinvointi [] 2 infektio [] mikä _____ 3 verenvuoto []

lääkkeet alkuraskaudessa _____

nimiehdotus lapselle (sairaalaa varten) tyttö _____ **poika** _____

SYNNYTTÄJÄN ALTISTEET

tupakointi ennen raskautta 0 ei [] 1 kyllä [] **montako savuketta keskimäärin vuorokaudessa** _____
tupakointi raskauden aikana 0 ei [] 1 kyllä [] **montako savuketta keskimäärin vuorokaudessa** _____
lopettanut ennen 13. raskausviikkoa 0 ei [] 1 lopettanut []
joutuuko muutoin alttiiksi tupakansavulle 0 ei [] 1 kyllä []

alkoholin käyttö ennen raskautta 0 ei [] 1 kyllä [] **keskimääräinen viikottainen annosten lukumäärä** __
alkoholin käyttö raskauden aikana 0 ei [] 1 kyllä [] **keskimääräinen viikottainen annosten lukumäärä** __

muita altisteita
1 liuottimet [] 2 metallit [] 3 torjunta-aineet [] 4 lakanpoistoaineet [] 5 väriaineet [] 6 muut kemikaalit []
7 melu [] 8 matala lämpötila [] 9 korkea lämpötila [] 10 pöly [] 11 kaasu [] 12 säteily []

LAPSEN ISÄN ALTISTEET

tupakointi ennen raskautta 0 ei [] 1 kyllä [] **montako savuketta keskimäärin vuorokaudessa** _____
tupakointi raskauden aikana 0 ei [] 1 kyllä [] **montako savuketta keskimäärin vuorokaudessa** _____
joutuuko muutoin alttiiksi tupakansavulle 0 ei [] 1 kyllä []

alkoholin käyttö ennen raskautta 0 ei [] 1 kyllä [] **keskimääräinen viikottainen annosten lukumäärä** __
alkoholin käyttö raskauden aikana 0 ei [] 1 kyllä [] **keskimääräinen viikottainen annosten lukumäärä** __

muita altisteita
1 liuottimet [] 2 metallit [] 3 torjunta-aineet [] 4 lakanpoistoaineet 5 väriaineet [] 6 muut kemikaalit []
7 melu [] 8 matala lämpötila [] 9 korkea lämpötila [] 10 pöly [] 11 kaasu [] 12 säteily []

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