Anxious personality traits in pregnant women

Associations with postpartum depression, delivery complications and health care use

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Abstract


Anxious personality traits, including those encompassed by negative emotionality (neuroticism) and the tendency to worry about close relationships (attachment anxiety) during pregnancy were the focus of this thesis. The overall aim was to examine perinatal correlates of these characteristics in terms of psychiatric and obstetric health as well as antenatal care (ANC).

Papers I-II were part of a large population-based project on pregnant women in Uppsala in 2009-2012 (n=2160). Papers III-IV adjoined participants from several projects in 2005-2011, on oral contraceptive use, infertility, induced abortion, premenstrual mood disorder, and perinatal depression (n=2819). The participants reported on the Swedish universities Scales of Personality for neuroticism (papers II-IV) and the Attachment Style Questionnaire (ASQ) for attachment anxiety (papers I-II). The participants also answered the Edinburgh Postnatal Depression Scale on depressive symptoms (paper II). In paper III, information on obstetric complications for primiparous women with singleton pregnancies (n=1969) was extracted from Swedish national health registers. In paper IV, ANC use was derived from medical records of obstetric low-risk women residing in Uppsala (n=1052).

The ASQ had similar psychometric properties in pregnant women (n=1631) as in previous reports (paper I). In non-depressed pregnant women (n=1431), the combination of neuroticism and attachment anxiety was the best risk indicator of postpartum depressive symptoms (paper II). Whereas high neuroticism was not related to obstetric complications (paper III), it was associated with higher use of ANC (paper IV).

Summarized, this thesis illustrates how anxious personality traits may predispose for postpartum depression and higher use of ANC in the absence of obstetric complications. Future development of these findings should be to evaluate individual and societal benefits of a greater emphasis on psychological support in ANC.

Keywords: Personality, neuroticism, adult attachment, perinatal depression, postpartum depression, obstetric complications, health care use

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To Helene and Christer for all their love
List of papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


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Populärvetenskaplig sammanfattning


För att mäta personlighetsdrag används skattningsskalor. Som andra mått behöver skattningsskalor utvärderas för att se ifall de ger samma resultat under upprepade förutsättningar, s.k. reliabilitet. Delarbete I utvärderade ett frågeformulär för vuxenanknytning bland 1631 gravida kvinnor och fann en lika bra reliabilitet som i tidigare studier i allmän befolkning.


I delarbete IV granskades journaler från 1052 kvinnor med låg risk för komplikationer under graviditet och förlossning för att se hur många besök, telefonsamtal och undersökningar som gjordes till mödravården under graviditeten. Kvinnor med högre neuroticism sökte mer vård än de med lägre neuroticism oberoende av andra faktorer som kan styra vårdökande.

Denna avhandling visar att gravida kvinnor med hög grad av oroliga personlighetsdrag har ökad risk för förlossningsdepression samt söker mer mödravård utan att ha någon ökad risk för obstetiska komplikationer. Framtida studier bör utvärdera vinster för individer och samhälle med strukturerat psykologiskt stöd till gravida kvinnor med hög grad av oroliga personlighetsdrag.
Abbreviations

ANC  Antenatal care
ASQ  Attachment Style Questionnaire
ASQ-SF Attachment Style Questionnaire-Short Form
BASIC study Biology, Affect, Stress, Imaging and Cognition during Pregnancy and Puerperium study
BMI  Body mass index
CI   Confidence interval
CS   Cesarean section
EPDS Edinburgh Postnatal Depression Scale
GDM  Gestational diabetes mellitus
IRR  Incidence rate ratio
LGA  Large for gestational age
MBR  Medical Birth Register
OR   Odds ratio
PND  Perinatal depression
SD   Standard deviation
SGA  Small for gestational age
SSP  Swedish universities Scales of Personality
STAI-AD State-Trait Anxiety Inventory for Adults
Introduction

Personality

Our language has a countless number of words to describe the characteristics of people. Beginning in the 1930s, researchers used statistical methods to group adjectives together in domains to map all of human personality. A result is the widespread five factor model (or the ‘big five’) of personality domains (1-3). As per this model, the big five domains of personality are neuroticism, extraversion, openness to experience, conscientiousness, and agreeableness, each of which contains several sub-ordered traits. Personality traits and domains are continuous constructs and no characteristic is in itself pathological, although very low or high levels may be maladaptive (4). Overall, personality is defined as the consistent patterns of an individual’s thoughts, feelings and behaviors (5). Temperament refers to infants’ innate patterns of emotion and reactions that are genetically and biologically determined. Adult personality has a substantial genetic origin (6, 7) and is theoretically developed through the interaction between temperament, experiences, and socialization. Traditionally, theory has assumed that personality is practically immutable, at least after a certain age (8). However, research shows that personality has a potential for change even in mature age (9).

Neuroticism

The personality domain neuroticism (also referred to as negative emotionality, trait anxiety, or emotional instability) describes the frequent experience of negative emotions (e.g., anxiety, fear, anger, irritability, or sadness) accompanied by perceiving the world as threatening and being susceptible to stress (6). There is some variation in the definitions, such as whether to include aspects of aggression and impulsivity (10). Central to several definitions is emotional reactions that are quick in their response and slow in their decline. Correspondingly, high neuroticism is associated with increased reactivity in emotion-eliciting brain circuits (e.g., the amygdala and insula) (11, 12) and less activity in circuits exerting inhibitory control of these (e.g., the anterior cingulate cortex) (13). At the cognitive level, neuroticism is associated with lower perceived control, negatively biased attention, interpretation and recall, and maladaptive coping strategies (6, 14).
Individuals high in neuroticism report reduced quality of life and lower subjective wellbeing (15, 16); furthermore, neuroticism is a strong predictor of diminished relationship quality (17). Pregnant women high in neuroticism are more likely to worry about their pregnancy and experience a higher fear of delivery (18, 19). Moreover, they report worse sleep and less social support (20, 21). A pregnancy and delivery clinically described as normal (i.e., without complications) are more often experienced negatively by women high in neuroticism than by other women (22). People high in neuroticism have a higher likelihood of migraine (23) and fibromyalgia, chronic fatigue syndrome, and irritable bowel syndrome (24). Some studies have found a link between high neuroticism and cardiovascular disease and mortality (25), although the evidence is mixed (26), with other studies reporting a lower mortality in individuals high in neuroticism (27). The most robust associations between neuroticism and morbidity concern mental health.

Neuroticism and depression

Daily depressed mood or loss of interest in practically all activities for at least two weeks, causing manifest distress and impairment, is the core symptomatology of a depressive episode (28). Several other symptoms accompany a depressive reaction, such as feelings of guilt or worthlessness, reduced concentration ability, disturbed sleep, weight loss or weight gain, persisting thoughts of death or suicide, or even suicide attempts. High neuroticism is common in people suffering from depression (29). A question, then, is what comes first. The development of depressive symptoms is usually accompanied by a momentary increase in neuroticism (30). Nevertheless, such a state effect cannot explain findings in which high neuroticism precedes the development of first-onset depression (31). A feasible interpretation of such prospective associations is that neuroticism is a predisposing factor for depression. Accordingly, neuroticism is suggested to underlie the higher prevalence of depression in women than in men (32) given that women commonly score higher on neuroticism measures (33-35). Having neurotic traits seems to be associated with a higher risk of facing stressful and adverse life events (36, 37). Moreover, having faced such events, individuals with neurotic traits seem more vulnerable to depression than those without such traits (38). Stress and adversity might act to mediate the path between neuroticism and depression.

Neuroticism and depression share etiological influences, including genetic variance (31, 39). Hence, it has been suggested that a common underlying cause may explain the association. In addition, measures of neuroticism and depression often use the same formulations (10). Neuroticism may constitute a less severe step along the same spectrum that also encompasses depression, or a precursor of depression (31). Neuroticism is suggested as an endophenotype for depression (40), i.e., an intermediate step between a genotype and a disorder. Still, notwithstanding the underlying etiology, neuroticism might be used as a highly effective general risk marker for depression (39).
Stability and change
Current evidence indicates that neuroticism has a relatively stable set point and that certain life events are associated with fluctuations around, or even a shift in, that set point (10). Stressful events, especially in adolescence, are associated with increases in neuroticism (36, 41). Furthermore, major life events affecting close relationships or socioeconomic status are related to weak, although, long-lasting changes in neuroticism (42). In a recent meta-analysis (9), changes in personality after psychotherapy were reported across a large body of intervention studies. Neuroticism is the domain showing the largest malleability, especially in those seeking help for anxiety. According to the estimation, even a short treatment period (4-8 weeks) has potential for substantial decreases in neuroticism that are beyond short-term.

The course of personality across childbearing has been examined by a handful of studies. Some studies indicate that women tend to become less anxious in the postpartum period, especially when breastfeeding (43-45). In a longer perspective, results are contradictory. Specht and colleagues (37), who followed 15,000 adults over a four-year period, saw no significant personality changes after the birth of a child. In contrast, in a population-based cohort of young adults, emotionality (corresponding to neuroticism) increased across nine years of follow-up after having children (46). The increase was most evident among those who reported high emotionality before becoming parents.

Adult attachment
Bowlby and Ainsworth’s joint theory of attachment (47) describes the dynamics of individual functioning in interpersonal relations, corresponding to some parts of personality. Although initial research focusing on infant attachment (48) for some came to represent the extreme view that personality development relies only on early experiences (49), even the original theory described attachment as a dynamic process ‘from the cradle to the grave’ (50). The attachment ‘styles’ described in infants have been applied to adult romantic relationships using self-report measures (51) or a standardized interview – the Adult Attachment Interview (52). Although the Adult Attachment Interview is sometimes considered a gold standard for adult attachment, self-report attachment has become a large field of its own (53). However, there has thus far been little evaluation of attachment questionnaires in pregnant women.

Adult attachment, commonly measured on the two overarching dimensions of attachment anxiety and avoidance, refers to personality features specifically relevant to close adult relationships (54). Anxious attachment is characterized by a need for closeness and chronic concerns about relationships (55). Avoidant attachment, by contrast, is associated with a discomfort with closeness and emotional distancing. Individuals high in attachment anxiety report
more pregnancy worry, parenting stress, and decreased relationship satisfaction (56). Moreover, persons high in attachment anxiety perceive less, and receive less, partner support (57). Anxious attachment has a moderate to strong correlation with neuroticism (34, 58) and shared genetic influences (7), motivating investigations to determine whether the concepts are redundant.

Challenges for perinatal health

Perinatal depression

The worldwide criteria for depression by the American Psychiatric Association (APA) (28) define perinatal depression (PND) as when a depressive episode has its onset in pregnancy or within the first postnatal month. However, in research and clinical practice, the limit for postnatal onset is often stretched well beyond the first postnatal month to the first year (59, 60). PND is distinct from the more common ‘baby blues’, a state of emotional instability affecting about every second woman in the immediate days after childbirth. The prevalence of PND is estimated to approximately 12% worldwide (61). Characteristics of PND, in addition to the symptoms described above, are the experience of severe anxiety and panic attacks (28). Women affected by PND have described crushed expectations of motherhood, emotional and social isolation, and intense feelings of shame (62). PND may be persistent and recurrent, following a course far beyond the first postnatal weeks (63-65).

Narratives of affected women describe devastating consequences for their close relationships (66). The partner relationship is likely to be strained: indeed, studies on fathers demonstrate that depression in one partner is a large risk factor for depressive development in the other (67). In addition, the affected parent may have reduced ability for sensitive and creative interaction with the child. Depression makes it more likely for mothers to display more negative and disengaged behavior towards their children and not to maintain recommended caregiving practices (68, 69). Perhaps most troubling is the possibility that a parent’s depression may have long-term negative consequences on the child’s mental development (67, 70, 71).

Like many other complex disorders, the origin of PND is multifactorial, involving the complex interplay of biological, psychological, and social factors (72). Research has identified several risk factors for PND: for example, previous depression, stressful life events, and low social support (60), as well as dysregulation of the hypothalamic-pituitary-adrenal axis, inflammatory processes, and certain genetic polymorphisms (72, 73). However, optimal development of preventive measures warrants risk markers that are easily measured and possible to change.
Overlap with anxiety

The APA defines fear as ‘the emotional response to real or perceived imminent threat’ and anxiety as ‘the anticipation of future threat’ (28, p.189). In an interview study of Danish pregnant women, some degree of anxiety was viewed as inherent to the experience of pregnancy (74). Nonetheless, severe anxiety may have extensive impact on the functioning of individuals in daily life. When suffering from anxiety, the individual may develop behaviors to avoid, control or cope with the emotional experience (28). Some behaviors (e.g., the avoidance of fear-eliciting situations) may be useful to reduce anxiety in the short term but do not make the person better prepared when confronting the situation again.

Anxiety disorders are conditions characterized by excessive fear or anxiety (28). Canadian researchers estimated the prevalence of anxiety disorders to 15.8% during pregnancy and 17.1% in the early postpartum period (75). At eight weeks postpartum, the point prevalence of clinical and subclinical general anxiety is estimated to almost 30% (76). Certain anxiety manifestations are specific to pregnancy (e.g. concerning worry about the baby’s health or fear of delivery) (77). Some researchers argue that pregnancy-related anxiety is a distinct clinical entity, such as with reference to the modest to moderate correlations with general anxiety and depressive disorders (77, 78).

There is a notable comorbidity between PND and anxiety disorders (76, 79), affecting approximately 5-13% of women in the early postpartum period (75, 80). In a longitudinal perspective, there is evidence of a bi-directional relation, so that antenatal anxiety conveys a risk of postpartum depression (81, 82) and vice versa (83). Even generally, the similarities and differences between depression and anxiety disorders have been much discussed (84) and neuroticism has been suggested as a disposition that underlies the comorbidity (31).

Screening and treatment

One purpose of Swedish maternity care is the early identification of women and babies at risk of morbidity, together with the initiation of preventive strategies, during pregnancy and in the early postpartum period (85). The first choice of treatment for depression of moderate severity during pregnancy and the postpartum period is psychotherapy, preferably cognitive-behavioral or interpersonal therapy (86). The Swedish national guidelines for mood and anxiety disorders recommend a depression screening for postpartum women with the Edinburgh Postnatal Depression Scale (EPDS) (87, 88). Yet, even though PND is as common in pregnancy as postnatally (61), the guidelines do not recommend any antenatal depression screening with the EPDS, largely because of the scarcity of evidence (85, 86, 89). Consequently, in practice, the identification of antenatal mental health issues relies entirely on clinical judgement. However, detecting mood disorders is difficult, especially without
structured tools. General practitioners relying only on clinical judgement detect just half of all depressed patients (89). In Sweden, 6.8% of Swedish pregnant women were psychologically or medically treated for any mental health problem in 2015 (90), which suggests an under-treatment.

Ideally, depressive episodes would be prevented instead of having to be treated after their onset. When it comes to antenatal identification of those at risk of developing postpartum depression, it is insufficient to use the EPDS alone (91). Accordingly, researchers are working to identify risk factors that may predict the development of depression. While causal risk factors may be a target for interventions, even those factors having questionable or no causal influence might still be useful as markers for identification (92).

**Importance of personality**
Neuroticism and anxious adult attachment – two concepts of anxious personality – have been implicated as vulnerabilities that may predispose for depression in the context of becoming a parent. Several prospective studies have found associations between neuroticism and postpartum depression (93-95). Concerning adult attachment, analogues of anxious attachment (96-99) or attachment insecurity without specifying subtype (100-104) are predictive of postpartum depression. Yet, some studies report no associations (105, 106).

While neuroticism and adult attachment are empirically highly related (34), theoretical models for their associations with PND are different. In the model for neuroticism, pregnancy and childbirth are not distinguished from other types of life stressors, but are described as ‘general’ stressors (107). Other researchers argue that these life events cause concerns, which, instead of being general, specifically regard close relationships (97, 103, 104). Therefore, adult attachment theory would be uniquely suited to explain the development of depressive symptoms. There are only a few longitudinal studies on the relative importance of neuroticism and adult attachment as risk factors for PND, and the scattering studies that do exist have presented inconsistent and conflicting results (97, 99, 106).

**Obstetric complications**
In this thesis, obstetric complications refer to a range of adverse events and conditions in pregnancy or delivery that concern the mother (maternal) or the child (fetal, referring to pregnancy, and neonatal, referring to the immediate postpartum period). These events may have implications for the health of the mother or child both immediately and in the longer run (108).

**Mode of delivery**
In addition to the non-instrumental vaginal delivery, sometimes referred to as normal (109), there are three other modes of delivery: *instrumental vaginal delivery, elective cesarean section (CS) and emergency CS*. An instrumental
vaginal delivery refers to when the final stage of a vaginal delivery is assisted mechanically. A CS, either elective or by emergency, is an abdominal operation. In Sweden, instrumental vaginal delivery is almost exclusively performed with vacuum extraction, i.e., using a suction cup placed on the child’s head (110). Among vaginal deliveries in Sweden during the study period, the proportion of instrumental delivery was about 8-9% with large regional variations (111). Instrumental vaginal delivery increases the risk of certain complications that include severe lacerations and heavy bleeding.

An elective CS is a daytime procedure that is scheduled in advance. In contrast, emergency CS (or instrumental vaginal delivery) is indicated when, during a delivery process, adverse conditions occur that sometimes prompt immediate action to deliver the child. Complications associated with CS are more common in the emergency setting and include heavy bleeding and thromboembolic events. Moreover, emergency CS and instrumental vaginal delivery are associated with a traumatic delivery experience (112).

The latest national recommendations in Sweden promote a vaginal delivery for pregnant women without specific maternal or fetal indications for CS (113). These recommendations are based on evidence indicating that CS is associated with neonatal respiratory problems and complications in subsequent pregnancies. However, during the past decades – and especially in the 1990s and early millennium – the proportion of CS in Sweden increased from 12% in 1985 to 18% in 2014 (111). The number of elective and emergency CSs are roughly equal (114). Perhaps contrary to the view presented by popular media, the increase of CSs is rising to only a small extent from maternal requests without medical indication (114). Instead, the changing maternal population explains a large part: for instance, higher age and higher body mass index (BMI) are associated with both elective and emergency CS (115). Furthermore, there have been changes in clinical practice favoring CS, such as for breech delivery (114). Nevertheless, because maternal request of CS has been an increasing trend, the Swedish Society of Obstetrics and Gynecology advocate continued attention to these trends (114).

Pregnancy complications

Some women develop high blood sugar levels during their pregnancy without previous signs of this problem, a condition known as gestational diabetes mellitus (GDM). In Sweden, the rate of GDM is 1-3% (116). Similarly to type-2 diabetes, the primary characteristic of GDM is insulin resistance, together with higher prevalence among individuals with higher BMI and age. Besides being a marker for future risk of type-2 diabetes, GDM is associated with obstetric complications (e.g., having a very large baby and giving birth by means of CS) (110).

Normal physiological adaptation during pregnancy involves a decrease in blood pressure followed by a gradual return as pregnancy proceeds (117). As a contrast, 6-8% of pregnant women develop gestational hypertension: high
blood pressure (>140/90 mmHg) that is induced by the pregnancy and onsets after 20 weeks of gestation (118). The definition excludes those with a previous history of hypertension. High blood pressure combined with the leakage of protein in the urine is a sign of preeclampsia, a serious pregnancy complication with dubious symptomatology affecting 3-7% of pregnant women (118). The pathophysiology is not fully understood, but supposedly involves an abnormal formation of the placenta, leading to inadequate blood supply and ischemia, as well as a systemic inflammation with the spread of endothelial damage and general vasoconstriction (119). Symptoms may be severe and arise from several organs, such as the kidneys, heart, liver, and central nervous system. The most severe complication is convulsions (eclampsia), affecting 1% of women with preeclampsia in high-income countries like Sweden (118). The only cure is to discontinue pregnancy by delivering the child, which is precariously balanced against the risks associated with a premature delivery. Some risk factors have been identified, such as primiparity, obesity, chronic hypertension, and diabetes (118, 119).

**Delivery complications**
A delivery process either starts spontaneously or is induced by pharmacological and/or mechanical methods. Induction may be performed when delivery is delayed or when a continued pregnancy is associated with hazards (such as in severe preeclampsia). Although a spontaneous start is considered most advantageous for delivery outcomes (110), the rate of induction has doubled since 1990, reaching 15.8% of all deliveries in 2014 (111). A normal delivery process involves cervical dilation and forceful, regular uterine contractions. Several factors may interfere with the progress and cause prolonged delivery (mechanical disproportion, the position of the child, dysfunctional uterine contractions, or maternal exhaustion) (120). Prolonged delivery increases the risk of lacerations and uterine infections and the child may be at risk of asphyxia and meconium aspiration (114). Prolonged delivery is more common in first-time and higher-aged mothers, as well as in women of shorter height, higher BMI, and those experiencing maternal distress during delivery (121).

During the expulsion of the child, shallow soft tissue lacerations are common and usually heal without complications. Severe lacerations (degree III-IV on a four-degree scale) involve the anal sphincter (the muscle responsible for anal control) and are associated with fecal incontinence, pain, and sexual dysfunction (122). The rate of severe lacerations in Sweden was estimated to 3.5% in 2014 (111), which is twice the rate reported in 1990. Instrumental vaginal delivery, in addition to primiparity, lower height, higher age, and higher BMI, is a risk factor for severe lacerations (115). The last phase of delivery involves the expulsion of the placenta. Placental retention is when the expulsion is delayed >30 minutes. Placental retention, as well as prolonged delivery, instrumental vaginal delivery, and emergency CS are associated with
**postpartum hemorrhage** (excessive bleeding). In Sweden, postpartum hemorrhage is defined as a bleeding of ≥1000 mL within the first 24 hours after delivery and affects about 7% of vaginal deliveries and 13% of CSs (110). Postpartum hemorrhage, which is associated with postpartum anemia, severe fatigue, and PND, may even lead to life-threatening cardiovascular shock (123).

**Fetal/neonatal complications**

*Premature birth* refers to deliveries before 37 full weeks of gestation, whether spontaneous or medically induced. In 2014, 4.4% of children in singleton pregnancies and 42.5% of children in multiple pregnancies were born prematurely (111). Premature birth is associated with increased neonatal complications and long-term negative health outcomes in proportion to the degree of prematurity (124, 125). The strongest risk factor for spontaneous premature birth is a previous premature delivery; socioeconomic factors, on the other hand, contribute to only a small extent (126).

In Sweden, fetal growth is monitored by comparing ultrasound estimates of weight with a national reference curve according to gestational age (127). **Small for gestational age (SGA)** is defined as two standard deviations (SDs) below the average expected weight and **large for gestational age (LGA)** as two SDs above the average expected weight. SGA is a marker for restricted growth in utero, although the group also includes babies that are constitutionally small without having deviated from their growth curve. Fetal growth restriction is associated with higher fetal and neonatal morbidity and impaired neurodevelopment (128, 129). Moreover, growth-restricted babies are more likely to be born prematurely and the combination of these renders newborns particularly vulnerable (128). Some risk factors for fetal growth restriction include primiparity, smoking, preeclampsia, placental disorders, and certain infections (115, 130). Having a large baby is associated with several adverse maternal outcomes (e.g. instrumental vaginal delivery, elective and emergency CS, prolonged delivery, severe lacerations, and postpartum hemorrhage), together with impaired neonatal health status (131). Risk factors for LGA are high BMI before pregnancy, higher age, and pre-existing or gestational diabetes (131).

Neonatal health status is universally estimated with the Apgar score, a quick method to assess five components: heart rate, respiratory effort, muscle tone, reflex irritability, and color (132). Each component is rated on a three-point scale (from 0 to 2), resulting in a total score ranging from 0 to 10. An *Apgar score <7 at 5 minutes* has been estimated at 0.8% of live born infants in Sweden and is associated with an increased risk of neonatal mortality and severe neurologic morbidity (132, 133). Some obstetric risk factors for low Apgar scores are vaginal breech delivery, high birthweight, and being born as the second twin (133). In Sweden, women born in Africa south of Sahara have
an increased risk of delivering infants with a low Apgar score; other socio-demographic risk factors are lower educational level and primiparity (115).

**Importance of personality**

According to a meta-analysis of prospective studies on maternal anxiety during pregnancy and adverse birth outcomes, maternal anxiety, including both state and trait measures, is associated with premature birth and low birthweight (134). Among studies assessing neuroticism or corresponding trait measures, some report associations with premature birth or low birthweight (135, 136), whereas others report no association (137, 138). For example, in a large population-based prospective Norwegian study, there was an increased risk of early term and late preterm deliveries in women scoring high on trait anxiety (135).

There is little evidence on other obstetric outcomes than pregnancy length and birthweight. A review from 2003 concluded that most studies show no associations between anxious characteristics and obstetric complications (139). However, in a convenience sample of 755 postpartum women in the UK (140), low emotional stability correlated with retrospectively self-reported instrumental vaginal delivery, emergency CS, prolonged delivery, severe lacerations, fetal distress, and epidural pain relief. Fear of delivery, which is more common in women high in neuroticism (18, 141), is related to delivery complications. For example, in a large, population-based Danish study (142), first-time mothers reporting fear of delivery had a higher risk of emergency CS and prolonged delivery than those reporting no fear of delivery, taking into account several potential confounders. A possible explanation is that high levels of stress hormones during the delivery inhibit uterine contractions (143), leading to prolonged delivery and the need of emergency intervention.

Additionally, there are several potential mediators in the association between neuroticism and adverse obstetric outcomes. First, women high in neuroticism less often quit smoking during pregnancy (144) and smoking is associated with the risk of, for example, premature delivery and low birthweight infants (145). Second, neuroticism is associated with obesity (146) and maternal obesity is a risk factor for instrumental vaginal delivery, CS, and having a large baby (147). Third, neuroticism has been associated with cardiovascular disease (25), which carries a risk of placental disorders such as preeclampsia (118).

**Swedish antenatal care**

Antenatal care (ANC) in Sweden is publicly financed and free-of-charge. Each of Sweden’s 21 counties and regions practice independent programs of ANC based on national recommendations (117). Healthy women with normal pregnancies follow a routine program of 8-9 scheduled individual antenatal
consultations to a midwife in primary care (primary ANC), along with 1-2 fetal ultrasound examinations for dating and organ screening (117). The routine program for healthy pregnant women does not include any scheduled visit to a physician. Women with conditions associated with the risk of obstetric complications (e.g., diabetes mellitus, hypertension, or pregnancy complications such as preeclampsia) follow individually adapted programs that may involve scheduled visits to specialized ANC units within obstetrics/gynecology departments. Additionally, all pregnant women may consult either primary ANC or specialized ANC upon perceived need. Hildingsson et al. (148) found that most Swedish women attend more ANC visits than are included in the routine program. In 2016, 55% of Swedish pregnant women consulted an obstetrician/gynecologist (110).

In early pregnancy, women are offered information on prenatal diagnostics of chromosomal abnormalities (e.g., trisomy 13, 18, and 21). During the study period, the Combined Ultrasound and Biochemical Screening (CUB) was gradually introduced in Sweden, with large regional variation in usage (149). CUB is a noninvasive screening test for chromosomal aberrations used in the end of the first trimester. Results from CUB indicating an increased probability of aberrations may be diagnostically confirmed or disconfirmed with invasive tests (amniocentesis or chorion villi biopsy). However, invasive methods convey a risk of fetal loss in about 1% of the tests (149). Before the introduction of CUB, invasive prenatal diagnostic methods were offered selectively to pregnant women with risk factors for chromosomal aberrations (e.g., higher age or earlier pregnancy with chromosomal aberration).

The majority of Swedish obstetrics/gynecology departments have a fear-of-delivery team (150). In addition to experienced midwives and obstetricians, the team may include a psychologist, a welfare officer, and sometimes a psychiatrist. Pregnant women with severe fear of delivery or with a request of CS without medical indication are referred to the team (150). The objective of the clinic is to promote a positive delivery experience, regardless of mode of delivery. In 2016, 8% of pregnant women consulted a fear-of-delivery team (110).

Alternative models of antenatal care

In high-income countries, there are discussions that ANC is overly focused on risks and medical interventions (151). The ‘medical model’, focused on medical surveillance to detect and intervene against pathology, is contrasted with the ‘midwife model’ or ‘social model’, promoting normalcy as far as possible and incorporating psychological and social aspects of pregnancy (151). While both models usually influence ANC, it is argued that less medicalization would benefit maternity care (152): for instance, such care occurs at the cost of continuous support. Recently, a Cochrane review of randomized trials
found lower incidence of obstetric complications in women receiving continuous support during delivery (153).

Caregiver continuity in the Swedish ANC is identified as an area in need of improvement (154). In delivery care, continuity of a midwife caregiver from the ANC is very unusual. ‘Caseload’ and ‘team’ midwifery are alternative models of ANC centered on a continuous relationship with one or a team of midwives in pregnancy, during delivery, and in the postnatal follow-up. In a Cochrane review, midwife continuity models of care have been associated with less medical intervention during delivery and a better delivery experience, without any difference in adverse outcomes (155). However, this may not apply to women with obstetric high-risk conditions inasmuch as they were excluded in the reviewed studies. Currently, a handful of Swedish delivery wards practice midwife continuity models of care (156, 157).

Health care use

**The Andersen behavioral model**

In research on the use of health care services, the Andersen behavioral model of health care use is a widely applied theoretical framework (158, 159). The model describes an individual’s use of health care by three groups of determinants: predisposing characteristics, enabling resources, and need factors (Table 1). The Andersen model has been criticized for not considering psychological components (such as personality) because personality associates with several of the included determinants (159, 160).

<table>
<thead>
<tr>
<th>Determinants of health services’ use in the Andersen behavioral model.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predisposing characteristics</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Demographics (age, gender, ethnicity, education)</td>
</tr>
<tr>
<td>Physical environment</td>
</tr>
<tr>
<td>Health beliefs (values regarding health, attitudes towards health services)</td>
</tr>
<tr>
<td>Knowledge about disease</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Importance of personality**

Neuroticism predicts the use of health care for mental disorders, general health care, and health care after myocardial infarction (159-162). For example, in a prospective population-based German study of the general population, changes in neuroticism predicted changes in the number of visits to a physician, irrespective of predisposing, enabling, and need factors (160). The economic costs of neuroticism have been estimated to exceed those of common mental disorders (163). During pregnancy, women with anxiety experience
more somatic symptoms (139). Increased use of ANC in Sweden is associated with symptoms of depression and anxiety (148, 164), history of psychiatric morbidity (110), and untreated severe fear of delivery (165), all of which are related to neuroticism. Yet, no study has examined the role of neuroticism in the use of ANC.

Rationale for the thesis
Anxious personality traits are stable tendencies in thoughts, emotions, and behaviors with implications for psychiatric disorders, perceived health, and social relationships. Even if such characteristics are easy to measure and have the potential to change after intervention, their importance in perinatal health is poorly outlined:

I. Adult attachment insecurity is currently studied as a risk factor in perinatal mental health. Still, none of the Swedish-translated self-report measures has been psychometrically evaluated in a pregnant cohort.

II. Neuroticism and adult attachment insecurity are anxious personality traits that could help in the identification of pregnant women at risk of postpartum depression; however, it is unclear whether these measures are redundant or whether they tap distinct aspects of personality.

III. Although neuroticism during pregnancy is suggested as a risk factor for adverse obstetric and neonatal outcomes, previous studies are typically small, use self-report outcome measures, and have often produced inconsistent and conflicting results.

IV. Neuroticism is a strong determinant of the use of health services. Yet, no study has investigated the importance of neuroticism for the use of ANC.

Aims and hypotheses
Paper I

Aims

Evaluate the reliability and factor structure of the Attachment Style Questionnaire-Short Form (ASQ-SF) for use in pregnant women

Compare the reliability and factor structure of the short and full versions of the Attachment Style Questionnaire (ASQ) among pregnant women
Hypotheses
- The ASQ-SF will have similar internal consistency and factor structure in a Swedish pregnant cohort as reported for the general population
- The psychometric properties of the ASQ-SF will equal or outperform those of the original version

Paper II
Aim
- Examine the overlap of adult attachment insecurity and neuroticism/trait anxiety as predictors of postpartum depressive symptoms, taking into account baseline depressive symptoms

Hypotheses
- There will be a certain degree of overlap between attachment insecurity and neuroticism/trait anxiety
- Insecure attachment in pregnancy will influence the risk of postpartum depressive symptoms even after taking into account neuroticism/trait anxiety, baseline depressive symptoms and previous depression
- Among those without antenatal depressive symptoms, the combination of high attachment insecurity and high neuroticism/trait anxiety will best identify women with the highest risk of postpartum depressive symptoms

Paper III
Aim
- Assess whether neuroticism is associated with adverse obstetric or neonatal outcomes

Hypothesis
- Neuroticism will be associated with adverse obstetric and neonatal outcomes

Paper IV
Aim
- Investigate the association between neuroticism and the use of publicly financed ANC in obstetric low-risk women, also considering predisposing and need factors for health care utilization

Hypothesis
- Women with high neuroticism scores will more often seek health care during pregnancy
Materials and methods

Overview (I-IV)

Table 2. Design, methods, participants, and main analyses of papers I-IV.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Design</th>
<th>Data collection</th>
<th>Participants</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Population-based, cross-sectional</td>
<td>Questionnaire</td>
<td>1631 pregnant women</td>
<td>Psychometric evaluation</td>
</tr>
<tr>
<td>II</td>
<td>Population-based, prospective</td>
<td>Questionnaires</td>
<td>1618 pregnant women</td>
<td>Generalized linear models</td>
</tr>
<tr>
<td>III</td>
<td>Convenience sample, cross-sectional</td>
<td>Questionnaire and national health registers</td>
<td>1969 pregnant women, primiparous, with singleton pregnancies</td>
<td>Logistic regression</td>
</tr>
<tr>
<td>IV</td>
<td>Convenience sample, longitudinal</td>
<td>Questionnaire and medical journals</td>
<td>1052 pregnant, obstetric low-risk women</td>
<td>Logistic and negative binomial regression</td>
</tr>
</tbody>
</table>
pregnancy diagnosed by ultrasound, protected personal data, or blood-borne disease were criteria for exclusion.

Participants completed several internet-based surveys (Figure 1). For papers I-II, the initial survey in mid-pregnancy (at about gestational week 17-20) asked for sociodemographic information, and the first follow-up (at about pregnancy week 32) contained an adult attachment instrument. For paper II, additional data were collected. From the initial survey, history of depression and certain pregnancy-related information were gathered. The survey at about pregnancy week 32 further measured personality and depressive symptoms. The personality questionnaire was either neuroticism (Group 1, enrolled until June 2011) or trait anxiety (Group 2, enrolled after June 2011). At two subsequent follow-ups (at six weeks and six months postpartum), participants again answered the measure on depressive symptoms.

Figure 1. Contents of the surveys (papers I-II).

Figure 2 shows a flowchart of participants in papers I-II. Of 10,267 eligible patients, 2160 (21.0%) accepted the study invitation. Of those women who accepted the invitation, 403 did not respond to the first follow-up. Participants were excluded if they exceeded time limits for answers (n=59) or left incomplete answers to the follow-up in pregnancy week 32 (n=19, papers I-II) or at six weeks postpartum (n=13, paper II only). Forty-eight persons participated twice since they gave birth a second time during the study period. Their second participation was excluded in the main analysis but used for test-retest reliability in paper I. For paper I, the final sample comprised 1631 individuals. For paper II, the final sample included 1618 individuals (another 79 women dropped out before the six-month follow-up but were not excluded from the analyses of depressive symptoms at six weeks postpartum). The paper II sample was further categorized into two groups depending on which personality
measure they answered: neuroticism (Group 1, n=1063) or trait anxiety (Group 2, n=555).

Compared with the excluded women (internal dropout), the final participants were more likely primiparous, born in Scandinavia, to have a college or university education, and to work or study in mid-pregnancy. For paper II, participation was further associated with lower neuroticism and having a planned pregnancy. Adult attachment, trait anxiety, or antenatal or postpartum depressive symptoms were not associated with exclusion.

Neuroticism cohort (III-IV)

Papers III-IV encompassed several projects in 2005-2011 based in Uppsala, Sweden in which participants answered a questionnaire that measures neuroticism (Table 3). The projects investigated oral contraceptive use (n=118) (166), infertility (n=320) (167), induced abortion (n=1320) (168), premenstrual mood disorder (n=44) (169), and PND (the BASIC study, 2009-2011, n=1017). Along with inhabitants of Uppsala County, participants were recruited from obstetrics/gynecology departments in Umeå, Örebro, Linköping, and Stockholm, or referred to Uppsala from nearby counties.

Table 3. Design and recruitment of studies in the neuroticism cohort (papers III-IV).

<table>
<thead>
<tr>
<th>Study theme</th>
<th>Design</th>
<th>Recruitment</th>
<th>Size (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral contraceptive use</td>
<td>Case-control</td>
<td>Advertisement in newspapers and on boards at health care centers: ongoing or past experience of combined oral contraceptive pills</td>
<td>118</td>
</tr>
<tr>
<td>Infertility</td>
<td>Cohort study</td>
<td>Women in consecutive couples undergoing infertility treatment</td>
<td>320</td>
</tr>
<tr>
<td>Induced abortion</td>
<td>Multi-center cohort study</td>
<td>Women requesting induced early abortion at outpatient clinics</td>
<td>1320</td>
</tr>
<tr>
<td>Premenstrual mood disorder</td>
<td>Case-control</td>
<td>Cases: Women consulting outpatient ward for premenstrual symptoms Controls: Newspaper advertisement for physically healthy women with regular menstrual cycles</td>
<td>44</td>
</tr>
<tr>
<td>PND (BASIC study)</td>
<td>Population-based cohort study</td>
<td>Pregnant women scheduled for routine ultrasound examination</td>
<td>1017</td>
</tr>
</tbody>
</table>

Figure 3 displays a flowchart of the study participants in papers III-IV. For paper III, women who made an incomplete neuroticism assessment (n=9), had not given birth or whose first delivery took place before 1984 or outside Sweden (n=809) or had a twin pregnancy (n=32) were excluded, leaving a final sample of 1969 participants. Through participants’ personal identity number (170), self-reported neuroticism was linked to sociodemographic information from the government agency Statistics Sweden (171) in addition to three Swe-
dish health registers: the Medical Birth Register (MBR) (172) concerning participants’ first delivery, the Patient Register (173) from five years before delivery to one year after delivery, and the Prescribed Drug Register (174) during pregnancy.

For paper IV, those who were not residents of Uppsala (n=924), did not give birth during the study period (n=403), moved from Uppsala County before or during pregnancy (n=235), gave birth outside Uppsala (n=26), could not be identified in the records (n=21), or whose personality was assessed after de-
livery (n=2) were excluded. Obstetric high-risk women (n=156) were also excluded to create a cohort with an expected low need of health care. Obstetric high-risk, for example, was defined as pre-existing or gestational diabetes or hypertension, preeclampsia, fetal growth restriction, and multiple pregnancy. The final participants were 1052 women who gave birth at Uppsala University Hospital in 2006-2014. The final sample, vs. the excluded (internal dropout) women, had lower neuroticism and were more likely university-educated. Medical records from Uppsala County concerning the first subsequent pregnancy after neuroticism assessment were used to derive measures on ANC use and adjustment variables.

Methods

Background information (I-IV)
Self-reported sociodemographic information (e.g., parity, age, country of birth, educational level, and work status) were included in papers I, II, and IV. Paper II further included a question battery for information relevant to PND (e.g., history of depression, intimate partner violence in a previous or current relationship, planning of pregnancy, and hours of sleep in mid-pregnancy). For paper III, background information was retrieved through the MBR (parity, age, height, BMI in early pregnancy, smoking in pregnancy, involuntary childlessness, and year of delivery), the government agency Statistics Sweden’s registers on the Swedish population (educational level), and the Patient Register and the Prescribed Drug Register (psychiatric morbidity).

Self-report instruments (I-IV)
In personality research, self-report instruments are arguably the most widely used method (175). Although self-reports may be affected by mood states and response styles (31), they also have distinct advantages. Reasonably, nobody else than the respondent has more information to share; moreover, the method favors accuracy because of a wish to do oneself justice (176). Lastly, self-reports comply with the requirements on convenience and efficiency in the clinical reality of interest to this research, i.e., consultations in maternal health care.

Adult attachment (I-II)
The ASQ (177) measures adult attachment in close relationships. In contrast to other attachment instruments (e.g. the Experiences in Close Relationships (54) and the Adult Attachment Scale (178)), it does not specifically address romantic partners. The ASQ measures the two main dimensions of adult attachment on the subscales of Avoidance and Anxiety (179, 180). Additionally,
the ASQ has five other subscales reflecting subcomponents of attachment avoidance and anxiety (Table 4). The two subscale and five subscale variants overlap, so that Avoidance has items from Discomfort with Closeness, Relationships as Secondary, and half of Confidence; Anxiety has items from Need for Approval, Preoccupation with Relationships, and the other half of Confidence (179, 180).

Table 4. Item examples of the five subscale variant of the ASQ.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Item example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discomfort with Closeness</td>
<td>I prefer to depend on myself rather than other people.</td>
</tr>
<tr>
<td>Relationships as Secondary</td>
<td>Achieving things is more important than building relationships.</td>
</tr>
<tr>
<td>Confidence</td>
<td>I feel confident that other people will be there for me when I need them.</td>
</tr>
<tr>
<td>Need for Approval</td>
<td>It’s important to me that others like me.</td>
</tr>
<tr>
<td>Preoccupation with Relationships</td>
<td>I find that others are reluctant to get as close as I would like.</td>
</tr>
</tbody>
</table>

Items are answered on a six-point Likert scale from 1 (‘totally disagree’) to 6 (‘strongly agree’). The results were calculated as subscale means from 1 to 6, where increasing values represent insecure attachment (except for the subscale Confidence). The internal consistency of the seven available subscales of the ASQ-SF has previously been demonstrated as good (Cronbach’s α 0.72-0.89) (97, 180).

From the original 40-item instrument, a 29-item short form (ASQ-SF) has been developed (180). The ASQ has a Swedish translation (181) and the full-version has been validated in a Swedish population (182). It has also been used in perinatal settings abroad (97, 104).

**Neuroticism (I-IV)**

In the present papers, the Swedish universities Scales of Personality (SSP) was used to assess personality. The SSP is a psychometrically improved version of the Karolinska Scales of Personality, a widely used personality measure in Scandinavian contexts (183). The neuroticism domain has 42 questions belonging to the subscales Somatic Trait Anxiety, Psychic Trait Anxiety, Stress Susceptibility, Lack of Assertiveness, Embitterment and Mistrust. A description of their contents is presented in Table 5.

Items are rated on a four-point Likert scale (from ‘does not apply at all’ to ‘applies completely’). The mean value of each subscale is converted into a normative score (T-score, with mean=50 and SD=10) according to age and gender based on a Swedish general population (184). The sum of the subscales’ T-scores equals the neuroticism score (mean=300 in the reference population). The SSP has a similar factor structure in pregnant women as in the
reference population, including three personality domains: neuroticism, aggressiveness, and sensation seeking (the latter two were not addressed in this study) (93). The neuroticism domain is concordant with its counterpart in the Big Five domains of personality (33).

Table 5. Contents of the subscales constituting the neuroticism domain of the Swedish universities Scales of Personality.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Description of measured characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somatic Trait Anxiety</td>
<td>Autonomic arousal, restless, tense</td>
</tr>
<tr>
<td>Psychic Trait Anxiety</td>
<td>Worrying, anticipating, lacking self-confidence</td>
</tr>
<tr>
<td>Stress Susceptibility</td>
<td>Easily fatigued, feeling uneasy when urged to speed up</td>
</tr>
<tr>
<td></td>
<td>Lacking ability to speak up and to be self-assertive in social situations</td>
</tr>
<tr>
<td>Lack of Assertiveness</td>
<td>Lacking ability to speak up and to be self-assertive in social situations</td>
</tr>
<tr>
<td>Embitterment</td>
<td>Dissatisfied, blaming and envying others</td>
</tr>
<tr>
<td>Mistrust</td>
<td>Suspicious, distrusting people’s motives</td>
</tr>
</tbody>
</table>

Trait anxiety (II)
The trait anxiety scale of the State-Trait Anxiety Inventory for Adults (STAI-AD) (185) estimates the respondent’s characteristic level of general anxiety. The scale generates total scores of 20-80 out of 20 questions with four-point Likert scale response options. The STAI-AD has good reliability (81) and is a recommended anxiety measure in perinatal research (186). The STAI-AD also has a scale for transient anxiety (state anxiety), but the trait anxiety scale has been reported as a better predictor for postpartum depression (81).

Depressive symptoms (II)
The EPDS is a 10-item self-rating scale developed to screen for PND with wide international use (87, 187). The EPDS was designed to overcome the challenges of depression screening in a population where many non-depressed individuals experience energy loss or disturbances in sleep, appetite or concentration; instead, focus lies on disturbed mood. Although originally meant for postnatal measurement, it was soon applied prenatally as well (187).

Items include symptoms of depressed mood over the past week and are answered on a four-point Likert scale (0-3), with total score ranging from 0-30. The scores can either be used in their continuous form or be dichotomized to identify clinically significant depressive symptoms. With a cut-off of ≥13 points, the EPDS identifies depressed postpartum women with a sensitivity of 72% and a specificity of 88% (89). However, this sensitivity level is low for a screening instrument (89). A lower cut-off is supported by studies using SCID-I as reference during pregnancy (188) as well as postpartum (189). In Swedish investigations using a cut-off of ≥12 points, the prevalence of depressive symptoms is 13.7-15.7% during pregnancy and 11.1% at two months postpartum (190, 191). In this thesis, clinically significant depressive symptoms during pregnancy or in the postpartum period were defined as EPDS ≥12.
Register data (III)

Sweden has several nationwide registers with individual data on residents’ health, which are available for epidemiological studies after ethical permission (172-174, 192). The Centre of Epidemiology within the National Board of Health and Welfare, a government agency under the Ministry of Health and Social Affairs, administers these registers. Because it is compulsory by law for health care providers to report data and not optional for individuals to erase their data, the registers are very comprehensive and inclusive. Data from different health registers can be merged given that all health registers use the personal identity number to file data for every individual (170).

Medical Birth Register

The MBR contains information on almost every delivery in Sweden since 1973 (172). The register is based on health records of primary ANC services and obstetrics/gynecology departments. In paper III, data on the participants’ first pregnancy (1984-2012) originated in the MBR. The extracted information comprised two types of data: diagnostic codes (e.g., the International Statistical Classification of Diseases and Related Health Problems (ICD) versions 8-10) (193) and MBR-specific variables originating from check boxes filled out at clinical visits. The categorization of outcomes using these diagnostic systems is presented in the Supplementary table.

Patient Register

The National Patient Register lists information on hospital care since the 1960s (173). Since 2001, it also includes outpatient visits to both public and private providers of psychiatric care and day surgery. Primary care visits are not included in the register. The quality of the Patient Register is overall good; however, the outpatient information is less complete than the inpatient register and 5% of the main diagnoses in psychiatric inpatient care are missing (173). In paper III, diagnoses from five years before to one year after delivery were retrieved from the Patient Register. The diagnoses were categorized into chronic somatic disease and psychiatric morbidity (Supplementary table).

Prescribed Drug Register

The Prescribed Drug Register, from 2005, covers information on all professionally prescribed and dispensed medical drugs in Sweden (174). Drugs are classified according to the Anatomical Therapeutic Chemical (ATC) classification system (194). For paper III, information on participants’ prescribed antidepressants and anxiolytics (ATC categories N05-N06) during pregnancy was extracted and used as an indicator of psychiatric morbidity.
Ethical considerations

The protocols of the present papers have been approved by the Regional Ethics Committee of Uppsala (reg. no. 2009/171, July 2009; and 2014/092, June 2014). The studies were performed in full accordance with the Declaration of Helsinki. Before giving their written consent, participants received oral and written information about the study protocol and aims. The information also included the possibility to withdraw participation at any time without reprisal.

Answering surveys like those in the BASIC project may be a source of discomfort in that they probe potentially sensitive psychological symptoms and experiences. Additionally, the investigated symptomatology (e.g., PND), may be severe. Therefore, the surveys included, together with contact information, explicit encouragement to contact the study personnel in case of perceived need of help. Women reporting suicidal ideation were contacted actively and offered referral to a psychologist or psychiatrist.

Because the databases for the papers comprised sensitive information on personal health, a code digit replaced the women’s personal identity numbers. Only the personnel involved in the research had access to the pseudonymized data and the code key list was stored separately. In paper III, personality scores were sent to the National Board of Health and Welfare for linkage to national health registers. In this process, data were completely anonymized.

Analysis

Psychometric evaluation (I)

Central aspects of quality of a measurement method, such as a self-report instrument, are reliability and validity. Good reliability of an instrument refers to its ability to reproduce the same results under the same circumstances. Good validity refers to the instrument’s accuracy in capturing the intended phenomenon. To achieve good validity, the instrument has to present at least acceptable reliability. Types of reliability examined in paper I were internal consistency, reproducibility of factor structure, and test-retest correlations.

Internal consistency refers to how well a set of items (e.g., a subscale) measures the same concept (e.g., attachment anxiety). In paper I, three indicators of internal consistency were used: item-subscale correlations, Cronbach’s $\alpha$, and Cronbach’s $\alpha$ when removing one item of the subscale at a time (‘$\alpha$ if item deleted’). Item-subscale correlations were found acceptable if $\geq 0.30$, and satisfactory $\alpha$ values were defined as $0.7 \leq \alpha \leq 0.9$ (195). The internal consistency of both the full-version ASQ and the short form ASQ-SF were computed and nominally compared.
Because there is a proposed factor structure of the ASQ and the ASQ-SF (180), a confirmatory factor analysis (CFA) was chosen with the aim to replicate this structure. The model, sketched in Figure 4, proposes eight underlying (‘latent’) variables to explain the variation in item response: the seven subscales of the ASQ and a response bias term encompassing every item. Each item was assigned to three latent variables (e.g., Discomfort with Closeness, Avoidance, and Response bias). The strength of the latent variables was indicated by the size of the item correlations (‘loadings’) and the overall quality of the CFA model (‘model fit’) was evaluated with a combination of several indices (196). Values of Comparative Fit Index (CFI) ≥0.95, Tucker Lewis Index (TLI) ≥0.95, Root Mean Square Error of Approximation (RMSEA) ≤0.05, and Standardized Root Mean Residual (SRMR) ≤0.08 were interpreted as indicators of good model fit. The model fit of the factor structure in both the full-version ASQ and the short form ASQ-SF was computed and nominally compared.

Test-retest correlations for the ASQ-SF subscales were computed by comparing the scores for the small subsample of women who participated twice during consecutive pregnancies (n=48). Although subscale means were non-normally distributed, Pearson and Spearman correlations were similar. To facilitate comparison with previous studies, Pearson correlations were reported. Calculations were run using the software IBM SPSS Statistics 21 (the Amos module was used for the CFA) and the significance value was set a priori at p<0.05.
Figure 4. The proposed factor structure of the ASQ with eight latent variables. Shaded item numbers are not included in the short form of the ASQ. After Karantzas et al. 2010 (180) with kind permission.
Association models (II-IV)

Papers II-IV investigated associations between different exposures and outcomes. To consider possible confounding of an association by other variables (potential confounders, or adjustment variables), these were entered alongside the exposure as independent variables in multivariable (adjusted) models. Figures 5-8 list the exposures, outcomes, and adjustment variables included in papers II-IV. Several outcomes are listed for each paper, but the multivariable models examined only one outcome at a time. Analyses were performed with IBM SPSS Statistics 21 (paper II) or the R statistical programming language, version 3.4.2 (papers III-IV). The significance level was set at p<0.05.

Paper II

Because the variables were non-normally distributed, pairwise associations between personality and depression variables were calculated with Spearman correlation analysis. Pairwise associations involving the variable ‘positive depression screening’, which consisted of binary data, were instead tested with Mann-Whitney U or Pearson χ² test.

Associations between adult attachment and depressive symptoms at six weeks and six months postpartum, while considering neuroticism/trait anxiety and other possible confounders, were investigated in multivariable models. The outcome (depressive symptoms scores) had a positively skewed distribution and thus generalized linear models with gamma distribution were applied.

A second set of analyses explored the usefulness of personality measures (attachment and neuroticism/trait anxiety) to identify women at risk of postpartum depression, beyond antenatal EPDS. In these analyses, women with positive antenatal EPDS screening for depression were excluded in that they would already be identified with available measures. Among women with a negative antenatal depression screening (n=1431), a combination of attachment anxiety and neuroticism (Group 1, n=943) or trait anxiety (Group 2, n=488) was evaluated for the risk of a positive postpartum depression screening. First, the personality variables were dichotomized into high and low values. Second, three ordinal categories were created: low attachment anxiety and low neuroticism (used as reference), high attachment anxiety or neuroticism, and high attachment anxiety and high neuroticism. In Group 2, trait anxiety was consistently used instead of neuroticism. Logistic regression models with positive depression screening postpartum (at six weeks in one analysis and at six months in another) as the outcome were carried out to obtain crude and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the high-scoring groups compared with the reference group.
Figure 5. Paper II exposure (E), outcomes (O), adjustment variables (A): first set of analyses. Continuous discrete data ( ).

Figure 6. Paper II exposure (E) and outcome (O): second set of analyses. Ordinal data ( ), binary data ( ).

**Paper III**

First, pairwise associations between neuroticism and the potential confounders were calculated with Mann-Whitney U or Kruskal Wallis tests. Second, associations between neuroticism (exposure) and obstetric complications (outcomes) were examined in multivariable logistic regression models. ORs with 95% CIs were calculated, not for a 1-unit increase in the exposure, but for a 63-unit increase. Sixty-three units of neuroticism equaled the interquartile range (IQR), that is, the difference between the 25th and 75th percentiles of answers. Because the model is linear, this may also be interpreted as the OR comparing women at any two points differing by 63 units. The models were crude (unadjusted) or adjusted for possible confounders in two steps. The first step included all adjustment variables except psychiatric morbidity, which was entered separately in the second step because of the conceptual overlap with neuroticism.
Figure 7. Paper III exposure (E), outcomes (O), adjustment variables (A). Continuous discrete data (●), binary data (○○).

Paper IV

Pairwise associations between neuroticism and the possible confounders were calculated with Mann-Whitney U or Kruskal Wallis tests. Then, associations were investigated between neuroticism (exposure) and different aspects of ANC use (outcomes) that consisted of either binary or continuous discrete data (on a scale with certain fixed values). Logistic regressions with ORs and 95% CIs were used for binary outcomes. Negative binomial regressions with incidence rate ratios (IRRs) and 95% CIs were used for continuous discrete outcomes because of their compilation of scores at zero.

To explore whether the associations were differently shaped than a straight line, logistic regressions were calculated with (1) neuroticism included as a linear variable and (2) neuroticism included as a non-linear variable (with restricted cubic splines). For each outcome, the alternative with best model fit in accordance with the Akaike information criterion was chosen. Two outcomes, ‘number of phone consultations or visits to a midwife in specialized ANC’ and ‘visit to a non-obstetrics/gynecology professional’ had non-linear associations with neuroticism.
For all linear models, risk estimates were calculated for a 58-unit increase in neuroticism, which was the same as the IQR. Therefore, risk estimates regarded the difference between the 25th and 75th percentiles of answers, or between any two points differing by 58 units. Both crude and adjusted models were estimated.

Figure 8. Paper IV exposure (E), outcomes (O), adjustment variables (A). Continuous discrete data ( ), binary data ( ).
Summary of results

Acceptable reliability of the ASQ (I)

Internal consistency values of the ASQ-SF are listed in Table 6. The internal consistency was nominally similar for the ASQ-SF and the full-version ASQ. The exceptions were a higher, yet unsatisfactory, $\alpha$ for the Relationships as Secondary scale (0.64) in the full-version and very low item-subscale correlations regarding for item 28 of the full-version, which is not included in the short form.

Table 6. Internal consistency measures of subscales in the ASQ-SF.

<table>
<thead>
<tr>
<th>ASQ-SF subscale (number of items)</th>
<th>Item-subscale correlations, range (mean)</th>
<th>$\alpha$ if item deleted, range</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoidance (16)</td>
<td>0.18-0.72 (0.50)</td>
<td>0.85-0.88</td>
<td>0.87</td>
</tr>
<tr>
<td>Anxiety (13)</td>
<td>0.17-0.74 (0.59)</td>
<td>0.87-0.90</td>
<td>0.89</td>
</tr>
<tr>
<td>DC (9)</td>
<td>0.42-0.74 (0.57)</td>
<td>0.82-0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>RS (4)</td>
<td>0.23-0.40 (0.34)</td>
<td>0.40-0.55</td>
<td>0.54</td>
</tr>
<tr>
<td>C (6)</td>
<td>0.53-0.71 (0.62)</td>
<td>0.79-0.82</td>
<td>0.83</td>
</tr>
<tr>
<td>NA (5)</td>
<td>0.24-0.71 (0.52)</td>
<td>0.63-0.79</td>
<td>0.76</td>
</tr>
<tr>
<td>PR (5)</td>
<td>0.36-0.61 (0.55)</td>
<td>0.70-0.80</td>
<td>0.77</td>
</tr>
</tbody>
</table>

The factor structure model had borderline fit in the ASQ-SF. Applied to the full-version ASQ, the fit was nominally inferior. Concerning latent variables, Anxiety was the strongest among those describing attachment, whereas Avoidance was a weak latent variable. The overall strongest latent variable was the error term for response bias.

The test-retest correlations for the subgroup of women answering the ASQ-SF during two consecutive pregnancies were as follows: Avoidance, $r=0.84$; Anxiety, $r=0.74$; Discomfort with Closeness, $r=0.80$; Relationships as Secondary, $r=0.67$; Confidence, $r=0.80$; Need for Approval, $r=0.65$; and Preoccupation with Relationships, $r=0.71$. 

40
Partial overlap of neuroticism and attachment anxiety (II)

Attachment anxiety contributed to the risk of postpartum depressive symptoms at six weeks and at six months beyond previous risk factors that were outside the concept of personality. High correlations were observed between attachment anxiety and neuroticism as well as between attachment anxiety and trait anxiety. In Group 1, attachment anxiety and neuroticism were, to some extent, independently associated with depressive symptoms at both six weeks and six months after delivery (Table 7). In Group 2, neither attachment nor trait anxiety retained statistical significance for an association with postpartum depressive symptoms when included in the same model.

Table 7. Depressive symptoms at six weeks postpartum by adult attachment, depression variables, and neuroticism (Group 1) or trait anxiety (Group 2).

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Std B</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment anxiety</td>
<td>0.017</td>
<td>0.014</td>
</tr>
<tr>
<td>Attachment avoidance</td>
<td>-0.005</td>
<td>0.406</td>
</tr>
<tr>
<td>Antenatal EPDS</td>
<td>0.050</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of depression</td>
<td>0.006</td>
<td>0.148</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>0.024</td>
<td>0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th>Std B</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment anxiety</td>
<td>0.015</td>
<td>0.093</td>
</tr>
<tr>
<td>Attachment avoidance</td>
<td>-0.005</td>
<td>0.540</td>
</tr>
<tr>
<td>Antenatal EPDS</td>
<td>0.049</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>History of depression</td>
<td>0.010</td>
<td>0.094</td>
</tr>
<tr>
<td>Trait anxiety</td>
<td>0.019</td>
<td>0.078</td>
</tr>
</tbody>
</table>

Note. Generalized linear models with standardized B (B / standard error of B) and p values.

In women with a negative antenatal depression screening, scoring high on both attachment anxiety and neuroticism was associated with a higher risk of a positive depression screening at six weeks postpartum as well as at six months postpartum as compared with low scores on both (Figure 9). The same result was found in Group 2, substituting trait anxiety for neuroticism.
Figure 9. Logistic regression-derived ORs with 95% CIs, for a positive postpartum depression screening (at six weeks or six months), between high vs. low scores on both attachment anxiety and neuroticism (Group 1). In Group 2, trait anxiety was used instead of neuroticism.

No obstetric complications in association with neuroticism (III)

Neuroticism was not independently associated with obstetric or neonatal outcomes (Figure 10). Among adjustment factors, young age, lower educational level, underweight and overweight, smoking in pregnancy, and psychiatric morbidity were crudely associated with neuroticism.

In the logistic regression models, women with higher neuroticism scores had 2.5 times higher odds of GDM (OR=2.53, 95% CI 1.20-5.33). After adjustment for psychiatric morbidity, the association was no longer significant, however. In addition, crude associations were present with instrumental vaginal delivery (OR=0.79, 95% CI 0.65-0.95) and placental retention (OR=0.66, 95% CI 0.44-0.99), but these did not sustain statistical significance after adjustment for sociodemographic factors. No associations with neuroticism were identified regarding the other study outcomes.
Greater use of ANC in women with high neuroticism (IV)

Among predisposing and need factors, neuroticism was crudely associated with younger age, being a first-time mother, having no university education, not working or studying, single status, and psychiatric morbidity. It was not associated with country of birth or BMI.

Results of the adjusted multivariable models are shown in Figure 11. After adjustment for possible confounders, women with higher neuroticism had more fetal ultrasounds (IRR=1.09, 95%CI 1.02-1.16), more visits to an obstetrician/gynecologist (IRR=1.14, 95%CI 1.00-1.30), more emergency visits to an obstetrician/gynecologist (IRR=1.22, 95%CI 1.03-1.45), and were more likely to visit a fear-of-delivery clinic (OR=2.71, 95%CI 1.71-4.29). In addition, they were more likely to consult midwives in specialist ANC (significant non-linear association, Figure 12) and visit a non-obstetrics/gynecology professional (significant non-linear association). Some other variables associated with increased ANC use after adjustments were being foreign-born (hospital admission) and having lower education (hospital admission, visit to a non-ObGyn professional, and elective cesarean section).
Figure 11. Adjusted association models of ANC outcomes and neuroticism (paper IV). ORs and IRRs with 95%CIs. * Statistically significant estimate.

Figure 12. Non-linear association between neuroticism and number of consultations to a midwife in specialist ANC. Negative binomial regression with IRRs (black line) and 95% CIs (grey area) for neuroticism scores compared with the 25th percentile reference.
Discussion

In the studies included in this thesis, pregnant women with anxious personality traits had a higher risk of postpartum depressive symptoms. Because their combination carried a higher risk of postpartum depressive symptoms than any of the measures alone, neuroticism and attachment anxiety were not redundant. Additionally, anxious personality traits were associated with higher use of ANC but not with obstetric complications. The ASQ-SF, a self-report instrument for adult attachment, had good reliability in a pregnant population, although its factor structure is not yet established.

Psychometric evaluation of the ASQ

The reliability of the short and full versions of the ASQ was acceptable when examined in pregnant women (paper I) and similar to previous reports in a general population (180). Consequently, the results encourage the use of the short form because of its parsimony. The subscale of attachment anxiety showed the best reliability. Concerning its validity, paper II provided some evidence of good qualities: attachment anxiety had construct validity in its partial overlap with the nearby concept of neuroticism and predictive validity in its prospective associations with depressive symptoms.

The main difference to previous psychometric evaluations was the lower coherence of attachment avoidance, and especially valuing relationships as secondary to achievement. The factor structure proposed in the general population was not as evident in this group, likely because of the lower reliability of the attachment avoidance construct. Some of the variance of attachment avoidance was possibly consumed by the error term named ‘response bias’. Despite the label, the term may consist of other sources of variance than biased responding. However, socially desirable responding (197, 198), if unevenly distributed, could be a source of low reliability of the attachment avoidance construct. Whether pregnant women respond with bias to self-report attachment avoidance enough to affect construct validity has not been explored. Yet, there seems to be little impact of response bias on the validity of personality instruments (199). To advance the understanding of attachment dimensions in pregnancy, this research suggests a need to investigate the compatibility of attachment avoidance with social norms of motherhood.
Adult attachment in consecutive pregnancies was moderately stable, being equivalent to previous reports in non-pregnant cohorts over considerably shorter time spans (177, 182). In contrast, lower stability has been reported from pregnancy to postpartum (97, 98). Instability of attachment across a major life event (for instance, the birth of a child) is expected as specified by attachment theory (97). Because the present test-retest correlations only engaged a small self-selected subgroup, results are too preliminary to be generalized to a pregnant population. Still, they are an indication of good reliability.

Importance of anxious personality traits in the perinatal setting

Depression

Results from paper II indicate an association between attachment and PND independently of general anxiety measures, which is consistent with previous claims (97, 99, 103, 104). In theory, a prominent difference between neuroticism and attachment anxiety is that the former does not involve interpersonal aspects of anxiety. In neuroticism, the tendency to react with negative emotions, perceive threats, and feel overwhelmed is assigned to situations in general (6). Early parenthood, with the associated sleep disturbance and fatigue, and strained partner relationship (200), would act as a general stressor for a person high in neuroticism. As stated by attachment theory, the worry and concern of persons high in attachment anxiety pertain specifically to negatively biased thoughts and memories of close relationships. Hence, by evoking associations of close relationships, pregnancy and the impending rearing of a child would be particularly stressful for those high in attachment anxiety.

Assessments of personality and depressive symptoms in pregnancy showed a large overlap. Still, anxious personality characteristics were predictive of postpartum depressive symptoms even in those pregnant women without baseline depressive symptoms. These adjusted associations in prospective material provide some support for a model of personality as a vulnerability factor for PND, keeping in mind that the observational design only allows for establishing correlations, not causality. In the pursuit of an explanatory causal model and the development of preventive measures for PND, this work highlights the benefits of combining the largely separated theoretical fields of personality and attachment.

Obstetric complications

In paper III, there were no robust associations between neuroticism and any of the obstetric complications. The findings are discordant with a study reporting a link between neuroticism and emergency CS, prolonged delivery, and
severe lacerations (140). However, those associations may have been inflated given that the complication rates were retrospectively self-reported, whereas paper III used register data. For premature birth and low birthweight, previous findings are mixed and inconclusive (135-138). In paper III, participants reported on neuroticism either before, during, or after pregnancy. Report dates were deleted to secure the integrity of the participants after merging health register data. Although personality characteristics seem to have a stable set-point (10), they are not immutable to change (e.g., in response to life events). Thus, the variability of time points may have diluted an association with antenatal neuroticism. On the other hand, even in prospective studies results are not unanimous (137, 138).

Another aspect concerns the exposure measurement, and by consequence, the very concept of perinatal anxiety. The mixed results abstracted above regard studies assessing general anxious characteristics, such as neuroticism. Anxiety that is specific to pregnancy has shown more robust links with obstetric complications (77, 78, 201). Although neuroticism overlaps with pregnancy-specific anxiety (18), it has been purported that the latter should be more sensitive to short-term variation (78). This argument could imply that state components of anxiety, rather than trait components, are accountable for the unfavorable effects on the physiology of pregnancy and delivery. Studies measuring current anxious symptomatology, rather than stable characteristics, report a connection with premature delivery or low birthweight (202, 203).

Alternatively, any negative effects of neuroticism might be compensated by positive health behaviors. It has been argued that some anxiety surrounding the pregnancy is an asset in that it motivates healthy choices (77). Drawing on findings from a lifelong prospective study on health, Friedman (204, p. 1102) describes a subgroup of individuals high in neuroticism that are ‘very vigilant about germs, symptoms needing attention, medical developments, and cooperation with treatment’. This combination of high neuroticism and high conscientiousness, another big five personality domain describing the tendency to be prudent, orderly, determined, and dependable, proposedly leads to healthy outcomes through numerous everyday decisions (204). Among women high in neuroticism, those high in conscientiousness are assumedly overrepresented in research. If so, the negative effects of neuroticism may be consistently underestimated, not only in paper III but also in research in general.

Role of health care

Higher neuroticism was associated with increased use of ANC in women without obstetric risk factors (paper IV). The pattern was most evident for specialized ANC and emergency care (e.g., in emergency visits to an obstetrician/gy-
The results are in agreement with earlier reports associating neuroticism with health care use in non-pregnant cohorts (159-162), as well as psychiatric morbidity with ANC use (110, 148, 164, 165).

Anxiety entails physiological aspects such as autonomic arousal and cognitive aspects such as increased sensitivity to bodily sensations (205). These features might explain the common amplification of physical symptoms in pregnancy-related anxiety (77). Furthermore, anxiety makes it likely to interpret symptoms as catastrophic (205). Frequent health care seeking is a potential strategy to control the emotional agony (77). In paper III, outcomes involving the evaluation and choice of a physician (hospital admission and sick leave) were not increased, supporting the notion that worry and concern were the main cause for seeking help.

One might argue that, because women high in neuroticism do not appear more at risk of obstetric complications (paper III), they do not have a medical need of extra health care. However, neuroticism is a potent indicator of psychological suffering and a considerable risk factor for the development of depression (paper II). The question follows whether the current ANC protocol provides expedient support. A model of care without structured psychological support could potentially feed a vicious circle of anxiety and health care seeking, given that it precludes the learning of adaptive behaviors. In turn, repeated emergency consultations aggravate the fragmentation of care. A recent study shows good feasibility of a midwife-led continuity model of care for women with fear of delivery (206). The results of paper IV suggest a reason to evaluate ANC models with greater emphasis on continuous support and the fostering of self-efficacy.

Methodological considerations

Paper I

A strength of the study was its population-based sampling. Still, the acceptance rate was low and the dropout analysis indicated that participants represented a socioeconomically more privileged group. Papers I-II were part of a larger project comprising questionnaires, visits, and collection of biological material. Thus, the very extent of the project may have discouraged some women from participating. Therefore, the reliability of the ASQ may be different in the general population of pregnant women. Relative to our measurements, the results indicated that the ASQ entailed error for attachment avoidance. Although this concept might be better quantified by interview measures, the study did not include any such measures because they are considerably more time-consuming to obtain.
Paper II
Sharing the same sampling as paper I, this study had the same major advantage (being population-based) and disadvantage (low acceptance rate). Other strengths were the prospective longitudinal design and the relatively low attrition rate. Nonetheless, individuals at higher risk of depression were more prone to withdraw, which is previously documented in perinatal settings (e.g., 106). However, to affect the association with attachment anxiety, dropouts would also need to possess lower attachment anxiety, which was not the case. Because dropping out was associated with higher neuroticism, the association between anxious personality characteristics and depression could be stronger in the non-participating population. Whether an independent proportion of that association depends on attachment anxiety would need further investigation.

A limitation was the exclusive use of self-reports for personality variables and depression. Associations may have been overestimated because of the common method (e.g., because of semantic overlap), a problem shared with a large proportion of studies on personality and depression (31). Moreover, self-reported depression may be misclassified, possibly in a biased manner depending on attachment orientation. Whereas an association with anxious attachment may have been exaggerated, an association with avoidant attachment may have been underestimated if these individuals were less ready to acknowledge symptoms of depression. The EPDS, perhaps despite its wide use as a depression screening tool, taps not only depression but also anxiety disorders (207). While this could be considered a limitation, another interpretation is that the EPDS sensitively detects perinatal psychopathology, with its attributes of both depressive and anxious symptoms.

The observational design renders the results susceptible to unmeasured, residual confounding. Nevertheless, information was available for several important potential confounders, which were addressed in multivariable models.

Paper III
The sample size was large in comparison with earlier studies, which is a strength in that the implied non-associations are not limited to large effect sizes. Yet, there are exceptions for those outcomes that are especially rare (e.g., GDM). In retrospect, those outcomes warrant even larger samples or a different study design. The sample comprised participants from several projects, some of which were population-based and had acceptable to good participation rates. The sample had some diversity, comprising several patient groups within obstetrics/gynecology together with non-patients. Nevertheless, because most of the recruitment took place in university towns, women with higher socioeconomic status were overrepresented. In the neuroticism cohort
(papers III-IV), women with higher education had lower neuroticism, corresponding to earlier reports (e.g., 160). Biased selection of participants with low neuroticism may have precluded the finding of an association, especially if it were likely that participants also had lower risk of obstetric complications. However, this should not be the case given that complication rates aligned with Swedish statistics.

When it comes to measurements, a limitation is that assessment of neuroticism was not consistently antenatal. This variation may have contributed to random error, with a potential dilution effect on the association between personality and complications. On the other hand, theory posits a certain stability of personality characteristics and the (sparse) available research does not unanimously support lower stability across the perinatal period than in other life periods (37). Obstetric complications were not self-reported, which has the advantage of preventing common method bias. In addition, Swedish health registers are very comprehensive (172-174). Nevertheless, some diagnoses may be underreported. In the MBR, a few percent of delivery diagnoses are suboptimal or incorrect (172). The potential misclassification of outcomes may have restricted the ability to find a true association. For all that, as mentioned, the complication rates were still overall in agreement with Swedish figures. For mode of delivery, cases with conflicting data were scrutinized and interpreted together with the co-authors. Moreover, those variables that appeared underreported were potential confounders (chronic somatic disease and psychiatric morbidity) and not outcomes.

To handle possible confounding, analyses were restricted to first-time mothers with singleton pregnancies and included multivariable adjustment for several relevant factors. For some outcomes, certain adjustment variables could constitute mediators (e.g., BMI). In those cases, the models may have been too strictly adjusted. On the other hand, with the single exception of GDM, no outcomes were crudely associated with higher neuroticism.

Paper IV

With the same origins as paper III and additionally restricting the sample to residents of Uppsala County, a possible overrepresentation of women with higher socioeconomic status and lower neuroticism may also exist for paper IV. Therefore, one might argue that the associations between neuroticism and ANC use may not be valid for the entire eligible sample. There was no access to the excluded participants’ medical records to compare the extent of health care use. However, within the sample, lower education was associated with both higher neuroticism and higher use of some of the ANC outcomes, which is why the results may be plausible even in the excluded group.

Analogous to paper III, the outcomes of paper IV were not self-reported and as a result not liable to common method bias. A disadvantage with medical records is the possible underreporting of psychiatric disorders. Therefore, the
association may be driven by manifest psychiatric morbidity instead of personality variation. Still, the implicated clinical need of psychological support remains as relevant in either case. Relating to other potential sources of confounding, three advantages may be listed. First, the setting (i.e., a maternity care that is free-of-charge) should minimize the influence of enabling factors. Second, the sample was restricted to those without ‘objective’ need (obstetric risk factors). Third, several relevant predisposing and need factors were included in the adjusted multivariable models. Although no corrections were made for multiple comparisons, the consistency of the results across several of the outcomes speaks for their validity.

Generalizability

A main aspect on the extent to which the present results are applicable to other populations concerns sociodemographic representability. In papers I-IV, recruitment was restricted to women with sufficient fluency in the Swedish language. Consequently, foreign-born women were underrepresented in the samples, with a prevalence of about 6%. The corresponding rate among childbearing women in Sweden in 2006-2014 was 20-25% (111). Available research shows that foreign-born women in Sweden have a higher risk of certain obstetric complications compared with Swedish-born women (e.g., GDM, emergency CS, and severe lacerations) (115). Furthermore, fear of delivery, a concept adjacent to anxiety proneness during pregnancy, is twice as common in foreign-born women (208). Because the associations investigated in this thesis include multifactorial pathways with a complex interplay, it cannot be dismissed that results may have been different in a cohort representing all childbearing women in Sweden.

Implications and suggestions for future research

The present findings support the possibility of early identification of women at risk of perinatal psychiatric morbidity. Measures of adult attachment and neuroticism might be a useful complement to the EPDS in identifying pregnant women at high risk of developing early postpartum depression. However, further study is needed to establish the optimal combination of measures or individual items. Such research would preferably be conducted with clinical diagnostic interviews to assess depressive and anxiety disorders. A more general lesson is that interpersonal aspects should not be disregarded when investigating personality domains of relevance for perinatal morbidity. Moreover, the results evoke questions on the course of anxious personality characteristics across the perinatal period and their longitudinal associations with pregnancy-specific anxiety. The study design of future epidemiological work is encouraged to ensure maximal participation of previously underrepresented groups.
(e.g., by means of language interpretation services) and to bear in mind possible recruitment bias in personality (i.e., high conscientiousness) that comes with rigorous protocols.

Based on the previous evidence that psychotherapy may lower neuroticism (9), preventive interventions to a selected part of the population characterized by high neuroticism may be investigated. Such preventive measures could include psycho-education, internet-based or group psychological therapy, extended education to ANC personnel, or an ANC protocol based on midwife continuity and the encouragement of self-efficacy. Outcome measures could comprise subjective wellbeing, clinical diagnostic measures of psychiatric morbidity, and indicators of the consumption of emergency obstetric care.

Conclusions

I. The ASQ-SF showed similar psychometric properties in pregnant women as in the general population and had good reliability, although the optimal factor structure needs further study. Results support the usage of the ASQ-SF in pregnant cohorts.

II. Beyond neuroticism/trait anxiety, attachment anxiety had a small independent effect on the risk of postpartum depressive symptoms. Combining items of adult attachment and neuroticism/trait anxiety could prove useful in antenatal screening for those at high risk of postpartum depressive symptoms.

III. Neuroticism was not independently associated with adverse obstetric or neonatal outcomes. Models examining sub-components of neuroticism or pregnancy-specific anxiety are encouraged.

IV. Neuroticism was associated with higher utilization of publicly financed ANC in obstetric low-risk women, even after adjusting for predisposing and need factors. To reduce subclinical anxiety, future studies should address the benefits of interventions as a complement to routine ANC programs.
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I would like to express my heartfelt gratitude to everyone that has given their support and inspiration during my years of doctoral studies.

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My love, for everything.

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References


## Supplementary

**Supplementary table.** *Categories of study variables by diagnostic coding systems (paper III).*

<table>
<thead>
<tr>
<th>Variable</th>
<th>ICD-9</th>
<th>ICD-10</th>
<th>KVÅ</th>
<th>Use of MBR-specific variables</th>
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<td>Psychiatric morbidity</td>
<td>304-305, 309, 313</td>
<td>F10-F13, F15-F16, F19, F30-F34, F38-F43, F50, F53, F60, F90, O993, Z73, Z865</td>
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<td>Involuntary childlessness</td>
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<td>Vaginal delivery,</td>
<td></td>
<td>O814</td>
<td></td>
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</tr>
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<td>vacuum extraction</td>
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<td>Gestational hypertension or</td>
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<td>preeclampsia</td>
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<td>Induction of delivery</td>
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<td>O620-O622, O628-O629, O63</td>
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<td>Postpartum hemorrhage</td>
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<td>SGA</td>
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<td></td>
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<td>Yes</td>
</tr>
<tr>
<td>LGA</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Apgar 5 minutes &lt;7</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Composite worst-case variable b</td>
<td>641C, 642F</td>
<td>O141, O142, O149, O15, O45, R568</td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Note. Cesarean section (CS), International Statistical Classification of Diseases and Related Health Problems (ICD), Medical Birth Register (MBR), small for gestational age (SGA), Swedish Classification of Health Interventions (KVÅ), large for gestational age (LGA). *a Also including prescribed drugs of the Anatomical Therapeutic Chemical Classification (ATC) categories N05-N06. *b Consisting of stillborn, eclampsia, severe PE, premature birth < 32 weeks, SGA < -2.5 SD (0.6%), placental abruption.*
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