Smoking and smoking cessation among Flemish women during pregnancy and postpartum

FACULTEIT GENEESKUNDE EN GEZONDHEIDSWETENSCHAPPEN

Smoking and smoking cessation among Flemish women during pregnancy and postpartum

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Abbreviations

5 A's framework	Ask, Advise, Asses, Assist, Arrange to follow up
AAR	Ask, Advise and Refer
ACOG	American College of Obstetricians and Gynaecologists
AHRQ	Agency for Healthcare Research and Quality
ANOVA	Analysis of Variance
ART	Assisted Reproductive Therapy
BDI	Beck Depression Inventory
CFA	Confirmatory Factor Analysis
CI	Confidence Interval
CO	Carbon Monoxide
COX	Cytochrome c Oxidase
CPD	Cigarettes (smoked) Per Day
DHA	Docosahexaenoic Acid
DNA	Deoxyribonucleic Acid
EFA	Exploratory Factor Analysis
EPDS	Edinburgh Postnatal Depression Scale
FSH	Follicle-Stimulating Hormone
FTND	Fagerström Test for Nicotine Dependence
HIS	Heaviness of Smoking Index
ICC	Intraclass Correlation Coefficient
IVF	In Vitro Fertilization
KCE	Federaal Kenniscentrum – Centre Fédéral d'Expertise [Belgian Health Care Knowledge Centre]
MRSS	Modified Reasons for Smoking Scale
NICE	National Institute for health and Care Excellence
NRT	Nicotine Replacement Therapy
OR	Odds Ratio
Ppm	Parts per million
PPROM	Preterm Premature Rupture of Membranes

SAS	Statistical Analysis System
SES	Socio-economic status
SHS	Second-Hand Smoking
SIDS	Sudden Infant Death Syndrome
SPSS	Statistical Package for Social Sciences
STIVORO	Stichting Volksgezondheid en Roken [Foundation for Public Health and Smoking]
TPB	Theory of Planned Behaviour
TTFC	Time To First Cigarette
VIGez	Vlaams Instituut voor Ziektepreventie en Gezondheidspromotie [Flemish Institute for prevention of diseases and health promotion]
VLOV/VBOV	Vlaamse Organisatie voor Vroedvrouwen/ Vlaamse Beroepsorganisatie voor Vroedvrouwen [Flemish Organization for Midwives]
VVOG	Vlaamse Vereniging voor Obstetrie en Gynaecologie [Flemish Organization for Obstetrics and Gynaecology]
WHO	World Health Organization

PART 1

Introduction and research aims

The World Health Organization (WHO) estimates that tobacco use is currently responsible for almost six million deaths each year – one death every six seconds (WHO recommendations for the prevention and management of tobacco use and second-hand-smoke exposure in pregnancy, 2013). Tobacco smoke is an aerosol of liquid droplets suspended in a mixture of gases and semi-volatile compounds (Thielen et al., 2008). Cigarette smoke contains over 4000 chemical constituents and additives including nicotine, carbon monoxide, several known carcinogens, toxic heavy metals, and many toxic chemicals (Rogers, 2009). There are growing public health concerns about the transfer of these harmful constituents from smoking pregnant women to the growing foetus (Cui et al., 2014).

Prenatal tobacco exposure, both active and passive, results in alterations in foetal blood flow and protein metabolism as well as the accumulation of certain chemicals both in the mother and the foetus. Each of these constituents can contribute to or cause adverse health consequences (Zhou et al., 2014).

1. Constituents and ingredients of tobacco and tobacco smoke

Tobacco constituents are those substances that are naturally present in tobacco. Tobacco ingredients are substances that are added to tobacco during the manufacturing process and are categorized as flavours and additives. Flavours give a specific taste to the product, while additives are substances used for specific technological purposes. Additives include *humectants*, increasing the moisture-holding capacity of the tobacco; *preservatives*, protecting the product from deterioration; *solvents*, used to dissolve or dilute ingredients; *binders and strengtheners*, ensuring to maintain the physical state of the product; and *fillers*, contributing to the volume of the product without affecting odour, taste, or flavour (Hecht, 2012).

Tobacco is the only legal product that is responsible for the death of a large proportion of its consumers when used as intended by manufacturers (WHO, 2013).

1.1. Nicotine

Nicotine is a neuroteratogen with an impact on the brain (Rogers, 2008; Zhou et al., 2014), which is naturally present in tobacco or added to tobacco products by manufactures (Hall et al., 2014). Seven seconds after inhaling nicotine, it binds to receptors in the central nervous system, resulting in the release of several hormones like acetylcholine, norepinephrine, dopamine, beta-endorphin, vasopressin and arginine. Tobacco addiction is caused by the nicotine in tobacco, which produces a cascade of actions, including the release of dopamine, which strengthens associations of positive feelings with smoking behaviour. Norepinephrine causes hypertension, tachycardia, and tachypnea, giving the impression of an accelerated metabolism. The other hormones provoke tension reduction (Coleman et al., 2015).

Most tobacco toxins have a low molecular weight and a high water solubility. Therefore these toxins can pass easily through the placental barrier, consequently causing a negative effect on the health of the foetus. In particular, nicotine and cotinine, a metabolite of nicotine, pass freely across the placenta to the foetus, which is exposed to relatively higher nicotine concentrations than its mother (Jauniaux and Burton, 2007). There is evidence for accumulation of nicotine in foetal serum and amniotic fluid in slightly higher concentrations than in maternal serum (Benowitz et al., 2009). The nicotine levels in the foetal serum exceed maternal concentrations by 15% (Andres and Day, 2000). Cotinine has a greater half-life than nicotine, and reaches much higher levels in the maternal plasma. Additionally, cotinine is found in the foetal circulation at levels that are relatively comparable to maternal levels (Andres and Day, 2000).

Maternal nicotine metabolism appears even to be faster during pregnancy; this faster metabolism is apparent from 18 to 22 weeks of pregnancy and disappears four weeks after childbirth (Bowker et al., 2015). Dempsey et al. (2002) performed an experimental study with ten healthy, volunteer, pregnant smokers who received two infusions of deuterium-labelled nicotine and cotinine during pregnancy (18-40 weeks) and one in postpartum (12 weeks). The clearance of nicotine increased on average by 60% during pregnancy, the clearance of cotinine even increased by 140%. There was a 54% increase in the metabolic clearance of nicotine via the cotinine pathway during pregnancy, primarily by liver cytochrome P450 CYP2A6. The half-lives of nicotine and

cotinine were shorter during pregnancy. Cotinine elimination was nearly twice as rapid during pregnancy than postpartum. These results have two important consequences. First, lower cotinine levels observed during pregnancy do not necessarily reflect less smoke exposure, and cut-off points used to classify non-smokers, passive smokers, and active smokers need to be lower in pregnant women compared to their non-pregnant counterparts. Second, no downward dose adjustment needs to be made for nicotine replacement therapy during pregnancy. On the contrary, higher than usual doses of nicotine may be necessary to optimize efficacy (Dempsey et al., 2002).

1.2. Carbon monoxide

Carbon monoxide (CO), a combusting product of tobacco (Banderali et al., 2015), crosses the placenta quickly and can be detected in the foetal circulation at levels that are 15% higher than in maternal circulation (Andres and Day, 2000; Lambers and Clark, 1996). CO binds rapidly to haemoglobin, forming carboxyhaemoglobin in both maternal and foetal blood and shifting the oxygen dissociation curve to the left, resulting in a decrease in the availability of oxygen to foetal tissues (Andres and Day, 2000). This will result in foetal hypoxia, which can be teratogenic (causing congenital anomalies or birth defects) and foetotoxic (poisonous to the foetus) (Banderali et al., 2015; Rogers, 2008).

CO has also a greater affinity to the other biological molecules that bind oxygen such as myoglobin, cytochrome P450 and cytochrome c oxidase (COX), or mitochondrial respiratory chain complex IV, emphasising foetal hypoxia. Maternal smoking could also be related to docosahexaenoic acid (DHA) supply to foetus. Prenatal DHA accretion determines myelination during a brain growth spurt. DHA concentrations in the erythrocyte phospholipids of infants have been associated with electroretinogram responses after birth and with response to visual stimulation until the age of two years. DHA concentrations in maternal circulation are influenced by its dietary supply (Larqué et al., 2006). Maternal smoking during pregnancy may progressively impair DHA synthesis and/or its placental transfer, which has been associated with restricted foetal growth (Banderali et al., 2015).

1.3. Other chemicals

There are many known carcinogens in tobacco, and there is evidence for an increase of some forms of cancer in the offspring of smokers, but direct links to specific carcinogens have not been established so far (Rogers, 2008). Cigarette smoke contains, besides nicotine and CO, scores of toxins, including cyanide, sulphides, cadmium, arsenic, benzene, formaldehyde, and carcinogenic hydrocarbons, which are capable of inducing direct cellular damage (Hall et al., 2014; Janiaux and Burton, 2007). Carcinogenic constituents include 1,3-butadiene, formaldehyde, nicotine-derived nitrosamine ketone, N-nitrosonornicotine, and benzene. Acrolein and acetaldehyde are two of the most harmful constituents to respiratory health, and arsenic and hydrogen cyanide provoke great cardiovascular health risk (Hall et al., 2014).

2. Health consequences of smoking during pregnancy for mother and child

Smoking before and during pregnancy can cause several health problems.

Smoking affects both male and female fertility in their reproductive age (Soares and Melo, 2008).

Smoking during pregnancy is one of the single most important avoidable cause of adverse pregnancy outcomes (Jauniaux and Burton, 2007). Maternal tobacco use is associated with increased risks for foetal loss, ectopic pregnancy, placental problems such as abruptio placentae and placenta praevia, preterm birth, premature rupture of membranes, low birth weight, small for gestational age, and congenital anomalies such as cleft lip (WHO recommendations for the prevention and management of tobacco use and second-hand-smoke exposure in pregnancy, 2013).

After birth, the risk for sudden infant death syndrome (SIDS) is increased among the offspring of women who smoked during and/or after pregnancy (WHO recommendations for the prevention and management of tobacco use and second-hand-smoke exposure in pregnancy, 2013).

There are also long-term health risks, such as respiratory and non-respiratory infections, cancer, and obesity (Rogers, 2007; Zhou et al., 2014).

2.1. Impact on fertility

Exposure to tobacco smoke affects all stages of human reproduction, both in men and women (WHO recommendations for the prevention and management of tobacco use and second-hand-smoke exposure in pregnancy, 2013).

A meta-analysis of Hughes and Brennan (1996) demonstrated a negative association between smoking and time to conception and live birth rate in case of natural conception. After adjustment for several confounders (body weight at age 18 years, history of endometriosis and PID, and income), smoking 20 cigarettes per day, starting to smoke before 18 years of age, and an educational level of less than 12 years contributed to an increased risk of infertility (Laurent et al., 1992). Although there were no significant differences in conception rates between smokers and non-smokers, smokers did experience a slight delay in conceiving in the first 4 to 9 months after the infertility date. It seems reasonable, therefore, to recommend that women stop smoking when they are attempting to become pregnant (Laurent et al., 1992).

A female neonate is born with a large reserve of oocytes which form a precious ovarian reserve. Damage to this limited pool of gametes by environmental factors such as cigarette smoke and its constituents, therefore represents a significant risk to a woman's reproductive capacity (Camlin et al., 2014). Chemicals in cigarette smoke, such as nicotine, cyanide, and carbon monoxide, can result in the loss rate of oocytes, which cannot regenerate or be replaced. This also means that menopause occurs earlier in smoking women compared to non-smokers, varying between 1 to 4 years (Schiverick and Salafia, 1999; Soares and Melo, 2008).

A meta-analysis showed that the overall odds ratio for risk of infertility in female smokers versus non-smokers was 1.60 (95%CI 1.34-1.91) (Rogers, 2013). Basal follicle-stimulating hormone (FSH) levels were reported to be 66% higher in active smokers than in non-smokers and 39% higher in passive smokers than in non-smokers. The outcomes of assisted reproduction therapy (ART) results remain controversial. Among smoking women undergoing ART procedures, ovarian response to hyperstimulation was found to be suboptimal compared to non-smokers. Studies showed a significant decrease in the number of retrieved oocytes in smokers. This may be the expression of the chronic

process of accelerated ovarian reserve consumption in smokers, but may also be the consequence of short-term effects of tobacco compounds in the process of meiotic maturation (Soares et al., 2007). The odds ratio for pregnancies per number of IVF-treated cycles in smoking women was 0.66 (95% CI 0.49-0.88) compared to non-smoking women (Rogers, 2009).

Research of Wright et al. (2006) did not find higher-than-expected levels of adverse pregnancy outcomes among smoking women undergoing ART procedures compared to non-smoking women. Smoking status did not significantly affect, number of oocytes retrieved, embryo quality score, implantation rate pregnancy outcome, or live birth rate (Wright et al., 2006).

Also male fertility is influenced by smoking. Spermatozoa from smokers have reduced fertilizing capacity, meaning lower sperm production and motility, and embryos display lower implantation rates. Even in-utero exposition to tobacco constituents leads to reduced sperm count in male and lower fertility in male and female offspring as adults (Rogers, 2009; Soares et al., 2007).

A review of Biebel et al. (2016) supports the causal relation between cigarette smoking and erectile dysfunction, the inability to attain and maintain an erection firm enough to have sexual intercourse. Most studies have suggested that smoking contributes to erectile dysfunction by vasoconstricting penile arteries in the short and long term because of atherosclerosis. A positive dose-response relation is suggested such that increased quantity and duration of smoking correlate with a higher risk of erectile dysfunction. Smoking cessation can lead to recovery of the erectile function, but only if limited lifetime smoking exposure exists (Biebel et al., 2016).

2.2. Foetal loss

2.2.1. Spontaneous abortion

Studies on early foetal loss or spontaneous abortion and active smoking showed conflicting results (Rogers, 2009; Salihu and Wilson, 2007; Wisborg et al., 2003). This can be attributed to the use of different definitions of 'spontaneous abortion', recall bias in self-administered questionnaires, and socially desired answers regarding smoking behaviour.

A Swedish study showed that women who were exposed to passive smoking had an increased risk for spontaneous abortion compared to non-exposed women, in active smokers the risk was even higher (George et al., 2006).

2.2.2. Stillbirth

The risk of late foetal loss or stillbirth was doubled in actively smoking mothers compared to non-smokers. Among mothers who stopped smoking in the first trimester, the risk of stillbirth was similar to those of non-smoking mothers (Rogers, 2008).

A more recent review showed an increased risk for stillbirth of 23% in pregnant smokers (OR = 1.23; 95% CI = 1.09-1.38) (Mund et al., 2013).

2.3. Ectopic pregnancy

Studies showed a significant dose-response relationship between daily consumption of cigarettes and the incidence of ectopic pregnancy; all odds ratios for categories over 10 cigarettes per day were significantly elevated (Bouyer et al., 2003; Rogers, 2009).

2.4. Placenta pathology

Smoking provokes morphological changes to the placenta starting in the first trimester of pregnancy. Maternal smoking alters the blood flow to the placenta and changes the balance between proliferation and differentiation of the cytotrophoblast. It is also associated with thickening of the trophoblastic basement membrane, increased collagen in the villous mesenchyme and decreased vascularization of the placenta (Janiaux and Burton, 2007). The placenta of smoking women degenerates faster which includes an increase of fibrosis and atrophic and hypovascular villi. This mechanism results in vasoconstriction in the uterine and placental vessels, which leads to feta-placental underperfusion and chronic hypoxia (Ortigosa et al., 2012). Finally, smoking disturbs the equilibrium among oxidant and antioxidant system, causing additional oxidative stress and augmenting lipid peroxidation, a deterioration of lipids resulting in cell damage of the placenta (Mund et al., 2013).

Although the placenta acts as a barrier to protect the foetus from toxic chemicals, some substances of tobacco used by the mother during pregnancy can cross the placenta and reach the foetus (Origosa et al., 2012). Research showed that the diameters of the umbilical arteries were significantly higher and the umbilical vein thickness wall was significantly larger in smoking women compared to non-smoking women, which leads to foeto-placental underperfusion and chronic hypoxia (Ortigosa et al., 2012).

The most important pathology related to smoking is placental abruption, the premature separation of the placenta from the uterine wall prior to delivery (Salihu and Wilson, 2007). Research showed an odds ratio of 1.9 (95% CI 1.8-2.0), which indicated an increased risk of 90% for placental abruption in smoking women (Rogers, 2008).

Maternal smoking has been associated with placenta praevia. The placenta is located near or over the os internum of the cervix. As labour approaches, this may lead to partial detachment and severe vaginal bleeding. A large study found an odds ratio of 1.40 (95% CI 1.26-1.57) among women who smoked less than 10 cigarettes per day and 1.72 (95% CI 1.53-1.94) among women who smoked over 10 cigarettes per day (Salihu and Wilson, 2007).

2.5. Preterm premature rupture of the membranes (PPROM)

PPROM is the rupture of the membranes before 37 weeks of gestation (Jacquemyn et al., 2011; Menon et al., 2011). The mechanism of ruptured membranes among smokers may be multifactorial (Andres and Day, 2000).

Nutritional deficits, primarily attributed to the effect of smoking on ascorbic acid levels, have been reported to increase the risk of PPROM. A decreased amount of type III collagen, resulting from decreased ascorbic acid levels were observed in patients with PPROM. The resulting collagen deficiency may compromise the integrity of the amniotic membranes (Andres and Day, 2000). Research showed that cigarette smoke can induce apoptosis both in amnion and chorion cells of the foetal membranes (Menon and Fortunato, 2009; Menon et al., 2011). Apoptosis, a form of cell death, occurs normally during development and aging, as a homeostatic mechanism to maintain cell populations in

tissues. It also occurs as a defence mechanism in case of immune reactions or damaged cells caused by disease or noxious agents, e.g. cigarette smoke (Elmore, 2007).

Decreased zinc levels and low copper concentrations are also associated with PPROM. Both have a weakening effect on the collagen, making the membranes more susceptible to rupture (Andres and Day, 2000).

Finally, smoking has been demonstrated to decrease the immunologic response during bacterial and viral infections which can lead to chorioamnionitis and PPROM (Andres and Day, 2000; Salihu and Wilson, 2007).

In a meta-analysis, Castles et al. observed a significant association between prenatal smoking and PPROM with an OR of 1.70 to 2.25 (Castles et al., 1999). More recently, Roelands et al. found a similar significant association with an OR of 1.70 (95% CI 1.5-1.9) (Roelands et al., 2009).

2.6. Preterm birth

Preterm birth is defined as a delivery before 37 weeks of gestation and is one of the major causes of neonatal morbidity and mortality (Goldenberg et al., 2008). Smoking during pregnancy nearly duplicates the risk of preterm birth (Goldenberg et al., 2008; Salihu and Wilson, 2007). Both nicotine and carbon monoxide are powerful vasoconstrictors, and are associated with placental damage and decreased utero-placental blood flow, which can lead to preterm birth (Goldenberg et al., 2008).

A clear dose-response relationship is observed between tobacco consumption and preterm birth: the higher the daily consumption of tobacco, the higher the risk of preterm birth (Salihu and Wilson, 2007; Rogers, 2008). A Swedish study found an odds ratio of 1.69 (95% CI 1.58-1.80) for very preterm birth (< 32 weeks of pregnancy) compared to 1.41 (95% CI 1.38-1.45) for preterm birth (≥ 32 weeks of pregnancy) in case of smoking more than 10 cigarettes per day (Källen, 2001).

2.7. Foetal growth

Several studies provided convincing evidence that maternal smoking and exposure to second-hand smoke cause a reduction in foetal

growth. The dose-response relationship is also extensively documented (Banderali et al., 2015; Rogers, 2009; Rogers, 2008). The effect of maternal smoking on intra-uterine growth and birth weight can be clarified as follows. CO can interfere with the foetus' oxygen supply. CO has a greater affinity to haemoglobin and accordingly increases carboxyhaemoglobin levels in the umbilical arteries, inhibiting oxygen delivery to the cells and therefore causing foetal hypoxia (Ko et al., 2014; Lambers and Clark, 1996). Nicotine has a vasoconstrictive effect on the umbilical arteries (Lambers and Clark, 1996). The combination of both CO and nicotine, causing a decreased supply of blood and oxygen transport to the foetus, can result in foetal growth restriction (Banderali et al., 2015; Ko et al., 2014; Lambers and Clark, 1996).

Moreover, foetal growth restriction due to tobacco smoking in pregnancy could be the result of epigenetic mechanisms. Exposure to tobacco smoke in utero has been related with changes in DNA methylation of genes associated with growth restriction (Banderali et al., 2015).

Literature shows differences in biometric measures as a result of prenatal tobacco use. When comparing smokers to non-smokers, a 119-g reduction in birth weight, a 0.53-cm reduction in length, and a 0.35-cm reduction in head circumference have been documented (Vardavas et al., 2010). Other research showed a decrease in birth weight of 377 g (Wang et al., 2002). A large Brazilian study about new-borns exposed to tobacco smoke throughout pregnancy presented an average decrease in birth weight of 223.4 g (95% CI 156.7-290.0), a decrease in birth length of 0.94 cm (95% CI 0.60-1.28), and a decrease in head circumference of 0.69 cm (95% CI 0.42-0.95) (Zhang et al., 2011). A review of Zhou et al. (2014) showed a decrease in foetal head circumference with 0.72-0.89 cm. The association between decreased head circumference and decreased brain volume has been demonstrated, leading to lower IQ scores especially in younger children (Zhou et al., 2014), alterations in brain microstructure, and changes in brain function (Ekblad et al., 2015).

Smoking during pregnancy also increases the risk of low birth weight (< 2500 g) (Salihu and Wilson, 2007), caused by the combination of preterm delivery and intra-uterine growth restriction, leading to a 'small for gestational age' baby (Hoppenbrouwers et al., 2011).

2.8. Sudden infant death syndrome (SIDS)

There are over 60 studies regarding the relationship between maternal smoking and second-hand smoke exposure during pregnancy and the risk of SIDS. The evidence from these studies strongly supports a causative role of exposure to tobacco smoke in the aetiology of SIDS. Also a dose-response relationship between maternal smoking and the risk of SIDS has been demonstrated (Rogers, 2008).

2.9. Long-term health risks

Nicotine has an impact on the brain at critical developmental stages, which can cause cognitive, emotional, and behavioural problems in children of smokers (Rogers, 2008; Zhou et al., 2014).

Maternal smoking is associated with an increased risk of infant respiratory infections, otitis media, bacterial meningitis, and necrotizing enterocolitis (Zhou et al., 2014). There is also a small increase of neoplasms (Zhou et al., 2014) and cancer, more specifically, brain tumours, and leukaemia (Rogers, 2008).

There is a relationship between maternal smoking and childhood overweight and obesity (Rogers, 2008). Research showed a strong relationship between maternal smoking and overweight/obesity at the age of 5-6 years (Toschke et al., 2003).

3. Prevalence of smoking during pregnancy

3.1. General prevalence of smoking

Globally, 22% of the world's population ≥ 15 years are estimated to be current tobacco smokers, including 36% men and 8% women (table 1) (WHO recommendations, 2013). The smoking prevalence of European women is globally the highest, 22%.

Table 1: Estimated current tobacco smoking, by WHO region, for men and women aged 15 years and older, 2009

WHO Region	Total (%)	Men (%)	Women (%)
Global	22	36	8
Africa	10	17	3
The Americas	21	26	16
Eastern Mediterranean	19	33	4
Europe	31	41	22
South-East Asia	18	30	5
Western Pacific	28	51	4

Source: WHO report on the global tobacco epidemic: Warning about the dangers of tobacco. Geneva, World Health Organization, 2011 (in WHO recommendations, 2013)

A shift in smoking prevalence from high-income to low- and middle-income countries can be noticed, with a recent increase in the prevalence of tobacco smoking among women, which is expected to rise to 20% by 2025 (WHO recommendations, 2013). The rise in tobacco use among younger females and the increasing use of alternative tobacco products, e.g. waterpipes, in countries with large populations is one of the most threatening potential developments of the epidemic's growth (World Health Organization, 2008).

Based on the results of the health inquiry of 2013 (*Gezondheidsenquête 2013*) the prevalence of smoking of Belgium's population ≥ 15 years is 23%, 19% smoke on daily basis and 4% are occasional smokers. This is a decrease of 2% compared to 2008 and a constant decrease since 1998, from 30% to 23%. Overall, the prevalence of smoking in men is 26%, in women 20%. Surprisingly, the prevalence of smoking in girls between 15 and 24 years is higher than in boys, respectively 18% and 15%, and these figures are even increasing. The prevalence in women between 25 and 34 years old, the most popular period for pregnancy and childbirth, is 13% (*Gezondheidsenquête 2013*).

3.2. Prevalence of smoking during pregnancy

The Pregnancy Risk Assessment Monitoring System (PRAMS) provides data on the prevalence of smoking during pregnancy in 40 Sites of the United States during the period from 2000 to 2010. They observed a declining prevalence from 15.2% in 2000 over 13.8% in 2005 to 12.3% in 2010 (Tong et al., 2009 and 2013).

The European Perinatal Health Report (Europeristat, 2010) provides data on perinatal mortality and morbidity, health outcomes, and several risk factors, including smoking during pregnancy. Data on maternal smoking during pregnancy were not available for some countries, including Belgium, and standardized collection procedures are necessary to improve comparability between EU countries. Some prevalence data were collected before or in the first trimester of pregnancy, others in the last pregnancy trimester. Some women may underreport smoking because of the taboo on smoking during pregnancy, which may lead to misclassification of smokers as non-smokers. Furthermore, information on the amount of cigarettes smoked is missing (European Perinatal Health Report, 2010).

Prevalence of smoking during the third trimester of pregnancy in 2010 varied from less than 5% in Lithuania and Sweden to 15% in Northern Ireland, 16% in Wales, 17.1% in France, and 19% in Scotland. There was a decrease of 1-3% compared to the prevalence in 2004. In France, the Netherlands, and the UK, the decrease was even more remarkable. For instance, the prevalence of smoking during pregnancy in The Netherlands was 13.4% in 2004 and decreased in 2010 to 10.5% in the first trimester and 6.2% in the third trimester (European Perinatal Health Report, 2010).

The prevalence of smoking during pregnancy in Flanders was studied by Hoppenbrouwers et al. (2011). Eligible data were obtained in postpartum from mothers of 2106 babies. Smoking during pregnancy was retrospectively reported by 12.3%. The prevalence of smoking in the year before pregnancy was 22.7% and differed substantially according to the educational level, with 34.3% in women who did not complete secondary school, 19.5% in women who completed secondary school and 3.9% in women who have a bachelor's of master's degree (Hoppenbrouwers et al., 2011).

4. Determinants of smoking cessation during pregnancy according to the socio-ecological model

Health promotion has been defined as 'Any combination of educational, political, regulatory, and organizational supports for actions and

conditions of living conducive to the health of individuals, groups, or communities' (Green and Kreuter, 2005). Since the prevalence of smoking during pregnancy is still high and smoking can cause severe maternal, foetal, and neonatal health problems, smoking during pregnancy is a serious health threat that needs to be addressed.

It is important to analyse a certain health problem, in order to determine which interventions can be used to motivate a person to behaviour change and to improve his/her health. A person's behaviour is influenced not only by his/her intrapersonal characteristics but also by the contexts in which he/she lives (Schölmerich and Kawachi, 2016). Within the health promotion field, ecological approaches can be used to better understand determinants of behaviour, such as smoking (Golden et al., 2012). The ecological approach focuses on the interrelationships between an individual and the different environmental levels (Kok et al., 2008). Ecological models specific to health promotion are multifactorial and target environmental, behavioural, and social policy changes that help individuals adopt a healthy behaviour (Quinn et al., 2004).

The socio-ecological model identifies six levels of contextual influences (Schölmerich and Kawachi, 2016). The *intrapersonal or individual level* takes into account a person's knowledge, attitudes, values, skills, behaviour, self-concept, and self-esteem. The *interpersonal level* includes a person's social networks, social supporters, family and friends, work groups, peers, and neighbours. The *organizational level* includes norms, incentives, organizational culture and structure, management styles, and communication networks. Communities are groups of people identified by common values and mutual concern for the development and well-being of their group or geographical area. Hence, the *community level* includes community resources, neighbourhood organizations, social and health services, organizational relationships, folk practices, governmental structures, and informal and formal leadership practices. The *public policy level* or society level includes legislation, policies, taxes, and regulatory agencies. The *supranational level* consists of associations composed of two or more societies (Kok et al., 2008; Quinn et al., 2004).

Based on the socio-ecological model, the following determinants of smoking cessation during pregnancy have been identified.

4.1. Intrapersonal level

Within the individual level, several clusters of determinants can be identified.

4.1.1. Socio-demographic factors

Socio-demographic factors that have been shown to significantly predict smoking cessation during pregnancy include maternal age, being married or living with partner, and higher socio-economic status, such as income, education, housing, and employment (Riaz et al., 2016). Regarding maternal age, results however are conflicting.

Several studies indicate that women between 20 and 35 years old (Moore et al., 2016; Riaz et al., 2016), and more specifically women between 25 and 29 years old (Fitzpatrick et al., 2016), are more likely to quit smoking during pregnancy compared to women over 30 years old. Research by Gilbert et al. (2015) found that women between 30 and 34 years are more likely to quit smoking compared to women between 20 and 24 years old and women over 35 years. Woodby et al. (1999) did not find any differences according maternal age. These conflicting results can be attributed to different designs (retrospective or prospective, observational or intervention study) and populations with different backgrounds (level of addiction, educational level, parity, and marital status).

Being married or having a partner is a determinant of smoking cessation (Moore et al., 2016; Riaz et al., 2016). Women without a partner are more likely to continue smoking during pregnancy (Smedberg et al., 2015).

Women who are higher educated (Boucher et al., 2016; Lu et al., 2001; Riaz et al., 2016; Smedberg et al., 2015) and being employed (Smedberg et al., 2015), are more likely to quit smoking once they know that they are pregnant.

4.1.2. Motivation to quit smoking

Pregnancy is an important reason for women to stop smoking (Gallus et al., 2013; McBride et al., 2003). Pregnant women identified the unborn baby's health as their most important motivation to quit smoking (McBride et al., 2003; Pledger, 2015). Feelings of shame and guilt

also appear to have an influence on a pregnant woman's intention to stop smoking (Pledger, 2015).

Identifying the motivational profile could give insight in the smoking behaviour of pregnant women. The Modified Reasons for Smoking Scale (MRSS) can be used to understand reasons for continued smoking during pregnancy. The MRSS consists of 21 questions measuring seven subscales: handling, pleasure, habit/automatism, stimulation, tension reduction/relaxation, addiction and social smoking (Berlin et al., 2003; Horn and Waingrow, 1966; Ikard et al., 1969). It is a widely accepted and validated scale that offers the opportunity to make a more integral assessment of the smoker and to extend the assessment procedure with a more detailed psychological profile. In addition, the MRSS is practical to use because it is a short questionnaire that takes no longer than a few minutes to complete (Boudrez and De Bacquer, 2012). To our knowledge, there are no studies describing the use of the MRSS in pregnant women.

4.1.3. Smoking-related factors

Women who are less addicted to nicotine (Boucher et al., 2016) and have lower scores on the Fagerström test for nicotine dependence (FTND) (Riaz et al., 2016) are more likely to remain abstinent during pregnancy. The FTND is a standard instrument for assessing the intensity of physical addiction to nicotine. The test provides a measure for nicotine dependence related to cigarette smoking. It contains six items that evaluate the quantity of cigarette consumption, the compulsion to use, and dependence. Yes/no items are scored from 0 to 1 and multiple-choice items are scored from 0 to 3, leading to a total score between 0 and 10. The higher the total score, the more intense is the client's physical dependence on nicotine (Fagerström, 1978).

Smoking less than 20 cigarettes per day is a determinant of smoking cessation (Moore et al., 2016; Riaz et al., 2016). Smoking less than five cigarettes per day during the last three months before pregnancy can predict abstinence (Gilbert et al., 2015).

A smoking history of less than 10 years is a predictor of smoking cessation during pregnancy (Woodby et al., 1999).

The combination of several instruments can also predict abstinence: Time To First Cigarette (TTFC; first question of the FTND), the number

of Cigarettes smoked Per Day (CPD; fourth question of the FTND), and the Heaviness of Smoking Index (HSI). Research showed that using CPD and TTFC together or CPD alone are significant predictors of quitting smoking during pregnancy (Kurti et al., 2016). Smokers who decrease their daily consumption drastically in early pregnancy are more likely to become abstinent during pregnancy (Kurti et al., 2016).

4.1.4. Cognitive skills

Knowledge of potential health risks was shown not to be sufficient to motivate pregnant women to quit smoking (Ingall and Cropley, 2009).

Haslam and Draper (2001) explored 'awareness' of the related health risks of smoking during pregnancy. The study illustrated that despite women having knowledge and being aware of the health risks of smoking during pregnancy, there was still a preference to rely on personal experience and experiences of others instead of trusting medical advice. Moreover, women who did accept information regarding health risks, were not sufficiently motivated to quit.

Health literacy has been defined by the WHO as "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health". Health literacy means more than being able to read pamphlets and successfully make appointments. By improving people's access to health information and their capacity to use it effectively, health literacy is critical to empowerment (World Health Organization, 7th Global Conference on Health Promotion: track themes). Higher level of health literacy (Smedberg et al., 2015) is a determinant of smoking cessation during pregnancy.

4.1.5. Prenatal factors

Women who are primiparous (Gilbert et al., 2015; Palma et al., 2007; Smedberg et al., 2015), who enter adequate prenatal care in early pregnancy in line with international guidelines (Moore et al., 2016; Palma et al., 2007; WHO, 2016), and have a planned pregnancy (Smedberg et al., 2015), are more likely to quit smoking during pregnancy.

Women with unfavourable lifestyle-related risk factors for adverse birth outcomes are at risk for continuing to smoke during pregnancy.

Women who did not use marijuana before pregnancy (Riaz et al., 2016), and used folic acid (Baron et al., 2013; Smedberg et al., 2015) are more likely to quit smoking once they know that they are pregnant.

4.1.6. Psychological factors

It is becoming increasingly clear that smoking and depression have a complex comorbid relationship because nicotine consumption affects mood, which increases dependence (Boucher and Konkle, 2016). Symptoms of depression may contribute independently to persistent smoking during pregnancy (Boucher and Konkle, 2016; Scott et al., 2009). Depressed persons may smoke to immediately improve their sense of well-being or as a quick reward. These responses may indicate why is more difficult for depressed pregnant women to quit smoking (Zhu and Valbo, 2002). Some research suggests that smokers themselves are convinced that quitting generates feelings of depression and dysphoria arising from nicotine withdrawal (Solomon et al., 2006), although this was not confirmed by other studies (Berlin, et al., 2010; Kahler et al., 2011). No evidence is available to confirm that quitting smoking during pregnancy increases psychological symptoms in the immediate post withdrawal period or later in pregnancy (Solomon et al., 2006). Women who quit smoking early in pregnancy and remained abstinent during postpartum reported less depressive symptoms compared with women who continued to smoke (Park et al., 2009; Solomon et al., 2006).

Research of Ingall and Cropley (2009) showed that women who lacked self-confidence regarding their ability to maintain abstinence in the postpartum, had a decreasing motivation to attempt quitting during pregnancy. Other research showed that women with higher levels of self-efficacy are more likely to quit during pregnancy (Maxson et al., 2012; Riaz et al., 2016; Woodby et al., 1999).

4.2. Interpersonal level

Within the interpersonal level, support is an important determinant. Lack of social support (Gilbert et al., 2015), or negative support from the partner (Maxson et al., 2012), is associated with higher risk of continued smoking during pregnancy. Perceiving more social support (Riaz et al., 2016), especially from the partner (Flemming et al., 2014; Maxson et al., 2012) is a determinant of smoking cessation.

Having a non-smoking partner (Boucher et al., 2016; Riaz et al., 2016) is a determinant of smoking cessation. In contrast, living together with a smoker is associated with higher risk of continued smoking during pregnancy (Gilbert et al., 2015; Homish et al., 2012).

4.3. Organizational level

Within the organizational level, norms (e.g. not smoking) within an organizational structure and culture are important determinants. While tobacco control initiatives particularly in high-income countries have been effective in reducing smoking during pregnancy, the stigmatization of smokers has been an unintended consequence (Chamberlain et al., 2013).

Pregnancy is considered as a window of opportunity for quitting smoking (Boucher and Konkle, 2016). Eighty percent of all women have at least one baby. Therefore, this provides an opportunity for health services to provide effective smoking cessation interventions to nearly all women who smoke, with every pregnancy as a possible opportunity for cessation. Pregnancy is the best moment for life long abstinence with all the benefits for mother and child (Tappin, 2016, commentaries on Jones et al., 2016). Studies have shown that the following interventions are effective in helping women who are pregnant to quit smoking: cognitive behaviour therapy, motivational interviewing, structured self-help and support from NHS Stop Smoking Services (NICE public health guidance 26, 2010). The 5 A's framework is recommended as a way to start a conversation about the smoking behaviour (Hoengenaert, 2013 in Domus Medica Guideline). Extensive research showed that women who are exposed to psychosocial interventions (Chamberlain et al., 2013) or patient education methods (Riaz et al., 2016) are more likely to quit smoking during pregnancy. However, a review of Filion et al. (2011) to estimate the efficacy of smoking cessation counselling among pregnant women, found little evidence that counselling alone (not supplemented with other interventions), is efficacious for smoking cessation in pregnant women (Filion et al., 2011).

The organizational level also includes the use of incentives, offered within a structured health service. Financial incentives may motivate smokers to a quit attempt. Chamberlain et al. (2013) found that most successful interventions for smoking cessation were those with finan-

cial incentives. However, these results were based on only four US trials with a small number of respondents. Mechanisms by which financial incentives operate to influence smoking behaviour are poorly understood. Mantzari et al. (2012) performed a qualitative study in pregnant smokers using interviews to examine facilitators and barriers for a quit attempt during pregnancy. Financial incentives were not mentioned as having an influential role in women's decision to quit smoking, they were often described as an 'added bonus' for someone who already wanted to quit. Tappin et al. (2015) performed a randomised control trial to test the effect of financial incentives. The control group received routine care and free nicotine replacement therapy (NRT) for 10 weeks. The intervention group received routine care and £400 in shopping vouchers spread over 12 weeks. When abstinence was confirmed by CO measurement at every pregnancy consultation (24-36 weeks), the women received a voucher, with a total of £400. At the end of pregnancy, significantly more women of the intervention group stopped smoking, 22.5% (n = 69) vs. 8.6% (n = 26) in the control group. A limitation of this study was that respondents were materially deprived Scottish women and therefore the results in this study are difficult to generalise to other populations.

In Belgium, no financial incentives are provided in case of abstinence, but a reimbursement of €30 per consultation, with a maximum of €240, is provided to women who complete a series of 8 smoking cessation counselling sessions by a registered tobaccologist. Since January 2017, the reimbursement in Flanders is calculated based on income and type of smoking cessation counselling (http://www.vlaanderen.be/nl/gezin-welzijn-en-gezondheid/gezond-leven/rookstopbegeleiding).

4.4. Community level

The community level, involving health care services and health care workers in particular for pregnant women, are described in this paragraph.

Regarding smoking cessation during pregnancy, numerous interventions with different forms of intensity delivered by midwives, nurses, gynaecologists or general practitioners are organized: e.g. counselling interventions (Chamberlain et al., 2013), incentive-based interventions (Chamberlain et al., 2013), social support interventions (Chamberlain et

al., 2013), the use of NRT (Coleman et al., 2015), telephone quit lines (Bombard et al., 2013), self-help material (Bombard et al., 2013), and smoking cessation websites (Herbec et al, 2014).

Midwives and gynaecologists believed that giving smoking cessation advice and support were within the scope of their practice (Flemming et al., 2016; Murphy et al., 2016; Röske et al., 2009). They also felt it was their duty to protect the unborn baby from harm, such as the health risks of smoking (Murphy et al., 2016). Smoking pregnant women identified a range of approaches that could be helpful in smoking cessation, these approaches were based on training and experience in working with pregnant women (Flemming et al., 2016). Nevertheless, research showed that midwives lack knowledge, feel uncomfortable discussing smoking or feel less confident to provide smoking cessation advice and counselling for pregnant women (Flemming et al., 2016; Herberts and Sykes, 2012; Murphy et al., 2016). Additionally, they expressed concerns and uncertainty about the use of NRT in pregnancy (Flemming et al., 2016). These skills deficits could induce a barrier to providing smoking cessation advice (Flemming et al., 2016). Many of the perceived barriers could be overcome by implementing effective mandatory training for midwives (Herberts and Sykes, 2012). However, it has been shown that few midwives and gynaecologists participated in a specific smoking cessation training (Röske et al., 2009). A review by Melvin et al. (2000) concluded that a brief cessation counselling session of 5 to 15 minutes, delivered by a trained provider and complemented with pregnancy specific, self-help materials, significantly increases rates of cessation among pregnant smokers (Melvin et al., 2000). Other research showed that training of maternity staff could give an answer to some of the deficits in knowledge about smoking and smoking cessation (Condliffe et al., 2005; de Vries et al., 2006). Also enactment, persuasion, and role modelling are recommended to further increase counselling skills in midwives as well as increasing their confidence with regard to their counselling roles (Bakker et al., 2005). Furthermore, training based on the 5 A's framework and motivational interviewing could ensure midwives and gynaecologists that they are delivering the recommended treatment modalities to smokers (Fiore et al., 2000; Flemming et al., 2016; Murphy et al., 2016). The 5 A's framework consists of 5 steps:

1. Ask whether she uses tobacco products;
2. Advise smokers to quit in a strong, clear, and personalized way;

3. Assess her willingness to quit using tobacco at the present time; if the smoker is not willing to make a quit attempt at the present time, then try to increase motivation to quit at a later time;
4. Assist in making a quit attempt, if the smoker is willing to attempt cessation, by providing brief counselling, prescription of pharmacotherapy, and provision of written self-help materials;
5. Arrange follow-up contacts to prevent the smoker from relapsing to tobacco use and enrol the smoker in telephone-quit line counselling or a local program (Chertok and Archer, 2015; Murphy et al., 2016; Winickoff et al., 2005).

Several guidelines recommend the use of the 5 A's framework in smoking cessation counselling (cfr. 4.6 supranational level).

It has been shown that health care providers do not provide all five steps. The combinations ask (step 1) and advise (step 2) or ask (step 1) and assess (step 3) are most commonly used (Chang et al., 2013). Okoli et al. (2010) found that fewer than 50% of health care providers working with pregnant women use all components of the 5A's to address smoking.

Another barrier is avoiding the topic, due to previous negative experiences of discussing smoking and smoking cessation (Flemming et al., 2016). Research of Murphy et al. (2016) describes the image some midwives have of their smoking pregnant clients as 'careless', 'irresponsible', and 'selfish'. Midwives reported to feel discouraged, pessimistic, and even angry with women who were not interested in or did not comply with their advice to quit (Murphy et al., 2016). However, it should be taken in consideration that the midwives in this study worked with South-African vulnerable women of mixed ethnic communities with high smoking rates.

Bakker et al. (2005) found a relatively small percentage of smoking midwives in their survey, between 20.9% and 25.2%. This means that the smoking rate among midwives was lower than among the general population of Dutch adult females (33.8%). Two meta-analysis of Duaso et al. (2017 and 2014) demonstrated that smoking doctors and nurses reduces the rate of consistently advising patients to stop smoking and arranging follow-up visits compared to smokers and ex-smokers. On the other hand, smoking doctors seem more likely to refer their patients to a smoking cessation programme (Duaso et al., 2014). It should be

noted that being a non-smoker could have an influence on the beliefs and practice regarding smoking during pregnancy.

In Flanders, several mass media campaigns are financed by the government in order to reduce the number of smokers, pregnant and non-pregnant. There is substantial information for professionals and smokers of all ages available on the website www.vlaanderenstoptmetroken.be (www.flandersquitsmoking.be), with a separate page for pregnant smokers. Another website, www.tabakstop.be, provides information regarding different ways of smoking cessation assistance and a telephone number (0800 111 00), where smokers can talk to a tobaccologist. This number is also printed on every pack of cigarettes and tobacco. To our knowledge, the effect of this media campaigns on smoking cessation during pregnancy, has not been studied so far.

Another way to promote smoking cessation is the use of the internet. The MumsQuit study showed that an internet-based tool was a potentially useful cessation aid for pregnant smokers, especially the online support, both for women with high and low socio-economic status (SES) (Herbec et al., 2014). Further research regarding the effect of internet tools on quitting is needed (Herbec et al., 2014).

Finally, the use of a telephone quit line should be considered. Telephone quit lines offer a free and anonymous smoking cessation service for pregnant smokers by trained counsellors. Despite the small effect on smoking cessation during pregnancy, the use of a telephone quit line over self-help alone should be highlighted (Bombard et al., 2013).

4.5. Public policy level

Within this level, the institution of a smoking ban, the introduction of smoke-free legislation and taxes on tobacco are described.

Belgium instituted a phased-in ban on smoking in public places. The first smoking ban dated from 1976 and installed a smoking ban in public transport, except in trains (KB 15/9/1976), the smoking ban in trains entered into force on 1/1/2004 due to a regulation of NMBS (*Nationale Maatschappij der Belgische Spoorwegen*; Belgian railway) itself. Subsequently, a smoking ban in enclosed public places entered into force in 1/1/1988 (KB 31/3/1987) and at general workplaces on 1/1/2006 (KB 19/1/2005). The latter was a prohibition on indoor smoking in order to protect

employees. It is only possible to smoke in separate enclosed smoking rooms. On 1/9/2008 (decree 6/6/2008) the smoking ban in educational institutions entered into force.

Also in the hospitality sector a phased-in smoking ban was instituted. The smoking ban in restaurants entered into force on 1/1/2007 (KB 2/12/2005) and in bars on 1/7/2014. This was a general ban with an exemption for clearly designated, enclosed smoking rooms with appropriate ventilation. In the hospitality sector all service is forbidden in smoking rooms (Samoy and Coutteel, 2016; http://ec.europa.eu/health/tobacco/docs/smoke-free_legislation_overview_en.pdf).

Since the stepwise introduction of smoke-free legislation in public places and the hospitality sector, the Flanders region has seen a steady decline in preterm births. Smoking during pregnancy is known to effect foetal growth and shorten gestation, and some research suggests second-hand smoke can contribute to the same problems (Windham et al., 2000). But the effect of smoking bans on gestation is less clear (Cox et al., 2013). Research by Cox et al. (2013) demonstrated a decline in the risk of spontaneous preterm delivery of -3.13% on 1/1/2007 (smoking ban in public places of 2006), and an annual decrease of -2.65% after 1/1/2010 (ban on smoking in restaurants in 2007 and bars serving food in 2010). The researchers accounted for other factors that might influence preterm births, such as age and educational level of the mother, national origin, parity, socio-economic status, and local air pollution (Cox et al., 2013). Also studies on the effect of a smoking ban in Scotland, Ireland, and the United States of America, showed similar positive results regarding the reduction of preterm birth (Kabir et al., 2009; Mackay et al., 2012; Page et al., 2012).

Higher taxes on tobacco have an influence on smoking cessation in pregnant women even more than in other time of life and especially in women who are already motivated to quit smoking (Ringel and Evans, 2001). Also White, older women who were higher educated were more responsive to higher cigarette taxes (Ringel and Evans, 2001). There was little evidence that higher taxes reduce daily cigarette consumption for remaining non-pregnant smokers (Ringel and Evans, 2001). It has also been shown that cigarette taxes may be an effective population-level intervention to decrease socioeconomic disparities in maternal smoking during pregnancy in 28 states of the USA. Hawkins and Baum (2014) showed that White and Black women with less than a high school

degree have some of the highest rates of maternal smoking during pregnancy, respectively 40% and 16%. These women were the most responsive to cigarette tax increases, but not to smoke-free legislation (Hawkins and Baum, 2014).

4.6. Supranational level

Pregnancy is theorized as a 'teachable moment' for women, because their perception of health risk is heightened (McBride et al., 2003). The United Nations estimates that there were globally 137 million births in 2010. At least 80% of pregnant women had at least one antenatal contact provided by skilled healthcare providers (doctors, nurses, or midwives), which is an opportunity to identify and address smoking and exposure to second-hand smoking (SHS) (World Health Organization, 2014).

Several European and Northern American countries developed guidelines in order to recommend interventions aimed at stopping smoking during pregnancy and following childbirth. These recommendations are based on reviews of the evidence, economic modelling, expert advice, stakeholder comments, and fieldwork (Agency for Healthcare Research and Quality (AHRQ), American College of Obstetricians and Gynaecologists (ACOG), Centre Fédéral d'Expertise des Soins de Santé in collaboration with KCE, Domus Medica, Haute Autorité de Santé, NICE public health guidance 26 (2010), NICE public health guidance 48).

The WHO published a set of 'Recommendations on prevention and management of tobacco use and SHS exposure in pregnancy'. These guidelines were developed in collaboration with several international agencies and organizations active in the field of tobacco and reproductive health (World Health Organization, 2014).

The primary objective of these guidelines was to reduce tobacco use and SHS exposure in pregnant women by providing evidence-based recommendations to healthcare providers and other related service providers on identification, management, and prevention of tobacco use and SHS exposure in pregnant women and, where relevant, advice for other members of their household on how to reduce SHS exposure of pregnant women (World Health Organization, 2013; World Health Organization, 2014).

Assessment of tobacco use at the first prenatal visit is recommended based on consistent and good quality patient-oriented evidence (GRADE A, AGREE Collaboration, 2001; Reinsperger et al., 2015). The Haute Autorité de Santé (HAS, 2014) and the NICE 'Public health guidance 26' recommend that midwives should assess the woman's exposure to tobacco smoke through discussion and use of a carbon monoxide (CO) assessment, should refer all women who smoke (including those who smoke lightly or infrequently) or stopped smoking in the last two weeks or have a CO reading indicative of smoking, to stop smoking services.

Neither varenicline nor bupropion should be offered to pregnant or breastfeeding women because they can affect the foetus (GRADE A) (HAS, 2014; Hoengenaert, 2013 in Domus Medica Guideline; NICE public health guidance 26, 2010). NRT should only be prescribed once they have stopped smoking (GRADE B) (Hoengenaert, 2013 in Domus Medica Guideline; NICE public health guidance 26, 2010). There is contradicting evidence on the effectiveness of NRT in helping women to stop smoking during pregnancy. The most robust trial to date has found no evidence that NRT is effective (or that it affects birth weight). In addition, there is insufficient evidence to conclude whether NRT increased the risk on stillbirth or on a child who needs specialized care (Coleman et al., 2015).

These guidelines and recommendations will be more effective in health care systems that provide an enabling tobacco control environment for healthcare workers, such as smoke-free health care facilities and tailored training in smoking counselling. A smoking ban is also supportive (cfr. Public policy level) (World Health Organization, 2013).

5. Research questions

Smoking and smoking cessation during pregnancy has been extensively studied, but some important gaps are observed in the literature. Therefore, **the overall aim of this PhD research was to improve insight into the determinants of smoking and smoking cessation among Flemish women during pregnancy and postpartum**. In this thesis, four studies are presented, based on an original research paper that has been published in a peer-reviewed journal. Every study is related to one or more levels of the socio-ecological model (Fig. 1).

In 2004 the Belgian government implemented a national smoking cessation policy which provided reimbursement of smoking cessation counselling by a tobaccologist for pregnant women, unfortunately with little success. From January 2006 to June 2009 the government only received 133 requests for reimbursement (Belga, 2010). Since gynaecologists perform most prenatal consultations and since there is an increasing percentage of women consulting a midwife in Flanders, they are well-placed to deliver smoking cessation advice during pregnancy. The first study can be linked to the organizational, community and public policy level of the socio-ecological model. The objectives of this study were **(1) to explore knowledge, beliefs and practice among midwives and gynaecologists concerning smoking cessation several years after the implementation of a smoking cessation policy for pregnant women and their partners** and **(2) to examine if midwives and gynaecologists in Flanders do have a role in smoking cessation in pregnant women** (Study 1).

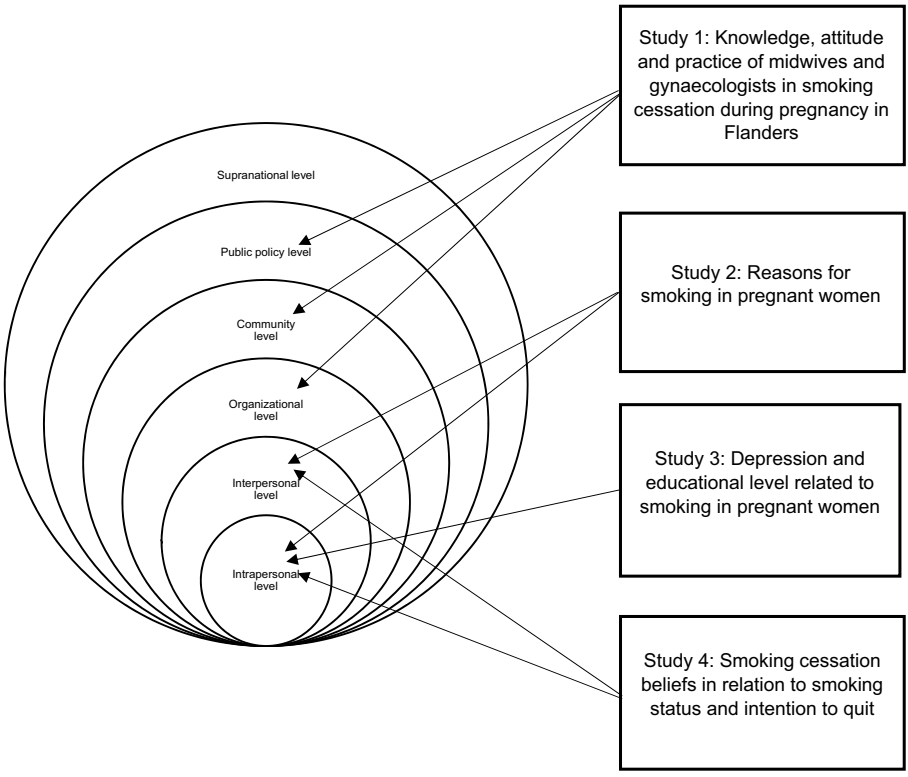
Several studies describe reasons for continued smoking (da Motta et al., 2010). Factors as emotional state, addiction to cigarettes, experiencing pleasure in smoking and influence of others, more specific, of a smoking partner, were mentioned as hindering smoking cessation. The Modified Reasons for Smoking Scale (MRSS) is a widely accepted scale that offers the opportunity to make a more integral assessment of the smoker and to extend the assessment procedure with a more detailed psychological profile (Boudrez and De Bacquer, 2012). A number of studies confirmed the validity and reliability of translated versions of the MRSS (Berlin et al., 2003; Boudrez and De Bacquer, 2012; de Souza et al., 2009). To our knowledge, there are no studies describing the use of the MRSS in pregnant women. The second study examined the intra- and interpersonal level of the socio-ecological model. The main objective of this study was **(3) to test the factorial structure, validity and reliability of the Dutch version of the MRSS in a sample of smoking pregnant women who subscribed for prenatal care**. In addition, we wanted **(4) to obtain more insight into the reasons for continued smoking during pregnancy and into the profile of pregnant smokers**, which is necessary knowledge to develop tailored interventions or appropriate counselling (Study 2).

Associations between feelings of depression, smoking behaviour, and educational level during pregnancy have been documented. Feelings of

depression may contribute to persistent smoking during pregnancy (Zhu and Valbo, 2002; Scott et al., 2009). However, there is a lack of longitudinal studies on feelings of depression in women with different antepartum and postpartum smoking patterns. Study 3 can be linked to the intrapersonal level of the socio-ecological model. We conducted a longitudinal study in order (**5) to obtain insight into the associations between smoking patterns and depressive feelings during pregnancy and postpartum, taking into account several sociodemographic characteristics** (Study 3).

A useful theoretical framework to capture smoking cessation beliefs is the Theory of Planned Behaviour (TPB). The TPB is one of the most frequently cited and influential models for the prediction of human social behaviour (Ajzen, 2011). Only one study assessed beliefs regarding smoking cessation during pregnancy based on the TPB. However, hypothetical questions were asked to non-pregnant smoking women to assess their intention to quit smoking in subsequent pregnancies (Ben Natan et al., 2010). This research can be related to the intra- and interpersonal level of the socio-ecological model. The aims of the fourth study were **(6) to analyse the association between smoking cessation beliefs and smoking status**, and **(7) to analyse the association between smoking cessations beliefs and intention to quit smoking, using the Theory of Planned Behaviour** in pregnant smokers and ex-smokers (Study 4).

Fig. 1: Original research studies related to the socio-ecological model, based on Kok et al. (2008)



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PART 2

Methodology

Research question 1 and 2 were investigated using a qualitative design. Research question 3 to 7 were investigated using a quantitative design.

6. Qualitative study: Role of midwives and gynaecologists in smoking cessation in pregnant women (study 1)

6.1. Study design

We conducted a qualitative study using semi-structured interviews in order to describe and analyse midwives' and gynaecologists' experiences with giving smoking cessation advice during pregnancy. Areas of interest included in the interview guide were based on the authors' clinical expertise regarding prenatal consultations, an existing interview guide from United Kingdom (Bull and Whitehead, 2006) and the 5 A's framework (Fiore et al., 2000).

6.2. Participants

Purposive sampling was used to select eligible participants. Purposive sampling is a sampling technique in which the researcher relies on his or her own judgment when choosing participants according to the needs of the study; in this case, participants of both occupational groups (midwives and gynaecologists) performing prenatal consultations.

Years of experience in prenatal care was taken into account (≤ 10 years and > 10 years). We expected to reach data saturation by recruiting three to five participants in each cell of the sampling matrix (table 2), with a minimum of twelve and a maximum of twenty participants. When data saturation was not reached, extra interviews would be performed.

Table 2: Sampling matrix

Midwives \ Gynaecologists	≤ 10 years of experience	> 10 years of experience
≤ 10 years of experience	3-5 (4)	3-5 (4)
> 10 years of experience	3-5 (5)	3-5 (4)

At the time of sampling, 467 gynaecologists and 198 independent midwives were registered in Flanders (2008). First, a list of gynaecologists

was obtained from the Flemish Organization for Obstetrics and Gynaecology. All 467 registered Flemish gynaecologists received an invitation to participate in the interview (April 2008). Two weeks later a reminder was sent to the non-responders. Five letters returned address unknown. Seventeen gynaecologists replied: two had no prenatal consultations, four planned to retire within the following months and eleven agreed to participate. Following further explanation by telephone, three gynaecologists refused participation. Finally, eight gynaecologists were interviewed, four with less than 10 years of experience in prenatal care, four with more than 10 years of experience. Second, a list of registered independent midwives was obtained from the Flemish Organization of Midwives. In total 198 midwives were invited to participate in the study (June 2008). Two weeks later a reminder was sent. Eleven midwives replied and finally nine midwives agreed to be interviewed. Five midwives had less than 10 years of experience in prenatal care, four had more than 10 years of experience. Recruitment was not continued, as data saturation and the objectives of the sampling matrix had been reached.

6.3. Data collection

Seventeen interviews were conducted between June 2008 and January 2010 and lasted between 23 and 61 minutes. One researcher performed all interviews, which ensures consistency throughout data collection. All interviews, except one, took place at the midwife's or gynaecologist's office.

6.4. Interview guide

Semi-structured face-to-face interviews were conducted using an interview guide with open-ended questions. The topics for the interview guide were partially inspired by the English questionnaire of Bull and Whitehead (2006). The questionnaire was translated into Dutch and two questions concerning knowledge about smoking cessation programs for pregnant women were adapted to the Belgian situation. A gynaecologist, a sociologist, two midwives, a psychologist-tobaccologist and an ethicist reviewed the interview guide in order to establish content validity. No additional items were added.

The final interview guide consisted of three main topics, with corresponding questions, regarding:

- Knowledge about risks of smoking during pregnancy, smoking cessation guidelines and interventions, and the use of nicotine replacement therapy (NRT):
  - Tell me what you know about the risks of smoking during pregnancy
  - To which extent are you familiar with the national policy regarding "stoppen met roken [smoking cessation]"? What is the content of this policy?
  - To which extent are you familiar with other interventions, campaigns, guidelines and their contents?
  - Tell me what you know about the use of NRT during pregnancy.
- Beliefs about smoking and smoking cessation in pregnant women:
  - To which extent do you agree with the following statement: "a pregnant woman is able to quit smoking"?
  - What are the main reasons why women continue to smoke during pregnancy?
  - Under which circumstances would it be better for a pregnant smoker to continue smoking rather than attempt to stop?
  - In your opinion, what are effective interventions to promote smoking cessation for pregnant women?
  - What is your opinion on influencing the decision of a pregnant woman to continue or to quit smoking?
  - To which extent do you agree with the following statement: "I am the right person to offer smoking cessation advice to pregnant women"?
- Dealing with smoking and smoking cessation during prenatal consultation:
  - Tell me how you conduct a conversation with a pregnant smoker *[note to interviewer: keep 5 A's in mind: Ask, Advise, Assess, Assist and Arrange follow-up]*
  - If interested, what kind of smoking cessation training would you need or prefer?

Finally, we asked participants about their work experience, training in smoking cessation counselling and their own smoking status.

The study was approved by the Ethical Committee of Ghent University Hospital (B67020084123). All interviews were audiotaped with permission from the participant. Written informed consent was obtained prior to the interview and confidentiality was assured. After completion of the study the tapes have been destroyed.

6.5. Data analysis

Data analysis was based on deductive content analysis. This method is used when the structure of analysis is operationalized on the basis of previous knowledge (Elo and Kyngäs, 2008). Analysis of the way participants handled smoking and smoking cessation during prenatal consultation was based on the 5 A's framework (Chang et al., 2003).

Members of the research team transcribed the recordings of each interview verbatim. The researchers checked the transcriptions with the recordings in order to gain accuracy. Transcripts, complemented with the field notes, were read several times to obtain a sense of the whole. A thorough reading of the transcripts was followed by the development of a categorization matrix based on the interview guide and the 5 A's framework. Subsequently, data were coded according to the developed categories (Elo and Kyngäs, 2008). Analyses were performed by two members of the research team. Findings were discussed with all authors and consensus with regard to the reflections was reached.

7. Quantitative study: smoking behaviour of pregnant and postpartum women (study 2-4)

7.1. Study design

We performed an observational, prospective, and non-interventional study. Data were collected at three points in time: before 16 weeks of pregnancy (T0), between 32 and 34 weeks of pregnancy (T1), and at least 6 weeks postpartum (T2). For determining T0, the confirmation of the pregnancy by blood analysis and ultrasound, and the decreased risk of spontaneous abortion after 12 weeks were taken into account. T1 was chosen in the third trimester to acquire data covering a large part of pregnancy and to avoid dropouts because of preterm birth. At T2,

women had already experienced the challenges of early motherhood and adapted their lifestyle to the new-borns.

Ethics approval was received from the Ethical Committee of the University Hospital of Ghent (B67020084123). Written informed consent was obtained from respondents, all of whom were assured of confidentiality.

7.2. Participants

A total of 627 respondents were recruited, of which 102 were smokers (16.3%) at T0. Respondents were recruited through the following procedures:

1. The research team was available during pregnancy consultations in two hospitals (University Hospital Ghent, AZ Nikolaas at Sint-Niklaas). One hundred twenty-five women were recruited in Ghent, and 140 women in Sint-Niklaas (total 265 women). At these locations, all participating women were invited for a CO-measurement using the Smokerlyzer Micro (Bedfont Scientific Ltd.), a biochemical validation of the smoking status (Usmani et al., 2008). CO-levels were defined in 257 women; eight respondents could not be tested because of lack of time. All respondents exhibiting CO-levels of ≥ 6 parts per million (ppm) were considered as smokers and categorized accordingly, even if they reported to be non-smoker (n = 2). Questionnaires were answered by telephone, except at T0: when possible, the first questionnaire was filled out at recruitment.

2. A convenience sample of 12 gynaecologists and 10 midwives agreed to facilitate participation of respondents. Through their mediation, 370 pregnant women were recruited and contacted by telephone. These respondents answered the questionnaires at the three time points by telephone without CO-measurement.

7.3. Data collection

Recruitment took place between September 2008 and March 2010; data were collected between September 2008 and December 2010. Convenience sampling was used, with a quota for smokers. Because of the risk of dropout of respondents in a longitudinal study, special attention was paid to the recruitment of at least 100 pregnant smokers.

7.4. Questionnaire and measurements

Questions were based on a standardized and validated questionnaire on smoking and smoking cessation, developed by Maastricht University and STIVORO (Mudde et al., 2006).

The following data were collected through self-report: smoking behaviour of the participant and her partner, reasons for smoking, physical nicotine dependence, feelings of depression, constructs and beliefs of the Theory of Planned Behaviour regarding intention to quit, and socio-demographic variables (age, educational level, job status, gravidity, and marital status).

7.4.1. Socio-demographic variables

The questionnaire included the following variables: maternal age, educational level, job status, marital status, and gravidity. Maternal age was coded into two levels according to the sample we used: < 29 years (mean of the sample) and ≥ 29 years if all respondents were included, < 27 years (mean of the sample of smokers and ex-smokers) and ≥ 27 years if smokers and ex-smokers were included. Respondents were asked for the highest grade or year of school completed. The education variable was coded into two levels: secondary school certificate or lower, meaning 12 years of education or less, or college or university degree. Unemployed women and housewives were classified as not having a paid job; working women and women on maternity leave were classified as having a paid job. Gravidity was coded into primigravida (pregnant for the first time) or multigravida.

7.4.2. Smoking

7.4.2.1. Smoking status

At every time point, respondents were asked to provide details about their previous and current smoking status, daily consumption, intention to quit, and duration of abstinence in case of successful quitting.

CO measurement was used at T0 to validate the self-reported smoking status in 257 of 627 respondents (42.7%). The cut-off point normally applied in smoking cessation studies in non-pregnant respondents is 10 ppm (West et al., 2005). Because the metabolism of pregnant women is accelerated, ending in faster elimination of CO particles in the body, 10

ppm may not give an accurate representation of their smoking status. There is no consensus concerning the correct cut-off point in pregnant smokers. Several limits have been used: 8 ppm (Christensen et al., 2004), 7 ppm (McGowan et al., 2010), 6 ppm (Secker-Walker et al., 1997), 4 ppm (Higgins et al., 2007), and 3 ppm (Usmani et al., 2008). A study by Benowitz et al. (2002) suggested that a cut-off point of > 7 ppm is too high and misses 36% of the self-reported smokers: therefore, 6 ppm was used as the cut-off point in our study.

Research has shown a very low rate of false reporting of smoking cessation in impersonal telephone interviews (Crittenden et al., 2007). Also, asking questions about smoking in a neutral way and giving respondents a choice between multiple answers increases the likelihood of obtaining correct answers (Lindqvist et al., 2002).

Women who reported to smoke at least 1 cigarette/week were considered to be smokers. Women who reported to be abstinent at least 1 week were considered to be ex-smokers. Based on the answers at the three data collection points and taking into account the results of the CO measurement, respondents were categorized as follows:

1. Smokers: women who smoked at least 1 cigarette/week, reporting to be smoking at all three time points. Even if CO-measurement showed a result lower than 6 ppm, they were classified as smokers;
2. Non-smokers: women who never smoked or had quit for longer than 1 year before T0, reporting to be non-smoker at all three time points. We classified women who quit more than one year as non-smoker, because the low relevance of their previous smoking behaviour in relation to the self-reported BDI and because their beliefs or feelings about smoking (cessation) could be influenced by recall bias. Research of Park et al. (2009) showed that ex-smokers' depressive symptoms decreased 24 weeks after delivery, whereas smokers' depressive symptoms increased;
3. Recent ex-smokers: women who reported to be abstinent at least 1 week and maximum 1 year before T0, reporting to be abstinent at all three time points;
4. Initial smokers: respondents with a variable smoking pattern who reported to be smoking at T0 and made a quit attempt;
5. Initial non-smokers: respondents with a variable smoking pattern who reported to be a non-smoker at T0, but relapsed at T1 or T2.

This subdivision was used in study 3.

Data records of all respondents categorized as smokers at T0 were used in study 2. For the test-retest reliability analysis, data records on the subgroup of women who were smokers at T0 and T1 were used. For study 4, we used data records of respondents categorized as smokers and ex-smokers at T0.

In line with previous research, daily consumption was coded into two levels: nine or less cigarettes per day and 10 or more cigarettes per day (Colman et al., 2003; Kharkova et al., 2016; Palma et al., 2007; Soares and Melo, 2008; Wright et al., 2006). Intention to quit was coded into two levels: no or low intention to quit and moderate or high intention to quit. Duration of abstinence in the case of successful quitting was coded in two levels: quit for less than 1 year and quit for 1 year or longer. Finally, only smokers were asked about their intention to quit. This item was scored on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) and coded into two levels: no or low intention to quit (score 1 to 3) and moderate or high intention to quit (score 4 and 5).

7.4.2.2. Modified Reasons for Smoking Scale

The Dutch version of the Modified Reasons for Smoking Scale (MRSS) was administered, including 21 questions measuring seven subscales: addictive smoking, pleasure to smoke, tension reduction, social smoking, stimulation, automatic smoking and handling (Berlin et al., 2003). Answers were given on a Likert scale ranging from 1 (never) to 5 (always). The subscale score consisted of the sum of the scores on the questions belonging to that specific subscale. The MRSS has been translated in Dutch and has been validated, in order to be used in clinical smoking cessation practice in the Dutch-speaking part of Belgium (Boudrez and De Bacquer, 2012).

7.4.2.3. Fagerström Test for Nicotine Dependence

We used the Dutch version of the Fagerström Test for Nicotine Dependence (FTND) as an accepted and standard measurement of physical dependence on nicotine (Fagerström, 1978). Scores on the test range from 0 to 10; a score between 1 and 2 indicates low nicotine dependence, between 3 and 4 low-to-moderate dependence, 5-7 moderate dependence and 8 or more indicate high dependence. Nicotine depend-

ence was assessed using the sum of the FTND and was coded into two levels: low (0-4) and high (5-10).

7.4.2.4. Partner's smoking status

The partner's smoking status (if applicable) was asked and categorized as 'smoking' or 'non-smoking'.

7.4.3. Feelings of depression

The Dutch validated version of the Beck Depression Inventory (BDI; Beck et al., 1979) was used to assess the self-reported degree of depression (Demyttenaere and De Fruyt, 2003). Because of the high content validity, the use of the BDI is internationally recommended (Ji et al., 2011). This inventory examines an individual's emotional condition in the week prior to assessment and is well suited for use in a primary care setting, both as a rapid screening test for depression during pregnancy (Bennett et al., 2004) and as a longitudinal assessment for depression (Marcus and Heringhausen, 2009). It measures 21 emotional, behavioural, and somatic symptoms, which are each rated from 0 to 3 (Beck et al., 1979). A score of 9 or less is considered normal, a score of 10-14 suggests a mild mood disturbance, and a score of 15 has been suggested as an indicator for clinical depression. Higher scores indicate an increasing severity of depression (Milgrom et al., 2011). The BDI was preferred to the Edinburgh Postnatal Depression Scale (EPDS). The BDI is internationally recognized and is available in a validated Dutch version. Research shows that both scales, BDI and EPDS, are highly predictive in identifying depressive disorders during pregnancy and postpartum (Ji et al., 2011).

7.4.4. Constructs and beliefs of the Theory of Planned Behaviour (TPB)

Smokers and ex-smokers answered questions about constructs and beliefs of the TPB. They answered questions regarding maternal and foetal health consequences of smoking cessation during pregnancy and craving symptoms in order to provide insight in their behavioural beliefs and attitude regarding smoking cessation. Health consequences were measured as the mean of three items ('attitude_health', Cronbach's $\alpha = 0.74$), craving consequences as the mean of four items ('atti-

tude_craving', Cronbach's α = 0.80). Higher scores indicated a positive attitude towards smoking cessation.

All respondents answered questions regarding perceived support and encouragement of partner, family and friends in smoking cessation and staying abstinent. They also answered questions about disapproval of smoking during pregnancy by significant others. Perceived encouragement of partner, family and friends in smoking cessation before or in early pregnancy was measured as the mean of two items ('subj. norm_cessation', Cronbach's α = 0.88), perceived support of partner, family and friends in staying abstinent during pregnancy was also measured as the mean of two items ('subj. norm_abstinence', Cronbach's α = 0.87). Higher scores indicated more perceived support. Perceived disapproval of significant others was measured as the mean of three items ('subj.norm_disapproval', Cronbach's α = 0.60). Higher scores indicated more perceived disapproval.

There were six universal circumstances for relapse or continued smoking ('perceived behavioural control', Cronbach's α = 0.95). Smokers and ex-smokers were asked if they felt able to avoid smoking in these particular situations in order to establish their perceived behavioural control. Higher scores indicated higher perceived behavioural control.

7.4.5. Data analysis

Structural equation modelling was performed to assess the construct validity of the MRSS (Muthén and Muthén, 1998). An exploratory factor analysis (EFA) was conducted, followed by a confirmatory factor analysis (CFA). Test-retest reliability (T0 before 16 weeks of pregnancy, T1 between 32 and 34 weeks of pregnancy) was computed using the intraclass correlation coefficient (ICC). Concurrent validity of the MRSS subscales was examined by means of associations with nicotine dependence (FTND), daily consumption, depressive symptoms (BDI score) and intention to quit. For reasons of consistency, we used non-parametric Mann-Whitney U-tests to examine these associations. All analyses were performed using IBM SPSS 21.0 (IBM, Armonk, NY, USA), except the EFA and CFA, which were conducted using Mplus version 6 (Muthén and Muthén, Los Angeles, CA, USA).

The effect on the BDI of smoking pattern, time point, smoking status of the partner, educational level, gravidity, job status, and maternal age

was examined with linear mixed models (PROC MIXED: normal distribution and identity link function). Data were analysed using SAS software, version 9.2 (SAS Institute, Inc., Cary, NC).

T-tests and two-way ANCOVA tests were performed to compare the beliefs of the TPB according to smoking behaviour and intention to quit, adjusted for maternal age and education. Data were analysed using IBM SPSS 22.0.

An overview of the methodology of the quantitative study is presented in table 3.

Table 3: Overview of the methodology used in the quantitative studies

	Study 2: Reasons for smoking in pregnant women	Study 3: Depression and educational level related to smoking in pregnant women	Study 4: Smoking cessation beliefs in relation to smoking status and intention to quit
Design	Longitudinal	Longitudinal	Cross-sectional
Timing data collection*	T0 – T1	T0 – T1 – T2	T0
Groups	1	5	2
Definition	◆ Smoker: smoked at least 1 cig/week	◆ Smoker: smoked at least 1 cig/week ◆ Non-Smoker: never smoked or quit at least 1 year prior to T0 ◆ Recent Ex-Smoker: quit at least 1 week to less than 1 year prior to T0 ◆ Initial Non-Smoker: variable pattern, with changes over T0-T1-T2 ◆ Initial Smoker: variable pattern, with changes over T0-T1-T2	◆ Smoker: smoked at least 1 cig/week ◆ Ex-Smoker: quit at least 1 week
Number of respondents	Smokers: 102 (-5) Total: 97 Attrition due to incomplete datasets: 5	Smokers: 53 (-35) Non-Smokers: 416 (-32) Recent Ex-Smokers: 30 (-15) Initial Smokers: 14 Initial Non-Smokers: 10 Total: 523 Attrition due to incomplete datasets: 82	Smokers: 87 (-15) Ex-Smokers: 177 (-7) Total: 264 Attrition due to incomplete datasets: 22
Measurements	◆ Modified Reasons for Smoking Scale ◆ Fagerström Test for Nicotine Dependence ◆ Beck Depression Inventory ◆ Socio-Economic Status	◆ Beck Depression Inventory ◆ Socio-Economic Status	◆ Socio-Economic Status ◆ Constructs of Theory of Planned Behaviour
Statistical analysis	Structural Equation Modelling, Cronbach's alfa, Intraclass Correlation Coefficient, Mann-Whitney U test	Linear mixed models, univariate and multivariate analysis	Chi²-test, Pearson correlation, student t-test, two-way ANCOVA test
Software	SPSS 21.0 and Mplus version 6	SAS 9.2	SPSS 22.0

Legend: * T0: < 16 weeks pregnancy
T1: 32-34 weeks pregnancy
T2: > 6 weeks postpartum

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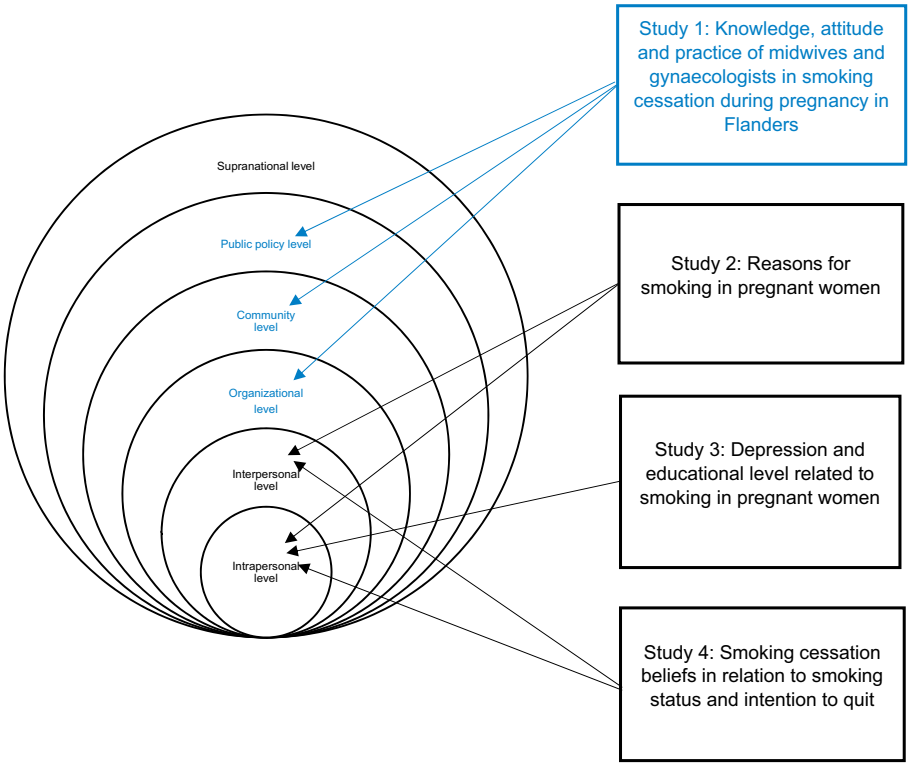
PART 3

Original research articles

8. Study 1: Knowledge, attitude and practice of midwives and gynaecologists in smoking cessation during pregnancy in Flanders[1]



[1] Based on: De Wilde, K., Tency, I., Steckel, S., Temmerman, M., Boudrez, H., Maes, L. (2015). Which role do midwives and gynecologists have in smoking cessation in pregnant women? – A study in Flanders, Belgium. Sexual & Reproductive Healthcare, 6, 66-73

8.1. Abstract

Objectives: The objectives of our study were 1) to explore knowledge, beliefs and practice among midwives and gynaecologists concerning a smoking cessation policy for pregnant women and their partners and 2) to examine if midwives and gynaecologists do have a role in smoking cessation in pregnant women.

Method: We performed a qualitative study using semi-structured interviews with nine midwives and eight gynaecologists. Data were analysed using deductive content analysis, based on the 5 A's framework (Ask – Advise – Assess – Assist – Arrange).

Results: The national smoking cessation policy seemed to be insufficiently known. 'Ask' and 'Advise' were part of a standard prenatal consultation, the next three steps were rarely implemented. Participants had a negative image of 'the smoking pregnant woman': a low educated woman with a smoking partner and 'bad examples' in their history. Reported barriers were fear of provoking resistance and lack of time and communication skills regarding smoking cessation.

Conclusions: These findings suggest that training in communication skills and dealing with resistance should be offered, i.e. by using motivational interviewing. It could be considered that a trained midwife or tobaccologist is part of an obstetrical team or that the AAR-method (Ask – Advise – Refer) is used instead of the 5 A's framework.

8.2. Introduction

Smoking during pregnancy is associated with a number of foetal and maternal health risks, such as stillbirth, low birth weight, preterm delivery, placenta pathology and sudden infant death syndrome (SIDS) (Everett-Murphy et al., 2011; Flemming et al., 2012).

The preconceptional and prenatal period is considered as the ideal teaching moment for smoking cessation counselling (Chang et al., 2013). However, a number of studies identified personal and organizational barriers to providing effective smoking cessation advice: lack of motivation or interest to work with clients on this subject (Bull, 2007), absence of clear guidelines (Bull, 2007), lack of knowledge where and to whom to refer to (Price et al., 2006), fear of providing advice with impact on the quality of their relationship (Herberts and Sykes, 2012), competing priorities in prenatal care such as acute obstetric complications (Abatemarco et al., 2007), underestimating the risks of smoking during pregnancy (Everett et al., 2005), absence of trust (Petersen et al., 2009), low chances of success (Röske et al., 2009; Thyrian et al., 2006) and in particular lack of time (Bull and Whitehead, 2006; Everett et al., 2005; Herberts and Sykes, 2012; Price et al., 2006) and specific training needs (Abatemarco et al., 2007; Bull, 2007; Bull and Whitehead, 2006; Herberts and Sykes, 2012; Röske et al., 2009). As a consequence, health care providers feel incompetent to give smoking cessation advice.

The American College of Obstetricians and Gynaecologists recommends use of the 5 A's, an evidence-based, clinical practice guideline for smoking cessation. The 5 A's remind health care providers to: 1) Ask the client about her smoking status at every prenatal visit; 2) Advise her to stop smoking in a clear, strong and personalized way; 3) Assess her willingness to stop smoking and motivations to quit, if she is not willing to make a quit attempt at the present time, then try to increase motivation to quit at a later time; 4) Assist the client to stop smoking by providing brief counselling, prescription of pharmacotherapy, and provision of written self-help material; and 5) Arrange specific follow-up to prevent the client from relapsing to tobacco use and enrol her in a local smoking cessation program (Chang et al., 2013).

Motivational interviewing (MI) is a style of patient-centred counselling developed to facilitate change in health-related behaviour. The core principle of the approach is negotiation rather than conflict (Treasure,

2004). MI is widely used to help people make an attempt to change their harmful behaviour and appears to be modestly successful in promoting smoking cessation, compared to standard care or brief interventions (Lai et al., 2010). Motivation may fluctuate over time or from one situation to another, and can be influenced to change in a particular direction. Lack of motivation or resistance to change is seen as something that is open to change. The main focus of MI is facilitating behaviour change by helping people to explore and resolve their ambivalence about behaviour change. Adopting a victim-blaming, aggressive and/or confrontational style as in traditional approaches, is likely to produce negative responses like arguing, which may be interpreted by the health care provider as denial or resistance (Lai et al., 2010).

In Flanders (Northern Belgium), prenatal care is mostly provided by a gynaecologist or a midwife and sometimes by a general practitioner. As such, these health care providers are well-placed to deliver smoking cessation advice during pregnancy. In 2011 the prevalence of smoking during pregnancy in Flanders was 12.3% (Hoppenbrouwers et al., 2011). Since 2004 the Belgian government implements a national smoking cessation policy. Smoking pregnant women attending at least eight consultations with a tobaccologist receive a reimbursement of €30 for every consult with a maximum of €240. Smoking partners of pregnant women receive €30 for the first and €20 for the following seven consultations. Folders and flyers promoting this reimbursement were distributed among midwives and gynaecologists by mail. From January 2006 until June 2009 the government only received 133 requests for reimbursement (www.standaard.be). The lack of success of this policy might be explained partly by a lack of awareness among health care providers, resulting in few referrals to tobaccologists. Furthermore, women continuing smoking during pregnancy might be a low motivated group, not yet prepared to invest in smoking cessation consultations and who are hard to reach with smoking cessation information and support. The national policy, originally restricted to pregnant women and their partner, was extended in October of 2009: smoking cessation reimbursement has been available since then for each counselling session (individually or in group) by a tobaccologist or a physician.

Since gynaecologists perform most prenatal consultations and since there is an increasing percentage of women consulting a midwife

(Ceuppens et al., 2010; De Gauquier et al., 2006; De Gauquier and Remacle, 2007), our study population was limited to gynaecologists and midwives. The objectives of our study were 1) to explore knowledge, beliefs and practice among midwives and gynaecologists concerning smoking cessation several years after the implementation of a smoking cessation policy for pregnant women and their partners and 2) to examine if midwives and gynaecologists in Flanders do have a role in smoking cessation in pregnant women.

8.3. Methods

8.3.1. Design

A qualitative study using semi-structured interviews was conducted in order to describe and analyse midwives' and gynaecologists' experiences with giving smoking cessation advice during pregnancy. Areas of interest included in the interview guide, were based on the authors' clinical expertise regarding prenatal consultations and the 5A's framework.

8.3.2. Participants

Purposive sampling was used to select eligible participants, representing both occupational groups (midwives and gynaecologists). In order to be included participants had to perform prenatal consultations. Years of experience in prenatal care were taken into account (≤ 10 years and > 10 years). We expected to reach data saturation by recruiting three to five participants in each cell of the sampling matrix, with a minimum of twelve and a maximum of twenty participants. When data saturation was not reached extra interviews would be performed.

In Flanders there were 467 registered gynaecologists and 198 registered independent midwives at the time of sampling (2008). First, a list of gynaecologists was obtained from the Flemish Organisation for Obstetrics and Gynaecology. All 467 registered Flemish gynaecologists received an invitation to participate in the interview (April 2008). Two weeks later a reminder was sent to the non-responders. Five letters returned address unknown. Seventeen gynaecologists replied: two had no prenatal consultations, four planned to retire within the following months and eleven agreed to participate. Following further explanation

by telephone, three gynaecologists refused participation. Finally, in total eight gynaecologists were interviewed, four with less than 10 years of experience in prenatal care, four with more than 10 years of experience.

Second, a list of registered independent midwives was obtained from the Flemish Organisation of Midwives. In total 198 midwives were invited to participate in the interview (June 2008). Two weeks later a reminder was sent. Eleven midwives replied and finally nine midwives agreed to be interviewed. Five midwives had less than 10 years of experiences, four had more than 10 years of experience.

Recruitment was not continued, as data saturation and the objectives of the sampling matrix had been reached.

8.3.3. Data collection

Seventeen interviews were conducted by the first author between June 2008 and January 2010 and lasted between 23 and 61 minutes. One researcher performed all of the interviews, thus ensuring consistency throughout the data collection. All interviews, except one, took place at the midwife's or doctor's office.

Semi-structured face-to-face interviews were conducted using an interview guide with open-ended questions. The topics for the interview guide were partially inspired by the English questionnaire of Bull and Whitehead (2006). The questionnaire was translated into Dutch and two questions concerning knowledge about smoking cessation programmes for pregnant women were adapted to the Belgian situation. A gynaecologist, a sociologist, two midwives, a psychologist-tobaccologist and an ethicist reviewed the interview guide in order to establish content validity. No additional items were added.

The final interview guide consisted of three main topics, with corresponding questions, regarding:

- Knowledge about risks of smoking during pregnancy, smoking cessation guidelines and interventions and the use of nicotine replacement therapy (NRT):
  - Tell me what you know about the risks of smoking during pregnancy

  - To which extent are you familiar with the national policy regarding 'stoppen met roken (smoking cessation)'? What is the content of this policy?
  - To which extent are you familiar with other interventions, campaigns, guidelines and their contents?
  - Tell me what you know about the use of NRT during pregnancy.
- Beliefs about smoking and smoking pregnant women:
  - To which extent do you agree with the following statement: "a pregnant woman is able to quit smoking"?
  - What are the main reasons why women continue to smoke during pregnancy?
  - Under which circumstances would it be better for a pregnant smoker to continue smoking rather than attempt to stop?
  - In your opinion, what are effective interventions to promote smoking cessation for pregnant women?
  - What is your opinion on influencing the decision of a pregnant woman to continue or to quit smoking?
  - To which extent do you agree with the following statement: "I am the right person to offer smoking cessation advice to pregnant women."
- Dealing with smoking and smoking cessation during prenatal consultation:
  - Tell me how you conduct a conversation with a pregnant smoker *[note to interviewer: keep in mind: Ask, Advice, Assess, Assist and Arrange follow-up]*
  - If interested, what kind of smoking cessation training would you need or prefer?

Finally we asked participants about their work experience, training in smoking cessation counselling and their own smoking status.

8.3.4. Ethical considerations

The study was approved by the Ethical Committee of Ghent University Hospital. All interviews were audiotaped with permission from the participant. Written informed consent was obtained prior to the interview and confidentiality was assured. After completion of the study the tapes will be destroyed.

8.3.5. Data analysis

Data analysis was based on deductive content analysis. This method is used when the structure of analysis is operationalized on the basis of previous knowledge (Elo and Kyngäs, 2008). Analysis of the way participants handled smoking and smoking cessation during prenatal consultation was based on the 5 A's framework (Chang et al., 2013).

Members of the research team (KDW, KT) transcribed the recordings of each interview verbatim. The researchers checked the transcriptions with the recordings in order to gain accuracy. Transcripts were read several times to obtain a sense of the whole. A thorough reading of the transcripts was followed by the development of a categorization matrix based on the interview guide and the 5 A's framework (table 4). Next, data were coded according to the categories (Elo and Kyngäs, 2008). Findings were discussed with all authors and consensus with regard to the reflections was reached.

Table 4: Categorization matrix based on the interview guide and the 5 A's framework in smoking cessation counselling and perceived barriers

Theme 1: Basic knowledge regarding foetal and maternal risks associated with smoking during pregnancy	**Focus**	**Risks**
	Foetus/child (M)	*List of risks:* IUGR, LBW, placental problems, SIDS
	Woman and foetus/child (G)	Fertility problems, stillbirth (M-teachers, G)
		Early menopause, lung diseases, cancer, premature aging of the skin, irritable or lazy baby, long term risks for the child (G) *Uncertainty about some risks*, such as preeclampsia, hypertension and malformations (M) *Importance* of smoking prevention, not only during pregnancy (society issue)

Theme 2: Specific knowledge regarding national smoking cessation guidelines and the use of NRT	**Existence of national policy**	**Content of national policy**	**Guidelines**	**NRT**
	Awareness of national policy	Number of consultations or amount of repayment, was largely unknown	No knowledge of other guidelines	Insufficient knowledge: not discussed with client or avoiding the topic (M) Sufficient knowledge, but not recommended: is it really safe? (G) Bupropion and varenicline: not prescribed, not safe during pregnancy (G)

Theme 3: The image of 'the smoking pregnant woman'	Image	Barriers for smoking cessation in pregnant women
	Negative image: low educated woman, smoking partner, 'bad examples' in their history *In contrast with* perception of 'pregnant woman': follows life style advice immediately 'Extra ultrasounds' vs 'no extra consultation time'	Addiction, ignorance, stress, (complex) social problems, lack of support of the partner and peers

Theme 4: The 5 A's framework	Ask	Advise	Assess	Assist	Arrange follow-up
Subtheme 1: Dealing with smoking (cessation) during prenatal consultation	Asking questions about the smoking behaviour	Advising smoking cessation		Information by leaflets or websites	Referral to tobaccologist or other professional in smoking cessation counselling, but client has to book own appointment
	Frequency: Asking once or at every consult Way of asking questions	Discussing health risks for mother and child		Information regarding smoking cessation counselling	
	No questions asked about the smoking behaviour of the partner	No advice: avoiding the topic Negative example: Advice to reduce daily consumption	No examples, this step is skipped	No use of NRT	

Theme 4: The 5 A's framework	Ask	Advise	Assess	Assist	Arrange follow-up
Subtheme 2: Barriers regarding the execution of 5 A's framework		Lack of time (G)	Lack of time (G)	Lack of time (G)	Lack of time (G)
		Lack of communication skills: how do I give advice? (M)	Lack of communication skills: how do I assess the readiness to quit smoking? (M)		
		Fear of provoking resistance (M)	Fear of provoking resistance (M)		
		Disappointment: no effect of advice, no influence on the woman			
		More urgent priorities in prenatal care			
		Giving advice is not my job (G)			

Theme 5: Perceived need for smoking cessation training	Training in smoking cessation counselling	Content of training	Need for training, suggestions for content
	3 midwives with training (table 5) No training due to lack of time (G)	Training did not meet needs: too theoretical, too short (M)	No need for training, prefer to refer their clients (G) *Suggestions for content:* Communication about sensitive topics (i.e. smoking cessation), dealing with resistance during conversation (role play?), dealing with own disappointment if advice is not followed (M)

The answers are provided by both occupational groups, unless otherwise specified: midwives (M) or gynaecologists (G)

8.4. Results

8.4.1. Participant characteristics

All participants were non-smokers at the time of the interview, two were ex-smokers. All participants, except two, were female. Three midwives attended a training in smoking cessation skills (Table 5). Participants came from different Flemish provinces.

Table 5: Characteristics of the participants

Number	Midwife (M) or gynaecologist (G)	Years of work experience	Training in smoking cessation skills	Additional information
1	G	5		
2	G	7		Stopped smoking more than 10 years ago, smoked for two years
3	G	18		
4	G	6		
5	M	18	Attended a theoretical training in smoking cessation skills of 4 hours	
6	M	2		
7	M	25	Attended training in smoking cessation skills of several days. Scientific interest in the topic	Stopped smoking more than 20 years ago, smoked for 6 months Teacher
8	M	23		Work experience in developing countries
9	M	5		
10	M	7	Training in and experience with the use of the Minimal Intervention Strategy (MIS) for smoking cessation in prenatal care	Worked for 4 years in the Netherlands
11	G	3		Teacher
12	M	7		Teacher, worked for 2 years in the Netherlands
13	G*	33		Teacher
14	M	30		
15	M	4		
16	G*	16		
17	G	15		

* = male participant

8.4.2. Themes

All data could be categorized in the five themes of the categorization matrix. The last interviews confirmed the validity of these theme, no new themes emerged. Each theme includes quotes from the participants.

8.4.2.1. Theme 1: Basic knowledge regarding foetal and maternal risks associated with smoking during pregnancy

Basic knowledge is defined as the readily available knowledge participants have at the moment of the interview without having to do research about the topic. The most common risks of smoking reported by both occupational groups were intrauterine growth restriction, low birth weight, placental problems and sudden infant death syndrome.

Midwives spontaneously mentioned foetal or neonatal risk factors and were more uncertain about some risks, such as preeclampsia, hypertension and malformations. Midwives-teachers also knew the risk of stillbirth and fertility problems.

Gynaecologists immediately made a distinction between neonatal and maternal risks. They mentioned such additional risks as fertility problems, early menopause, lung diseases, different forms of cancer, premature aging of the skin, an irritable or lazy baby and long term risks for the child such as negative influence on school results, addictive behaviour and allergies. In their opinion, the risks of premature skin aging and fertility problems have a stronger effect on smoking cessation compared to a list of neonatal risks.

All participants were convinced that prevention is required because of the risks for mother and child. Smoking prevention as well as smoking cessation in general are considered to be important health issues. They believed that smoking cessation advice should start before pregnancy, preferably in high school, since smoking cessation can take several attempts and requires time, even more than the duration of a pregnancy. Sensitizing society by promoting non-smoking is important as well, according to the participants.

8.4.2.2. Theme 2: Specific knowledge regarding national smoking cessation guidelines and the use of nicotine replacement therapy (NRT)

In most cases, the specific knowledge regarding smoking cessation guidelines or interventions was limited. The precise requirements of the programme for reimbursement, such as the number of consultations or the amount of the repayment, was largely unknown. Half of the participants thought that the national policy provided free smoking cessation counselling.

The interviewed midwives had insufficient knowledge regarding the use of NRT in pregnancy; therefore they avoided this topic during prenatal consultation. Gynaecologists were aware of the fact that bupropion and varenicline are contra-indicated during pregnancy and although they knew that NRT could be used safely during pregnancy, they did not recommend it.

8.4.2.3. Theme 3: The image of 'the smoking pregnant woman'

Participants had a negative image of 'the smoking pregnant woman': a low educated woman living with a smoking partner and 'bad examples' in their history, such as smoking during a previous pregnancy without visible or immediate problems for the baby or the mother, which makes them minimalize their smoking habit.

> *She told me that her neighbour smoked twenty-five cigarettes every day and that she had a baby weighing over four kilograms. Yes, that is what she told me! And what can I do, how can I convince her, she was right. (Midwife 5)*

This image doesn't fit with perceptions of the participants of a 'pregnant woman': a woman who follows life style advice immediately, in order to give birth to a healthy baby. Hence, a minority of the participants believed that smoking related pregnancy complications have to be attributed to the responsibility of the woman herself. Some gynaecologists even believed that these women should not be rewarded with additional attention or consultation time. Other participants believed that they need extra ultrasounds in order to examine the foetal growth, which implies extra costs for the couple and the society.

Participants believed that addiction, ignorance, stress, (complex) social problems and a lack of support of the partner and peers are barriers to attempts to cease smoking.

Most midwives and gynaecologists did not believe that there are acceptable situations in which it is better for pregnant women to continue smoking, even in stressful situations. Others had a different opinion and advised to reduce daily consumption of cigarettes instead of quitting.

> *When she can't stop smoking, I tell her to reduce the number of cigarettes to an absolute minimum. (…) Less than three cigarettes a day, in which case she is not considered to be a smoker any longer. (Gynaecologist 4)*

8.4.2.4. Theme 4: The 5A's framework in smoking cessation counselling and perceived barriers

Subtheme 1: Dealing with smoking (cessation) during prenatal consultation

The 5A's method of smoking cessation (Chang et al., 2013) was used as a framework to analyse the practice of the participants:

- Ask: All participants asked questions about the smoking status and daily consumption of their clients during the first visit and documented it in the medical record. Most midwives and some gynaecologists asked the questions again during the following visits. The smoking status of the partner was not questioned.

  > *I ask: 'Do you smoke?'. When she answers 'Yes', then I want to know how much she smokes. I try to get insight in her reality, on the condition that she tells the truth of course. (…) I write the answers down in the medical record. (…) During the next consultation I ask if she has cut down her daily consumption. (Midwife 7)*

- Advise: Most participants felt it was their duty to provide smoking cessation advice, but admitted that there are often other more urgent priorities in prenatal care, such as giving information about different ways of giving birth, pain relief and breastfeeding. Especially gynaecologists expressed lack of time. One gynaecologist thought that she was overqualified and that giving life style

advice, including smoking cessation advice, belonged to the tasks of a tobaccologist or general practitioner.

> *I don't have the time. I am not the kind of person who wants to spend half an hour to motivate smoking cessation. I think that I am too highly qualified. That's not my job, I have too many other things to do. I want to refer them [smokers] to a specialist. (Gynaecologist 4)*

Most participants advised smoking cessation, some advised to reduce the daily consumption, especially in stressful situations.

> *I think that if the woman gets too much stressed about the fact that it is forbidden to smoke, then the only thing you can say, is: 'Alright, you can smoke a few cigarettes a day.' I try to motivate her to smoke less than ten cigarettes, if possible less than five cigarettes a day. (Gynaecologist 3)*

Risk factors associated with smoking during pregnancy were discussed with the woman in order to convince her to quit.

Midwives admitted that they lack communication skills to talk about a sensitive topic like smoking and smoking cessation during pregnancy; they feared provoking resistance or not having any influence on the woman's behaviour.

> *Lack of self-confidence and knowledge is visible, so my message about smoking cessation is not strong enough, the client doesn't listen and then I feel like I can do nothing to influence her decision. (Midwife 5)*

> *I try to start a conversation about smoking behaviour, but when I feel that it [the conversation] is blocked and I get the opposite effect, then I will be very careful. I know that they will not stop smoking and that I am not able to do something about it. I don't want to chase them away so that they drop out of prenatal care. (Midwife 14)*

- Assess: Participants skipped this step during prenatal consultation. After asking questions about the smoking behaviour they immediately gave cessation advice without assessing if the woman was ready to quit smoking.
- Assist: Several participants used leaflets to support or replace their

advice or referred to websites that discuss smoking cessation and different ways of counselling. NRT is not recommended.

- Arrange follow up visits: Three independent midwives referred to a general practitioner or a tobaccologist. Most gynaecologists referred to a general practitioner, a tobaccologist or a psychologist working in the same hospital. All referring participants were not sure that the referral had any effect since the woman herself had to make the appointment(s) with the tobaccologist. For most women this barrier would be too high, participants thought.

The results as a whole demonstrate that the participants have insufficient knowledge of effective health education methods, in particular regarding smoking cessation.

Subtheme 2: Barriers regarding the execution of 5 A's framework

Participants were aware of the fact that asking questions about smoking behaviour should lead them to an action, but immediately they mentioned different barriers that hindered them from taking action. Because of a lack of time, a lack of communication skills and fear of resistance they sometimes barely discuss or avoid the topic. Some participants expressed their disappointment regarding the poor effect of their smoking cessation advice. Therefore, they were reluctant to assess the smoking behaviour because they felt that it was a "*waste of their precious consultation time, because the smoker didn't quit anyway (gynaecologist 16)*".

8.4.2.5. Theme 5: Perceived need for smoking cessation training

None of the gynaecologists attended smoking cessation training due to their busy schedule. Most of them believed that it was better to refer the client to e.g. a tobaccologist than to attend a training session.

Three midwives attended some kind of training and two of them even expressed a need for more extensive training to provide them with a theoretical background about the risks of smoking during pregnancy as well as the skills to communicate about sensitive topics like smoking cessation, to deal with resistance and to conduct motivational interviewing, if possible by using role play. Some participants would like a testimony of an ex-smoker and some suggestions on how to deal with their own disappointment if the woman refuses to follow their advice.

8.5. Discussion

The objectives of our study were 1) to explore knowledge, beliefs and practice among midwives and gynaecologists concerning smoking cessation several years after the implementation of a smoking cessation policy for pregnant women and their partners and 2) to examine if midwives and gynaecologists in Flanders do have a role in smoking cessation in pregnant women.

All participants knew that smoking during pregnancy can cause severe health problems in (pregnant) women and babies. Despite this general opinion, there was a difference in the focus of midwives and gynaecologists regarding these risks. Midwives were focused on foetal and neonatal risks since contacts are limited to pregnancy and postpartum. Risks for the pregnant woman herself were less known, thought of and rarely discussed with their clients. Gynaecologists also have contact with women during non-pregnancy related consultations. Therefore, they focussed on risks for both woman and foetus.

Most participants believed that knowledge of the health risks is the most important motivation for smoking cessation. Therefore, risks were listed during the first consultation and with this information participants expected women to quit. However, it has been shown that information alone is not sufficient for behavioural change; the health risks of smoking are well known and yet 30% of the population continues to smoke (Naidoo and Wills, 2009).

The number of consultations and the amount of reimbursement of the national policy was largely unknown. For example, half of the participants thought that the national policy provided in free smoking cessation counselling. Hence, they gave the wrong information to their clients. Gynaecologists and midwives should be better informed about the content of the national smoking cessation policy for pregnant women, or the pregnant women themselves should be reached with relevant information on smoking cessation in an effective way. This includes also promoting referral to a tobaccologist.

The knowledge regarding NRT, especially of midwives, was insufficient and thus NRT was not recommended. In Flanders NRT is over-the-counter medication. If the woman doesn't inform the pharmacist about her pregnancy, she can buy the product without specific information regarding the use and the dose of NRT during pregnancy. NRT is

the only pharmacotherapy for smoking cessation that has been tested in RCTs conducted in pregnancy.

There were no statistically significant differences in rates of miscarriage, stillbirth, premature birth, low birth weight, admissions to neonatal intensive care or neonatal death between NRT or control groups, but further research regarding efficacy and safety is needed (Coleman et al., 2012).

Participants had a negative image of 'the smoking pregnant woman': a low educated woman living with a smoking partner and 'bad examples' in their history. This image doesn't fit with the ideal image of the participants of a 'pregnant woman': a woman who follows life style advice immediately, in order to give birth to a healthy baby. It could be possible that these prejudices hinder a conversation about smoking cessation. At the time of the interview none of the participants smoked, this also could make it more difficult to understand why a pregnant woman can't or won't stop smoking.

All participants asked questions about the smoking status and the daily consumption. Midwife 7, who attended a more extensive training in smoking cessation, and midwife 10, with experience in MIS in prenatal care, also asked how long the client smoked, what brand and on which occasion she smoked, which led to a more profound insight in her smoking behaviour. By asking the right questions it is possible to gather extra information, hence the right arguments for that specific woman that can be used to motivate her smoking cessation.

The smoking status of the partner was not questioned and passive smoking was not a topic of conversation. Given the health problems related to passive smoking (Higashida and Ohashi, 2014), this topic needs special attention as well.

Several participants offered an information leaflet or referred to a website to support the oral information or as a replacement of the information in case of lack of time. Leaflets are useful as supplementary communication to inform, educate and advise people about health issues. However, when leaflets are given without oral smoking cessation advice, they have less effect (Naidoo and Wills, 2009).

In line with previous observations (Herberts and Sykes, 2012), the most important barriers for giving smoking cessation advice were lack of

time, lack of communication skills in sensitive topics such as smoking cessation, and dealing with resistance. Most gynaecologists believed that a conversation about the smoking behaviour would take too much time, time they don't have in their opinion during a standard prenatal consultation of ten to fifteen minutes. Midwives mentioned several times that they didn't know how to start a conversation without provoking resistance or without 'chasing the woman away'. Their experiences with these conversations were negative, so they discussed the topic superficially, hoping that the woman would get the message. Even midwife 5, who attended a short theoretical training about smoking cessation during pregnancy, still felt she lacked the appropriate skills.

None of the gynaecologists attended a training in smoking cessation and most of them were not willing to do so. They preferred to refer the woman. Three midwives attended a training and even wanted to be trained more. However in this study there were no important differences in dealing with smoking cessation between trained and non-trained midwives. This may suggest that the duration and content of the training did not meet the needs. Midwives reported that most were too short, too theoretical and did not provide participants with the right skills to communicate about a sensitive topic such as smoking.

'Ask', 'Advice' and to a lesser extent 'Assist' of the 5 A's framework were implemented in smoking cessation communication, which is similar to previous studies (Chang et al., 2013). Although gynaecologists preferred to refer their clients, referral to a tobaccologist is rare and when a woman is referred, she seldom makes an appointment, according to the participants. This might be explained by the fact that the gynaecologist or the midwife is someone the woman knows and trusts, a tobaccologist is in almost all cases a stranger to them. Also the fact that they didn't assess the woman's readiness to quit may hinder making the appointment.

There are two possible suggestions to help smoking pregnant women. A first strategy would be that there is someone within the obstetric team trained in giving smoking cessation advice and is seen as a confidant by the pregnant woman (Ebert et al., 2009). Since gynaecologists expressed mostly time pressure as a barrier during their prenatal consultation, it could be considered to organize more shared consultations with a trained midwife. The midwife can provide prenatal care com-

bined with life style advice, such as smoking cessation advice, and build a partnership with the woman (Ebert et al., 2009; International Confederation of Midwives, 2010). A second and possibly more effective strategy in Flanders is to use an abbreviated version of the 5 A's framework, more specifically the AAR-method: 1) Ask questions about the smoking behaviour; 2) deliver brief Advice to quit smoking and determine the readiness and motivation to quit; and 3) Refer to specialized smoking cessation counselling, i.e. by a tobaccologist or a trained midwife (Tobacco Cessation Leadership Network). Motivation may fluctuate over time or from one situation to another, which means that motivation can be influenced by searching for the right arguments for each particular client. The technique of motivational interviewing (MI) can be used to initiate a conversation about smoking, to explore and resolve uncertainties about smoking cessation and to motivate them to make a quit attempt. By using this technique an aggressive or confrontational approach is avoided and self-belief of the client is encouraged (Everett-Murphy et al., 2011; Lai et al., 2014). It would be recommendable that health care providers are trained in using MI in order to avoid resistance in clients and to enhance their own self-confidence in discussing sensitive topics. When they assess an increased motivation of the woman to quit smoking, she can be referred to a tobaccologist. This also ensures a separation between prenatal care and smoking cessation counselling so that fear of clients dropping out of prenatal care is avoided.

8.6. Limitations

A possible limitation is the number of participants involved in the study. Only eight gynaecologists and nine midwives agreed to participate, despite the fact that all registered gynaecologists and independent midwives in Flanders received an invitation and a reminder. This may indicate that only health care providers with special interest in the topic agreed to participate.

A second limitation is the fact that qualitative studies are contextual, which means that the results should be related to the context of the study. This study focused on gynaecologists and midwives performing prenatal consultations in Flanders. This does not imply that these findings have no meaning in other contexts, but that they must be interpreted in relation to the other context.

8.7. Conclusions

Participants had a negative image of 'the smoking pregnant woman': a low educated woman living with a smoking partner and 'bad examples' in their history. It could be possible that these prejudices hinder a conversation about smoking cessation.

The most important barriers reported to providing smoking cessation counselling are lack of time, restricted communication skills and fear of provoking resistance. Even trained midwives experience these barriers and have doubts about their competencies in giving smoking cessation advice. Gynaecologists seem not interested in training regarding smoking cessation and prefer to refer their clients.

The following two possible suggestions to help smoking pregnant women should be explored:

Training in smoking cessation counselling of a team member who is seen as a confidant by the pregnant woman. This could be a trained midwife, who can provide prenatal care combined smoking cessation advice.

A possibly more effective strategy in Flanders is to use an abbreviated version of the 5 A's framework, more specifically the AAR-method. The role of the midwife and gynaecologist is then limited to asking questions about smoking behaviour, providing brief advise, determining the readiness to quit and referring clients to specialized smoking cessation counselling.

Further research should focus on the implementation of the AAR-method in order to increase the number of pregnant women who stop smoking.

Conflict of interest

The authors do not have any financial and personal relationships with other people or organisations that could inappropriately influence or bias their work.

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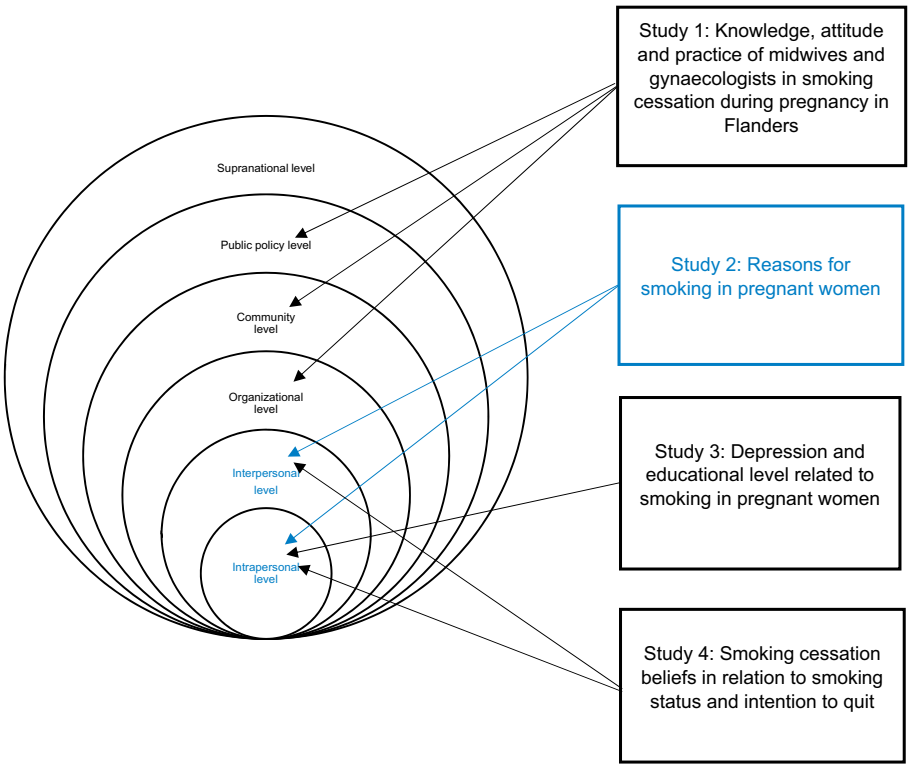
9. Study 2: Reasons for smoking in pregnant women[2]



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9.1. Abstract

Rationale, aims and objectives: Smoking during pregnancy can cause several maternal and neonatal health risks, yet a considerable number of pregnant women continue to smoke. The objectives of this study were to test the factorial structure, validity and reliability of the Dutch version of the Modified Reasons for Smoking Scale (MRSS) in a sample of smoking pregnant women and to understand reasons for continued smoking during pregnancy.

Method: A longitudinal design was performed. Data of 97 pregnant smokers were collected during prenatal consultation. Structural equation modelling was performed to assess the construct validity of the MRSS: an exploratory factor analysis was conducted, followed by a confirmatory factor analysis. Test-retest reliability (< 16 weeks and 32-34 weeks pregnancy) and internal consistency were assessed using the intraclass correlation coefficient and the Cronbach's alpha, respectively. To verify concurrent validity, Mann Whitney U-tests were performed examining associations between the MRSS-subscales and nicotine dependence, daily consumption, depressive symptoms and intention to quit.

Results: We found a factorial structure for the MRSS of 11 items within 5 subscales in order of importance: *tension reduction, addiction, pleasure, habit and social function.* Results for internal consistency and test-retest reliability were good to acceptable. There were significant associations of nicotine dependence with *tension reduction* and *addiction* and of daily consumption with *addiction* and *habit*.

Conclusion: Validity and reliability of the MRSS were shown in a sample of pregnant smokers. *Tension reduction* was the most important reason for continued smoking, followed by *pleasure* and *addiction*. Although the score for nicotine dependence was low, *addiction* was an important reason for continued smoking during pregnancy, therefore NRT could be considered. Half of the respondents experienced depressive symptoms. Hence, it is important to identify those women who need more specialized care, which can include not only smoking cessation counselling but also treatment for depression.

9.2. Introduction

The health consequences of smoking during pregnancy for both mother and child are well documented. There is an increased risk of placental abruption, intra-uterine growth restriction, pre-term birth, low birth weight, stillbirth, infant death, respiratory problems after birth and sudden infant death syndrome (Levitt et al., 2007; Lumley et al., 2009). In Europe, the prevalence of smoking during pregnancy ranges from 7.6% in the Netherlands (Hoppenbrouwers et al., 2011) to 31% in Spain (Palma et al., 2007). In Flanders — the northern region of Belgium — the prevalence of smoking in women is 22.7% in the year prior to the pregnancy, decreasing to 12.3% during pregnancy (Hoppenbrouwers et al., 2011), meaning that 10% quit when they plan a pregnancy or as soon as they discover they are pregnant. Hence, pregnancy is for some women a good opportunity to change smoking habits (Hannover et al., 2008).

A systematic review of qualitative studies investigating the psychological and social factors around women attempting to quit smoking during pregnancy, demonstrated that women were aware of the health risks for the foetus associated with smoking (Ingall and Cropley, 2010). However, knowledge of potential health risks was not sufficient to motivate them to quit (Hoekzema et al., 2014; Ingall and Cropley, 2010). The findings of Gilman et al. suggested that nicotine dependence may be the most important health barrier to smoking cessation during pregnancy (Gilman et al., 2008).

Research from da Motta et al. (2010) showed that pregnant women continued to smoke for several reasons. Respondents mentioned emotional state, addiction to cigarettes, experiencing pleasure in smoking and influence of others, more specific, of a smoking partner, as factors that hinder smoking cessation. This study however was not carried out in pregnant women, but took place between 24 and 48 hours after birth (da Motta et al., 2010). Smoking pregnant women reported significantly higher scores on a depression scale (BDI-scale) compared to non-smoking pregnant women (De Wilde et al., 2013). Thus, experiencing depressive symptoms may also be a reason for continued smoking during pregnancy.

In general, smoking has been described as a way for individuals to control their feelings. According to Tomkins, four basic motivational char-

acteristics of the behaviour of smokers can be distinguished: smoking to increase a positive affect, smoking to reduce a negative affect, habitual smoking or smoking with no affect, and addictive smoking, which entails both positive and negative affect (Tomkins, 1966).

Based on this model, Horn and Waingrow originally created the Reasons for Smoking Scale (RSS), a 23-item scale with six subscales: handling, pleasure, habit/automatism, stimulation, tension reduction/relaxation and addiction (Horn and Waingrow, 1966; Ikard et al., 1969). The RSS was modified by Raymond Niaura to include a 'social smoking' subscale in addition to the traditional subscales (Berlin et al., 2003). This Modified Reasons for Smoking Scale (MRSS) consists of 21 questions measuring seven subscales. The MRSS is a widely accepted scale that offers the opportunity to make a more integral assessment of the smoker and to extend the assessment procedure with a more detailed psychological profile. In addition, the MRSS is practical to use because it is a short questionnaire that takes no longer than a few minutes to complete (Boudrez and De Bacquer, 2012).

A number of studies confirmed the validity and reliability of translated versions of the MRSS. Berlin et al. tested the French version of the MRSS in male and female smokers who attended a smoking cessation program and had a high intention to quit (Berlin et al., 2003). De Souza et al. tested the Brazilian version of the MRSS in male and female respondents who volunteered to donate blood and did not have the intention to quit smoking (de Souza et al., 2009). The Dutch version of the MRSS was tested by Boudrez and De Bacquer in male and female smokers who volunteered at the stop-smoking clinic and had a high intention to quit (Boudrez and De Bacquer, 2012).

To our knowledge, there are no studies describing the use of the MRSS in pregnant women. The main aim of this study was to test the factorial structure, validity and reliability of the Dutch version of the MRSS in a sample of smoking pregnant women who subscribed for prenatal care. In addition, we wanted to obtain more insight into the reasons for continued smoking during pregnancy and into the profile of pregnant smokers, which is necessary knowledge to develop tailored interventions or appropriate counselling.

9.3. Methods

9.3.1. Design

This study is part of a larger survey with an observational, longitudinal design, aiming to provide insight into the determinants of smoking and smoking cessation among Flemish pregnant women (De Wilde et al., 2015; De Wilde et al., 2013).

Data were collected at three points in time: before 16 weeks of pregnancy (T0), between 32 and 34 weeks of pregnancy (T1), and at least 6 weeks postpartum (T2).

Only data from smokers recruited at T0 were used in the present study, except for the test-retest reliability analysis for which data of smokers at T0 and T1 were used.

The study was approved by the Ethical Committee of Ghent University Hospital. All respondents provided oral and written informed consent and were assured of confidentiality.

9.3.2. Sampling

Recruitment and data collection took place between September 2008 and December 2010. Convenience sampling was used. As dropout of respondents could be expected in a longitudinal study, special attention was paid to the recruitment of pregnant smokers. A total of 627 respondents were recruited, of which 102 were smokers (16.3%) at T0.

Two recruitment procedures were followed. Firstly, respondents were recruited by the research team during prenatal consultations in two hospitals. One hundred twenty-five women were recruited in the Ghent University Hospital and 140 women in AZ Nikolaas at Sint-Niklaas (total 265 women). At these locations, all respondents participated in a CO measurement using the Smokerlyzer Micro (Bedfont Scientific Ltd.), a biochemical validation of the smoking status (Usmani et al., 2008). The first questionnaire was filled out at the moment of recruitment when there was enough time left, otherwise the questionnaire was answered by telephone a few days later. Secondly, 467 registered gynaecologists and 198 registered independent midwives were sent requests to assist in recruiting respondents. Twelve gynaecologists and ten midwives, geographically spread over Flanders, agreed to par-

ticipate in the project. Through their mediation, 370 additional women were recruited. Data from these women were obtained through telephone survey without CO measurement.

9.3.3. Self-reported measurements

9.3.3.1. Smoking behaviour

At every time point, respondents were asked to provide details about their previous and current smoking status, daily consumption (cigarettes/day) and intention to quit. Data of all respondents categorized as smokers at T0 were used in this study. For the test-retest reliability analysis, data on the subgroup of women who were smokers at T0 and T1 were used. Daily consumption was coded into two levels: nine or less cigarettes per day and 10 or more cigarettes per day. Intention to quit was coded into two levels: no or low intention to quit and moderate or high intention to quit.

We used the Dutch version of the Fagerström Test for Nicotine Dependence (FTND) as an accepted and standard measurement of physical dependence on nicotine in order to test concurrent validity with subscales of the MRSS (Fagerström, 1978). Scores on the test range from 0 to 10; a score between 1 and 2 indicates low nicotine dependence, between 3 and 4 low-to-moderate dependence, 5-7 moderate dependence and 8 or more indicates high dependence. Nicotine dependence was assessed using the sum of the FTND and was coded into two levels: low (0-4) and high (5-10).

The Dutch version of the Modified Reasons for Smoking Scale (MRSS) was administered, including 21 questions measuring seven subscales: addictive smoking, pleasure to smoke, tension reduction, social smoking, stimulation, automatic smoking and handling (Berlin et al., 2003). Answers were given on a Likert scale ranging from 1 (never) to 5 (always). The subscale-score consisted of the sum of the scores on the questions belonging to that specific subscale.

9.3.3.2. Depressive symptoms

In order to test concurrent validity with subscales of the MRSS, the Dutch version of the Beck Depression Inventory (BDI) (Beck et al., 1979) was used for assessing the self-reported degree of depression (Demyt-

tenaere and De Fruyt, 2003). The BDI examines an individual's emotional condition in the week prior to assessment and is well suited for use in a primary care setting, both as a rapid screening test for depression during pregnancy and as a longitudinal assessment for depression (Bennett et al;, 2004; Marcus and Heringhausen, 2009). It measures 21 emotional, behavioural, and somatic symptoms, which are each rated from 0 to 3 (Beck et al., 1979). Higher scores on the total inventory indicate an increased severity of depression (Milgrom et al., 2011). The BDI was coded in two levels: 9 or less indicating no symptoms of depression, and 10 or more indicating at least mild mood disturbance.

9.3.3.3. Socio-demographic variables

The questionnaire included the following variables: age, educational level, employment status, and gravidity. Age was coded into two levels: < 27 years (mean of the sample of smokers) and ≥ 27 years. Respondents were asked for the highest grade or year of school completed. The variable education was coded into two levels: secondary school certificate or lower, meaning 12 years of education or less, or college or university degree. Unemployed women and housewives were classified as not having a paid job; working women and women on maternity leave were classified as having a paid job. Gravidity was coded into primigravida (pregnant for the first time) or multigravida.

9.3.4. Statistical analysis

Characteristics of the respondents were described using mean and standard deviation for continue variables and range and percentages for categorical variables.

Structural equation modelling was performed to assess the construct validity of the MRSS (Muthén and Muthén, 1998). An exploratory factor analysis (EFA) was conducted, followed by a confirmatory factor analysis (CFA). The Weighted Least Squares Means and Variance adjusted (WLSMV) estimation method was used for ordinal variables. Scaling of the latent variables was done indirectly by fixing the factor loading of the first observed item at one. A number of fit indices were considered to assess the fit of the proposed model to the empirical data (Hu and Bentler, 1995). The overall Chi^2 fit index was calculated, but it is known to be largely influenced by sample size and therefore rarely

used to evaluate a model fit. For the Root Mean Square Error of Approximation (RMSEA), a value < 0.06 was considered as a good fit, a value < 0.08 was considered as an acceptable fit and a value > 0.10 led to rejection of the model. For the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI), a threshold value > 0.90 was considered as a good fit (Vander Weele, 2012). Standardized factor loadings > 0.50 were perceived as good, loadings > 0.40 indicated an acceptable correlation and those < 0.40 were perceived as low.

Cronbach's alpha was computed to examine the internal consistency of the MRSS subscales. A value of ≥ 0.70 was considered as good, a value of ≥ 0.60 as acceptable. Item-total correlations were accepted if they were between 0.30 and 0.70.

Test-retest reliability (T0 before 16 weeks pregnancy, T1 between 32 and 34 weeks pregnancy) was computed using the intraclass correlation coefficient. A value of ≥ 0.70 was considered as good, a value of ≥ 0.60 as acceptable.

Some of the subscales showed skewed distributions, they were described through median values and inter-quartile ranges; correlations among subscales and age and educational level were examined through Spearman correlation coefficients.

Concurrent validity of the MRSS subscales was examined by means of associations with nicotine dependence (FTND), daily consumption, depressive symptoms (BDI-score), and intention to quit. For reasons of consistency, we used non-parametric Mann Whitney U-tests to examine these associations.

All the analyses were performed using IBM SPSS 21 (IBM, Armonk, NY, USA), except the EFA and CFA, which were conducted using Mplus version 6 (Muthén and Muthén, Los Angeles, CA, USA).

9.4. Results

9.4.1. Sample characteristics

Results of 97 respondents were included, all of them were pregnant at the time of the study. The mean age of the sample was 27.3 ± 5.4 years, ranging from 17 to 41 years. Most respondents (70.1%) had maximum 12 years of education, 23.7% had a bachelor or masters' degree, 6.2%

was missing. Forty-two women (43.3%) were primigravida, 55 women (56.7%) were multigravida (range 2-8).Thirty-eight women (39.2%) worked fulltime, 22 (22.7%) worked part-time, 2 (2.1%) were on maternity leave and 24 (24.7%) had no paid job (9.3% missing).

The mean daily cigarette consumption was 9.3 ± 6.2 cigarettes (range 1-28), the score on the FTND ranged between 0 and 7 with a mean score of 2.60 ± 1.86. The mean age at which the women started smoking was 15.2 ± 2.4, ranging from 10 to 23 years. The mean score on the BDI was 10.98 ± 6.57 (range 0-36; 17.5% missing), suggesting that many respondents experienced depressive symptoms. Thirty-five respondents (36.0%) had a normal score of 9 or lower, 45 respondents (46.2%) had a score of 10 or more (17.8% missing). In the group with an elevated score, 15 respondents (15.3%) even had a score of at least 15, the indicator for clinical depression, 30 respondents (30.9%) had a score between 10 and 14, suggesting a mild emotional disturbance.

9.4.2. Construct validity, internal consistency and test-retest reliability

The factorial structure of the MRSS in this sample of pregnant women was first verified with an EFA, which resulted in a seven factor solution (based on the criterion of eigenvalue > 1), with a good model fit (RMSEA = 0.04; CFI = 0.978; TLI = 0.945; $Chi^2 = 97.35$, $p = 0.15$). The factor containing only one item was not retained. One factor with only negative loadings was also not retained. Seven items (1, 2, 9, 12, 15, 16 and 17) were deleted due to low loadings < 0.40 on all factors. For the remaining items, a clear 5-factor structure was recognized. This structure was tested and confirmed in a CFA, demonstrating an acceptable model fit (RMSEA = 0.074; CFI = 0.94; TLI = 0.91; $Ch^2 = 84.13$, $p = 0.01$) and factor loadings ≥ 0.40.

Results are reported in table 6, showing standardized factor loadings of the CFA, together with Cronbach's α values for internal consistency. Cronbach's α showed higher values after deleting items 21 and 13 from the *social function* and *habit* subscales, respectively. An additional CFA for the 5-factor structure without items 21 and 13 indeed showed a slightly improved model fit (RMSEA = 0.075; CFI = 0.96; TLI = 0.94; $Chi^2 = 52.45$, $p = 0.02$). We therefore decided to delete both items and retain a final structure of 11 items belonging to 5 subscales. Internal

consistency was good for the subscales *tension reduction* and *social function* (Cronbach's $\alpha > 0.70$), acceptable for the subscale *addiction* (Cronbach's $\alpha > 0.60$) and borderline acceptable for the subscales *pleasure* (Cronbach's $\alpha > 0.59$) and *habit* (Cronbach's $\alpha > 0.58$). The item-total correlation for the 3-item subscale *tension reduction* ranged between 0.589 and 0.668.

The test-retest reliability of the subscales was assessed for 75 respondents who reported to be a smoker at T0 and T1 (drop-out of 22.7%). The intraclass correlation coefficient (ICC) was good (> 0.70) or acceptable (> 0.60) for all subscales (table 6).

9.4.3. Descriptive results for the subscales

Table 7 presents the median value and the inter-quartile range for all subscales. The highest scores were found for the subscales *tension reduction*, *pleasure* and *addiction*. Significant positive correlations were detected among the different subscales (Table 7).

In order to control for potential confounders, correlations between the subscales, age and educational level were examined. A significant negative correlation between age and the subscale *social function* was observed. No significant correlation was observed between the subscales and educational level (results not shown).

9.4.4. Concurrent validity

We examined associations between the different subscales and nicotine dependence, daily consumption, depressive symptoms, and intention to quit (table 8).

There was a significant association between nicotine dependence and the subscales *tension reduction* (Mann-Whitney U = 814.000; $p < 0.01$) and *addiction* (Mann-Whitney U = 788.000; $p < 0.01$): women with a higher FTND-score, scored higher on these subscales.

There was also a significant association between daily consumption and the subscales *addiction* (Mann-Whitney U = 1630.000; $p < 0.01$) and *habit* (Mann-Whitney U = 1531.000; $p < 0.01$): women who reported a higher daily consumption scored higher on these subscales.

Table 6: Results of confirmatory factor analysis (standardized factor loadings), internal consistency (Cronbach's alfa) and test-retest reliability (intraclass correlation coefficient) of the MRSS in 97 pregnant smokers

Subscales MRSS	Tension reduction	Social function	Pleasure	Addiction	Habit
1. I smoke cigarettes to keep myself from slowing down. §					
2. Handling a cigarette is part of the enjoyment of smoking it. §					
3. Smoking cigarettes is pleasant and relaxing.			0.61		
4. I light up a cigarette when I feel angry about something.	0.82				
5. When I have run out of cigarettes, I find it almost unbearable until I can get one.				0.82	
6. I smoke cigarettes automatically without even being aware of it.					0.83
7. It is easier to talk and get along with other people when smoking.		0.88			
8. I smoke cigarettes to stimulate me, to perk myself up. ¥					
9. Part of the enjoyment of smoking a cigarette comes from the steps I take to light up. §					
10. I find cigarettes pleasurable.			0.82		
11. When I feel uncomfortable or upset about something, I light up a cigarette.	0.76				
12. I am very much aware of the fact when I am not smoking a cigarette.					
13. I light up a cigarette without realizing I still have one burning in the ashtray.					(0.55)
14. While smoking I feel more confident with other people.		0.79			
15. I smoke cigarettes to give me a 'lift'. §					
16. When I smoke a cigarette, part of the enjoyment is watching the smoke as I exhale. §					
17. I want a cigarette most when I am comfortable and relaxed. §					
18. When I feel 'blue'or want to take my mind off cares and worries, I smoke cigarettes.	0.79				
19. I get a real gnawing hunger for a cigarette when I haven't smoked in a while.				0.66	
20. I've found a cigarette in my mouth and did not remember putting it there.					0.71
21. I smoke much more when I am with other people.		(0.41)			
Cronbach's α	0.79	0.65 0.75†	0.59	0.67	0.47 0.58‡
Intraclass Correlation Coefficient ²	0.79***	0.65***	0.78***	0.74***	0.61***

§ 7 items were not retained in the CFA, due to negative loadings or loadings below 0.40 in the EFA
¥ 1 subscale with only 1 item was not retained in the CFA
† Cronbach's alfa after deleting item 21
‡ Cronbach's alfa after deleting item 13
² Test-retest reliablitity analysis was performed on a smaller sample of 75 respondents
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed)

Table 7: Descriptive results for and correlations among the MRSS subscales (Spearman's correlation coefficient) in 97 pregnant smokers

Subscale	Median IQR	Tension reduction	Social function	Pleasure	Addiction	Habit
Tension reduction	4.0 (3 – 4.33)	1	0.254*	0.160	0.330**	0.247*
Social function	2.0 (1 – 3)		1	0.150	-0.020	0.245*
Pleasure	3.5 (3 – 4)			1	0.213*	0.016
Addiction	3.5 (3 – 4)				1	0.297**
Habit	2.5 (1.5 – 3)					1

IQR = interquartile range
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed)

Table 8: Association of MRSS subscales with smoking behaviours and depressive symptoms in 97 pregnant smokers

	Tension reduction	Social function	Pleasure	Addiction	Habit
	p-value MD [IQR]	*p*-value MD [IQR]	*p*-value MD [IQR]	*p*-value MD [IQR]	*p*-value MD [IQR]
Dependence (FTND)	0.002**	0.146	0.088	0.004**	0.120
Low (n = 81)	12 [9-13]	4 [2-6]	7 [6-8]	7 [6-8]	5 [3-6]
High (n = 13)	13 [12.75-14.25]	5 [4-7.25]	8 [7.5-10]	9 [6.5-10]	6 [5.25-8.5]
Daily consumption	0.230	0.751	0.778	0.001**	0.009**
≤ 9cig/d (n = 47)	12 [8-13]	4 [2-6]	7 [6-8]	7 [4-8]	4 [3-6]
≥ 10 cig/d (n = 50)	12 [10-13]	4 [2-6]	7.5 [6-9]	8 [6-9]	5 [4-7]
Depressive symptoms (BDI-score)	0.223	0.190	0.283	0.976	0.104
0-9 (n = 33)	12 [9-13]	4 [2-6]	7 [6-8]	7 [5.5-9]	4 [3-6]
≥ 10 (n = 46)	13 [10-13]	5 [3-6]	8 [6-9]	7 [6-9]	5 [4-7]
Intention to quit	0.696	0.192	0.283	0.150	0.151
Low (n = 35)	12 [9-13]	4 [2-6]	8 [6-9]	8 [6-9]	5 [3-7]
High (n =62)	12 [9-13]	4 [2-6]	7 [6-8]	7 [5-8]	5 [3-6]

MD = Median IQR= interquartile range BDI= Beck Depression Inventory
p-value based on results of Mann-Whitney U-test
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (2-tailed)

9.5. Discussion

To our knowledge, this study was the first to examine the factorial structure, validity and reliability of the Dutch version of the MRSS in a sample of smoking pregnant women who registered for prenatal care. As a second aim, we wanted to obtain more insight into the reasons for continued smoking during pregnancy and into the profile of pregnant

smokers, which is necessary for developing tailored interventions or appropriate counselling.

Our study population consisted of pregnant women with lower daily cigarette consumption and lower nicotine dependence than the study populations of previous psychometric research on the MRSS of Berlin et al. (2003) and Boudrez and De Bacquer (2012). In the present study the mean daily consumption was 9.3 ± 6.2 cigarettes (range 1-28), while others registered a mean daily consumption in women of 25.1 ± 7.5 cig/d (Berlin et al., 2003) and 21 cig/d (Boudrez and De Bacquer, 2012), which is more than double compared to our study population. The score on the FTND ranged between 0 and 7 with a mean score of 2.60 ± 1.86 which is lower than in previous studies (6.2 ± 1.9 in Berlin et al., 2003; and 6.3 in Boudrez and De Bacquer, 2012). Characteristics of our study population were more comparable with de Souza et al., who found a mean daily consumption of 15 ± 9.2 cig/d, and a FTND score of 3.7 ± 2.4 (Berlin et al., 2003). It should be taken into account that the inclusion criteria for the other studies were different and that our study population was pregnant unlike the respondents in previous research. It is known that pregnant women reduce their daily consumption compared to the months before their pregnancy (Kapaya et al., 2015).

Berlin et al. (2003) tested the French version of the MRSS in male and female smokers who registered in a smoking cessation program. De Souza et al. (2009) tested the Brazilian version of the MRSS in male and female respondents who volunteered to donate blood. They both confirmed the factorial structure with seven subscales of the original MRSS. Boudrez and De Bacquer (2012) tested the Dutch version of the MRSS in male and female smokers who volunteered at a stop-smoking clinic. They identified four factors, however a different method was applied, forcing alternative models in case a factor included less than three items. In the present study, the seven original factors were identified using EFA, but due to a factor containing only one item and another factor with only negative loadings, these items were not retained. Based on CFA and reliability analyses, the final solution included five subscales with good to (borderline) acceptable internal consistency and good to acceptable test-retest stability: *tension reduction, social function, pleasure, addiction* and *habit*. The subscales *handling* and *stimulation* were not retained in the final solution. This could mean that only the most important reasons for smoking remain relevant dur-

ing pregnancy. This is in line with other findings from da Motta et al., where the mostly cited reasons were pleasure, dependency, stress or negative emotions and influence of others (da Motta et al., 2010).

Research shows that most pregnant smokers endorse smoking as an essential coping mechanism, even if they are aware of the health consequences (Ingall and Cropley, 2010). In the present study, the highest score was found for the subscale *tension reduction* indicating this is the main reason why pregnant women continued smoking. The transition to motherhood and corresponding role changes can influence the stress level (Edwards et al., 2008) and possibly, smoking can be a way to relieve stress or to cope with stressful situations. The subscales *pleasure* and *addiction* scored almost as high as the subscale *tension reduction*. Besides smoking in order to relieve stress, pregnant women also smoked because they enjoy smoking or because they expressed that they are addicted to cigarettes, although the FTND showed no excessive high scores in this sample. *Habit* and *social function* had the lowest scores. The items in the MRSS regarding *habit* refer to situations where someone is not aware of the fact that she is smoking. Probably a pregnant woman is very aware of lighting up a cigarette, especially when she is in the presence of others. Social control and the taboo regarding smoking during pregnancy could influence the scores on these subscales.

Concurrent validity of the MRSS-subscales in relation to several variables was examined. In line with the study of Berlin et al., we found a significant relationship between daily consumption and the subscale *addiction* (Berlin et al., 2003). Women who had a higher daily consumption, indicated that they smoked more for reasons of addiction. It is known that addiction to cigarettes can hinder smoking cessation da Motta et al., 2010). There was also a significant association between nicotine dependence and the subscales *tension reduction* and *addiction*, meaning that women with higher FTND-scores reported a higher cigarette consumption. It was remarkable that the mean score on the FTND was 2.6, indicating that respondents had a low average physical dependence. It could be that they experienced a more psychological dependence and were concerned about having craving symptoms. Most common symptoms of nicotine withdrawal are both physical and psychological: dysphoric or depressed mood, insomnia, irritability, frustration, anger, anxiety, restlessness, difficulty concentrating,

decreased heart rate, and increased appetite or weight gain (Durcan et al., 2002). It is important for health care workers to discuss possible craving symptoms prior to quitting and to search for any solution taking into account the preferences of the client. Advising the intake of nicotine replacement therapy (NRT) is one way to deal with craving symptoms. NRT is the only pharmacotherapy for smoking cessation that has been tested in randomized controlled trials (RCTs) conducted in pregnancy. Suter et al. conducted a comprehensive review regarding the effects of nicotine on the foetus and the effect of NRT during pregnancy, including the use of the nicotine containing patch and gum and the e-cigarette (Suter et al., 2015). Until now, there is lack of evidence whether NRT – regardless the method of administration – is effective or safe when used to promote smoking cessation in pregnancy or whether it has positive or negative impacts on pregnancy outcomes. Therefore, further research on the efficacy and safety of NRT during pregnancy is needed, in particular evidence from placebo-controlled RCTs investigating higher doses of NRT than those already tested in previous studies (Coleman et al., 2012; Suter et al., 2015). The use of Bupropion and Varenicline is contraindicated during pregnancy (NICE public health guidance 48, 2013). Extensive research showed an elevated risk for ventricular septal defect in women who used Bupropion during the first trimester of their pregnancy (Louik et al., 2014). Harrison-Woolrych et al. (2013) performed a nation-wide cohort study on the use of Varenicline during pregnancy in New Zealand during a period of four years. Only 23 of 2739 pregnant women reported the use of Varenicline while pregnant. Adverse outcomes were identified in five of 17 live births, but it was difficult to assess the possible role of Varenicline. Due to the limited numbers of cases in this study, it was difficult to draw conclusions, and further research is necessary (Harrison-Woolrych et al., 2013).

Although we did not find a significant relationship between the MRSS-subscales and depressive symptoms, we observed that the majority of the respondents (46.2%) scored above 10 on the BDI. Symptoms of depression may contribute independently to persistent smoking during pregnancy (Scott et al, 2009). Depressed persons may smoke to immediately improve their sense of well-being or as a quick reward. These responses may make it more difficult for depressed pregnant women to quit smoking (Zhu and Valbo, 2002). Previous research on this sample of respondents showed that most smoking women were low educated

(maximum 12 years of education) and a significant relationship between smoking, low educational level, and depression was established in this study (De Wilde et al., 2013). Therefore, it is important to identify those women who need more specialized care, which can include not only smoking cessation counselling but also treatment for depression.

The strength of the present study is that is the first to examine the factorial structure, validity and reliability of the Dutch version of the MRSS in smoking pregnant women through a longitudinal study. This scale was already tested in a population of men and women, whether or not considering smoking cessation, but to our knowledge, the MRSS was never investigated in a pregnant population. Particular strengths of the study are the availability of detailed assessments of smoking behaviour and psychological profile in pregnant women, the use of interview-based data collections, and biochemical validation of the smoking status.

A limitation that deserves consideration is the relatively small sample size of the present study. In total, data of 97 respondents were eligible for analysis. However, this is the first time that the MRSS was tested in pregnant women, the novelty of this small sample needs to be considered. There are generally two types of recommendations for required sample size in factor analysis: based on the minimum absolute number of cases or based on the subject-to-variable ratio (MacCallum et al., 2001). In this study the subject-to-variable ratio is close to the recommended minimum of 5:1 (Fabrigar et al., 1999; Henson and Roberts, 2006).

9.6. Conclusion

In conclusion, validity and reliability of the MRSS were shown in a sample of pregnant smokers who subscribed for prenatal care. Based on data from 97 pregnant smokers we found a factorial structure for the MRSS of 11 items within 5 subscales showing an acceptable to good model fit. Results for internal consistency and test-retest reliability of the five subscales were good to acceptable. The results of this study thus suggest that the MRSS is appropriate for use in pregnant smokers.

Tension reduction was the most important reason why pregnant women smoked, followed by *pleasure* and *addiction*. Although the average score

for nicotine dependence was low in this sample, *addiction* was an important reason for continued smoking during pregnancy and NRT could therefore be considered. Half of the respondents experienced depressive symptoms. Hence, it is important to identify those women who need more specialized care, which can include not only smoking cessation counselling but also treatment for depression.

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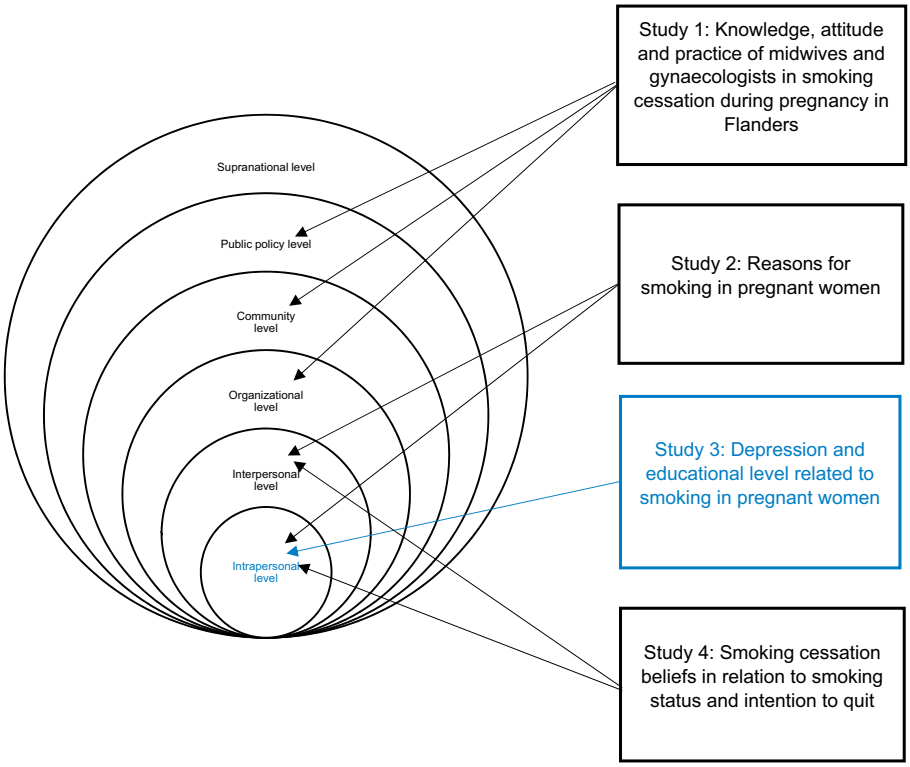
10. Study 3: Depression and educational level related to smoking in pregnant women[3]



[3] Based on: De Wilde, K., Trommelmans, L., Laevens, H., Maes, L., Temmerman, M., Boudrez, H. (2013). Smoking patterns, depression, and sociodemographic variables among Flemish women during pregnancy and the postpartum period. Nursing Research, 2, 394-404

10.1. Abstract

Background: Relationships among feelings of depression, smoking behaviour, and educational level during pregnancy have been documented. Feelings of depression may contribute to persistent smoking during pregnancy. No longitudinal studies assessing feelings of depression in women with different antepartum and postpartum smoking patterns are available.

Objectives: The aim was to determine relationships between depressive symptoms, sociodemographic characteristics, and smoking pattern during and after pregnancy.

Methods: An observational, prospective, non-interventional study was conducted. Data were collected during two stages of pregnancy (T0: < 16 weeks and T1: 32-34 weeks) and postpartum (T2: > 6 weeks) in 523 Flemish women. Feelings of depression (measured using the Beck Depression Inventory (BDI)), smoking behaviour, and sociodemographic variables were analysed using a general linear mixed model implemented in SAS Proc MIXED.

Results: smokers and initial smokers reported significantly more depressive symptoms at all time points compared with recent ex-smokers, non-smokers, and initial non-smokers ($p < 0.001$). The three-way interaction among time point, smoking pattern, and educational level was significant ($p = 0.02$). Evolution of mean BDI over time differed by educational level. Among participants with secondary school certificate or less, differences were observed between smokers and non-smokers, recent ex-smokers and initial non-smokers, and non-smokers and initial non-smokers. Among participants with a college of university degree, no differences were observed.

Discussion: A wide variety of smoking patterns were observed during pregnancy and early postpartum. Smoking patterns were associated with depression and showed complex interactions with educational level. Assessment and intervention for both smoking and depression are needed throughout the perinatal period to support the health of mothers, their infants, and families.

10.2. Introduction

Smoking during pregnancy causes significant foetal and maternal morbidity, including placental abruption, intrauterine growth restriction, preterm birth, low birth weight, stillbirth, and infant death (Levitt et al., 2007; Lumley et al., 2009). Postnatal parental smoking is an important risk factor for sudden infant death syndrome, bronchitis, pneumonia, asthma, and middle ear infections (Levitt et al., 2007; Lumley et al., 2009). In Europe, the prevalence of smoking during pregnancy ranges from 7.6% in the Netherlands (Hoppenbrouwers et al., 2011) to 31% in Spain (Palma et al., 2007). Relapse rates in postpartum for women who quit during pregnancy fluctuate between 9.5% and 18.5% within 3 months (Lauria et al., 2011); other research shows that 66-80% are smoking again within one year (Pickett et al., 2009). In Flanders – the Dutch-speaking part of Belgium – the prevalence of smoking in women is 22.7% in the year prior to the pregnancy, this decreases to 12.3% during pregnancy. Three months after delivery the prevalence is 14.2% (Hoppenbrouwers et al., 2011).

Depression during pregnancy is associated with a modest but statistically significant risk for preterm birth (Grote et al., 2010), poor health behaviours, preeclampsia, poor pregnancy outcomes, and increased risk of progression to postpartum depression (Bennett et al., 2004). During pregnancy and in the postpartum period, women experience hormonal fluctuations which can increase the occurrence of mood disorders (Bennett et al., 2004; Marcus and Heringhausen, 2009). Loss of energy and changes in sleep pattern and appetite may be attributed to the pregnancy, but these symptoms might also be signs of depression. The transition to motherhood and corresponding role changes can also influence the mental health of women, especially of primigravidas, who may face problems related to the life circumstances that altered pregnancy and motherhood (Edwards et al., 2008; Emmanuel and St John, 2010). The American College of Obstetricians and Gynaecologists therefore recommends screening for depression during each pregnancy trimester and, if necessary, referral to specialist care (Grote et al., 2010; Lancaster et al. 2010). Research also suggests that prenatal depression is one of the strongest predictors of postpartum depression (Beck, 2001). About 20% of pregnant women show elevated depressive symptomatology (Marcus et al., 2003); a few studies suggest that 5%-10% experience a major depressive disorder (Marcus and Heringhausen, 2009;

Melville et al., 2010). The prevalence of depression increases during pregnancy (Bennett et al., 2004). No specific data are available from Flanders on depression during pregnancy.

Symptoms of depression may contribute independently to persistent smoking during pregnancy (Scott et al., 2009). Depressed persons may smoke in order to immediately improve their sense of well-being, or as a quick reward. These responses may make it more difficult for depressed pregnant women to quit smoking (Zhu and Valbo, 2002). Some research suggests that smokers themselves are convinced that quitting generates feelings of depression and dysphoria arising from nicotine withdrawal (Solomon et al., 2006), this was not confirmed by other studies (Berlin et al., 2010; Kahler et al., 2011). No evidence is available to confirm that quitting smoking during pregnancy increases psychological symptoms in the immediate post-withdrawal period or later in pregnancy (Solomon et al., 2006). Women who quit smoking early in pregnancy and remained abstinent during postpartum reported less depressive symptoms compared to women who continued to smoke (Park et al., 2009; Solomon et al., 2006).

There is a positive association between higher educational level (> 12 years of education) and the likelihood of quitting smoking before entering prenatal care. Less educated women (≤ 12 years of education) are more likely to continue to smoke during and after pregnancy (Higgins et al., 2009). The association of educational level with smoking behaviour is also present in Flanders: 34.3% in women with less than 12 years of education are smoking, 19.5% in women with 12 years of education and 3.9% in women with a college or university degree (mean prevalence 12.3%) (Hoppenbrouwers et al., 2011).

Lancaster et al. (2010) found a small association between a lower educational level and antepartum depressive symptoms in bivariate studies, but there was no significant association in the multivariate studies.

Lack of social support, especially of partner support, is significantly associated with depressive symptoms during pregnancy (Lancaster et al., 2010). Living with a smoking partner makes it harder for a pregnant woman to quit. Partners are major amplifiers of smoking behaviour both positive and negative, and are key contributors towards the success or failure of the women's smoking cessation efforts (Hauge et al., 2011; Schneider et al., 2010).

Relationships between feelings of depression, sociodemographic characteristics, and smoking behaviour during pregnancy have been documented (Leung et al., 2012). So far, however, there have been no longitudinal studies assessing these factors antepartum and postpartum. This study extends previous work in male and non-pregnant populations to women during and after pregnancy.

The aim of this longitudinal study is to obtain insight into the associations between smoking patterns and depressive feelings during pregnancy and postpartum, taking into account several socio-demographic characteristics. The following research questions were formulated:

1. Which patterns of smoking behaviour can be observed during and after pregnancy?
2. Which patterns of depression can be observed during and after pregnancy?
3. Is there a relationship between smoking pattern and feelings of depression during and after pregnancy, independent from sociodemographic characteristics?

To answer these questions, pregnant women were asked about their smoking habits, their feelings of depression, and their partner's smoking habits. Answers were assessed in relation to sociodemographic variables: age, educational level, job status, gravidity, and marital status.

10.3. Methods

10.3.1. Design

The design was observational, prospective, and non-interventional. Data were collected at three points in time: before 16 weeks of pregnancy (T0), between 32 and 34 weeks of pregnancy (T1) and at least 6 weeks postpartum (T2). For determining T0, the confirmation of the pregnancy by blood analysis and ultrasound and the decreasing chance of spontaneous abortion after 12 weeks were taken into account. T1 was chosen in the third trimester to acquire data covering a large part of the pregnancy and to avoid drop-outs due to pre-term birth. At T2, women had already experienced the challenges of early motherhood and adapted there lifestyles to the new-borns. Ethics approval was received from the Ethical Committee of the University Hospital of Ghent. Writ-

ten informed consent was obtained from respondents, all of whom were assured of confidentiality.

10.3.2. Sampling

Recruitment took place between September 2008 and March 2010; data were collected between September 2008 and December 2010. Convenience sampling was used, with a quota for smokers. Because drop-out of respondents could be expected in a longitudinal study, special attention was paid to the recruitment of pregnant smokers. The prevalence of smoking during pregnancy in Belgium is 12.3%. A total of 627 respondents were recruited, of which 102 were smokers (16.3%) at T0.

Respondents were recruited through the following sources:

1. The research team was available during pregnancy consultations in two hospitals (University Hospital Ghent, AZ Nikolaas at Sint-Niklaas). One hundred twenty-five women were recruited in Ghent and 140 women in Sint-Niklaas (total 265 women). At these locations, all participating women were invited for a CO-measurement using the Smokerlyzer Micro (Bedfont Scientific Ltd.), a biochemical validation of the smoking status (Usmani et al., 2008). CO-levels were defined in 257 women; 8 respondents could not be tested because of lack of time. All respondents exhibiting CO-levels ≥ 6 ppm were considered as smokers and categorized accordingly, even if they reported to be non-smoker (n = 2). Questionnaires were answered by telephone, except at T0: if there was the possibility the first questionnaire was filled out at the moment of recruitment.
2. A convenience sample of 12 gynaecologists and 10 midwives agreed to participate in the project. Through their mediation, 370 women were recruited and contacted by telephone. These respondents answered the questionnaires by the telephone without having a CO-measurement.

CO-measurement was used to validate the self-reported smoking status in 257 of 627 respondents (42.7%). The cut-off point normally applied in smoking cessation studies in non-pregnant respondents is 10 ppm. Because the metabolism of pregnant women is accelerated, ending in faster elimination of CO particles in the body, 10 ppm may not give an accurate representation of their smoking status. There is no consensus

concerning the correct cut-off point in pregnant smokers. Several limits have been used: 8 ppm (Christensen et al., 2004), 7 ppm (McGowan et al., 2010), 6 ppm (Secker-Walker et al., 1997), 4 ppm (Higgins et al., 2007), and 3 ppm (Usmani et al., 2008). A study by Benowitz et al. (2002) suggested that a cut-off point of > 7 ppm is too high and misses 36% of the self-reported smokers: therefore, 6 ppm was used as the cut-off point.

Research has found a very low rate of false reporting of smoking cessation in impersonal telephone interviews (Crittenden et al., 2007). Also, asking questions about smoking in a neutral way and giving respondents a choice between multiple answers increases the likelihood of obtaining correct answers (Lindqvist et al., 2002). In this study Pearson's correlation coefficient between self-reported smoking status of the respondents and smoking status according to CO-level was significant ($r = 0.993$; $p < 0.001$). Therefore, it may be assumed that the answers regarding smoking status are reliable.

10.3.3. Measurements

The following data were collected through self-reporting: smoking behaviour of the participant and her partner, feelings of depression, and sociodemographic variables (age, educational level, job status, gravidity, and marital status).

10.3.3.1. Smoking

At every time point, respondents were asked to provide details about their previous and current smoking status, daily consumption, and duration of abstinence in the case of successful quitting. On the basis of answers at the three data collection points and taking into account the results of the CO-measurement, respondents were categorized as follows:

1. Smokers: respondents who reported to be smoking at all time points;
2. Non-smokers: respondents who never smoked or had quit for longer than 1 year before T0, they reported to be non-smoker at all time points;
3. Recent ex-smokers: respondents who quit less than 1 year before T0, they reported to be abstinent at all time points;

4. Initial smokers: respondents with a variable smoking pattern who reported to be smoking at T0 and made a quit attempt;
5. Initial non-smokers: respondents with a variable smoking pattern who reported to be a non-smoker at T0, but relapsed at T1 or T2.

The partners'smoking status (if applicable) was asked and categorized as 'smoking' or 'non-smoking'.

10.3.3.2. Feelings of depression

The Dutch version of the Beck Depression Inventory (BDI; Beck et al., 1979) was used to assess the self-reported degree of depression (Demyttenaere and De fruyt, 2003). This inventory examines an individual's emotional condition in the week prior to assessment and is well suited for use in a primary care setting, both as a rapid screening test for depression during pregnancy (Bennett et al., 2004) and as a longitudinal assessment for depression (Marcus and Heringhausen, 2009). It measures 21 emotional, behavioural, and somatic symptoms, which are each rated from 0 to 3 (Beck et al., 1979). A score of 9 or less is considered normal; a score of 10-14 suggests a mild mood disturbance, and a score of 15 has been suggested as an indicator for clinical depression. Higher scores indicate an increasing severity of depression (Milgrom et al., 2011).

The BDI was preferred to the Edinburgh Postnatal Depression Scale. The BDI is internationally recognized and is available in a validated Dutch version. Research shows that both scales, BDI and Edinburgh Postnatal Depression Scale, are highly predictive in identifying depressive disorders during pregnancy and postpartum (Ji et al., 2011).

10.3.3.3. Socio-demographic variables

The questionnaire included the following variables: age, educational level, job status, and gravidity. Age was coded into two levels: < 29 years (mean of the sample) and ≥ 29 years. Respondents were asked for the highest grade or year of school completed. The education variable was coded into two levels: secondary school certificate or lower, meaning 12 years of education or less, or college or university degree. Unemployed women and housewives were classified as not having a paid job; working women and women on maternity leave were classified as

having a paid job. Gravidity was coded into primigravida (pregnant for the first time) or multigravida.

10.4. Data analysis

Data were analysed using SAS® software, version 9.2 (SAS Institute Inc., Cary, NC, USA). Respondents' characteristics were examined using means and standard deviations for age and percentages for categorical variables (educational level, job status, gravidity, and smoking status of the partner).

The effect on the BDI of smoking pattern, time point, smoking status of the partner, educational level, gravidity, job status, and age was examined with linear mixed models (PROC MIXED: normal distribution and identity link function). Respondent number was considered a random effect, and successive BDIs within the same respondent were considered a repeated measure. A first-order autoregressive variance covariance matrix was included to take into account the dependency of successive BDI scores within the same person. The modelling procedure started with the univariate analyses. Variables with a $p < 0.25$ in the univariate analyses were included in the multivariate analysis. Gravidity and job status were not considered in the multivariable analysis because they were associated with age and educational level, respectively. Non-significant main effects in the multivariable analysis were eliminated one by one starting with the main effect with the highest p-value. Only when significant main effects ($p < 0.05$) remained in the model, interactions (two-way and higher-order interactions) of the main effects were included in the model. A backward elimination procedure was conducted again starting with the highest-order interaction term. At all times, residual plots were used to evaluate the model fit.

10.5. Results

10.5.1. Characteristics of respondents

Initially 627 women were recruited. Of these, 21 gave informed consent but could not subsequently be reached, one woman was expecting twins and was excluded. Eventually, 605 respondents were contacted at T0. Several respondents were excluded because of missing values. Finally, 523 respondents were included, whereas 82 respondents

(13.56%) were lost to follow-up. Table 9 gives an overview of the distribution of the demographic variables (age, educational level, job status, gravidity, and smoking status of the partner) according to the smoking pattern. The mean age of the respondents was 29 years (range 17-45 years; SD 4.38). Of the partners, 369 (70.6%) were non-smokers and 140 (26.77%) smokers. Only 18.3% of the non-smoking women had a smoking partner, whereas more than 70% of recent ex-smokers and initials smokers had a smoking partner. In the smokers group, 40% had a smoking partner.

10.5.2. Patterns of smoking during and after pregnancy

On the basis of answers at the three data collection points and taking into account the results of the CO-measurement, respondents were categorized in five smoking patterns: smokers, non-smokers, recent ex-smokers, initial smokers and initial non-smokers (table 10). Respondents with missing values regarding their smoking pattern at T1 and T2 were excluded. Smokers and recent ex-smokers with a missing value regarding their smoking pattern at T1 or T2 were also excluded. Respondents of the non-smokers group were assumed to be non-smokers at all time points and were included. Finally, 523 respondents were included, whereas 82 respondents (13.56%) were lost to follow-up. To assess the effect of attrition, the BDI at T0 was compared between the respondents from which information on the smoking status was available at T1 and T2 and those from which information was missing at T1 and/or T2. The BDI at T0 was not statistically significantly different ($p = 0.28$) between those included and excluded.

Table 9: Characteristics of the respondents

	Smokers (n = 53)	Recent ex-smokers (n = 30)	Non-smokers (n = 416)	Initial smokers (n = 14)	Initial non-smokers (n = 10)
Age					
Mean (SD)	30.1 (4.98)	27.2 (4.6)	29.2 (4.1)	26.6 (4.7)	28.2 (1.9)
Range	23 – 45	18 – 41	18 – 45	21 – 36	26 – 32
Educational level n (%)					
Secondary school certificate or less	22 (73.3)	43 (81.1)	104 (25.0)	7 (50.0)	3 (30.0)
College or university degree	8 (26.7)	10 (18.9)	312 (75.0)	7 (50.0)	7 (70.0)
Job status n (%)					
Paid job	27 (90.0)	40 (75.5)	396 (95.2)	10 (71.4)	10 (100.0)
No paid job	3 (10.0)	13 (24.5)	19 (4.6)	4 (28.6)	0 (0.0)
Missing			1 (0.2)		
Gravidity n (%)					
1	17 (56.7)	17 (32.1)	172 (41.3)	11 (78.6)	5 (50.0)
2	7 (23.3)	22 (41.5)	148 (35.6)	2 (14.3)	2 (20.0)
3	3 (10.0)	8 (15.1)	59 (14.2)	3 (7.1)	3 (30.0)
4	1 (3.3)	3 (5.7)	29 (7.0)		
≥ 5	2 (6.6)	3 (5.7)	8 (1.9)		
Smoking Partner n (%)					
Smoking partner	12 (40.0)	38 (71.1)	76 (18.3)	10 (71.4)	4 (40.0)
Non-smoking partner	15 (50.0)	12 (22.6)	334 (80.4)	3 (21.4)	5 (50.0)

Table 10: Overview of smoking patterns, number of respondents included, and attrition

Smoking pattern	T0	T1	T2	Explanation	Number of respondents included	Attrition
Smokers	Smoker	Smoker	Smoker	Persistent smokers	53	Missing T1 = 1 Missing T2 = 18 Missing T1 and T2 = 16
Subtotal					**53**	**35**
Non-smokers	Non-smoker	Non-smoker	Non-smoker	Respondents who never smoked OR	232 Missing T1 = 23 Missing T2 = 40 232 + 23+ 40 = 295	Missing T1 and T2 = 23
	Non-smoker	Non-smoker	Non-smoker	Quit more than 1 year prior to the data collection	108 Missing T1 = 1 Missing T2 = 12 108 + 1 + 12 = 121	Missing T1 and T2 = 9
Subtotal					**416**	**32**
Recent ex-smokers	Non-smoker	Non-smoker	Non-smoker	Non-smoker who reported having quit within the year prior to T0	30	Missing T1 = 0 Missing T2 = 10 Missing T1 and T2 = 5
Subtotal					**30**	**15**
Variable smoking pattern: Initial smokers	Smoker	Smoker	Non-smoker	Quit after 34 weeks of pregnancy or in postpartum	3	
	Smoker	Non-smoker	Smoker	Quit during pregnancy, even though they later resumed	3	
	Smoker	Non-smoker	Non-smoker	Quit early in pregnancy	8	
Subtotal					**14**	**0**
Variable smoking pattern: Initial non-smokers	Non-smoker	Smoker	Non-smoker	Intermittent smoking pattern	1	
	Non-smoker	Smoker	Smoker	Started again during pregnancy	3	
	Non-smoker	Non-smoker	Smoker	Started again after the baby was born	6	
Subtotal					**10**	**0**
Total					**523**	**82**

10.5.3. Patterns of depression during and after pregnancy

Table 11 shows the mean BDI score according to the smoking pattern during and after pregnancy. At all time points, the mean BDI score of recent ex-smokers, non-smokers, and initial non-smokers was normal (< 10). Smokers and initial smokers showed an elevated mean BDI score (≥ 10) during pregnancy. After pregnancy, their BDI score normalized.

Table 11: BDI scores over time by smoking pattern

Pattern	Statistic[a]	Time of measurement		
		T0	T1	T2
Smokers	M	11.17	11.28	9.61
	SD	7.00	7.95	7.15
	Range	0-36	0-42	0-31
Non-smokers	M	6.95	7.02	5.29
	SD	4.75	4.48	3.86
	Range	0-29	0-33	0-21
Recent ex-smokers	M	6.09	7.45	4.22
	SD	5.33	7.11	3.70
	Range	0-24	0-31	0-13
Initial smokers	M	10.77	12.33	7.69
	SD	5.16	5.16	4.80
	Range	3-19	4-19	0-18
Initial non-smokers	M	7.71	6.00	5.56
	SD	3.04	2.07	3.75
	Range	3-13	3-10	1-13

T0 = Prior to 16 weeks gestation; T1 = 32-34 weeks gestation; T3 = after 6 weeks postpartum; BDI = Beck Depression Inventory.
[a] Statistics are for BDI total scores (M = mean; SD = standard deviation).

10.5.4. Relationships between BDI score, smoking pattern, and sociodemographic variables

The results of the univariate analysis are shown in Table 12. At all sampling points (T0, T1, and T2), smokers and initial smokers reported significantly more depressive symptoms compared with recent ex-smokers, non-smokers, and initial non-smokers ($p < 0.001$). Women with a secondary school certificate or less reported a significantly higher BDI score than higher educated women ($p < 0.001$). Women without a paid job had a significantly higher BDI score compared with women with a job ($p = 0.01$). The BDI score was significantly lower after delivery ($p < 0.001$). Having a smoking partner resulted in a significantly higher score on the BDI scale ($p = 0.02$). Women younger than 29 years (mean of the sample) had a significantly higher BDI score ($p = 0.008$). There was no significant difference in BDI score between primigravidas and multigravidas ($p = 0.06$).

The results of the multivariable analysis are shown in Table 13 and Figure 2. All main effects in the final model were significant (Table 13). The two-way interaction between smoking pattern and time point was not significant (p = 0.15). The two-way interaction between educational level and smoking pattern was also not significant (p = 0.30). There were however significant differences in reported BDI within the educational level between the smoking patterns. Smokers with a secondary school certificate or less scored significantly higher on the BDI compared with their non-smoking counterparts (p = 0.05). Initial smokers with a college or university degree scored significantly higher on the BDI scale compared with non-smokers and recent ex-smokers with a college or university degree. We found in respondents with a college or university degree no significant difference in BDI score between smokers, recent ex-smokers, and non-smokers. The two-way interaction between educational level and time point was significant (p = 0.009). The pattern of the BDI score was significantly different in time between respondents with a low or high education. In women with a secondary school certificate or less, the mean BDI decreased in time (T0 = 9.62, T1 = 8.72, T2 = 8.25). In women with a college or university degree, the highest score was found at the end of pregnancy, the lowest in postpartum (T0 = 7.29, T1 = 8.49, T2 = 4.98). The three-way interaction between time point, smoking pattern, and educational level was significant (p = 0.02; Figure 2). Significant differences (p = 0.05) of the evolution of the mean BDI over time was assessed pair wise between smoking pattern classes within educational level class and between the educational level classes of each smoking pattern class. The evolution of the mean BDI over time differed between the educational level classes of smokers. Within respondents with a secondary school certificate or less, differences were observed between smokers and non-smokers, recent ex-smokers and initial non-smokers, and non-smokers and initial non-smokers. Within the respondents with a college or university degree, no differences were observed.

Table 12: BDI: Univariate analysis

Variables	BDI		*F*-value (df_{num}, df_{denum})	*p*-value
	Mean	Standard error		
Smoking pattern			12.06 (4, 486)	< 0.001
Smokers	10.16[b]	0.57		
Non-smokers	6.4[a]	0.20		
Recent ex-smokers	5.56 [a]	0.77		
Initial smokers	9.83[b]	1.10		
Initial non-smokers	6.23[a, b]	1.40		
Educational level			40.39 (1, 496)	< 0.0001
Secondary school certificate or less	8.52[a]	0.32		
College or university degree	6.06[b]	0.22		
Job status			6.14 (1, 489)	0.0136
Paid job	6.70[a]	0.19		
No paid job	8.50[b]	0.70		
Time point			40.15 (2, 643)	< 0.0001
T0	7.35[a]	0.22		
T1	7.54[a]	0.23		
T2	5.68[b]	0.23		
Smoking behaviour of the partner			5.37 (1, 495)	0.021
Smoking partner	7.51[a]	0.35		
Non-smoking partner	6.55[b]	0.22		
Gravidity			3.49 (1, 496)	0.0624
Primigravida	6.41	0.29		
Multigravida	7.12	0.24		
Age			7.11 (1, 495)	0.0079
< 29 years	7.34[a]	0.27		
≥ 29 years	6.35[b]	0.26		

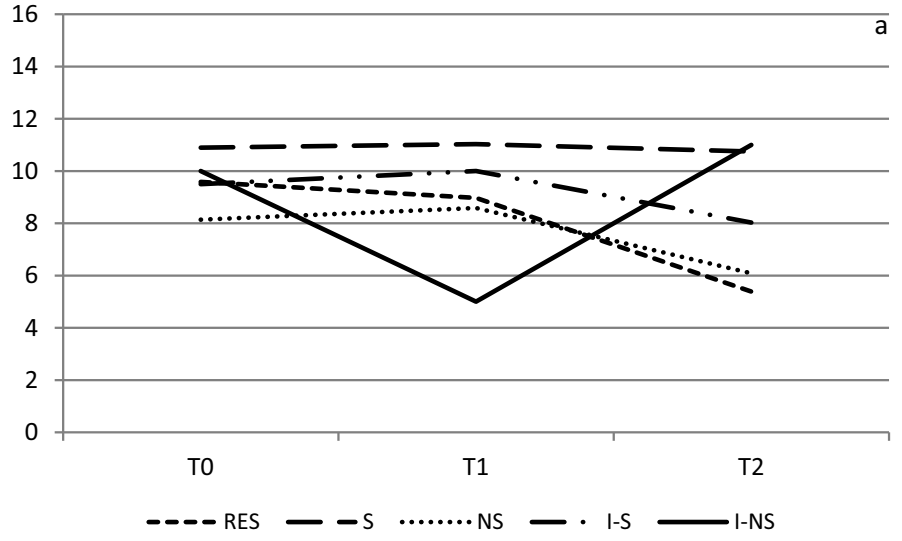
Values with a different superscript within a variable differ significantly from one another (Bonferroni corrected $p < 0.05$).

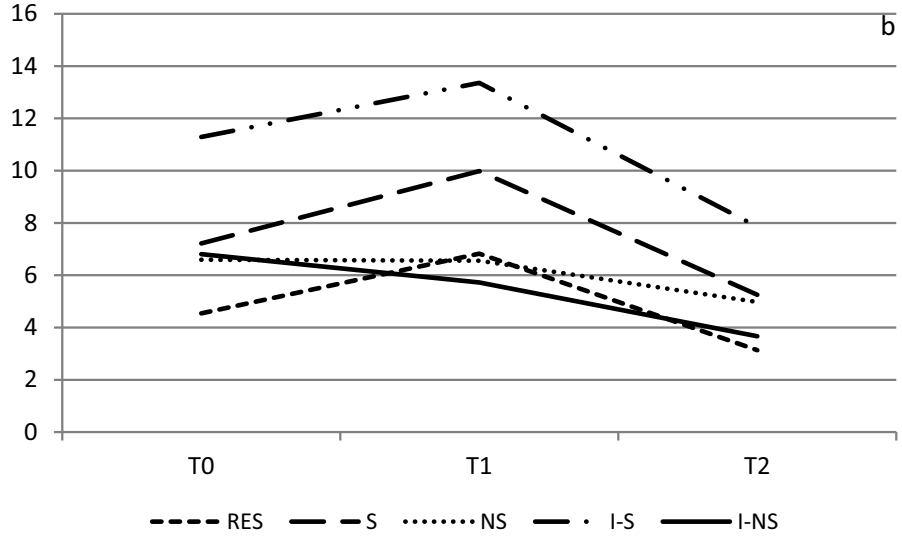
Table 13: Multivariate analysis

Variables	BDI		*F*-value (df_{num}, df_{denum})	*p*-value
	Mean	Standard error		
Main effects				
Smoking pattern			4.50 (4, 486)	0.0014
Smokers	9.19[a]	0.71		
Non-smokers	6.82[b]	0.22		
Recent ex-smokers	6.41[a, b]	0.83		
Initial smokers	10.00[a]	1.09		
Initial non-smokers	7.03[a, b]	1.58		
Educational level			4.81 (1, 474)	0.0288
Secondary school certificate or less	8.86[a]	0.71		
College or university degree	6.91[b]	0.54		
Time point			8.09 (2, 594)	0.0003
T0	8.46[a]	0.55		
T1	8.60[a]	0.55		
T2	6.6[b]	0.54		
Interaction effects				
Smoking pattern*time point			1.51 (8, 619)	0.15
Educational level*smoking pattern†			1.23 (4, 486)	0.297
Secondary school certificate or less				
Smokers	10.89[a]	0.63		
Non-smokers	7.60[b]	0.39		
Recent ex-smokers	6.41[a, b]	0.83		
Initial smokers	9.18[a, b]	1.61		
Initial non-smokers	8.67[a, b]	2.72		
College or university degree				
Smokers	7.48[a, b]	1.27		
Non-smokers	6.04[a]	0.23		
Recent ex-smokers	6.41[a, b]	0.83		
Initial smokers	10.83[b]	1.46		
Initial non-smokers	5.40[a, b]	1.60		
Educational level*time point†			4.77 (2, 594)	0.0088
Secondary school certificate or less				
T0	9.62[a]	0.87		
T1	8.72[a]	0.86		
T2	8.25[a]	0.86		
College or university degree				
T0	7.29[a]	0.66		
T1	8.49[a]	0.67		
T2	4.98[b]	0.65		
Time point*smoking pattern *educational level[c] See figure 2			2.29 (8, 619)	0.02

Values with a different superscript (a, b) within a variable differ significantly from one another (Bonferroni corrected $p < 0.05$).
† Superscripts refer to within classes of educational level. [c] See Figure 2. BDI = Beck Depression Inventory.

Figure 2: Mean BDI in recent ex-smokers (RES), smokers (S), non-smokers (NS), initial smokers (I-S) and initial non-smokers (I-NS) at successive time points (T0, T1, and T2) in respondents with a secondary school certificate or less are shown in (a) and in respondents with a college or university degree are shown in (b)





10.6. Discussion

The aim of this longitudinal study was to obtain a better insight into the possible association between smoking patterns and depressive feelings during pregnancy and postpartum, taking into account several sociodemographic characteristics. The longitudinal design is a strength of this study: Respondents were questioned three times. This made it possible to examine mood fluctuations and changes in smoking pattern both during pregnancy and postpartum.

Most importantly, recent ex-smokers reported fewer feelings of depression compared with smokers and initial smokers during pregnancy and postpartum, confirming the results of recent research that found decreasing feelings of depression in the case of successful quitting (Berlin et al., 2010; Kahler et al., 2011). Smoking, as well as depression, can result in preterm birth and low birthweight; the combination of both risk factors might aggravate these complications (Bull, 2007; Goedhart, et al., 2009; Grote et al., 2010). This emphasizes the fact that both smoking cessation and feelings of depression should be addressed during prenatal consultations.

Second, smokers with a secondary school certificate or less reported a mean BDI score of 10.89, which indicates that they experienced moderate feelings of dysphoria during and after pregnancy. However, this score is lower than the clinical depression indicator of 15. The increased BDI scores at all time points in lower educated smoking women, as illustrated in Figure 2A, might be explained by the meanings smoking has for these women – smoking might be a way of dealing with negative feelings or experiences (e.g., problems related to altered life circumstances because of motherhood, feelings of failure because of lack of a paid job, financial problems, problems of accommodation, a problematic relationship, or a lack of support from their partner). Further investigation is needed to identify these meanings of smoking. Low socioeconomic status, including lower educational level and job status, and depression, have been shown to be independent risk factors leading to persistent smoking during pregnancy (Zhu and Valbo, 2002; Solomon et al., 2006). The findings on BDI score and educational level are in line with these studies, but go further in showing that feelings of depression remain significant during the entire pregnancy and in postpartum. This finding is important for smoking cessation interventions in lower educated pregnant women and new mothers. Thus, smoking

cessation might be hampered by depressive symptoms, and interventions that treat dysphoria and depression may facilitate smoking cessation (Cinciripini et al., 2010).

Respondents with a variable smoking pattern showed mixed results. It is remarkable that the high educated initial smokers showed an elevated BDI score compared with their low educated counterparts (Figure 2B). This could suggest that their experiences with smoking cessation were more negative or that they experienced other problems at that time point. At T2, the mean BDI score normalized both in low and high educated respondents (8.03 and 7.86, respectively). Partners are major amplifiers of smoking behaviour, both positive and negative, and are key contributors toward the success or failure of the women's smoking cessation efforts (Hauge et al., 2012; Schneider et al., 2010). In this study recent ex-smokers and initial smokers had the highest percentage of smoking partners (71.1% and 71.4%, respectively). This means that women who recently attempted quitting are more at risk for relapse and that their partner should be involved in smoking cessation counselling.

The recorded relapse rate of smoking was low (T1: four respondents in the initial non-smokers group, T2: three respondents of the initial smokers and six of the initial non-smokers), but it is possible that more recent ex-smokers relapsed and subsequently refused further participation in the study. Of the original 45 respondents in this group, 15 respondents were excluded because of attrition. However, it can be assumed that women who admitted being a smoker provided the correct information regarding their smoking behaviour, given the negative societal bias against pregnancy and smoking.

A possible limitation to this study is the relatively high dropout rate of 13.56%, partially because of our own strict exclusion criteria for smokers (39.8%) and recent ex-smokers (33.3%). If there were any missing values regarding their smoking behaviour at T1 or T2, the respondents were excluded. In non-smokers, the dropout rate was 7.1%. Consequently, some of the groups are rather small. The high level of dropout might be explained by the lack of benefits associated with participation, resulting in a lower commitment to complete the survey at T1 and T2 (Crittenden et al., 2007). It is also known that a telephone survey in longitudinal research has a higher dropout rate than face-to-face contact, especially in respondents of low socioeconomic status because of incon-

sistent telephone availability (Biener et al., 2010; Crittenden et al., 2007). Smokers, especially smokers with a lower socioeconomic status, participate less easily in scientific research and dropout more often than nonsmokers (Crittenden et al., 2007). In this study, the dropout percentage was comparable with other research, which reported a dropout of 43% in smokers and ex-smokers over a period of 1 year (Biener et al., 2010).

It can be concluded that recent ex-smokers reported less symptoms of depression compared with smokers and initial smokers, independent of their educational level, suggesting that smoking cessation shortly before or in early pregnancy does not aggravate depressive symptoms during pregnancy and in postpartum. Mean BDI scores decreased in postpartum, except in low educated smokers, where BDI scores remained constantly above 10 during pregnancy and postpartum, suggesting that smoking could be a way of coping with difficult life conditions.

In case of a presumption of feelings of depression, healthcare providers could consider measuring the level of depression in pregnant women, for example, by using the BDI. In case of a score of ≥ 15, not only referral to a specialized smoking cessation consultation could be considered but also specialized therapy treating depression. Given the relationship between smoking, low educational level, and depression established in this study, it is suggested that professionals should take enough time to explore not only obstetric parameters but also the lifestyle of the pregnant woman during a first consultation. A history should include questions about educational level, job status, and smoking habits of the woman and, if appropriate, of the partner. Specific attention should be paid to feelings of depression in women with a lower educational level, not only during pregnancy when there are more contacts with healthcare workers but also during postpartum when contacts are fewer. Smoking cessation advice and the detection and treatment of depression during pregnancy can prevent the occurrence of more severe health problems in new mothers and babies. It is important to identify those women who may need more specialized care and that smoking cessation counselling is tailored to their needs and possibilities, paying attention to an appropriate methodology (e.g., using appropriate language and didactical tools). If possible, the partner should also be involved in the consultation.

Further studies should address and examine the impact of partner support in smoking cessation and relapse prevention, especially in low educated couples and recent ex-smokers, and identify the meanings smoking has in low educated women.

10.7. Conclusion

A wide variety of smoking patterns were observed during pregnancy and the early postpartum. Smoking patterns were associated with depression and showed complex interactions with educational level. Assessment and intervention for both smoking and depression are needed throughout the perinatal period to support the health of mothers, their infants, and families.

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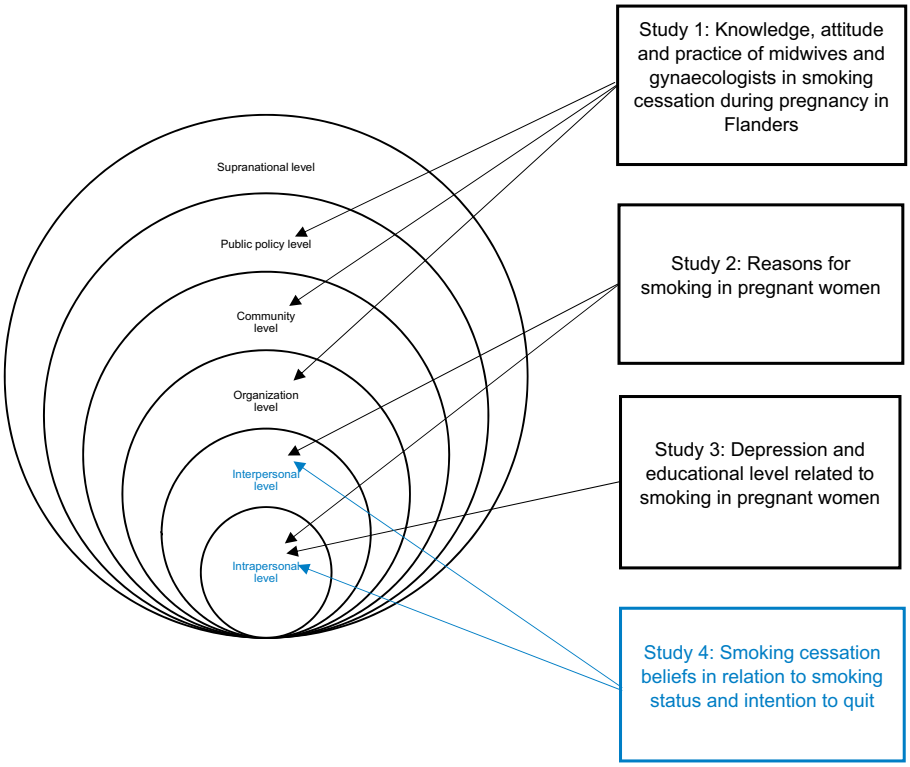
11. Study 4: Smoking cessation beliefs in relation to smoking status and intention to quit[4]



[4] Based on: De Wilde, K., Maes, L., Boudrez, H., Tency, I., Temmerman, M., Clays, E. (2016). Analysis of smoking cessation beliefs in pregnant smokers and ex-smokers using the Theory of Planned Behavior, Journal of Public Health doi: 10.1007/s10389-016-0784-x

11.1. Abstract

Aim: To analyse the association between smoking cessation beliefs and smoking status, and between smoking cessations beliefs and intention to quit, using the Theory of Planned Behaviour (TPB).

Subjects and methods: An observational study using a questionnaire was performed; data were collected from 264 Flemish pregnant smokers and ex-smokers before week 16 of pregnancy.

Results: There was a significant difference in the behavioural beliefs of the TPB between smokers and ex-smokers, after controlling for education and age. All respondents experienced more support from their non-smoking partners to maintain abstinence during pregnancy. We found no significant difference in the behavioural beliefs of the TPB between respondents with low and high intention to quit smoking.

Conclusion: Our results suggest that attitude, subjective norms, support especially from the partner, and perceived behavioural control are associated with actual smoking behaviour in pregnant women and not with intention to quit smoking. It is important to engage the partner and/or significant others in smoking cessation counselling so that they can support the pregnant woman in an attempt to quit or to maintain abstinence.

11.2. Introduction

Smoking during pregnancy can cause various maternal and neonatal health problems (Lumley et al., 2009). There is an increased risk of placental abruption, intrauterine growth restriction, preterm birth, low birth weight, stillbirth, respiratory problems after birth, and sudden infant death syndrome (Levitt et al., 2007; Lumley et al., 2009). Smoking cessation in pregnant women reduces tobacco-related adverse pregnancy outcomes (Lumley et al., 2009). The preconceptional and prenatal period is considered the optimal teaching moment for smoking cessation counselling (Herzig et al., 2006; Chang et al., 2013). Therefore, it is important to examine behavioural determinants related to smoking cessation and intention to quit smoking during pregnancy in order to develop effective interventions.

A systematic review of qualitative studies on psychological and social factors in women attempting to quit smoking during pregnancy demonstrated that women were aware of the foetal health risks associated with smoking (Ingall and Cropley, 2010; Flemming et al., 2014). Nevertheless, knowledge of potential health risks was not sufficient to motivate quitting (Ingall and Cropley, 2010; Flemming et al., 2014; Hoekzema et al., 2014). Other studies showed that pregnant smokers with a high level of nicotine dependence, lower education, and a partner who smoked had a high risk denial and a low motivation to quit smoking (Tombor et al., 2010). According to the cognitive dissonance theory, a lower risk perception results in denial as a coping strategy (Tombor et al., 2010).

Several studies investigated factors related to smoking cessation during pregnancy. The following factors have been found to be associated with increased smoking cessation during pregnancy: having no previous live births (Palma et al., 2007; Gilbert et al., 2015), attending adequate prenatal care (Palma et al., 2007), smoking less than five cigarettes per day during the last three months before pregnancy (Gilbert et al., 2015), having a higher educational level (Lu et al., 2001), having higher levels of self-efficacy (Maxson et al., 2012), and positive support from the other parent (Maxson et al., 2012; Flemming et al., 2014). Research by Gilbert et al. (2015) found that women between 30 and 34 years were more likely to quit smoking (Gilbert et al., 2015), while other studies did not confirm these findings (Palma et al., 2007). Guilt about being unable to quit (Ebert and Fahy, 2007), lack of social support (Gilbert et

al., 2015), or lack of support from the other parent (Maxson et al., 2012), living together with a smoker (Homish et al., 2012; Gilbert et al., 2015), higher levels of perceived stress before or during pregnancy (Ebert and Fahy, 2007; Maxson et al,. 2012; Flemming et al., 2014; Gilbert et al., 2015), and symptoms of depression (Maxson et al., 2012; De Wilde et al., 2013) are associated with higher risk of continued smoking during pregnancy.

A useful theoretical framework to capture smoking cessation beliefs is the Theory of Planned Behaviour (TPB). The TPB is one of the most frequently cited and influential models for the prediction of human social behaviour (Azjen, 2011). The central factor in the TPB is the individual's intention to perform a given behaviour. Intentions are assumed to capture the motivational factors that influence a behaviour and indicate how hard people are willing to try, or how much effort they plan to exert, in order to perform the behaviour. Intention is influenced by three main constructs: attitude towards the behaviour (evaluation of the outcomes of the behaviour), subjective norm (perception of whether significant others believe they should perform the behaviour), and perceived behavioural control (perception of how easy or difficult it is to perform the behaviour) (Azjen, 1991). Perceived behavioural control is very similar to Bandura's construct of self-efficacy, an individual's judgment of how well a person can perform a behaviour under various inhibiting conditions (Glanz et al., 1997; Gwaltney et al., 2009). Topa and Moriano (2010) performed an extensive meta-analysis to evaluate the success of the TPB as a predictor of smoking behaviour through meta-analytic structural equation modelling and demonstrated the predictive validity of TPB for smoking (Topa and Moriano, 2010).

To our knowledge, only one study has assessed beliefs regarding smoking cessation during pregnancy based on the TPB. However, hypothetical questions were asked of non-pregnant smoking women, assessing their intention to quit smoking in future pregnancies (Ben Natan et al., 2010). An important finding of this study was that women who had more negative attitudes towards smoking during pregnancy had a greater intention to stop smoking in a subsequent pregnancy. Further, perceived behavioural control was the strongest predictor of intention. However, this factor was influenced by exposure to a smoking environment, such as a smoking partner and friends, over whom women usually do not have any control. Therefore, perceived behavioural control

was reduced in women exposed to passive smoking (Ben Natan et al., 2010).

The aims of this study in Flemish pregnant smokers and ex-smokers were (1) to analyse the association between smoking cessation beliefs and smoking status, and (2) to analyse the association between the smoking cessation beliefs and intention to quit smoking.

11.3. Methods

11.3.1. Design

This study was part of a larger survey with an observational, longitudinal design. The aim of this longitudinal study was to gain insight into the determinants of smoking and smoking cessation among Flemish pregnant women (De Wilde et al., 2015; De Wilde et al., 2013). Data were collected at three points in time: before 16 weeks of pregnancy (T0), between 32 and 34 weeks of pregnancy (T1), and at least 6 weeks postpartum (T2). In this paper, we report only the results of T0.

The study was approved by the Ethical Committee of Ghent University Hospital. Written informed consent was obtained from all individual participants included in the study and they were assured of confidentiality.

11.3.2. Sampling

Data collection took place between September 2008 and December 2010 in Flanders (northern region of Belgium) by using convenience sampling. Only Dutch-speaking respondents over 18 years old were included. Since respondents could be expected to drop out in a longitudinal study, special attention was paid to the recruitment of pregnant smokers. A total of 635 respondents were recruited, of whom 102 were smokers (16.1%) and 184 ex-smokers (28.9%) at T0.

Two recruitment procedures were used. Firstly, respondents were recruited by the research team during prenatal consultations at two hospitals. One hundred twenty-five women were recruited in Ghent University Hospital and 140 women in AZ Nikolaas Hospital at Sint-Niklaas (total of 265 women). At these locations, all respondents underwent a CO measurement using the Smokerlyzer Micro (Bedfont Scien-

tific Ltd.), a biochemical validation of the smoking status (Usmani et al., 2008). The questionnaire was completed at the moment of recruitment. Secondly, all 467 registered gynaecologists and 198 registered independent midwives received an invitation to recruit respondents. Twelve gynaecologists and ten midwives, geographically spread across Flanders, agreed to participate in the project. Through their mediation, 370 additional women were recruited. Data from these women were obtained through telephone surveys without CO measurement. Previous research on this sample showed no differences in demographics between women with validated self-reports of smoking status compared to women who did not have a validated smoking status (De Wilde et al., 2013).

11.3.3. Self-reported measurements

11.3.3.1. Smoking behaviour

Respondents were asked to provide details about their previous and current smoking behaviour, daily consumption (cigarettes/day), intention to quit in case of smoking, and duration of abstinence in case of successful quitting. Women who reported smoking at least 1 cigarette/week were considered to be smokers. Women who reported abstinence for at least the previous week prior to the first data collection moment (T0) were considered to be ex-smokers. Ex-smokers were asked to recall their attitudes and perceptions at the time they smoked. Since preliminary analyses on these data showed no significant differences between recent ex-smokers (respondents who had quit less than one year before entering the study) and ex-smokers (respondents who had quit more than one year ago) in their smoking cessation beliefs, further analyses compared two groups: smokers and ex-smokers.

11.3.3.2. Constructs and beliefs of the TPB

Questions and statements on smoking behaviour and determinants of smoking cessation were part of the Dutch questionnaire 'Questionnaire for research on smoking and smoking cessation' [Meetinstrumenten voor onderzoek naar roken en stoppen met roken], developed by Maastricht University and STIVORO [Stichting Volksgezondheid en Roken, Foundation for Public Health and Smoking] (Mudde et al., 2006). This is a standardized and validated questionnaire for research on smoking

and smoking cessation. Mudde et al. (2006) used questions and statements which had already been pretested or used in publications in peer-reviewed journals (Mudde et al., p. 17-22 and p. 41-52) (Table 14). A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used.

Smokers and ex-smokers answered questions about maternal and foetal health consequences of smoking cessation during pregnancy and craving symptoms in order to provide insight into their behavioural beliefs and attitude regarding smoking cessation (Table 14). Health consequences were measured as the mean of three items ('attitude_health', Cronbach's α = 0.74), craving consequences as the mean of four items ('attitude_craving', Cronbach's α = 0.80). Higher scores indicated a positive attitude towards smoking cessation.

All respondents answered questions regarding perceived support and encouragement from their partner, family, and friends in smoking cessation and staying abstinent. They also answered questions about disapproval of smoking during pregnancy by significant others. Perceived encouragement from partner, family, and friends in smoking cessation before or during early pregnancy was measured as the mean of two items ('subj. norm_cessation', Cronbach's α = 0.88) as well as perceived support from partner, family and friends in staying abstinent during pregnancy ('subj. norm_abstinence', Cronbach's α = 0.87). Higher scores indicated more perceived support. Perceived disapproval from significant others was measured as the mean of three items ('subj. norm_disapproval', Cronbach's α = 0.60). Higher scores indicated more perceived disapproval.

There were six universal circumstances (Table 14) for relapse or continued smoking ('perceived behavioural control', Cronbach's α = 0.95). Smokers and ex-smokers were asked if they felt able to not smoke in these particular situations in order to establish their perceived behavioural control. Higher scores indicated higher perceived behavioural control.

Finally, only smokers were asked about their intention to quit. This item was also scored on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) and was coded into two levels: no or low intention to quit (scores 1 to 3) and moderate or high intention to quit (scores 4 and 5).

Table 14: Questionnaire regarding smoking and smoking cessation based on constructs, beliefs, and items of the theory of planned behaviour (TPB)

Constructs of TPB	Beliefs of TPB	Items of TPB	Cronbach's α
Attitude	**Behavioral beliefs**		
	Attitude_health	Remaining abstinent will improve your health	0.74
		Remaining abstinent is better for the health of your unborn child	
		Remaining abstinent is better for the health of the people around you	
	Attitude_craving	You will miss conviviality if you remain abstinent	0.80
		You will have a harder time relaxing if you remain abstinent	
		You will experience craving and withdrawal symptoms if you remain abstinent	
		You will feel bored more frequently if you remain abstinent	
Subjective norm	**Normative beliefs**		
	Subj. norm_cessation	Your partner encourages you to quit smoking due to your pregnancy	0.88
		Your friends and family encourages you to quit smoking due to your pregnancy	
	Subj. norm_abstinence	Your partner encourages you to remain abstinent during your pregnancy	0.87
		Your friends and family encourage you to remain abstinent during your pregnancy	
	Subj. norm_disapproval	People around you tell you that smoking is unhealthy for your baby	0.60
		People around you refuse to light your cigarette or give you a cigarette	
		You think people around you have a negative opinion about your smoking behavior	
Perceived behavioral control	**Control beliefs**		
	Perceived behavioral control	You feel stressed or tense, do you manage not to smoke?	0.95
		You are annoyed or angry, do you manage not to smoke?	
		You are out for the evening (at a party, visiting friends), do you manage not to smoke?	
		You feel sad or depressed, do you manage not to smoke?	
		Someone offers you a cigarette of your favorite brand, do you manage not to smoke?	
		You see someone enjoying a cigarette, do you manage not to smoke?	
Intention		You are considering quitting smoking	

Questionnaire for research on smoking and smoking cessation, translation of 'Meetinstrumenten voor onderzoek naar roken en stoppen met roken', developed by Maastricht University and STIVORO (Mudde et al., 2006). The original Dutch questionnaire was used in this study.

11.3.4. Socio-demographic variables

The questionnaire included questions about age and educational level. Respondents were asked for their highest grade or year of completed education. This variable was coded into two levels: secondary school certificate or lower, meaning 12 years of education or less (low), and college or university degree (high).

11.3.5. Data analysis

Data were analysed using SPSS 22.0.

Descriptive statistics (mean, standard deviation and Chi^2-test) were used to describe the characteristics of the respondents and their responses regarding the smoking cessation beliefs of the TPB. Pearson correlation and t-tests were used to determine the relationship between demographic characteristics (age and education) and the beliefs of the TPB. T-tests and two-way ANCOVA tests were performed to compare the beliefs of the TPB according to smoking behaviour and intention to quit, adjusted for age and education.

11.4. Results

11.4.1. Characteristics of the sample

For the purposes of this study, we only included complete data records of smokers and ex-smokers at T0. Data of non-smokers and incomplete datasets were excluded. Data records of 264 respondents, 87 smokers and 177 ex-smokers, were eligible. All respondents were between 6 and 16 weeks pregnant.

The group consisting of smoking pregnant women was significantly different from their ex-smoking counterparts: they were younger and less well-educated, and significantly more of them had a smoking partner. Sixty-four percent of the smokers had a high intention to quit smoking (Table 15).

Table 15: Characteristics of the study population

	Total	Smokers	Ex-smokers	*p*
N (%)	264 (100)	87 (32.9)	177 (67.1)	
Age				t = 3.75***
Mean (SD)	28.76 (4.68)	27.23 (5.30)	29.58 (4.11)	
Range	17-45	17-41	21-45	
Education				X^2 = 31.83***
Low n (%)	120 (45.5)	61 (70.1)	59 (33.3)	
High n (%)	144 (54.5)	26 (29.9)	118 (66.7)	
Smoking partner				X^2 = 56.50***
Smoking partner n (%)	122 (46.2)	69 (79.3)	53 (29.9)	
Non-smoking partner n (%)	142 (53.8)	18 (20.7)	124 (70.1)	
Intention to quit smoking				
Low n (%)		31 (36.0)	/	
High n (%)		55 (64.0)	/	

p for difference between smokers and ex-smokers, based on independent-samples t-test or Chi^2 for independent samples
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (two-tailed)

11.4.2. Association between smoking cessation beliefs and smoking behaviour

After controlling for education and age, there was still a significant difference in smoking cessation beliefs between smokers and ex-smokers. Compared to smokers, ex-smokers reported a more positive attitude towards health consequences of smoking cessation, were more confident that they could deal with craving symptoms, experienced more support from their partner and significant others to maintain abstinence during pregnancy, and perceived more disapproval from their network if they smoked during pregnancy. They also reported being more in control of their smoking behaviour in tempting circumstances. Only perceived support to quit smoking before or during early pregnancy ('subj. norm_cessation') was significantly lower in ex-smokers compared to smokers (Table 16).

Smokers experienced less support from their smoking partner during pregnancy (mean = 5.32) compared to ex-smokers (mean = 7.19), after controlling for age (F = 4.55; $p = 0.034$). Non-smoking partners provided more support to both smokers (mean = 6.75) and ex-smokers (mean = 7.94).

Table 16: Association of behavioural beliefs with smoking behaviour, education, and age (n= 264)

	Smoking behaviour				Education				Age	
Behavioral determinants	Smokers mean (SD)	Ex-smokers mean (SD)	t †	F §	Low mean (SD)	High mean (SD)	t †	F §	r ‡	F §
Attitude_health	4.26 (0.76)	4.71 (0.43)	5.04***	18.20***	4.40 (0.67)	4.67 (0.52)	-3.30**	2.39	0.23**	6.08*
Attitude_craving	3.15 (0.54)	3.74 (0.42)	7.31***	43.96***	3.34 (0.56)	3.71 (0.46)	-4.48***	3.68	0.19*	0.031
Subj. norm_cessation	3.26 (1.22)	2.40 (1.81)	-4.13***	8.95**	2.80 (1.57)	2.54 (1.74)	1.12	0.09	-0.20**	5.65*
Subj. norm_abstinence	2.77 (1.66)	3.85 (1.40)	4.86***	22.79***	3.09 (1.69)	3.73 (1.46)	-2.80**	3.99*	-0.105	9.84**
Subj. norm_disapproval	3.18 (0.86)	3.69 (0.97)	3.00**	9.99**	3.29 (0.99)	3.47 (0.84)	-0.99	0.001	-0.011	1.12
Perceived behavioural control	2.34 (0.88)	4.58 (0.64)	20.47***	340.22***	3.34 (1.41)	4.21 (1.04)	-5.01***	0.78	0.204**	1.36

† Results of independent t-test; § Results of two-way ANCOVA; ‡ Results of Pearson's correlation
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed)

11.4.3. Association between smoking cessation beliefs and intention to quit smoking

There was no significant difference in smoking cessation beliefs between respondents with high or low intention to quit, after controlling for education and age (Table 17).

Table 17: Association of behavioural beliefs with intention to quit smoking, education, and age (n= 86)

	Intention to quit smoking				Education				Age	
	Low Mean (SD)	High Mean (SD)	t †	F§	Low Mean (SD)	High Mean (SD)	t †	F§	r ‡	F§
Attitude_health	4.15 (0.67)	4.33 (0.80)	-1.08	0.06	4.18 (0.76)	4.45 (0.77)	-1.26	1.51	0.23*	6.40*
Attitude_craving	3.12 (0.67)	3.16 (0.49)	-0.30	0.06	3.05 (0.52)	3.23 (0.54)	-1.03	1.06	0.03	0.74
Subj. norm_cessation	3.21 (1.05)	3.26 (1.31)	-0.17	0.48	3.02 (1.24)	3.52 (1.19)	-1.64	3.37	-0.21	4.26*
Subj. norm_abstinence	2.37 (1.75)	2.99 (1.60)	-1.60	0.55	2.39 (1.72)	3.42 (1.35)	-2.74**	6.12*	-0.24*	6.87*
Subj. norm_disapproval	2.99 (0.91)	3.28 (0.81)	-1.56	0.64	3.13 (0.91)	3.27 (0.78)	-0.61	0.193	-0.07	0.528
Perceived behavioral control	2.16 (0.92)	2.41 (0.82)	-1.28	0.27	2.18 (0.86)	2.76 (0.80)	-2.81**	6.51*	0.03	1.04

† Results of independent t-test; § Results of two-way ANCOVA; ‡ Results of Pearson's correlation
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed)

11.5. Discussion

This study examined the association between smoking cessation beliefs and smoking status, and the association between smoking cessation beliefs and intention to quit smoking in a population of pregnant smokers and ex-smokers.

There was a significant difference in the smoking cessation beliefs of the TPB between smokers and ex-smokers, after controlling for education and age.

Ex-smokers were significantly more convinced that smoking cessation is favourable for the health of their unborn child and their own health. Even though smokers are generally aware of potential health risks, it has been suggested that they underestimate the risks of smoking during pregnancy because they believe that risks are being exaggerated and therefore do not consider quitting smoking (Tombor et al., 2010). Also, personal experience should be taken into account. Research has shown that women who smoked in previous pregnancies supposed that health risks have been exaggerated because they have a 'healthy child' and that a smaller baby is easier to deliver (Flemming et al., 2014). Therefore, it is important to give correct information about potential health risks and the opportunities for smoking cessation (Tombor et al., 2010).

Ex-smokers were significantly more confident that they would be able to deal with craving symptoms based on their own experience with smoking cessation. They reported feeling less bored and experienced fewer withdrawal symptoms or found a way of coping. Smokers were shown to believe that stress caused by a quit attempt is as dangerous as the risk of smoking (Flemming et al., 2014). This belief is even supported by health care workers. Most of them advised smoking cessation, although some only advised reducing daily consumption (Chang et al., 2008), especially in stressful situations (Baha and Le Faou, 2009; Borland et al., 2013; De Wilde et al., 2015).

Smokers experienced more support to quit smoking before or in early pregnancy compared to ex-smokers. This could be attributed to recall bias, because ex-smokers had already quit several weeks or months previously. Research shows that women who quit smoking during pregnancy experienced more active praise and encouragement from significant others than those who did not quit (Koshy et al., 2010) and

that family and friends can act as both facilitators and barriers to quitting. Some women felt that family and friends encouraged them to consider quitting and attempted to quit, although their concern was primarily limited to the months of pregnancy. However, in another study, women spoke more often of family and friends as barriers to quitting, since smoking was part of these relationships at home, at work, and in the community (Flemming et al., 2014). In the present study, smoking pregnant women were more likely to have a smoking partner. Results showed that smoking women experienced less support from their smoking partner to become abstinent during pregnancy compared to ex-smokers. A partner's smoking status and attitudes to smoking cessation are important facilitating or inhibiting factors. If the partner is also trying to quit, it will be perceived as support and this may facilitate a woman's quit attempt. If the partner continues smoking, it will be perceived as a barrier, which will make it harder for the woman to quit or remain abstinent (Flemming et al., 2014). Exposure to environmental tobacco smoke produced by family and friends is an additional barrier in quitting or remaining abstinent (Flemming et al., 2014). Being a member of a smoking network can influence the decision to continue to smoke. Quitting could put the woman outside her network, causing her to lose the support she needs during pregnancy, despite the risks it may pose to her unborn child (Masho et al., 2014). Therefore, health care workers should not only inquire about the smoking status of the pregnant woman, but also of her partner and members of her social network.

Ex-smokers experienced more disapproval from significant others compared to smokers before they decided to quit, which could suggest that disapproval served as a facilitator for smoking cessation in this sample. For some women, disapproval could facilitate a quit attempt; for others, it could serve as a barrier. Many women described partners who monitored their smoking through controlling and abusive behaviours. Some women felt forced to cut down. While this could facilitate a reduction in smoking, it occurred in circumstances that were undermining and threatening. Partners were reported to be confrontational and persistent, demanding that the women quit smoking and controlling their access to cigarettes by removing cigarettes or refusing money to buy them (Flemming et al., 2014). It could be suggested that expressing disapproval in a non-abusive and non-controlling manner could have a positive effect on smoking cessation.

Ex-smokers reported higher perceived behavioural control, almost twice as high as smokers. This may indicate that they have already experienced difficult and tempting situations in which they were able to maintain abstinence. This is comparable with research on self-efficacy, a corresponding construct to perceived behavioural control (Brug et al., 2012). Self-efficacy seems to play a central role in smoking cessation, although a meta-analysis of over 50 studies has challenged this assumption. Assessments of self-efficacy completed after the onset of a quit attempt were more strongly associated with a positive cessation outcome compared to assessments prior to a quit attempt. Although there was a significant relationship between self-efficacy and cessation outcome, it was surprisingly small. This may indicate that self-efficacy reflects rather than predicts relapse, which may have implications for smoking cessation interventions targeting self-efficacy (Gwaltney et al., 2009). However, Topa and Moriano (2010) demonstrated that smokers should be aware that perceived behavioural control exerts a strong influence both on the intention to smoke and the behaviour of smoking (Topa and Moriano, 2010). The strength of the subjective norm on the intention to smoke and on behaviour is very important. Moreover, they suggest that as long as prevention campaigns do not change society's global appraisal of tobacco consumption, long-term individual behaviours will not be modified (Topa and Moriano, 2010).

There was no significant difference in the smoking cessation beliefs of the TPB between smokers with high or low intention to quit. This means that intention to quit in the present population of smoking pregnant women was not significantly associated with attitude, subjective norm, or perceived behavioural control and that other factors, such as stress and depression, must be considered. Previous research on this population showed that smoking pregnant women, in particular less well-educated women, reported significantly more symptoms of depression compared to ex-smokers and non-smokers (De Wilde et al., 2013). Less well-educated pregnant smokers reported high scores on the Beck Depression Inventory, a screening tool for depression. Symptoms of depression may contribute independently to persistent smoking during pregnancy (Beck et al., 1979; Scott et al., 2009; Smedberg et al., 2015). Depressed persons may smoke to immediately improve their sense of well-being, as a quick reward, to cope with stress, or to escape from difficult circumstances. These reasons may indicate why it is more difficult for depressed pregnant women to quit smoking (Zhu and

Valbo, 2002). Moreover, smoking can provoke guilt and disapproval from peers. As mentioned previously, research has shown that for some women, disapproval could facilitate a quit attempt; for others, it served as a barrier to quitting and it could encourage women to conceal their smoking behaviour or their pregnancy status (Flemming et al., 2014).

In the study by Ben Natan et al. (2010), attitude, subjective norms, and perceived behavioural control were found to be predictors of intention to quit smoking (Ben Natan et al., 2010). However, respondents in their study were not pregnant at the time of data collection. Reports of smoking and smoking cessation were based on recollections of previous pregnancies, which may increase the likelihood of recall bias. Respondents also answered hypothetical questions assessing their intention to quit smoking in future pregnancies, which could have induced socially desirable answers.

The strength of the present quantitative study is that it is the first to analyse the association between the smoking cessation beliefs of the TPB with smoking status and intention to quit smoking during pregnancy in a population of pregnant women. However, some limitations of this study deserve consideration. A first limitation is the relatively small sample size of smokers; in total, the data of 87 smoking respondents were eligible for analysis. No significant difference was observed in the smoking cessation beliefs of the TPB between respondents with low and high intention to quit smoking. Hence, the theory was not confirmed for intention to quit, which could be due to the smaller sample size and the lack of power. Therefore, larger studies are required to confirm our results. A second limitation that needs to be considered is a possible recall bias among the respondents. Some of the ex-smokers had already quit several weeks or months previously, which could make it more difficult to remember how they experienced support before or during early pregnancy from significant others. Finally, the present cross-sectional study could only examine an association and no causal relation between smoking status, intention to quit, and smoking cessation beliefs of the TPB. Further research could focus on a possible effect of the determinants of the TPB on intention to quit and smoking cessation using a longitudinal design.

We can conclude that there was a significant difference in the smoking cessation beliefs of the TPB between smokers and ex-smokers, after controlling for education and age. Hence, our results suggests that atti-

tude, subjective norms, and perceived behavioural control are associated with smoking behaviour in pregnant women. There was no significant difference in the smoking cessation beliefs of the TPB between respondents with low and high intention to quit smoking. Therefore, the theory was not confirmed for intention to quit. Considering these conclusions, health care workers, more specifically midwives and obstetricians, should pay special attention to their communication regarding the health risks of smoking during pregnancy. It is important to provide correct and complete information about potential health risks and the opportunities for smoking cessation. Perceived support from partner, family, and friends is important in smoking cessation, both before and during pregnancy. Therefore, it is important to engage the partner and/or significant others in smoking cessation counselling so that they can support the woman in a quit attempt. Health care workers should advise single women to find a buddy who provides support during a quit attempt.

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PART 4

General discussion

Smoking during pregnancy is associated with increased foetal and maternal health risks such as foetal loss, ectopic pregnancy, placental abruption, placenta praevia, preterm birth, premature rupture of membranes, low birth weight, small for gestational age babies, and congenital anomalies. The overall aim of this PhD thesis is to improve insight into the determinants of smoking and smoking cessation among Flemish women during pregnancy and postpartum in order to develop more efficient smoking cessation interventions. Therefore, we performed one qualitative and three quantitative studies.

12. Summary of the main findings

The objectives of the first study were to explore knowledge, beliefs and practice among midwives and gynaecologists concerning smoking cessation several years after the implementation of a national smoking cessation policy, which provided reimbursement of smoking cessation counselling by a tobaccologist for pregnant women. In addition, the role of midwives and gynaecologists in Flanders in smoking cessation in pregnant women was assessed. A qualitative study was performed using semi-structured interviews with nine midwives and eight gynaecologists. We found that all participants reported spontaneously a number of severe health problems for (pregnant) women and babies: intrauterine growth restriction, low birth weight, placental problems and sudden infant death syndrome. Most participants believed that knowledge of the health risks is the most important motivation to induce a quit attempt. The number of consultations and the amount of reimbursement of the national smoking cessation policy was largely unknown. Knowledge regarding the usage of nicotine replacement therapy (NRT) was insufficient and therefore not recommended. The 5 A's framework was partially used in their contact with the pregnant women (Fiore et al., 2008). "Ask", "Advice" and to a lesser extent "Assist" were implemented in smoking cessation communication. There was also little interest in training in smoking cessation counselling. Based on the results of our study, lack of time, lack of communication skills in sensitive topics such as smoking cessation, and fear of provoking resistance were identified as barriers for giving smoking cessation advice to pregnant women. Therefore, training in smoking cessation counselling is desirable. Another possibility is to refer clients to a specialist like the tobaccologist

Several studies describe reasons for continued smoking (da Motta et al., 2010). The Modified Reasons for Smoking Scale (MRSS) offers the opportunity to make a more integral assessment of the smoker (Boudrez and De Bacquer, 2012). A number of studies confirmed the validity and reliability of translated versions of the MRSS (Berlin et al., 2003; Boudrez and De Bacquer, 2012; de Souza et al., 2009). To our knowledge, there are no studies describing the use of the MRSS in pregnant women. The main aim of the second study was to test the factorial structure, validity and reliability of the Dutch version of the MRSS in a sample of smoking women seeking prenatal care. In addition, we wanted to understand the reasons for continued smoking during pregnancy and to map the profile of pregnant smokers, which is indispensable for developing tailored interventions or appropriate counselling. An observational, prospective, non-interventional study was conducted. Data were collected using a questionnaire in 97 Flemish pregnant smokers: before week 16 (T0) and between week 32 and 34 of pregnancy (T1). We identified five subscales with good to (borderline) acceptable internal consistency and good to acceptable test-retest stability. In order of importance, those scales were: tension reduction, social function, pleasure, addiction and habit. Concurrent validity of the MRSS subscales in relation to several variables was examined. We found a significant relationship between daily consumption and the subscale addiction and between nicotine dependence and the subscales tension reduction and addiction. Hence, the results of this study suggest that the MRSS can be appropriately used in pregnant smokers.

Associations among feelings of depression, smoking behaviour, and educational level during pregnancy have been demonstrated. Feelings of depression may contribute to persistent smoking during pregnancy (Zhu and Valbo, 2002; Scott et al., 2009). The aim of the third longitudinal study was to obtain insight into the associations between smoking patterns and depressive feelings during pregnancy and postpartum, taking into account several sociodemographic characteristics. We performed an observational, prospective, non-interventional study, using the Beck Depression Inventory (BDI) to assess symptoms of depression. Data were collected during two stages of pregnancy (T0: < 16 weeks and T1: 32-34 weeks) and during postpartum (T2: > 6 weeks) in 523 Flemish women. It was concluded that

recent ex-smokers[5] reported less symptoms of depression compared with smokers[6] and initial smokers[7], independent of their educational level. This may suggest that smoking cessation shortly before or in early pregnancy does not aggravate depressive symptoms during pregnancy and postpartum. Mean BDI scores decreased in postpartum, except in low educated smokers, where BDI scores remained constantly above the threshold for dysphoria during pregnancy and postpartum. This may suggest that smoking could be a way of coping with difficult life conditions.

The Theory of Planned Behaviour (TPB) is one of the most frequently cited and most influential models for the prediction of human social behaviour and can also be used to capture smoking cessation beliefs (Ajzen, 2011). The aims of the fourth study in pregnant smokers and ex-smokers were to analyse the association between smoking cessation beliefs and smoking status, and to analyse the association between smoking cessations beliefs and intention to quit smoking, using the TPB. An observational study using a questionnaire was performed; data were collected from 264 Flemish pregnant smokers and ex-smokers before week 16 of pregnancy (T0). We found that there was a significant difference in smoking cessation beliefs of the TPB between smokers and ex-smokers, after controlling for education and age. Hence, our results suggest that attitude, subjective norm, and perceived behavioural control are associated with smoking behaviour in pregnant women. Ex-smokers were significantly more convinced than smokers that smoking cessation is favourable for their own health and the health of their unborn child, and that they were able to deal with craving symptoms based on their own experience with smoking cessation. Ex-smokers experienced more disapproval from significant others compared to smokers. There was no significant difference in smoking cessation beliefs of the TPB between respondents with low and high intention to quit smoking. Therefore, the theory could not be confirmed for intention to quit smoking in pregnant women.

[5] Recent ex-smokers: respondents who quit less than 1 year before T0 and reported to be abstinent at all three time points

[6] Smokers: respondents who reported to be smoking at all three time points

[7] Initial smokers: respondents with a variable smoking pattern who reported to be smoking at T0 and made a quit attempt

13. Overall discussion

13.1. Study 1: Knowledge, attitude and practice of midwives and gynaecologists in smoking cessation during pregnancy in Flanders

Pregnancy is considered as a window of opportunity for quitting smoking (Boucher and Konkle, 2016). Eighty percent of all women have at least one baby and receive prenatal care by skilled healthcare providers (World health Organization, 2013). Hence, this contact with the healthcare system provides an excellent occasion to promote smoking cessation in relatively young and healthy women, and before development of tobacco-related diseases. Quitting early in life (between 25 and 34 years) can save up to 10 years of life. Besides protecting the immediate foetal and maternal health, smoking cessation has long-term health benefits for women, infants and children, and other family members (World health Organization, 2013). Therefore, smoking cessation is one of the most effective interventions for improving mothers' and children's health and thus serves as an indicator of the quality of antenatal preventive healthcare services (European Perinatal health report 2010; Lumley et al., 2009).

The first study can be linked to the organizational, community and public policy level of the socio-ecological model. We examined the knowledge, beliefs and practice of midwives and gynaecologists in smoking cessation during pregnancy in Flanders in order to understand their (potential) role in this topic.

It was clear that the respondents were aware of different health risks of smoking during pregnancy: intrauterine growth restriction, low birth weight, placental problems and sudden infant death syndrome. Gynaecologists identified more health risks than midwives, who were more focused on the foetal consequences rather than those for the woman herself. Research shows that over the last three decades interventions with a foetus-centric perspective had poor success (Boucker and Konkle, 2016). Therefore, it should be considered to provide pre- and post-pregnancy interventions, with a scope on both foetal and women's health consequences (Boucker and Konkle, 2016).

Respondents listed the negative health consequences as possible motivations to quit smoking. Nevertheless, it is recognised that knowledge

as such is not enough for smoking cessation (Naidoo and Wills, 2009), especially if it does not match the beliefs and motivations of the smoker. Hence, health care workers can ask questions in a non-judgemental way in order to discover together possible motivations for the (pregnant) woman to quit smoking.

Midwives and gynaecologists have limited knowledge regarding (inter)national smoking cessation guidelines and interventions. Therefore, they are not familiar with recommendations regarding the use of NRT or the 5 A's framework as a communication tool, as recommended by the Flemish Domus Medica guideline. Domus Medica is the professional union of general practitioners, therefore it could be that their guidelines do not reach midwives and gynaecologists. Both the websites of the Flemish Organisation for Obstetrics and Gynaecology and the Flemish Organisation for Midwives contain links on the clients' page to information regarding smoking cessation. It could be supposed that these links are consulted by clients, rather than by healthcare professionals. On the other hand, midwives and gynaecologists are well aware of the fact that bupropion and varenicline are prohibited during pregnancy and lactation. This knowledge is related to their medical background; they are aware of the fact that only a few drugs are safe during pregnancy. Fewer than half of the healthcare professionals working with pregnant women use all components of the 5A's to address smoking (Okoli et al., 2010). It could be suggested that a combination of theoretical and practical training based on the use of the 5 A's framework and motivational interviewing should be offered to midwives, general practitioners and gynaecologists. This is consistent with a review of Flemming et al. (2016), who advises professional education, both pre-qualification and in continuing professional development, enabling healthcare professionals in providing smoking cessation support to pregnant women. In our study none of the gynaecologists and only three midwives attended a (short) smoking cessation training. Most of them believed that it was better to refer the client to e.g. a tobaccologist than to attend a training session.

Respondents had a negative image of 'the smoking pregnant woman': a low educated woman living in socially disadvantaged situations, having a smoking partner and "bad examples" in her past. Some of the respondents showed understanding for the multiple problems of the women. Other respondents strengthened the responsibility of the

women and believed that their smoking behaviour increased the existing problems, because of the expenses of tobacco and the negative influence on the health of the couple and the (unborn) baby. This negative image was supported by their own experience with smoking pregnant women. The Advice no. 9265 of the Superior Health Council of Belgium (2015) describes smoking during pregnancy as complex problem that is related to a lower SES, poverty, and disadvantaged situations. However, there are still insufficient data available about the characteristics of Flemish smoking pregnant women and their related problems (Smoking and pregnancy and smoking in families with young children: arrangements and interventions' by the Flemish institute for prevention of diseases and health promotion, 2011; ['Roken en zwangerschap en roken in gezinnen met jonge kinderen: welke maatregelen en interventies' van he Vlaams Instituut voor Ziektepreventie en Gezondheidspromotie, 2011]). Pregnant women, their partner, and their family were one of the target groups in the tobacco policy of the Flemish government 2009-2015' ['Vlaamse actieplan tabak, alcohol, drugs 2009-2015']. For the future action plan of 2016-2020, the emphasis has shifted to assessing effective interventions for socially deprived pregnant women and their partner in Flanders.

Hoppenbrouwers et al. (2011) found a mean prevalence of 12.3% for smoking during pregnancy in Flanders. Looking more into detail, the prevalence of smoking during pregnancy was 3.9% in women with a bachelor's or master's degree, 19.5% in women with a secondary school degree, and even 34.3% in women who did not complete secondary school education. The prevalence of smoking during pregnancy in women living in deprived situations was 39.3% (Hoppenbrouwers et al., 2011). Approximately 1 in 10 women (10.6%) reported being exposed to second-hand smoke during pregnancy, 4.3% of them being a non-smoker (Hoppenbrouwers et al., 2011). Passive smoking can also induce maternal and foetal health risks, although to a lesser extent than active smoking. Nevertheless, it is important to question partners about their smoking behaviour and to advise smoking cessation. Based on the results from study 1, there was limited attention for exposure to second-hand smoke of smoking pregnant women. If a pregnant woman was a non-smoker, the topic was even not discussed, so it was not known if these women were exposed to passive smoking and their partners were withhold from smoking cessation advise.

Consistent with other research, midwives and gynaecologists reported several barriers in providing smoking cessation advice, especially lack of time (Abatemarco et al., 2007; Bull and Whitehead, 2006; Herberts and Sykes, 2012; Murphy et al., 2016), limited communication skills in sensitive topics like smoking behaviour (Everett et al., 2005; Flemming et al., 2016; Herberts and Sykes, 2012; Murphy et al., 2016; Price et al., 2006), and fear of resistance (Abatemarco et al., 2007; Murphy et al., 2016).

Within the public policy level of the socio-ecological model, the present smoking ban is useful to protect the society, more specific pregnant women, against passive smoking. Additional data from the complete sample of 605 pregnant women (42 missing), collected at T0, provide an overview of their opinion regarding the smoking ban in bars and restaurants in Belgium (Table 18).

Table 18: Opinion of pregnant women regarding smoking ban in bars and restaurants in the total population (additional analyses) (N = 563)

	Smoking ban in restaurants		Smoking ban in bars	
	Smokers n (%)	Non-smokers n (%)	Smokers n (%)	Non-smokers n (%)
Totally disagree	2 (2.3)	5 (1.1)	42 (47.7)	44 (9.3)
Disagree	2 (2.3)	6 (1.3)	25 (28.4)	90 (18.9)
Neutral	9 (10.2)	11 (2.3)	11 (12.5)	72 (15.2)
Agree	32 (36.4)	85 (17.9)	3 (3.4)	107 (22.5)
Totally agree	43 (48.9)	368 (77.5)	7 (8.0)	162 (34.1)
Total	88 (100.0)	475 (100.0)	88 (100.0)	475 (100.0)

Both smokers (n = 88) and non-smokers (n = 475) were in favour of the smoking ban in restaurants. In total 75 smokers answered (totally) agree, in non-smokers 453 respondents (totally) agreed. There was a significant difference between smokers and non-smokers regarding the smoking ban in restaurants, non-smokers were more likely to (totally) agree with this statement ($Chi^2 = 35.01$; $p < 0.001$).

There was also a significant difference between smokers and non-smokers regarding the smoking ban in bars, only 10 smokers and 269 non-smokers were in favour of the smoking ban in bars ($Chi^2 = 106.32$; $p < 0.001$).

Within the organizational level of the socio-ecological model, the use of incentives remains controversial. Public perceptions of remunerating

individuals to change behaviour can be negative. Nevertheless, research of Tappin et al. (2015) indicates that financial incentives can motivate pregnant smokers to quit. Their results showed that significantly more smokers who were offered incentives, stopped smoking (22.5%) compared to controls (8.6%). Other research regarding the acceptability of incentives for health behaviours showed that adult participants of a market research panel in UK, preferred cash or voucher incentives equally over no incentive. They also preferred financial incentives available to the general population instead of to targeted groups, such as pregnant women or people living in low-income households (Giles et al., 2016). In Flanders, no financial incentives are provided to (pregnant) smokers until so far, mainly because of the controversial character and the rather limited budget for healthcare. Providing material incentives to smokers in order to motivate smoking cessation should provoke perhaps less discussion than financial support. In case of pregnancy, this non-financial support could consist of diapers, baby clothes or vouchers for baby equipment. Perhaps increased taxes on tobacco could be used to provide these financial or material incentives. In order to provide the incentive only to women who have actual quit smoking, validation of the self-reported smoking status of the pregnant woman is necessary, e.g. by using CO-measurement (Mantzari et al., 2012). Respondents in our study were not in favour of using CO-monitoring because they believed that this would damage the confidential relationship with the client and would provoke resistance. This conviction could be caused as healthcare professionals are not familiar with the procedure of a CO-measurement and therefore are reluctant to use it.

The results of this study can be discussed in relation to additional non-published results from the sample of pregnant women used in study 3 (n = 605), collected before 16 weeks pregnancy (T0). Questions were asked about their perception of received smoking cessation advice. Additional analyses showed that most of the pregnant women believed it was the role of the gynaecologist, followed by the general practitioner, the midwife and the pharmacist, to provide smoking cessation advice (table 19). This perception is in contrast with the role that midwives and gynaecologists see for themselves. Midwives are concerned about resistance from their clients against the smoking cessation advice provided. Sometimes they even are disappointed because their influence on the smoking behaviour of pregnant women is rather limited.

Gynaecologists perceived competing priorities during the short time of the consultation, which can result in avoiding the topic.

Table 19: Perception of pregnant women regarding the healthcare provider who has to provide smoking cessation advice (multiple answers possible) (N = 605)

	Yes n (%)	No n (%)
Gynaecologist	526 (94.3)	32 (5.7)
General practitioner	362 (64.9)	196 (35.1)
Midwife	236 (42.3)	322 (57.7)
Pharmacist	95 (17.0)	462 (83.0)

Within the sample of 605 pregnant women, the national smoking cessation policy was known by 108 respondents (17.9%) and only 1 smoking pregnant woman consulted a tobaccologist. Among these 108 respondents, the national policy was known in 27 smokers (31.0%), 26 ex-smokers (15.1%) and 55 non-smokers (18.1%). This means that even though the policy is best known in smokers, there is still room for improvement in promoting this policy. Since January 2017, the reimbursement in Flanders is calculated based on income and type of smoking cessation counselling (http://www.vlaanderen.be/nl/gezin-welzijn-en-gezondheid/gezond-leven/rookstopbegeleiding). Clients only pay their personal contribution, tobaccologists receive their salary directly from the Flemish Government.

Midwives and gynaecologists of study 1 reported that the first step of the 5 A's framework (to ask) was carried out. It could be supposed that these respondents were more motivated to help their clients quit smoking compared to non-responders. On the other hand, pregnant women from study 3 (n = 560; 100%) were asked at T0 if one of the healthcare providers asked questions about their smoking behaviour. This was confirmed by 453 pregnant women (80.9%): 376 (67.1%) women were non-smoker, 77 were smoker (13.8%). This means that the majority of healthcare providers performs step 1 of the 5 A's framework (to ask). However, 107 pregnant women (19.1%) state that questions were not asked on their smoking behaviour, of them 98 (17.5%) women were non-smoker, 9 were smoker (1.6%). This means that 1 in 5 pregnant women was not questioned or did not remember to be questioned about her smoking behaviour. Negative answers may be due to recall bias, for some respondents it was hard to remember the questions asked during the anamnesis.

Smoking pregnant women from study 3 (n = 85) were asked at T0 who provided smoking cessation advice: 46 smokers (54.1%) received advice from their gynaecologist, 21 (27.7%) from their midwife and 18 (21.2%) from their general practitioner. Seventy-one smokers reported they received the following advice: reduction of daily consumption during pregnancy (29 smokers; 40.8%), immediate and complete smoking cessation (21 smokers; 30.2%), smoking cessation during pregnancy (15 smokers; 21.1%) and smoking cessation together with the partner (6 smokers; 8.4%). This is consistent with the advice mentioned by the midwives and gynaecologists, in particular the advice to reduce consumption during pregnancy over immediate and complete smoking cessation. It is easier advising reduced tobacco consumption only during pregnancy than advising complete smoking cessation, the first advice will provoke less resistance. This was also confirmed by Flemming et al. (2016). Advising women to cut down rather than to quit was seen as a more feasible option because it is less stressful for the woman and prevents the healthcare worker to be seen as an harassing person with repeated messages about smoking cessation (Flemming et al., 2016).

13.2. Study 2: Reasons for smoking in pregnant women

Study 2 can be related to the intrapersonal and interpersonal level of the socio-ecological model.

Based on the MRSS, we identified five subscales or reasons why pregnant women smoke: tension reduction, pleasure, addiction, habit, and social function. The highest score was found for the subscale tension reduction which indicates the main reason why pregnant women continued smoking. Smokers, pregnant or non-pregnant, report that mood, anxiety, and stress can be improved or relieved by smoking. Moreover, concentration and arousal is increased after smoking a cigarette (Ebert and Fahy, 2007). The transition to motherhood and difficulties in adjusting to the demands of the maternal role can influence the stress level (Edwards et al., 2008) and, possibly, smoking can be a way to relieve stress or to cope with these stressful situations. Anxiety may be associated with pregnancy, which is considered by some women as a stressful life event (Kowalyk et al., 2009). Other research in Flanders also showed that less planned pregnancies were significantly associ-

ated with perceiving more stress and less social support, and with smoking during pregnancy (Goossens et al., 2016). It could be suggested that pregnant women endorse smoking as an essential coping mechanism, even when they are aware of the health consequences (Ingall and Cropley, 2010).

The subscale pleasure scored almost as high as the subscale tension reduction. The pleasure that smoking provides is caused by nicotine which is delivered to the central nervous system within 10 to 20 seconds of inhalation, and produces a cascade of actions resulting in a dose-dependent increase in dopamine levels. Dopamine is a neurotransmitter, its release provides feelings of pleasure and satisfaction, thus maintaining and reinforcing the smoking behaviour that created the dopamine release (Ebert and Fahy, 2007). Hence, smoking offers pregnant women a brief, pleasurable moment, which can be addictive and difficult to give up. For women in deprived situations or with low SES, an enjoyable break from the stressful situations in which they are living, could hinder smoking cessation.

The subscale addiction scored as high as the subscale pleasure and almost as high as the subscale tension reduction. This means that pregnant women smoked because they reported to be addicted to cigarettes, although the mean FTND showed no excessive high scores in this sample (mean FTND = 2.6). This may indicate that respondents had a low average level of physical dependence. These results are comparable with research by Berlin et al., who also found lower daily cigarette consumption and a lower FTND score in smoking pregnant women. It is possible that they experienced a more psychological dependence or that they were concerned about having craving symptoms in case of quitting. Pregnant women may report less severe withdrawal symptoms than non-pregnant smokers on the first day of abstinence compared to two weeks after the quit date (Berlin et al., 2016). Women who had a higher daily consumption indicated that they smoked more for reasons of addiction. On the other hand, it is known that pregnant women reduce their daily consumption compared with the months before their pregnancy (Kapaya et al., 2015), which could also be a reason for the lower average level of physical dependence as measured by the FTND.

In order to deal with craving symptoms, several studies regarding the use of NRT were performed. Nicotine metabolism appears to be faster

during pregnancy, especially from 18 to 22 weeks of pregnancy until four weeks after childbirth (Bowker et al., 2015). An experimental study with ten healthy, pregnant smokers showed that the clearance of nicotine increased approximately by 60% during pregnancy, the clearance of cotinine even increased by 140%. There was a 54% increase in the metabolic clearance of nicotine via the cotinine pathway during pregnancy, primarily by liver cytochrome P450 CYP2A6. The half-lives of nicotine and cotinine were shorter during pregnancy and cotinine elimination was nearly twice as rapid during pregnancy than postpartum (Dempsey et al., 2002). Increased nicotine clearance may contribute to increased craving and withdrawal symptoms among pregnant smokers compared to the general population of smokers (Berlin et al., 2016). Endocrine mechanisms may also be associated with relapse to smoking or increased craving and withdrawal symptoms. Relapse to smoking may be associated with increased plasma cortisol concentration in women (Al'Absi et al., 2015) but not in men. A recent meta-analysis demonstrated that among non-pregnant women, withdrawal symptoms are greater in the luteal than in the follicular phase and craving to tobacco shows a similar tendency (Weinberger et al., 2015). Fluctuations in progesterone level is a physiological effect in pregnancy. Plasma progesterone levels are usually 10 to 20 times higher in pregnancy than progesterone levels in the luteal phase in non-pregnant women. Higher levels of craving and withdrawal symptoms among pregnant smokers than among non-pregnant smokers are likely associated with the physiological, pregnancy related fluctuations in plasma progesterone concentration (Berlin et al., 2016). These results have an important consequence regarding the use of NRT. No downward dose adjustment needs to be made for NRT during pregnancy. On the contrary, higher than usual doses of nicotine may be necessary to optimize efficacy (Dempsey et al., 2002). A recent review by Coleman et al. (2015) regarding pharmacological interventions for promoting smoking cessation during pregnancy showed that NRT was found not to be more effective than placebo. Pregnant women showed low adherence to the offered dose leading to low smoking cessation rates in pregnant smokers. The review did not show evidence that NRT used for smoking cessation in pregnancy has either positive or negative impacts on birth outcomes. These findings suggest that it would be ethical and acceptable for future RCTs to investigate higher doses of NRT than those tested in the included studies (Coleman et al., 2015; Suter et al., 2015). Moreover, the

use of the e-cigarette and its safety is currently a topic under debate. E-cigarettes are hand-held battery operated devices whose use closely mimics the act of smoking. The first generation of the e-cigarettes was a look-alike of the classic cigarette, called the 'cig-a-like', and used cartridges filled with nicotine dissolved in propylene glycol. The next generation of e-cigarettes had a tank system, so nicotine and/or flavours could be added according to the preference of the user. The third generation of e-cigarette had variable power, which results in a better taste of the different liquids. Users of the e-cigarette preferred to be called 'vapers', not smokers. The vapour of the e-cigarette contains only a small fraction of health damaging chemicals and these levels are much lower than in tobacco smoke (Hajek, 2016; Schipper, 2016). The Superior Health Council of Belgium [Hoge Gezondheidsraad van België, advies nr. 9265, 2015] recommends the e-cigarette in smoking cessation counselling, under the condition that the e-cigarette and liquids are produced according to European quality standards and legislation. In general, vaping is likely to be at least 95% less dangerous than smoking over long-term use (Hajek, 2016). The impression of e-cigarettes as a healthier alternative to smoking may influence use in pregnancy (Kahr et al., 2015). Healthcare workers need to be prepared for questions of e-cigarette safety and efficacy as smoking cessation devices from their smoking pregnant clients and smoking women who are planning to become pregnant. At present, the risk-to-benefit ratio is currently under study. Therefore e-cigarettes cannot be recommended as either a safe nor efficacious tool for smoking cessation during pregnancy (Kahr et al., 2015; Suter et al., 2015).

The subscales habit and social function showed the lowest scores in this study. The items in the MRSS regarding habit refer to situations where someone is not aware of the fact that he or she is smoking. Probably, a pregnant woman is very aware of lighting up a cigarette, especially when she is in the presence of others. Social control and the taboo regarding smoking during pregnancy could influence the scores on these subscales. Pregnant women feel vulnerable to social pressure. In case of continued smoking during pregnancy, they often feel criticized or judged by society. They feel pressure to conform to the image of 'a good mother', which can provoke guilt and personal conflict in case they are not able to quit (Ebert and Fahy, 2007).

Additional non-published data from the sample of pregnant women used in study 3, showed that smokers and non-smokers had different opinions regarding smoking during pregnancy (Table 20).

Table 20: Perception of smokers and non-smokers regarding smoking during pregnancy (additional analyses) (N = 562)

	Statement: "A pregnant woman may not smoke at all"		Statement: "It is better to reduce daily consumption of cigarettes than to be stressed by quitting altogether"	
	Non-smokers n (%)	Smokers n (%)	Non-smokers n (%)	Smokers n (%)
Totally disagree	7 (1.5)	5 (5.7)	114 (24.1)	5 (5.7)
Disagree	26 (5.5)	7 (8.0)	132 (27.8)	7 (8.0)
Neutral	53 (11.2)	18 (20.5)	89 (18.8)	18 (20.5)
Agree	126 (26.6)	36 (40.9)	96 (20.3)	36 (40.9)
Totally agree	262 (55.3)	22 (25.0)	43 (9.1)	22 (25.0)
Total	474 (100.0)	88 (100.0)	474 (100.0)	88 (100.0)

These figures showed that 388 of non-smokers (81.9%) (totally) agreed that smoking during pregnancy is not permitted, only 58 smokers (65.9%) (totally) agreed. Significantly more non-smokers believed that a pregnant woman may not smoke at all ($Chi^2 = 116.67$; $p < 0.001$). Regarding the statement that it is better to reduce daily consumption than to be stressed by quitting altogether, 246 non-smokers (51.9%) (totally) disagreed and they spontaneously added that it is better to quit completely. Only 12 smokers (13.7%) (totally) disagreed with this statement. Significantly more non-smokers believed that reduction of daily consumption is not better than being stressed by quitting altogether ($Chi^2 = 53.58$; $p < 0.001$). These results are in line with the information they received from their healthcare workers, who advise them to reduce their daily consumption, preferably to maximum 5 cigarettes per day (Study 1).

13.3. Study 3: Depression and educational level related to smoking in pregnant women

The aim of this study was to determine relationships between depressive symptoms, sociodemographic characteristics, and smoking pattern during and after pregnancy. Study 3 can be linked to the intrapersonal level of the socio-ecological model.

For this part of the PhD thesis, respondents from the quantitative study were divided into five groups according to their smoking behaviour. Based on the answers at the three data collection points and taking into account the results of the CO measurement, respondents were categorized in five groups: smokers, non-smokers, recent ex-smokers, initial smokers and initial non-smokers (7.4.2.1 Smoking status)

The most important finding was that recent ex-smokers reported fewer feelings of depression compared to smokers and initial smokers during pregnancy and postpartum. This confirmed the results of other research that showed decreasing feelings of depression in the case of successful quitting (Berlin et al., 2010; Kahler et al., 2011). Additional non-published data from the sample of pregnant women from study 3, showed significant differences on 7 out of 21 items of the BDI in smokers compared to both recent ex-smokers and non-smokers, including sadness, sense of failure, guilt, expectation of punishment, self-dislike, indecisiveness, and work difficulty (Independent-Samples Kruskal-Wallis Tests; $p < 0.001$). This suggests that smokers expressed higher feelings of sadness and guilt because they failed to quit smoking during pregnancy. The item somatic preoccupation showed a significant difference between smokers and recent ex-smokers (Kruskal-Wallis = 6.679; $p < 0.05$). This could mean that smokers were more concerned about their health and the health of their baby compared to recent ex-smokers. In 7 items (namely pessimism, dissatisfaction, self-accusations, suicidal ideas, crying, irritability, and body image change) there were significant differences between smokers and non-smokers, but not between smokers and recent ex-smokers. In the remaining 6 items (namely social withdrawal, insomnia, fatigue, loss of appetite, weight loss, and loss of libido) there were no significant differences between smokers, non-smokers and recent ex-smokers. This means that typical feelings during pregnancy, did not differ between the three groups of women.

Second, smokers with a secondary school certificate or less reported a mean BDI score of 10.89, which indicates that they experienced moderate feelings of dysphoria during and after pregnancy. However, this score is lower than the clinical depression indicator of 15. Depressive symptoms might be an independent contributor of persistent smoking among expectant mothers (Boucher and Konkle, 2016; Castro e Couto et al., 2015). Depression during pregnancy can result in preterm birth,

low birthweight and intra intrauterine growth restriction (Goedhart et al., 2009; Grote et al., 2010, Stein et al., 2014). These complications can be deteriorated by smoking (Banderali et al., 2015; Goldenberg et al., 2008; Menon et al., 2011). Several recent studies demonstrated that smoking and low levels of education are associated with higher depression scores (Biaggi et al., 2015; de Vargas Nunes Colla et al., 2017; Lancaster et al., 2010; Miguez et al., 2017).

Women who are higher educated (Boucher et al., 2016; Lu et al., 2001; Riaz et al., 2016; Smedberg et al., 2015) and employed (Smedberg et al., 2015), are more likely to quit smoking once they find out that they are aware of their pregnancy. Being higher educated opens doors to better paid jobs, giving people financial means for preventive actions, including smoking cessation counselling and medication. A higher education can also be associated with greater health literacy, referring to cognitive and social skills enabling people to gain access to health services, understand and use information in ways which promote and maintain good health (World Health Organization, 7th Global Conference on Health Promotion: track themes, 2009). A higher level of health literacy is a determinant of smoking cessation during pregnancy (Smedberg et al., 2015). Understanding the information regarding the foetal and maternal health risks may motivate pregnant women to quit from smoking during their pregnancy, and make them more confident to maintain abstinence in negative situations during pregnancy (Crittenden et al., 2007). On the other hand, it is recognised that knowledge alone is not enough for smoking cessation (Naidoo and Wills, 2009). Pregnant smokers often minimize the associated foetal and maternal risks, which does not lead to quitting, especially if they experienced a previous uncomplicated pregnancy (Ingall and Cropley, 2010). The message regarding risks that health professionals should provide needs to be clear and consistent. Cutting down is not an effective method as compensatory smoking might occur, e.g. people shift to 'light' brands or inhale deeper (Ingall and Cropley, 2010). Comparing these results with our own findings, we found that midwives and gynaecologists listed the negative health consequences as possible motivations to quit smoking. They advised to reduce daily consumption during pregnancy over immediate and complete smoking cessation (study 1). Moreover, stressing exclusively the foetal and neonatal health risk can induce relapse after birth because the reason to quit no longer exists (Crittenden et al., 2007).

The increased BDI scores at all three time points in lower educated smoking women (study 3), might be explained by the meanings smoking has for these women. Smoking might be a way of dealing with stress caused by negative feelings or experiences, such as problems related to altered life circumstances, feelings of failure and guilt because of the impossibility to quit smoking, financial problems, problems of accommodation, a problematic relationship, or lack of support from their partner or significant others. These findings can be related to the results of study 2, where reasons for smoking in pregnant women were studied using the MRSS. The highest score was found for the subscale tension reduction, which indicates that stress was the main reason why pregnant women continued smoking. In total, 94 smokers disclosed their educational level: 26 of them (27.7%) had a bachelor or master degree, 68 (72.3%) had a secondary school certificate or less. In comparison, 359 (72.8%) non-smokers had a bachelor or master degree.

13.4. Study 4: Smoking cessation beliefs in relation to smoking status and intention to quit

Study 4 can be related to the intrapersonal and interpersonal level of the socio-ecological model.

We analysed the association between smoking cessation beliefs and smoking status, as well as with the intention to quit, using the TPB. The three main constructs of the TPB are attitude toward the behaviour, subjective norm and perceived behavioural control (Azjen, 1991).

Our results demonstrated a significant difference in the smoking cessation beliefs of the TPB between smokers and ex-smokers, after controlling for education and age.

A positive attitude toward smoking cessation was reported by ex-smokers, they were significantly more convinced that smoking cessation is favourable for the own health and the health of their unborn child. Literature shows that primiparous women (Gilbert et al., 2015; Palma et al., 2007; Smedberg et al., 2015) with a planned pregnancy (Smedberg et al., 2015), who enter adequate prenatal care in early pregnancy (Moore et al., 2016; Palma et al., 2007), and with a higher level of health literacy (Smedberg et al., 2015) are more likely to quit smoking during pregnancy. Clients are regularly exposed to health messages, and healthcare workers have greater opportunity to follow-up a quit

attempt. In the best case scenario, women plan their smoking cessation before pregnancy. Therefore, it is important to motivate couples to have at least one preconceptional consultation in order to give correct information regarding the maternal and neonatal health risks of smoking during pregnancy and the benefits of smoking cessation. Because preconceptional consults are still insufficiently known, also other moments should be ceased to promote smoking cessation, e.g. when contraception is discussed.

The majority of smoking women attempt to alter their smoking habits before or early in pregnancy by decreasing their daily intake or by quitting. Nevertheless, some women report increasing their tobacco consumption as a result of increased stress associated with the current pregnancy, changing roles as a (new) mother, and the guilt of not being able to quit smoking (McCurry et al., 2002). Self-reported guilt and sense of failure are two items assessed by the BDI-scale (Beck et al., 1988, study 3).

Ex-smokers were significantly more confident being able to deal with craving symptoms based on their own experience with smoking cessation. Because of the changes in nicotine metabolism (Bowker et al., 2015), a quit attempt seems to be more difficult during pregnancy, as effective medication (bupropion and varenicline) is prohibited due to the risk of malformations (NICE public health guidance 26, 2010). Research demonstrated that smokers believed that stress caused by a quit attempt is as dangerous as the risk of smoking (Flemming et al., 2014). This finding is also supported by additional non-published data from our sample of pregnant women in study 3 (table 20). Only 13.7% smokers (totally) disagreed with the statement 'It is better to reduce daily consumption than to be stressed by quitting altogether', compared to 51.9% in non-smokers. Significantly more non-smokers believed that 'reduction of daily consumption is not better than being stressed by quitting altogether' ($Chi^2 = 53.58$; $p < 0.001$). These results are in line with the information they received of their healthcare workers, who advise them to reduce their daily consumption, preferably to maximum 5 cigarettes per day (Study 1).

Smokers experienced more support to quit smoking before or early in pregnancy compared to ex-smokers. A pregnant woman is influenced by her environment, which can be related to the interpersonal level of the socio-ecological model.

Being married or having a partner is a determinant of smoking cessation (Moore et al., 2016; Riaz et al., 2016). Women without a partner are more likely to continue smoking during pregnancy (Oskardottir et al., 2016; Smedberg et al., 2015). Having a non-smoking partner is a determinant of smoking cessation (Boucher et al., 2016; Riaz et al., 2016). In contrast, living together with a smoker is associated with a higher risk of continued smoking during pregnancy (Gilbert et al., 2015; Homish et al., 2012). A non-smoking partner is perceived as someone who is able to give support during a quit attempt (Ingall and Cropley, 2010; Maxson et al., 2012). A supportive partner is an important source of support while a critical, unsupportive partner may be an additional source of strain (Maxson et al., 2012). Bottorff et al. (2006) illustrated the influence of the partner on women's success on quitting. Especially a non-smoking partner could be very supportive for a pregnant woman who made a quit attempt, so quitting reduced conflict and created a more peaceful environment. The reduction in conflict became a motivating factor in remaining abstinent (Bottorff et al., 2006). On the other hand, a partner can put pressure on the woman to cut down or to quit. This suggests that even at home women are marginalised and exposed to stigma regarding their smoking. Consequently, women have nowhere to escape from the daily stress and pressure to quit smoking, which can only increase their feelings of being ashamed and guilty about their smoking behaviour (Ingall and Cropley, 2010). In study 4, we found that ex-smokers experienced more disapproval from significant others before quitting compared to smokers. This could suggest that disapproval served as a facilitator for smoking cessation in our sample of pregnant women.

Ex-smokers reported higher perceived behavioural control, almost twice as high as smokers. This may indicate that they have already experienced difficult and tempting situations in which they were able to maintain abstinence. Self-efficacy is a corresponding construct to perceived behavioural control (Brug et al., 2012). This finding is in line with previous research, where higher levels of self-efficacy were associated with non-smoking rather than smoking. Several smokers would like to quit during pregnancy, but as they experience higher levels of negative feelings and less support, they may lose confidence in their ability to quit, preventing them from being successful in their smoking cessation attempts (Maxson et al., 2012).

There was no significant difference in the smoking cessation beliefs of the TPB between smokers with high or low intention to quit. This means that intention to quit in the present population of smoking pregnant women was not significantly associated with attitude, subjective norm, or perceived behavioural control and that other factors, such as stress (study 2) and depression (study 3), must be taken in consideration.

14. Strengths and limitations

14.1. Study design and study population

Several strengths and limitations in this PhD research should be discussed. Strengths are the use of multiple study designs (qualitative and quantitative, including longitudinal and cross-sectional design), the use of various analytical techniques (e.g., univariate and multivariate analyses, structural equation modelling, linear mixed models), the use of a theoretical framework (Theory of Planned Behaviour), the use of a biochemical test to validate the self-reported smoking status (CO-measurement), and the use of validated multi-item measures (Fagerström Test for Nicotine Dependence, Modified Reasons for Smoking Scale, Beck Depression Inventory) to investigate smoking and smoking cessation during pregnancy and postpartum in Flanders. To our knowledge, it was the first time that the MRSS (study 2) and the TPB (study 4) were tested in a sample of pregnant women, so the novelty of the sample should also be taken into account.

An overall limitation of this PhD research is the relatively small sample size of the studies. In study 2, data of only 97 smokers were eligible for analysis. Two types of recommendations are generally used to determine the required sample size for factor analysis: based on the minimum absolute number of cases (10 respondents/item) or based on the recommended minimum subject-to-variable ratio of 5:1 (Fabrigar et al., 1999; Henson and Roberts, 2006; MacCallum et al., 2001). The MRSS contains 21 items, this means that the sample size of 97 respondents was close to the recommended minimum of 105. Because of the longitudinal design of study 3, many respondents were lost to follow-up at T1 and/or T2, which also affected the sample size. Our own strict exclusion criteria for smokers and recent ex-smokers could also be considered as

a strength, because analyses were only performed on complete data sets (T0-T1-T2). In total, there was a relatively high dropout rate of 13.56%, more specifically 39.8% for smokers and 33.3% for recent ex-smokers. In comparison, the dropout rate in non-smokers was only 7.1%. Consequently, some of the groups are rather small. The high level of dropout might be explained by the lack of benefits or incentives associated with participation, resulting in a lower commitment to complete the survey at T1 and T2 (Crittenden et al., 2007). It is also known that a telephone survey in longitudinal research has a higher dropout rate than face-to-face contact, especially in respondents of low socioeconomic status because of inconsistent telephone availability (Biener et al., 2010; Crittenden et al., 2007). Smokers, especially smokers with a lower socioeconomic status, participate less easily in scientific research and drop out more often than non-smokers (Crittenden et al., 2007). In this study, the dropout percentage was comparable with other research, which reporting dropout of 43% in smokers and ex-smokers over a period of one year (Biener et al., 2010).

A strength of study 1 is the fact that the viewpoint of midwives and gynaecologists about their role in smoking cessation during pregnancy, has not been documented preciously in Flanders. In order to establish validity, several procedures were followed. First, investigator triangulation was used in the analysis process. Second, there was an active search for 'negative' cases, which didn't fit the pattern. Finally, extensive field notes describing the context and emotions of the interviewee and the role of the interviewer, were taken. Member checking, the participant views of the credibility of interpretations and findings based on the transcripts of the interviews, was not used. A limitation of this study is the number of participants involved in the study. Only eight gynaecologists and nine midwives agreed to participate, despite the fact that all 467 registered gynaecologists and 198 independent midwives in Flanders received an invitation and a reminder. This may indicate that only healthcare providers with special interest in the topic agreed to participate. Regardless of this small sample size, the predefined number of respondents (between 12 and 20) as well as data saturation were achieved. A second limitation is the fact that qualitative studies are contextual, which means that the results should be related to the context of the study, more specifically gynaecologists and midwives performing prenatal consultations in Flanders. This does not imply that these findings have no meaning in other contexts or coun-

tries, but that they must be interpreted in relation to or be replicated in other contexts before transferring them to these contexts.

The cross-sectional design of study 4 has the weakness of being inconclusive about the direction of observed relationships. Therefore we could only examine an association and no causal relation among smoking status, intention to quit, and smoking cessation beliefs of the TPB. The TPB itself has also some limitations. It is a rational model, which assesses individual behaviour. Not all behaviour is rational, e.g. behaviour linked with an addiction such as smoking. The weight of each determinant of the TPB may vary over cultures, subpopulations and contexts. The meaning of health, environmental factors, life styles, determinants of behaviour, media characteristics, or settings may differ across cultural groups. Beliefs may be different, but beliefs will influence behaviour (Bartholomew et al., 2006). The use of self-reported measures of behaviours tends to overestimate the variance explained by the TPB compared to observed behaviour. The first may be influenced by recall bias or social desirability (Lheureux et al., 2016).

Finally, a possible recall bias among respondents should be taken into consideration. Some pregnant women have been forgotten which questions their gynaecologist or midwife had asked and what kind of advice had been given. Some of the ex-smokers had already quit several weeks or months before T0, which could make it more difficult to remember how they experienced support from significant others before or early in pregnancy.

14.2. Measurements

Regarding the use of the CO-measurement, there are some limitations. The research team was present during prenatal consultations in two hospitals (Sint-Niklaas, Ghent) to recruit respondents (T0). At these locations, all respondents were asked to fill out the first questionnaire. In order to reduce the risk for socially desirable answers, these respondents were also invited for a CO-measurement using the Smokerlyzer Micro (Bedfont Scientific Ltd.). CO-levels were defined in 257 women; eight respondents could not be tested because of lack of time. At T1 and T2, questionnaires were answered by telephone. Three hundred and forty respondents did not perform the CO-test, because they were recruited through the prenatal consultation of 12 gynaecologists

and 10 midwives, geographically spread over Flanders. These 340 respondents answered the questionnaires at all three time points by telephone. It could be possible that not every woman disclosed her smoking behaviour if there was no biochemical validation of the self-reported smoking status (Shipton et al., 2009). On the other hand, data collection through impersonal telephone interviews (Crittenden et al., 2007), asking questions about smoking in a neutral way and giving respondents a choice between multiple answers increases the likelihood of obtaining correct answers (Lindqvist et al., 2002).

Another limitation is the conflicting literature regarding the cut off-point of the CO-measurement. We used a cut off-point of 6 ppm, which means that every respondent with a test result of 6 ppm or more was categorized as smoker. Only 2 self-reported non-smokers had a CO-level ≥ 6 ppm. One of them refused further cooperation at T1 and T2. The other woman disclosed her smoking behaviour afterwards and explained that she lied because her partner, convinced of her abstinence, was present at the CO-measurement. This illustrates the fact that a partner can put pressure on a pregnant woman, who feels so guilty and ashamed, that she lied about her smoking behaviour.

More recent research advises a cut-off point of 4 ppm (Bailey, 2013). This cut-off point had a sensitivity[8] of 90% and specificity[9] of 92%, identifying most pregnant smokers, especially those who have smoked at least 5 cigarettes in the last 24 hours (Bailey, 2013). However, the short half-life of CO is approximately 1 to 4 hours, therefore CO-measurement may not detect low levels of smoking (Usmani et al., 2008). In our study, we found five self-reported smokers with a CO-level lower than 6 ppm (1 ppm (n = 1); 4 ppm (n = 3); 5 ppm (n = 1)), hence, they were all classified as smokers. Using the cut-off point of 4 ppm as advised by Baily (2013), 25 respondents from our study population should be classified as smokers. Twenty-two self-reported non-smokers had a CO-level of 4 or 5 ppm, they were classified as non-smokers. Three recent ex-smokers had a CO-result of 4 or 5 ppm and consequently classified as ex-smoker. It is possible that these respondents were incorrectly classified, because of the short half-life of CO. Sensitivity and specificity in our sample with a cut-off point of 6 ppm was respectively 89% and

[8] % of smokers classified correctly
[9] % of non-smokers classified correctly

98%. If a cut-off point of 4 ppm would be used, the sensitivity would be 92%, which is close to the specificity in our sample, the specificity was much lower, 87%.

The use of the BDI-scale can also be discussed. This scale was preferred to the Edinburgh Postnatal Depression Scale (EPDS) for assessment of depression symptoms. Both scales are based on self-report. The BDI is internationally recognized, available in a validated Dutch version, and commonly used as a longitudinal metric for depression, as in our study (Marcus, 2009). Research shows that both scales, BDI and EPDS, are highly predictive in identifying depressive disorders during pregnancy and postpartum (Ji et al., 2011). The BDI-scale contains 21 items, including sadness, pessimism, sense of failure, dissatisfaction, guilt, expectation of punishment, self-dislike, self-accusations, suicidal ideas, crying, irritability, social withdrawal, indecisiveness, body image change, work difficulty, insomnia, fatigue, loss of appetite, weight loss, somatic preoccupation, and loss of libido (Beck et al., 1988). Because of the sensitivity of the instrument, however, normal symptoms in pregnancy can sometimes be misconstrued as indicators of depression, and can lead to higher scores on self-report measures (Castro e Couto et al., 2015; Marcus, 2009). It is important for healthcare workers to take this into account. Nevertheless, results of individual items of the BDI showed that there was no significant difference in these items between smokers, recent ex-smokers and non-smokers (section 13.3). Comparison of these scales showed that the BDI has better psychometric properties than the more widely used EPDS and should thus be used preferentially (Castro e Couto et al., 2015). Moreover, the BDI is also used in several recent research regarding antenatal depression (Batmaz et al., 2015; Castro e Couto et al., 2015; Terzioglu et al., 2016).

15. Recommendations and directions for future research

Numerous recommendations and directions for future research, based on the socio-ecological model, can be made.

Within the intrapersonal level of the socio-ecological model, several recommendations can be formulated. Midwives and gynaecologists are used to perform an assessment of the personal, familial, and obstetrical history of their clients. Furthermore, it is important to assess an exten-

sive smoking history in order to get an overview of the smoking behaviour of the woman and her potential motivation to quit smoking. This involves asking questions about the amount of cigarettes smoked per day before and during pregnancy, as well as whether she is smoking alone or in group, whether her partner is smoking, and if she undertook already a quit attempt. Scales, such as the FTND, MRSS, and the BDI, can facilitate the dialogue between client and healthcare professional. It is essential to identify smoking women who are at risk for continued smoking during pregnancy: e.g. women with a low education, a low SES, a teen pregnancy, an unhealthy lifestyle, and low health literacy. Smoking cessation counselling should be tailored to the individual needs and possibilities, thereby taking into account their health literacy and paying attention to an adequate methodology (e.g., using appropriate language and didactical tools). Some women may need additional care and besides smoking cessation counselling also treatment for depression or stress reduction sessions. Also referral to social services can be taken into account. Our results showed that low educated smoking women are the most vulnerable and require additional care.

Besides collecting data by questionnaires in pregnant women, further research could concentrate on performing focus groups or interviews with low educated smoking pregnant women in order to ask in-depth questions about their reasons for continued smoking and the specific counselling or therapy they need or prefer. This is the most vulnerable group, who is difficult to reach, but they can benefit the most of combined care, including prenatal care, smoking cessation counselling, and psychological support. Also interviewing ex-smokers could give insight in strategies that are effective, also for low educated women.

There was no significant difference in the smoking cessation beliefs of the TPB between smokers with high or low intention to quit. Further research could focus on a possible effect of the determinants of the TPB on intention to quit and smoking cessation using a longitudinal design or a larger sample.

Within the interpersonal level of the socio-ecological model, support of the partner and significant others is an important determinant. When possible, the (smoking) partner should also be involved in the smoking cessation advice. Further studies should address and examine the impact of partner support in smoking cessation and relapse prevention, especially in low educated couples and recent ex-smokers.

Within the organizational level of the socio-ecological model, incentives can be used as a reward for health behaviour change, but this remains controversial. The use of incentives is not (yet) established in Flanders. It could be considered to provide financial or material incentives to pregnant women, who remain abstinent. Incentives during pregnancy should be complemented with smoking cessation counselling in order to prevent relapse after birth. Further research could focus on the effect of incentives on quit and relapse rate in Flanders.

Within the community level of the socio-ecological model, the effectiveness of the smoking cessation interventions and strategies should be considered. Research demonstrates that interventions provided by trained professionals result in higher quit rates compared to untrained professionals (Carson et al., 2012; Chertok and Archer, 2015; Okoli et al., 2010). This training could be a combination of theoretical and practical exercises based on the use of the 5 A's framework and motivational interviewing (Chertok and Archer, 2015; Flemming et al., 2016). Also increasing the knowledge regarding NRT should be included. Another perhaps more effective strategy in Flanders is to of use an abbreviated version of the 5 A's framework, in particular the AAR-method. It could be recommended that healthcare professionals take the smoking history of the client using records with a template based on the AAR-framework. The role of the midwife and gynaecologist is then limited to asking questions about smoking behaviour, providing brief advice, determining the readiness to quit and referring their clients to a tobaccologist. Further research should focus on the implementation of the AAR-method in order to increase the number of pregnant women who quit smoking.

In order to prevent relapse in postpartum, it should be considered to provide pre- and post-pregnancy interventions, with a scope on both foetal/neonatal and women's health consequences (Boucker and Konkle, 2016).

Also the use of complex interventions, a combination a several interconnecting interventions, could be considered. These are usually non-pharmacological interventions, for example interventions directed at health professionals' behaviour, individual or community based interventions, or group interventions (Campbell et al., 2000; Craig et al., 2012). The combination of several interventions could increase the

cumulative effect compared to the effect of every single intervention: e.g.

- Individual counselling sessions complemented with a brochure and an app
- Group sessions in combination with an incentive for maintaining abstinence
- Combination of counselling with NRT and an informative website

Regardless the kind of intervention(s), the message given by health care providers should be clear: immediate and complete cessation, ideally before pregnancy, is preferred over decreased consumption of tobacco. Unclear messages, such as reduction of daily consumption, provoke uncertainty or leave room for interpretation.

Smoking during pregnancy has both ethical, legally and political aspects. This can be related to the public policy level of the socio-ecological model. It is the main duty of the government to protect the public from harm. The foetus is not able to protect itself. Ethically, this is a strong argument that policymakers, and society as a whole, should protect its children by legally restricting the distribution and trading of tobacco (Maxson et al., 2012). Since 1976, Belgium instituted a phased-in ban on smoking in public places including public transport, general workplaces, and educational institutions. A phased-in smoking ban in the hospitality sector was instituted since 1/1/2007 in restaurants and 1/7/2014 in bars. It should be recommended that policy makers expand the smoking ban, for example to cars, play grounds, and theme parks, and that offenders should be penalized.

Increased taxes on tobacco products could possibly induce smoking cessation, under the condition that the price of tobacco products rises preferably with 50%. These incomes could be used for incentives, reimbursements, or for the implementation of smoking cessation interventions (Flemish Institute for Prevention of Diseases and Health Promotion, 2011).

Finally, within the supranational level of the socio-ecological model, further research on effective smoking cessation interventions (in Flanders) should be performed. This research could target specific groups, e.g. pregnant women and their partner, low SES-couples, and pregnant teenagers. Also research on the safety and use in a quit program of

NRT and the e-cigarette in pregnancy is useful. These results are essential in updating the national and international guidelines on smoking cessation during pregnancy.

Several governmental services and health promotion organizations in Flanders and the Netherlands provide posters, leaflets and brochures regarding a zero-tolerance for tobacco, alcohol and drugs during pregnancy, which can be freely downloaded from the Internet. These self-help materials can also be ordered against payment, varying between €0.50 and €0.95 for one brochure. However, the use of these brochures in prenatal consultations is rather limited, probably because of the relatively high cost for the healthcare professional. It should be recommended that leaflets on one topic, e.g. smoking cessation during pregnancy, are distributed free of charge to midwives and gynaecologists performing prenatal consultations. The distribution of the self-help material can also be an opportunity to enhance their knowledge concerning smoking cessation interventions, NRT, and the e-cigarette, if the self-help material is complemented with an update of the latest research.

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Summary

Tobacco use is an alarming public health problem worldwide and causes significant morbidity and mortality. Globally, 22% of the world's population over 15 years are estimated to be current tobacco smokers, including 36% men and 8% women. Among the global population of smokers, women are a subpopulation that have proven to be particularly vulnerable to the adoption and effects of tobacco use over their lifespan. In Flanders, the prevalence of smoking is 22%, the prevalence of smoking during pregnancy is 12.3%.

Cigarette smoke contains over 4000 chemical constituents and additives including nicotine, carbon monoxide, several known carcinogens, toxic heavy metals, and many toxic chemicals. Prenatal tobacco exposure results in alterations in foetal blood flow and protein metabolism as well as the accumulation of certain chemicals both in the mother and the foetus. Each of these constituents can contribute to or cause adverse health consequences.

Smoking affects both male and female fertility in their reproductive age. Smoking during pregnancy is one of the single most important avoidable cause of adverse pregnancy outcomes, e.g. foetal loss, ectopic pregnancy, placental abruption, placenta praevia, preterm birth, premature rupture of membranes, low birth weight, small for gestational age, and sudden infant death syndrome.

Within the health promotion field, ecological approaches can be used to better understand determinants of behaviour, such as smoking, because these models are multifactorial and target environmental, behavioural, and social policy changes that help individuals to adopt a healthy behaviour. Therefore, the socio-ecological model was chosen to describe determinants of smoking cessation during pregnancy.

The overall aim of this PhD research was to improve insight into the determinants of smoking and smoking cessation among Flemish women during pregnancy and postpartum. In this thesis, one qualitative and three quantitative studies are presented, each related to one or more levels of the socio-ecological model.

The first study can be linked to the organizational, community and public policy level of the socio-ecological model. The objectives of this study were (1) to explore knowledge, beliefs and practice among mid-

wives and gynaecologists concerning smoking cessation several years after the implementation of a smoking cessation policy for pregnant women and their partners and (2) to assess the role of midwives and gynaecologists in smoking cessation in pregnant women in Flanders. A qualitative study was performed using semi-structured interviews with nine midwives and eight gynaecologists. The findings demonstrate that respondents had sufficient knowledge regarding specific health risks of smoking during pregnancy, but showed a gap regarding the use of NRT. The 5 A's framework was partially used in their contact with the pregnant women. "Ask", "Advice" and to a lesser extent "Assist" were implemented in smoking cessation communication. Lack of time, lack of communication skills in sensitive topics such as smoking cessation, and fear of provoking resistance were identified as barriers for giving smoking cessation advice to pregnant women. Therefore, training in smoking cessation counselling is desirable. Another possibility is to refer clients to a specialist like the tobaccologist

The second study examined the intra- and interpersonal level of the socio-ecological model. The main objective of this observational, prospective, non-interventional study was (3) to test the factorial structure, validity and reliability of the Dutch version of the Modified Reasons for Smoking Scale in a sample of 97 smoking pregnant women at two data collection points (< 16 weeks and 32-34 weeks). In addition, we wanted (4) to obtain more insight into the reasons for continued smoking during pregnancy and into the profile of pregnant smokers, which is necessary knowledge to develop tailored interventions or appropriate counselling. We identified five subscales with good to (borderline) acceptable internal consistency and good to acceptable test-retest stability. In order of importance, those scales were: tension reduction, social function, pleasure, addiction and habit. Concurrent validity of the MRSS subscales in relation to several variables was examined. We found a significant relationship between daily consumption and the subscale addiction and between nicotine dependence and the subscales tension reduction and addiction. The results of this study suggest that the MRSS can be used during prenatal consultation to identify possible reasons for continued smoking in order to find motives for quitting.

Associations between feelings of depression, smoking behaviour, and educational level during pregnancy have been documented. Research shows that feelings of depression may contribute to persistent smoking

during pregnancy. However, there is a lack of longitudinal studies on feelings of depression in women with different antepartum and postpartum smoking patterns. Study 3 can be linked to the intrapersonal level of the socio-ecological model. We conducted a longitudinal study in order (5) to obtain insight into the associations between smoking patterns and depressive feelings during pregnancy and postpartum, taking into account several sociodemographic characteristics. We performed an observational, prospective, non-interventional study, using the Beck Depression Inventory (BDI) to assess symptoms of depression. Data were collected during two stages of pregnancy (< 16 weeks and 32-34 weeks) and during postpartum (> 6 weeks) in 523 Flemish women. It was concluded that recent ex-smokers reported less symptoms of depression compared with smokers and initial smokers, independent of their educational level. This may suggest that smoking cessation shortly before or early in pregnancy does not aggravate depressive symptoms during pregnancy and postpartum. Mean BDI scores decreased in postpartum, except in low educated smokers, where BDI scores remained constantly above the threshold for dysphoria during pregnancy and postpartum. This may suggest that smoking could be a way of coping with difficult life conditions.

A useful theoretical framework to capture smoking cessation beliefs is the Theory of Planned Behaviour (TPB). The fourth study can be related to the intra- and interpersonal level of the socio-ecological model. The aims of the this observational study were (6) to analyse the association between smoking cessation beliefs and smoking status, and (7) to analyse the association between smoking cessations beliefs and intention to quit smoking, using the Theory of Planned Behaviour in pregnant smokers and ex-smokers. A questionnaire was used; data were collected from 264 Flemish pregnant smokers and ex-smokers < 16 weeks of pregnancy. We found that there was a significant difference in smoking cessation beliefs of the TPB between smokers and ex-smokers, after controlling for education and age. Hence, our results suggest that attitude, subjective norm, and perceived behavioural control are associated with smoking behaviour in pregnant women. Ex-smokers were significantly more convinced than smokers that smoking cessation is favourable for their own health and the health of their unborn child, and that they were able to deal with craving symptoms based on their own experience with smoking cessation. Ex-smokers experienced more disapproval from significant others compared to smokers. There was

no significant difference in smoking cessation beliefs of the TPB between respondents with low and high intention to quit smoking. Therefore, the theory could not be confirmed for intention to quit smoking in pregnant women.

After presenting and discussing the results, recommendations and directions for further research are formulated, based on the socio-ecological model. Healthcare professionals who perform prenatal consultations, should carry out an extensive smoking history assessment in order to get insight in the smoking behaviour of their clients and to refer the motivated ones to a tobaccologist. If necessary, additional care, such as psychological support or stress reduction sessions, should be provided. Also the partner should be involved in order to provide support. Interventions delivered by trained healthcare professionals are the most effective and have the highest quit rates. Therefore, a combination of theoretical and practical training is recommended. The use of incentives for clients who remain abstinent should be considered. Expanding the smoking ban to places with families and young children as well as increasing taxes on tobacco products should be considered. Finally, further research should focus on partner support, especially in socially deprived couples, and the use of NRT and the e-cigarette during pregnancy.

Samenvatting

Tabaksgebruik is een zorgwekkend internationaal gezondheidsprobleem en gaat gepaard met een significante morbiditeit en mortaliteit. Men schat dat 22% van de wereldbevolking ouder dan 15 jaar tabak gebruikt, waarvan 36% mannen en 8% vrouwen. Binnen deze populatie van rokers vormen vrouwen een subgroep die zeer vatbaar is om te starten met roken, met alle bijhorende negatieve gevolgen. De prevalentie van roken in de algemene Vlaamse populatie bedraagt 22%, tijdens de zwangerschap is dit 12.3%.

Sigarettenrook bevat meer dan 4000 chemische bestanddelen en additieven, waaronder nicotine, koolstofmonoxide, verschillende gekende carcinogenen, giftige zware metalen en toxische chemicaliën. Prenataal tabaksgebruik veroorzaakt veranderingen in de foetale bloedstroom en het eiwitmetabolisme. Bovendien stapelen de chemicaliën zich op, zowel bij de moeder als bij de foetus. Alle bovenvermelde bestanddelen van tabak kunnen gezondheidsproblemen veroorzaken of verergeren.

Roken beïnvloedt zowel de mannelijke als de vrouwelijke vruchtbaarheid tijdens de reproductieve leeftijd. Roken tijdens de zwangerschap is één van de belangrijkste oorzaken van ongunstige zwangerschapsuitkomsten, b.v. miskraam, ectopische zwangerschap, placenta solutio, placenta praevia, preterme geboorte, vroegtijdig breken van de vliezen, laag geboortegewicht, dysmaturiteit en wiegendood.

Binnen de gezondheidspromotie kan een ecologische benadering gebruikt worden om de determinanten van gedrag, zoals roken, beter te begrijpen. Deze modellen zijn multifactorieel en focussen op omgevings- en gedragsverandering en op wijzigingen in het beleid op sociaal vlak met als doel een individu te helpen om een gezond gedrag aan te nemen. Daarom werd het sociaal-ecologisch model gekozen om de determinanten van rookstop tijdens de zwangerschap te beschrijven.

De algemene doelstelling van dit doctoraat was het verbeteren van het inzicht in de determinanten van roken en rookstop bij Vlaamse vrouwen tijdens de zwangerschap en het postpartum. Er worden één kwalitatieve en drie kwantitatieve studies voorgesteld, elk gerelateerd aan één of meer niveaus van het sociaal-ecologisch model.

De eerste studie kan gelinkt worden aan drie niveaus van het sociaal-ecologisch model: de organisatie van gezondheidszorg, de heersende

waarden en normen in een gemeenschap en het sociaal-politiek kader. De doelstellingen van deze studie waren (1) het in kaart brengen van kennis, overtuigingen en praktijkvoering van vroedvrouwen en gynaecologen betreffende rookstop, verschillende jaren na het invoeren van een nationaal rookstopbeleid voor zwangere vrouwen en hun partner en (2) het bestuderen van de rol van vroedvrouwen en gynaecologen binnen rookstopbegeleiding tijdens de zwangerschap in Vlaanderen. Er werd een kwalitatieve studie uitgevoerd aan de hand van semi-gestructureerde interviews bij negen vroedvrouwen en acht gynaecologen. De bevindingen toonden aan dat de respondenten beschikten over voldoende kennis in verband met de specifieke gezondheidsrisico's van roken tijdens de zwangerschap, maar er werd een hiaat vastgesteld in de kennis rond het gebruik van nicotinesubstitutietherapie (NST). Het 5 A's raamwerk werd gedeeltelijk gebruikt in het contact met zwangere vrouwen. De stappen "Ask" [vraag], "Advise" [adviseer] en in mindere mate "Assist" [help] werden geïmplementeerd in hun communicatie rond rookstop. Tijdsgebrek, het missen van de gepaste communicatietechnieken om gevoelige onderwerpen, zoals rookstop, bespreekbaar te maken en angst om weerstand uit te lokken, werden geïdentificeerd als barrières om rookstopadvies te geven aan zwangere vrouwen. Daarom is een aangepaste opleiding in rookstopbegeleiding wenselijk. Een andere mogelijkheid is om de rokende cliënten door te verwijzen naar een specialist zoals een tabakoloog.

De tweede studie kan gerelateerd worden aan het intra- en interpersoonlijk niveau van het sociaal-ecologisch model. De hoofddoelstelling van deze observationele, prospectieve, niet-interventionele studie was (3) het testen van de onderliggende factoren, validiteit en betrouwbaarheid van de Nederlandstalige versie van de *Modified Reasons for Smoking Scale* in een populatie van 97 zwangere vrouwen op twee momenten (< 16 weken en tussen 32-34 weken zwangerschap). Bovendien beoogde de studie om (4) meer inzicht te verwerven in de redenen waarom een vrouw blijft roken tijdens de zwangerschap en in het profiel van een zwangere rookster, wat nodig is om rookstopinterventies op maat van deze doelgroep te ontwikkelen. Vijf subschalen werden geïdentificeerd met goede tot aanvaardbare interne consistentie. In volgorde van belangrijkheid waren dit stressreductie, sociale functie, genot, verslaving en gewoonte. De concurrente validiteit van de subschalen van de MRSS in relatie tot verschillende variabelen werd eveneens bestudeerd. We vonden een significant verband tussen dagelijkse consumptie van

tabak en de subschaal verslaving en tussen afhankelijkheid van nicotine en de subschalen stressreductie en verslaving. De resultaten van deze studie suggereren dat de MRSS kan gebruikt worden tijdens een prenatale consultatie om de mogelijke redenen waarom de zwangere blijft verder roken te identificeren met als doel motieven voor rookstop te vinden.

Associaties tussen gevoelens van depressie, rookgedrag en opleidingsniveau tijdens de zwangerschap werden reeds beschreven in de literatuur. Onderzoek toont aan dat gevoelens van depressie onafhankelijk kunnen bijdragen tot het verder roken tijdens de zwangerschap. Er is echter een gebrek aan longitudinale studies die de gevoelens van depressie bij verschillende rookpatronen tijdens de zwangerschap en in het postpartum in kaart brengen. Studie 3 kan gerelateerd worden aan het intrapersoonlijk niveau van het sociaal-ecologisch model. Er werd een longitudinale studie uitgevoerd met als doel (5) inzicht te verwerven in de verbanden tussen rookpatronen en depressieve gevoelens tijdens zwangerschap en postpartum, rekening houdend met verschillende socio-demografische variabelen. Er werd een observationele, prospectieve, niet-interventionele studie opgezet, waarbij gebruik werd gemaakt van de *Beck Depression Inventory* (BDI) om symptomen van depressie te registreren. Gegevens werden verzameld bij 523 Vlaamse vrouwen op twee momenten tijdens de zwangerschap (< 16 weken en tussen 32-34 weken) en in het postpartum (> 6 weken). Recente exrokers rapporteerden minder symptomen van depressie vergeleken met rokers en initiële rokers, onafhankelijk van hun opleidingsniveau. Dit zou suggereren dat rookstop kort voor of in het begin van de zwangerschap depressieve symptomen tijdens zwangerschap en postpartum niet verergert. De gemiddelde BDI-score zakte in het postpartum, behalve bij de laag opgeleide rokers. Bij hen bleef de BDI tijdens zwangerschap en postpartum constant boven de drempel voor dysforie. Dit zou kunnen betekenen dat roken voor hen een manier is om met moeilijke levensomstandigheden om te gaan.

De theorie van het gepland gedrag (*Theory of Planned Behaviour*, TPB) is een bruikbaar theoretisch kader om overtuigingen in verband met rookstop te bestuderen. De vierde studie kan gelinkt worden aan het intra- en interpersoonlijk niveau van het sociaal-ecologisch model. De doelstellingen van deze observationele studie waren het analyseren van het verband (6) tussen overtuigingen bij rookstop en rookgedrag, en (7)

tussen overtuigingen bij rookstop en intentie om te stoppen met roken, gebruikmakend van de TPB bij zwangere rokers en ex-rokers. Gegevens van 264 Vlaamse zwangere rokers en ex-rokers werden verzameld aan de hand van een vragenlijst, afgenomen vóór 16 weken zwangerschap. Er werd een significant verschil vastgesteld in de factoren van de TPB tussen rokers en ex-rokers, onafhankelijk van opleidingsniveau en leeftijd. Bijgevolg suggereren deze resultaten dat attitude, subjectieve norm en ingeschatte beheersing van het gedrag verband houden met rookstop tijdens de zwangerschap. Ex-rokers waren significant meer overtuigd dat rookstop voordelen had voor hun gezondheid en die van hun ongeboren kind in vergelijking met rokers. Bovendien vonden ex-rokers dat ze meer in staat waren om met ontwenningsverschijnselen om te gaan, gebaseerd op hun eigen ervaring met rookstop in vergelijking met rokers. Tot slot ervaarden ex-rokers meer afkeuring van belangrijke derden in vergelijking met rokers. Er was geen significant verschil in de factoren van de TPB tussen respondenten met een hoge en een lage rookstopintentie, onafhankelijk van opleidingsniveau en leeftijd. Bijgevolg kan de theorie niet bevestigd worden voor rookstopintentie bij zwangere vrouwen.

Na de presentatie en de discussie van de resultaten zijn aanbevelingen en suggesties voor verder onderzoek geformuleerd, gebaseerd op het sociaal-ecologisch model. Gezondheidswerkers die prenatale consultaties doen, dienen een uitgebreide rookanamnese af te nemen met als doel inzicht te verwerven in het rookgedrag van hun cliënten en de gemotiveerden door te verwijzen naar een tabakoloog. Indien dit noodzakelijk blijkt, dient er bijkomende zorg, b.v. psychologische begeleiding of relaxatiesessies, aangeboden worden. Ook de partner zou betrokken moeten worden, zodat deze aangepaste ondersteuning kan bieden. Rookstopinterventies die verstrekt worden door opgeleide gezondheidswerkers blijken het meest effectief en hebben de hoogste stopcijfers. Daarom is een theoretische opleiding in combinatie met praktijkoefeningen aanbevolen. Het gebruik van (financiële) beloningen voor cliënten die rookvrij blijven, kan hierbij overwogen worden. Een uitbreiding van het rookverbod naar plaatsen waar gezinnen met jonge kinderen komen, net als een verhoging van de taksen op tabaksproducten kan eveneens in overweging genomen worden. Tot slot kan verder onderzoek zich toespitsen op steun door de partner, vooral bij koppels in kansarmoede, en op het gebruik van nicotinesubstitutie en de elektronische sigaret tijdens de zwangerschap.

Curriculum vitae

Personalia

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Education

30th April 2015:	C1 Academic English – IELTS, British Council of Brussels
1998-1999:	Geaggregeerde voor het secundair onderwijs – groep 2 – in de sociale gezondheidswetenschappen, graduated at Ghent University of Ghent
1995-1999:	Licentiaat in de medisch-sociale wetenschappen, graduated at Ghent University of Ghent
1987-1988:	Vroedvrouw, graduated at Hoger Instituut Maria Middelares of Sint-Niklaas
1984-1987:	Gegradueerde ziekenhuisverpleegster, graduated at Hoger Instituut Maria Middelares of Sint-Niklaas

Professional Experience

2017-present:	Head of Midwifery education (40%), head of Nursing education (40%) and Lector Midwifery (20%) at University College Odisee of Sint-Niklaas
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1999-2003:	Lector Midwifery (100%) at Catholic University College Sint-Lieven of Sint-Niklaas
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1988-1995:	Midwife at Onze Lieve Vrouw van Troost of Dendermonde

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