

# Smoking, pregnancy and fertility

December 2021

## Introduction

Smoking during pregnancy is the leading modifiable risk factor for poor birth outcomes, including stillbirth, miscarriage, and pre-term birth.<sup>1 2</sup> Smoking during pregnancy also increases the risk of children developing several respiratory conditions, attention and hyperactivity difficulties, learning difficulties, problems of the ear, nose and throat, obesity, and diabetes.<sup>1 3 4</sup>

As of 2020/21, 9.5% of women were smoking at the time of delivery, which equates to around 51,000 babies born to pregnant smokers in England each year.<sup>5</sup> Rates of smoking in pregnancy have a strong social and age gradient with poorer and younger women much more likely to smoke in pregnancy.<sup>6</sup>

In the 2017 Tobacco Control Plan for England, the Government set a target of reducing the prevalence of smoking during pregnancy to less than 6% by 2022, measured as smoking at the time of delivery (SATOD).<sup>7</sup> However, to achieve this ambition smoking in pregnancy rates would need to decline by 3.5 percentage points by 2022, almost as much as the total decline over the last decade.

This fact sheet reviews the prevalence of, and harm caused by smoking during pregnancy as well as some of the longer-term health risks faced by children born to parents who smoke. It also examines the impact of smoking on fertility.

## Smoking in pregnancy and coronavirus

COVID-19 is a respiratory viral infection that affects the lungs and airways. It is caused by a novel virus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).<sup>8</sup> This virus has been responsible for millions of infections and deaths worldwide since it emerged in December 2019 and was declared a pandemic in March 2020.<sup>9 10</sup>

While data on the link between smoking and COVID-19 is of mixed quality, there is now good evidence to suggest that smoking increases the risk of severe COVID-19 symptoms. A UK study published in January 2021 by researchers from Imperial College London, King's College London, and the ZOE symptom tracking app suggests that current smokers who get coronavirus are twice as likely to attend hospital and tend to report more symptoms than non-smokers.<sup>11</sup> A more recent study published in September 2021 found that current smokers were 80% more likely to be admitted to hospital and significantly more likely to die from COVID-19.<sup>12</sup> The researchers combined genetic data with data from primary care records, COVID-19 test results, hospital admissions data and death certificates.

Similarly, the evidence on the impact of COVID-19 during pregnancy is still developing. At the time of publication there was no data suggesting an increased risk of miscarriage or early pregnancy loss or a problem with the baby's development in relation to COVID-19.<sup>13</sup> NHS guidance about pregnancy and coronavirus is available [here](#).

This mixed and developing evidence on smoking and COVID-19 should be put in the context of the proven risks of both smoking and smoking during pregnancy. Smoking damages the heart and lungs and weakens the immune system, making it more likely that smokers will get complications and take longer to recover from illnesses. Pregnant women who smoke are much more likely to experience negative birth outcomes such as stillbirth and miscarriage or contract infections such as pneumonia.<sup>1 14</sup>

Evidence shows that smoking tobacco, and being exposed to secondhand tobacco smoke, is associated with significantly increased risk of developing respiratory diseases in children and adults.<sup>15</sup> Tobacco smoke weakens the immune system and its capacity to respond to infections which can put you at risk of severe respiratory diseases.<sup>16</sup>

For further information see the British Heart Foundation webpage: [Does smoking increase or reduce your risk from coronavirus?](#)

## Inequalities and smoking in pregnancy

Smoking during pregnancy is a health inequality associated with complications in pregnancy, stillbirths, neonatal death and serious long-term health implications for both mothers and their babies.<sup>17</sup> There are big variations in maternal smoking rates, depending on age, geography, socio-economic status, and ethnicity.<sup>6</sup>

18

Women from disadvantaged backgrounds are more likely to smoke before pregnancy; less likely to quit in pregnancy and, among those who quit, more likely to resume after childbirth.<sup>19 20</sup> A survey conducted in the UK, reveals 40% of mothers in routine and manual occupations were the most likely to have smoked before or during pregnancy compared to mothers in managerial and professional occupations (14%).<sup>21</sup> Younger women are also more likely to smoke during pregnancy. In 2017/18, 31% of women aged under 20 were current smokers at their booking appointment compared to just 6% of women over the age of 40.<sup>22</sup>

In Scotland 26.6% of pregnant women in the most deprived quintile were smokers at booking, compared to 3.3% in the least disadvantaged group.<sup>23</sup> A similar trend was found in Northern Ireland.<sup>24</sup>

Pregnant women are also more likely to smoke if they are less educated, live in a community with high smoking rates, single or have a partner that smokes.<sup>6 20</sup> Women who live with a smoker are six times more likely to smoke throughout pregnancy. Additionally, those who live with a smoker and manage to quit are more likely to relapse once the baby is born.<sup>21 25</sup>

For further information about the association between smoking and health inequalities See ASH's Briefing: [Health Inequalities and Smoking](#)

# Impact of maternal smoking on pregnancy outcomes and the baby's health

Smoking during pregnancy, or exposure to second-hand smoke (SHS), restricts oxygen to the baby causing its heart to work faster and exposing it to harmful toxins.<sup>26</sup> As a result, it is responsible for an increased rate of stillbirths, miscarriages, low birthweights (babies who are born weighing less than 2,500 grams),<sup>27</sup> and birth defects. It also significantly increases the risks of sudden infant death syndrome (SIDS) and adverse health effects in children after birth.<sup>6 27</sup>

A report published by the Royal College of Physicians in 2010 estimated that in the UK, smoking during pregnancy causes up to 5,000 miscarriages, 300 peri-natal deaths and around 2,200 premature births each year.<sup>27</sup> Table 1 shows the increased risk of negative birth outcomes resulting from smoking and exposure to second-hand smoke during pregnancy.

**Table 1: Impact of smoking and exposure to secondhand smoke during pregnancy**

	<b>Maternal Smoking</b>	<b>Secondhand smoke exposure</b>
<b>Low Birth Weight</b>	2 times more likely	Average 30-40g lighter
<b>Heart Defects</b>	25% more likely	Increased risk
<b>Stillbirth</b>	47% more likely	Possible increase
<b>Preterm birth</b>	27% more likely	Possible increase
<b>Miscarriage</b>	32% more likely	Increased risk
<b>Sudden Infant Death</b>	3 times more likely	45% more likely

Source: Zhao L et al. Parental smoking and the risk of congenital heart defects in offspring: An updated meta-analysis of observational studies. 2020; RCP. Hiding in plain sight: treating tobacco dependency in the NHS. 2018; Pineless BL et al. Systematic review and meta-analysis of miscarriage and maternal exposure to tobacco smoke during pregnancy. 2014; RCP & RCPCH. Passive Smoking and Children. 2010

Compared to 2017/18, it is estimated that if the Government's ambition to reduce rates of smoking in pregnancy to 6% or less by 2022 is realised, it will result in:<sup>28</sup>

- 45 – 73 fewer stillbirths
- 11 – 25 fewer neonatal deaths
- 482- 766 fewer preterm births
- 1455 – 2407 fewer babies born at low birth weight.
- 7 – 11 fewer sudden infant deaths

## FOETAL GROWTH AND BIRTH WEIGHT

Maternal smoking during pregnancy is known to be associated with intrauterine growth restriction which can result in low birth weights and babies who are small for their gestational age (SGA).<sup>27 29</sup> Available evidence has shown that smoking during pregnancy can lead to growth reduction of the foetal head and smaller head circumference at the time of birth.<sup>30 31</sup> Babies born to mothers who smoked have been found to weigh an average of 250 grams less compared to those born to non-smokers.<sup>27</sup>

## MISCARRIAGE, STILLBIRTH, AND PRETERM BIRTH

The risks of miscarriage, perinatal mortality (stillbirth and neonatal death) and preterm birth are all linked to smoking during pregnancy.<sup>27</sup>

Miscarriage, also known as spontaneous abortion, is one of the most common adverse pregnancy outcomes. It usually occurs during the first 24 weeks of pregnancy as a result of chromosomal abnormalities, hormonal problems, lifestyle and environmental factors.<sup>32</sup> Smoking during pregnancy has been found to increase the risk of miscarriage by 24-32%.<sup>27</sup> A systematic review published in 2014 found that there is a dose respondent relationship between the number of cigarettes smoked and the risk of miscarriage, with a 1% increase in relative risk of miscarriage per cigarette smoked per day.<sup>33</sup> Secondhand smoke exposure during pregnancy was found to increase the risk of miscarriage by 11%.<sup>33</sup>

Perinatal mortality includes stillbirth, where a baby is born dead after 24 completed weeks of pregnancy, and neonatal death, the death of a baby within the first four weeks of being born.<sup>34</sup> In 2010 it was estimated that maternal smoking causes 300 perinatal deaths in the UK each year.<sup>27</sup> A systematic review published in 2015 found that women who smoke during pregnancy have a 47% increased risk of stillbirth and that the risk of death increases with the amount smoked during pregnancy.<sup>26</sup>

Preterm birth (birth of a baby born before 37 weeks gestational age) continues to be the biggest cause of neonatal mortality and morbidity in the UK, with neurodevelopmental disability being one of the major long-term consequences.<sup>35</sup> Maternal smoking increases the risk of preterm birth and in 2010 it was estimated that smoking was responsible for 2,200 premature singleton births in the UK each year.<sup>27</sup> Similarly, a study from Sweden found that heavy smoking during pregnancy increased the risk of having an extremely preterm baby (born before 28 weeks gestation) by 91%.<sup>36</sup> The association between smoking and preterm birth was stronger for earlier-term births.<sup>36</sup>

## Maternal smoking and child health

Exposure to tobacco smoke during pregnancy negatively impacts offspring from infancy to childhood and into adulthood.<sup>27</sup>

### SUDDEN INFANT DEATH SYNDROME

Maternal smoking during pregnancy and post-natal exposure to tobacco smoke is a major risk factor associated with sudden infant death syndrome (SIDS), also known as cot death.<sup>27 37</sup>

Research has established that babies whose mothers smoke are up to 3 times more likely to die from sudden infant death, compared with babies whose mothers do not smoke.<sup>27</sup> Additionally, infants (children less than 1 year) who co-sleep with mothers that smoke have been found to be at an elevated risk of cot death.<sup>38</sup> A study published in 2019 found that maternal smoking during any trimester more than doubles the risk of sudden infant death.<sup>39</sup> However, mothers that reduced the number of cigarettes smoked or decided to quit decreased the risk of SIDS compared to mothers who continued smoking.<sup>39</sup>

To help reduce the risk of cot death it is highly recommended that all parents maintain a smokefree home.<sup>40</sup> Since October 2015, it has been illegal to smoke in a private car carrying someone under the age of 18.<sup>41</sup>

## ASTHMA AND RESPIRATORY INFECTIONS

Infants and children of parents who smoke are twice as likely to suffer from a serious respiratory infection as the children of non-smokers.<sup>27</sup> Smoking during pregnancy can also increase the risk of asthma and wheezing in young children and adolescents.<sup>42 43</sup> Research suggests that the increased risk of asthma and respiratory infections may be due to changes in biological receptors in the baby's immune system that are responsible for recognising and fighting infections and bacteria.<sup>44</sup> Smoking during pregnancy is also associated with an increased risk of infantile colic.<sup>45 46</sup>

Early developmental exposure to cigarette smoke can result in epigenetic changes – which alter the structure of genes - in the lungs of the offspring which can be transferred to the following generations, resulting in adult-onset of respiratory disease.<sup>47</sup> Some evidence shows an association between maternal smoking, early childhood exposure to second-hand smoke and the development of emphysema in adulthood. The findings suggest that the lungs may not recover completely from the effects of early-life exposure.<sup>48 49</sup>

## MENINGITIS

Evidence shows that maternal smoking appears to more than double the risk of bacterial forms of meningitis, such as meningococcal meningitis.<sup>27 50</sup> Low birth weight and premature birth – both of which are associated with maternal smoking – are also risk factors for meningococcal disease.<sup>50</sup>

A 2012 meta-analysis study found that secondhand smoke exposure in the home doubled the risk of invasive meningococcal disease, with some evidence of an exposure–response gradient. This effect was strongest in children under 5 years and in children whose mothers smoked during pregnancy.<sup>51</sup>

## HIGH CHOLESTEROL AND OBESITY (START)

A 27-year study examining cholesterol in children found evidence suggesting that maternal smoking in pregnancy is associated with an increased rise in total cholesterol levels and a tendency towards an adverse lipoprotein profile in the offspring.<sup>52</sup>

Another study concluded that smoking among pregnant women is independently associated with significantly lower high-density lipoprotein cholesterol in healthy 8-year-olds.<sup>53</sup> Adults who were small for gestational age at birth as a result of maternal smoking also have an increased risk of hypercholesterolemia (high cholesterol).<sup>54</sup> An additional study conducted among school children aged 9 and 10 years found that Body Mass Index (BMI) and Obesity Index (OI) were higher in children whose mothers smoked during pregnancy. And the degree of elevation was positively correlated with the duration of maternal smoking.<sup>55</sup>

There is strong evidence that childhood overweight and obesity can be related to smoking during pregnancy.<sup>56 57 58</sup> Two meta-analyses of 7 and 14 studies respectively found that, for children of mothers who smoked during pregnancy, there was a 47-50% increase in the odds of being overweight in childhood.<sup>59 60</sup>

## CHILDHOOD CANCER

Maternal smoking during pregnancy is also linked with an increased risk of childhood cancer.<sup>61</sup> The association with lymphoma was seen in a case-control study published in 1986, researchers observed a dose-response relationship between the number of cigarettes smoked per day by the mother during pregnancy and cancer risk in offspring. Compared to a control group the risk for the experimental group was

doubled for non-Hodgkin lymphoma, acute lymphoblastic leukaemia, and Wilms' tumour.<sup>62</sup>

A 2016 meta-analysis study also found increased risks of brain and central nervous system tumours and even lymphoma, predominantly non-Hodgkin lymphoma in children of mothers who smoked during pregnancy.<sup>63</sup> Another study suggests maternal smoking during pregnancy maybe a risk factor for retinoblastoma (retinal cancer) and certain types of childhood brain tumours.<sup>64</sup>

## OFFSPRING FERTILITY

Research suggests that maternal smoking may have a negative impact on the fertility of both male and female offspring.<sup>65 66 67</sup> Smoking during pregnancy reduces the number of germ cells that form in the developing foetus.<sup>68</sup> In males it has an impact on protamine, a protein essential in sperm production which can lead to fertility problems.<sup>69</sup> Other studies further show that men whose mothers smoked while pregnant are at risk of having smaller testes,<sup>70</sup> lower mean sperm concentration and lower total sperm counts.<sup>71</sup>

## OTHER ADVERSE HEALTH IMPACTS

Further impacts of smoking during pregnancy include:

- Increased risk of congenital defects in the offspring of smokers,<sup>72</sup> including orofacial clefts;<sup>73 74</sup> neural tube defects (defects of the brain, spine, or spinal cord)<sup>75 76</sup>; cardiovascular/heart defects, musculoskeletal and other defects.<sup>73</sup>
- Potential adverse implications for the long-term physical growth and intellectual development of the child.<sup>77 78</sup>
- Researchers have also found that adults exposed to tobacco smoke in utero had a more adverse cardiovascular disease risk profile.<sup>79</sup> There is even evidence that prenatal and postnatal second-hand smoke contributes to insulin resistance in children.<sup>80</sup>
- Maternal smoking has been associated with an increased risk of learning difficulties.<sup>81</sup> Available evidence has established that smoking during pregnancy increases foetal testosterone levels<sup>82</sup> which have been associated with an increased risk for autism,<sup>83</sup> and antisocial disorder later in life.<sup>84</sup> Numerous studies have also demonstrated a link between maternal smoking and ADHD,<sup>85 86</sup> as well as new research linking second-hand smoke and ADHD.<sup>87</sup>
- Studies have found that maternal smoking is associated with increased conduct problems and externalising, aggressive and overactive behaviour in children.<sup>88 89</sup> Smoking during pregnancy and exposure to secondhand smoke in early childhood have been found to be “quite strong” predictors of anti-social behaviour and crime later in life.<sup>90 91 92</sup> This finding is supported by other studies exploring the relationship between maternal smoking during pregnancy and behaviour problems in childhood and adolescence,<sup>88 93 94</sup> including smoking (particularly among girls)<sup>95 96</sup> and other substance use.<sup>97 98 99</sup>
- A population-level study of children in Finland found that the risk of psychiatric morbidity was significantly higher in the children of mothers who smoked during pregnancy.<sup>100</sup> A follow-up study found that this was still the case even when genetic and familiar factors are thoroughly controlled.<sup>101</sup>
- Some evidence suggests that prenatal exposure to tobacco smoke may be associated with benign breast disease later in life.<sup>102</sup>

## Secondhand smoke exposure

Tobacco smoke contains over 7,000 chemical compounds, many of which can cause cancer<sup>103</sup> and dozens of which are known or suspected reproductive toxins.<sup>104</sup> Consequently, exposure to secondhand smoke before and during pregnancy can lead to many of the same adverse birth outcomes experienced by women who smoke, including difficulty becoming pregnant in the first place.

### LOW BIRTH WEIGHT AND PRETERM BIRTH

Non-smoking women exposed to other people's tobacco smoke during pregnancy are more likely to have lower-weight babies.<sup>1 105 106</sup> On average, infants born to mothers exposed to secondhand smoke during pregnancy are 30-40g lighter than infants born to women who have not been exposed.<sup>27</sup> Low birth weight (LBW) is associated with adverse health and developmental outcomes.<sup>107</sup> Exposure to secondhand smoke has also been significantly associated with a greater risk of preterm birth.<sup>108</sup>

### PERINATAL MORTALITY AND CONGENITAL MALFORMATIONS

Exposure to secondhand smoke during pregnancy is associated with a higher risk of stillbirth,<sup>109 110</sup> spontaneous abortion<sup>111</sup> and of having a baby with congenital malformations.<sup>104</sup>

### LEUKAEMIA

Some studies show evidence of prenatal and postnatal secondhand smoke potentially having a causal relationship with leukaemia,<sup>112 113</sup> particularly acute lymphoblastic leukaemia.<sup>114</sup> A study conducted in Australia found that paternal smoking around the time of conception increased risk factor of acute lymphoblastic leukaemia in children by 15%.<sup>114</sup> The risk increased to 44% in children whose fathers smoked more than 20 cigarettes per day at the time of conception.<sup>114</sup>

### FERTILITY AND REPRODUCTION (SEE FERTILITY SECTION BELOW)

Evidence also suggests that smoking and secondhand smoke exposure damages female fertility and can make it harder for women to conceive<sup>115</sup> (see fertility section below).

## Quitting smoking during pregnancy

Pregnancy is a "teachable moment", and evidence has shown that more women quit smoking when they are pregnant than at any other time during their lives.<sup>116</sup> One study found that pregnant smokers were twice as likely to attempt to quit smoking as non-pregnant women.<sup>117</sup> Many women manage to quit smoking during pregnancy without support, although this may make the risk of postpartum relapse greater.<sup>118</sup>

Smoking cessation interventions have been shown to reduce the number of newborns with low birth weight and preterm births.<sup>119</sup> In one study, compared to ongoing heavy smoking, quitting was associated with a 299g increase in birth weight, while the babies of light smokers who quit entirely saw a 63g increase in birth weight.<sup>120</sup>

### NATIONAL GUIDANCE

In England, reducing stillbirths and neonatal deaths is a national priority.<sup>121</sup> The National Institute for Health and Care Excellence (NICE) has published guidance to on supporting pregnant smokers to quit during

pregnancy and after childbirth<sup>122</sup> and on the support that should be provided by maternity services.<sup>123</sup> Among the recommendations are that all women should be monitored for carbon monoxide exposure (a marker for smoking) and asked about their smoking status at their maternity booking appointment, with smokers referred to specialist stop smoking support.<sup>123</sup>

In 2016, the NHS launched the Saving Babies' Lives Care Bundle (SBLCB)<sup>124</sup> as part of measures designed to halve rates of stillbirth and neonatal death by 2025, with an updated Version 2 published in 2019.<sup>125</sup> <sup>126</sup> 'Element 1: Reducing smoking in pregnancy' recommends carbon monoxide (CO) testing of all pregnant women at the antenatal booking appointment; CO testing at 36 weeks; referral to a stop smoking service/specialist based on an opt out system; and training on CO monitor use and Very Brief Advice (VBA) for all relevant maternity staff.

The NHS Long Term Plan, published in 2019, includes a commitment to deliver an opt-out smokefree pregnancy pathway including focused sessions and treatments for expectant mothers and their partners."<sup>127</sup> This support will complement, rather than substitute, existing local authority-funded stop smoking services. Approximately 43% of NHS trusts surveyed by ASH in 2020 reported commissioning specialist stop smoking support for pregnant women in 2020/21.<sup>128</sup>

## NICOTINE REPLACEMENT THERAPY

Pregnant women who are trying to quit smoking should be supported to use nicotine replacement therapy (NRT) to help them manage nicotine withdrawal and stay smokefree. A review of the efficacy and safety of NRT in pregnancy found that NRT increased smoking cessation rates, measured in late pregnancy, by approximately 40%.<sup>129</sup> The authors found no evidence that NRT used for smoking cessation in pregnancy has either positive or negative impacts on birth outcomes.

Another study found that NRT use significantly decreased the risk of preterm delivery and low birth weight compared to smokers and found that NRT use does not appear to increase the risk of malformations.<sup>130</sup> Since NRT is metabolised faster during pregnancy, pregnant women may need higher doses of NRT in order to alleviate cravings.<sup>131</sup> Additional research is needed on which types and doses of NRT are the most effective in helping pregnant smokers quit, while also protecting the foetus.<sup>129</sup>

Currently, the National Institute for Health and Care Excellence (NICE) recommends the use of NRT by pregnant women only if they have been unable to quit without NRT, recognising that NRT is a reduced risk way of using nicotine compared to smoking, but is unlikely to be without risk. NICE does not recommend the use of either bupropion or varenicline by pregnant or breastfeeding women.<sup>122</sup>

## BEHAVIOURAL SUPPORT

Behavioural support involves scheduled meetings in which people who smoke receive information, brief advice, encouragement, and some form of behavioural intervention – motivational interviewing or cognitive behavioural therapy.<sup>132</sup> In the UK, this therapy is offered weekly for at least the first 4 weeks of a quit attempt that is, for 4 weeks following the quit date.<sup>132</sup>

Evidence has shown that behavioural support is effective in increasing quit rates.<sup>133</sup> However, a Cochrane review found that compared with usual care, a combination of behavioural interventions as an adjunct to NRT increased the chance of success by about 10% to 20%.<sup>134</sup>



## FINANCIAL INCENTIVES

Evidence shows that financial incentive schemes designed to support women to quit smoking during pregnancy are effective in increasing quit rates when coupled with evidence-based support in line with NICE Guidance.<sup>135</sup> A 2017 Cochrane review found psychosocial interventions which involve counselling, feedback and incentives increased the proportion of women who had stopped smoking in late pregnancy. However, the characteristics and context of the interventions should be carefully considered before implementing it in your setting.<sup>17</sup>

The latest Cochrane Review of the evidence on the use of financial incentives for smoking cessation found that women receiving incentives were more than twice as likely to quit and remain quit postpartum compared to women receiving usual care without incentives.<sup>136</sup>

Evidence shows incentive schemes are also cost-effective. A UK study which involved over 600 women from Glasgow assessed the cost-effectiveness of offering up to £400 of shopping vouchers in addition to routine care. The evaluation was undertaken from the UK NHS perspective for the cost year 2013, with results showing that the incremental cost per quitter at 34-38 weeks pregnant was £1127. The lifetime model resulted in a longer-term cost of £482 for each quality-adjusted life-year gained (£482/QALY). This is well below the NICE cost-effectiveness threshold of £20,000 per QALY.<sup>137</sup>

## WHOLE FAMILY APPROACH: ENGAGING WOMEN'S PARTNERS

The NHS Long Term Plan's commitment to include pregnant women's partners in the tobacco dependence treatment pathway recognises that women's environments have a crucial impact on their smoking.<sup>127</sup>

Evidence suggests that over three-quarters of women who quit smoking during pregnancy relapse postpartum, and this period should continue to be a focus for providing support to new mothers.<sup>118 138</sup> One way pregnant women can get support is through initiatives to make homes smokefree, thus protecting all family members from smoke exposure and reducing the chances of relapse. Several studies conducted in the UK reveal that adjusting to a new maternal identity as a non-smoker can be a major challenge for women who quit smoking during pregnancy.<sup>139 140</sup> However, women may be more likely to successfully quit smoking if partners and other household members who smoke are also supported to stop smoking.

Evidence from a pilot in Dorset, where specialist smoking midwives provide pharmacotherapy and combined behavioural counselling sessions to both pregnant smoker and smoking partners/family members for the duration of the 12-week programme show that these kind of interventions are effective in engaging pregnant smokers and increase quit rates.<sup>141</sup> The findings reveal pregnant women's quit rate increased from 75% to 82% while partner engagement rate increased from 4% to 39% and partner quit rates increased from 2.2% to 60%.<sup>141</sup> This indicates that interventions which are delivered at the household level can be effective for engaging smoking partners, as they frame smoking as a household responsibility, with family-wide impact. Partners need to be involved not just as providers of social support but as participants with a stake in the change process.<sup>142</sup>

## E-CIGARETTES AND PREGNANCY

Electronic cigarettes (e-cigarettes) are currently the most popular aid to quitting smoking in England.<sup>143</sup> Evidence shows that e-cigarettes are considerably less harmful than smoking, though not completely risk

free.<sup>144</sup> <sup>145</sup> According to the findings of a recent Cochrane review, nicotine-containing e-cigarettes are approximately 70% more effective in supporting smokers to quit successfully than NRT.<sup>146</sup>

Little research exists regarding the safety of using e-cigarettes during pregnancy, however evidence from adult smokers in general suggests that they are likely to be significantly less harmful to a pregnant woman and her baby than continuing to smoke. More research is needed in this area. As in other populations, pregnant women who use e-cigarettes are likely to do so to stop smoking.<sup>147</sup> While licensed Nicotine Replacement Therapy (NRT) products such as nicotine patches, gum and inhalers are the recommended option, if a pregnant woman chooses to use an e-cigarette to help her quit smoking or stay smokefree, she should be supported to do so.<sup>148</sup>

See also: Smoking in Pregnancy Challenge Group information on [Using e-cigarettes before, during and after pregnancy](#)

## **The Smoking in Pregnancy Challenge Group**

The Smoking in Pregnancy Challenge Group is a coalition of organisations committed to reducing rates of smoking in pregnancy. The Group is a partnership between the Royal College of Midwives, the Royal College of Obstetricians and Gynaecologists and the Royal College of Paediatrics and Child Health, the voluntary sector and academia.<sup>149</sup> The Challenge Group has produced several reports reviewing the progress made in reducing smoking in pregnancy in England, including the most recent: [Getting back on track: Delivering a smokefree start for every child](#) in 2021.<sup>150</sup>

Challenge Group resources and information can be accessed here:

<https://smokefreeaction.org.uk/smokefree-nhs/smoking-in-pregnancy-challenge-group/smoking-in-pregnancy-challenge-group-resources/>

## **Fertility**

Smoking negatively impacts the ability to conceive for both men and women.<sup>151</sup> Toxicants from smoking affect gametes, hormone regulation and reproductive organs reducing the chance of, or delaying conception.<sup>152</sup> Smoking during pregnancy also has negative implications for the offspring's fertility later in life.<sup>104</sup>

A literature review examining the relationship between smoking and fertility concluded that tobacco use affects every system involved in the reproductive process.<sup>153</sup> This is supported by a systematic literature review which found that "all stages of reproductive functions are targets of cigarette smoke toxicants."<sup>154</sup>

### **FEMALE FERTILITY**

Many factors, including smoking, influence a woman's ability to conceive and have a healthy baby.<sup>155</sup> <sup>156</sup> Specifically, smoking affects uterine receptivity. Uterine or endometrial receptivity is the ability of the uterus to allow embryos to implant with the quantity of tobacco smoked is negatively correlated with the level of uterine receptivity.<sup>157</sup> However, there is no safe level of smoking, and even comparatively low levels of smoking can have a significant impact on female fertility. Cotinine, a by-product of nicotine, can damage fallopian tubes through altering gene expression.<sup>158</sup>

There is also evidence that women who were ever-smokers during their reproductive years had greater estimates of risk of tubal ectopic pregnancy.<sup>111 116</sup> This was also evident among never-smoking women with the highest levels of lifetime exposure to secondhand smoke.<sup>111 158</sup>

Smokers have been found to have both shorter and more variable menstrual cycle lengths than non-smokers which can affect fertility.<sup>159</sup> More variable cycle lengths can impact on fertility as the timing of ovulation is less predictable. Smokers tend to have shorter cycles compared to non-smokers, which are specifically shorter in the follicular phase, indicating abnormalities in ova maturation. These abnormalities lead to a reduced chance of successful conception.<sup>155</sup> Smokers also have a tendency to have shorter menstrual cycling lifespans – meaning they are likely to enter the menopause earlier than non-smokers, reducing their reproductive lifespan.<sup>160 161</sup>

There is evidence to suggest that smoking reduces the success rates of fertility treatment. Studies of women undergoing assisted reproductive treatment have demonstrated a significant negative effect associated with smoking.<sup>115 162</sup> One study of 499 women seeking IVF treatment found a 50% reduction in implantation rate among smokers compared to women who had never smoked.<sup>163</sup>

## ORAL CONTRACEPTION

Women who use combined oral contraceptives are at increased risk of heart disease;<sup>164</sup> because the risk of heart disease in young women is low, the benefits of using the pill generally outweigh the risks for young women who do not smoke. Pill-users who smoke are also at risk of venous thromboembolism and arterial thrombosis (blood clots in the veins and arteries).<sup>165 166</sup> It is therefore important that all women who take the contraceptive pill be advised not to smoke.

## MENOPAUSE

Smoking is associated with early onset of menopause.<sup>167 168</sup> The likelihood of earlier menopause is related to the number of cigarettes smoked; with those smoking more than ten cigarettes a day have an increased risk of early menopause.<sup>169</sup>

A recent study conducted in the United States of America found that there is an association between smoking, infertility, and early onset menopause.<sup>170</sup> Women who had never smoked but exposed to a lifetime of passive smoke had an increased risk of infertility, and they were more likely to reach menopause 13 months earlier compared to non-smokers and those not exposed to passive smoke.<sup>170</sup> This was also evident among active smokers, as they were more likely to reach menopause almost 22 months earlier than never smoked women.<sup>170</sup>

Stopping smoking may lower the risk of early menopause. While current smokers' risk of early menopause is twice that of non-smokers, in ex-smokers, the risk is higher by just one-third. Research suggests that polycyclic aromatic hydrocarbons found in tobacco smoke can trigger premature egg cell death which may, in turn, lead to earlier menopause.<sup>171</sup> Another study suggests that chemicals in tobacco smoke alter endocrine function, which in turn affects the release of pituitary hormones. This endocrine disruption is thought to contribute to adverse outcomes, including earlier menopause.<sup>172</sup>

## MALE FERTILITY & SEXUAL IMPOTENCE

A range of studies have demonstrated the negative impact of smoking on male sex cells. There is a significant association between smoking and sexual impotence, with the association increasing with the number of cigarettes smoked per day.<sup>173 174</sup>

There is a correlation between the number of cigarettes smoked and the damage to sperm, and researchers have found that any level of smoking is associated with reduced male fertility.<sup>67 155</sup> Compared to non-smokers, smokers typically have lower semen volume, lower sperm count and reduced sperm motility<sup>175</sup> all of which reduce the chances of successful conception. Specifically, by-products of nicotine reduce the motility of sperm and their fertilization capacity.<sup>176 177</sup>

Sperm from smokers specifically have a reduced fertilization capacity in the form of lower acrosin activity. Acrosin is the digestive enzyme that aids in the penetration of ova.<sup>175</sup> Smoking causes DNA fragmentation which prevents successful activation of acrosin, therefore preventing fertilisation of ova.<sup>175</sup>

Male smokers have an increased risk of erectile dysfunction as chemicals from cigarette smoke damage arteries affecting the blood supply to the penis.<sup>178</sup>

## External Reviewers

Professor Caitlin Notley, Professor of Addiction Sciences and Director of the Faculty of Medicine and Health 'Citizen's Academy', University of East Anglia

### **When referring to this publication, please cite as:**

Action on Smoking and Health (ASH). Smoking, pregnancy and fertility. 2021

# References

## References last checked December 2021

- 1 Royal College of Physicians. [Hiding in plain sight: treating tobacco dependency in the NHS](#). London: RCP, 2018.
- 2 Mund M, Louwen F, Klingelhofer D, Gerber A. [Smoking and pregnancy—a review on the first major environmental risk factor of the unborn](#). Int J Environ Res Public Health. 2013 Nov 29;10(12):6485-99. doi: 10.3390/ijerph10126485. PMID: 24351784; PMCID: PMC3881126.
- 3 Kovess V, Keyes KM, Hamilton A, Pez O, Bitfoi A, Koç C, Goelitz D, Kuijpers R, Lesinskiene, Mihova Z, Otten R. [Maternal smoking and offspring inattention and hyperactivity: results from a cross-national European survey](#). European child & adolescent psychiatry. 2015 Aug 1;24(8):919-29.
- 4 Montgomery SM, Ekbohm A. [Smoking during pregnancy and diabetes mellitus in a British longitudinal birth cohort](#). Bmj. 2002 Jan 5;324(7328):26-7.
- 5 NHS Digital. [Statistics on Women's Smoking Status at Time of Delivery: England Quarter 4, 2020-21](#). July 2021.
- 6 Smoking in Pregnancy Challenge Group. [Review of the Challenge 2018](#).
- 7 Department of Health and Social Care. [Smoke-free generation: A Tobacco Control Plan for England](#). July 18, 2017.
- 8 Long B, Brady WJ, Koyfman A, Gottlieb M. [Cardiovascular complications in COVID-19](#). The American journal of emergency medicine. 2020 Jul 1;38(7):1504-7.
- 9 Xu Z, Shi L, Wang Y, Zhang J, Huang L, Zhang C, Liu S, Zhao P, Liu H, Zhu L, Tai Y. [Pathological findings of COVID-19 associated with acute respiratory distress syndrome](#). The Lancet respiratory medicine. 2020 Apr 1;8(4):420-2.
- 10 Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z. [Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China](#). The lancet. 2020 Feb 15;395(10223):497-506.
- 11 Hopkinson NS et al. [Current smoking and COVID-19 risk: results from a population symptom app in over 2.4 million people](#). Thorax. 2021 Jul 1;76(7):714-22.
- 12 Clift AK et al. [Smoking and COVID-19 outcomes: an observational and Mendelian randomisation study using the UK Biobank cohort](#). Thorax. 2021 Sep 12.
- 13 Royal College of Obstetricians and Gynaecologists & Royal College of Midwives. [Coronavirus infection and pregnancy FAQs. July 2021](#).
- 14 Harger JH, Ernest JM, Thurnau GR, Moawad A, Momirova V, Landon MB, Paul R, Miodovnik M, Dombrowski M, Sibai B, Van Dorsten P. [Risk factors and outcome of varicella-zoster virus pneumonia in pregnant women](#). The Journal of infectious diseases. 2002 Feb 15;185(4):422-7.
- 15 Jayes L, Haslam PL, Gratzou CG, Powell P, Britton J, Vardavas C, Jimenez-Ruiz C, Leonardi-Bee J, Dautzenberg B, Lundbäck B, Fletcher M. [SmokeHaz: systematic reviews and meta-analyses of the effects of smoking on respiratory health](#). Chest. 2016 Jul 1;150(1):164-79.
- 16 Arnon Y, Shoenfeld Y, Amital H. [Effects of tobacco smoke on immunity, inflammation and autoimmunity](#). Journal of autoimmunity. 2010 May 1;34(3):J258-65.
- 17 Chamberlain C, O'Mara-Eves A, Porter J, Coleman T, Perlen SM, Thomas J, McKenzie JE. [Psychosocial interventions for supporting women to stop smoking in pregnancy](#). Cochrane database of systematic reviews. 2017(2).
- 18 Public Health England (PHE). [Health matters: smoking and quitting in England](#). 2015.
- 19 Smedberg J, Lupattelli A, Mårdby AC, Nordeng H. [Characteristics of women who continue smoking during pregnancy: a cross-sectional study of pregnant women and new mothers in 15 European countries](#). BMC pregnancy and childbirth. 2014 Dec;14(1):1-6.
- 20 Royal College of Paediatrics and Child Health (2020). [State of Child Health](#). London: RCPCH.
- 21 NHS Digital. [Infant Feeding Survey - UK, 2010](#). November 2012.
- 22 NHS Digital. [NHS Maternity Statistics, England 2017-18, October 2018](#).
- 23 ISD Scotland. [Births in Scottish Hospitals: Maternity and births](#), 2019
- 24 Public Health Agency. [Statistical Profile of Children's Health in Northern Ireland](#). 2019.
- 25 Orton S, Coleman T, Coleman-Haynes T, Ussher M. [Predictors of postpartum return to smoking: a systematic review](#). Nicotine and Tobacco Research. 2018 May 3;20(6):665-73.
- 26 Marufu TC, Ahankari A, Coleman T, Lewis S. [Maternal smoking and the risk of still birth: systematic review and meta-analysis](#). BMC public health. 2015 Dec 1;15(1):239.
- 27 Royal College of Physicians. [Passive smoking and children. A report by the Tobacco Advisory Group](#). London: RCP, 2010.
- 28 Lucy Lyus, Policy and Research Manager, The Lullaby Trust. [Impact of smoking on future rates of stillbirth, neonatal and infant mortality and poor birth outcomes in England](#). June 2018.
- 29 Ko TJ, Tsai LY, Chu LC, Yeh SJ, Leung C, Chen CY, Chou HC, Tsao PN, Chen PC, Hsieh WS. [Parental smoking during pregnancy and its association with low birth weight, small for gestational age, and preterm birth offspring: a birth cohort study](#). Pediatrics & Neonatology. 2014 Feb 1;55(1):20-7.
- 30 Roza SJ, Verburg BO, Jaddoe VW, Hofman A, Mackenbach JP, Steegers EA, Witteman JC, Verhulst FC, Tiemeier H. [Effects of maternal smoking in pregnancy on prenatal brain development](#). The Generation R Study. European Journal of Neuroscience. 2007 Feb;25(3):611-7.
- 31 Himes SK, Stroud LR, Scheidweiler KB, Niaura RS, Huestis MA. [Prenatal tobacco exposure, biomarkers for tobacco in meconium, and neonatal growth outcomes](#). The Journal of Pediatrics. 2013 May;162(5):970-975. DOI: 10.1016/j.jpeds.2012.10.045.
- 32 National Institute for Health and Care Excellence (NICE). [MISCARRIAGE, 2020](#).
- 33 Pineles BL, Park E, Samet JM. [Systematic review and meta-analysis of miscarriage and maternal exposure to tobacco smoke during pregnancy](#). American journal of epidemiology. 2014 Apr 1;179(7):807-23.
- 34 Draper ES, Gallimore ID, Smith LK, Fenton AC, Kurinczuk JJ, Smith PW, Bobby T, Manktelow BN, [on behalf of the MBRRACE-UK Collaboration. MBRRACE-UK Perinatal Mortality Surveillance Report, UK Perinatal Deaths for Births from January to December 2019](#). Leicester: The Infant Mortality and Morbidity Studies, Department of Health Sciences, University of

Leicester. 2021.

35 National Health Institute for Health and Care Excellence (NICE). [Preterm Labour and Birth, 2019](#).

36 Dahlin S, Gunnerbeck A, Wikström AK, Cnattingius S, Edstedt Bonamy AK. [Maternal tobacco use and extremely premature birth—a population-based cohort study](#). BJOG: An International Journal of Obstetrics & Gynaecology. 2016 Nov;123(12):1938-46

37 Liebrechts-Akkerman G, Lao O, Liu F, van Sleuwen BE, Engelberts AC, L'Hoir MP, Tiemeier HW, Kayser M. [Postnatal parental smoking: an important risk factor for SIDS](#). European journal of pediatrics. 2011 Oct 1;170(10):1281.

38 Zhang K, Wang X. [Maternal smoking and increased risk of sudden infant death syndrome: a meta-analysis](#). Legal medicine. 2013 May 1;15(3):115-21.

39 Anderson TM, Ferres JM, Ren SY, Moon RY, Goldstein RD, Ramirez JM, Mitchell EA. [Maternal smoking before and during pregnancy and the risk of sudden unexpected infant death](#). Pediatrics. 2019 Apr 1;143(4):e20183325.

40 Behm I, Kabir Z, Connolly GN, Alpert HR. [Increasing prevalence of smoke-free homes and decreasing rates of sudden infant death syndrome in the United States: an ecological association study](#). Tobacco Control. 2012 Jan 1;21(1):6-11.

41 HM Government. [Smoking in cars with children banned from today](#). 1 October 2015.

42 Burke H, Leonardi-Bee J, Hashim A, Pine-Abata H, Chen Y, Cook DG, Britton JR, McKeever TM. [Prenatal and passive smoke exposure and incidence of asthma and wheeze: systematic review and meta-analysis](#). Pediatrics. 2012 Apr 1;129(4):735-44.

43 Hollams EM, De Klerk NH, Holt PG, Sly PD. [Persistent effects of maternal smoking during pregnancy on lung function and asthma in adolescents](#). American journal of respiratory and critical care medicine. 2014 Feb 15;189(4):401-7.

44 Noakes PS, Hale J, Thomas R, Lane C, Devadason SG, Prescott SL. [Maternal smoking is associated with impaired neonatal toll-like-receptor-mediated immune responses](#). European Respiratory Journal. 2006 Oct 1;28(4):721-9

45 Shenassa ED, Brown MJ. [Maternal smoking and infantile gastrointestinal dysregulation: the case of colic](#). Pediatrics. 2004 Oct;114(4):e497-505.

46 Canivet CA, Östergren PO, Jakobsson IL, Dejin-Karlsson E, Hagander BM. [Infantile colic, maternal smoking and infant feeding at 5 weeks of age](#). Scandinavian journal of public health. 2008 May;36(3):284-91.

47 Harding R, Maritz G. [Maternal and fetal origins of lung disease in adulthood](#). Semin Fetal Neonatal Med. 2012 Apr;17(2):67-72. doi: 10.1016/j.siny.2012.01.005.

48 Lovasi GS, Roux AV, Hoffman EA, Kawut SM, Jacobs Jr DR, Barr RG. [Association of environmental tobacco smoke exposure in childhood with early emphysema in adulthood among nonsmokers: the MESA-lung study](#). American journal of epidemiology. 2010 Jan 1;171(1):54-62.

49 Beyer D, Mitfessel H, Gillissen A. [Maternal smoking promotes chronic obstructive lung disease in the offspring as adults](#). Eur J Med Res. 2009 Dec 7;14 Suppl 4:27-31. [View article](#)

50 Goldacre MJ, Wotton CJ, Maisonneuve JJ. [Maternal and perinatal factors associated with subsequent meningococcal, Haemophilus or enteroviral meningitis in children: database study](#). Epidemiology & Infection. 2014 Feb;142(2):371-8.

51 Murray RL, Britton J, Leonardi-Bee J. [Second hand smoke exposure and the risk of invasive meningococcal disease in children: systematic review and meta-analysis](#). BMC public health. 2012 Dec 1;12(1):1062.

52 Jaddoe VVW, de Ridder MAJ, Van Den Elzen APM. [Maternal smoking in pregnancy is associated with cholesterol development in the offspring: A 27-years follow-up study](#). Atherosclerosis. 2008 Jan;196(1):42-8.

53 Ayer JG, Belousova E, Harmer JA, David C, Marks GB, Celermajer DS. [Maternal cigarette smoking is associated with reduced high-density lipoprotein cholesterol in healthy 8-year-old children](#). European heart journal. 2011 Oct 1;32(19):2446-53.

54 Wen X, Triche EW, Hogan JW. [Birth Weight and Adult Hypercholesterolemia: Subgroups of small-for-gestational-age based on maternal smoking status during pregnancy](#). Epidemiology. 2010 Nov;21(6):786-90. doi: 10.1097/EDE.0b013e3181f20990.

55 Ino T, Shibuya T, Saito K, Inaba Y. [Relationship between body mass index of offspring and maternal smoking during pregnancy](#). International journal of obesity. 2012 Apr;36(4):554-8.

56 Chen H, Saad S, Sandow S, Bertrand P. [Cigarette smoking and brain regulation of energy homeostasis](#). Frontiers in pharmacology. 2012 Jul 25;3:147.

57 Shi Y, de Groh M, Morrison H. [Perinatal and early childhood factors for overweight and obesity in young Canadian children](#). Canadian Journal of Public Health. 2013 Jan 1;104(1):e69-74

58 Rayfield S, Plugge E. [Systematic review and meta-analysis of the association between maternal smoking in pregnancy and childhood overweight and obesity](#)

*J Epidemiol Community Health* 2017; 71:162-173.

59 Weng SF, Redsell SA, Swift JA, Yang M, Glazebrook CP. [Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy](#). Archives of disease in childhood. 2012 Dec 1;97(12):1019-26..

60 Oken E, Levitan EB, Gillman MW. [Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis](#). International journal of obesity. 2008 Feb;32(2):201-10.

61 Bhattacharya S, Beasley M, Pang D, Macfarlane GJ. [Maternal and perinatal risk factors for childhood cancer: record linkage study](#). BMJ open. 2014 Jan 1;4(1):e003656..

62 Stjernfeldt M, Lindsten J, Berglund K, Ludvigsson J, GROUP FT, CHILDREN OS. [Maternal smoking during pregnancy and risk of childhood cancer](#). The Lancet. 1986 Jun 14;327(8494):1350-2.

63 Rumrich IK, Viluksela M, Vähäkangas K, Gissler M, Surcel HM, Hänninen O. [Maternal smoking and the risk of cancer in early life—a meta-analysis](#). PloS one. 2016 Nov 8;11(11):e0165040

64 Heck JE, Contreras ZA, Park AS, Davidson TB, Cockburn M, Ritz B. [Smoking in pregnancy and risk of cancer among young children: A population-based study](#). International journal of cancer. 2016 Aug 1;139(3):613-6.

65 Cooper AR and Moley, KH. [Maternal tobacco use and its preimplantation effects on fertility: more reasons to stop smoking](#). Semin Reprod Med. 2008 Mar;26(2):204-12. doi: 10.1055/s-2008-1042959.

66 Ye X, Skjaerven R, Basso O, Baird DD, Eggesbo M, Uicab LA, Haug K, Longnecker MP. [In utero exposure to tobacco smoke and subsequent reduced fertility in females](#). Human reproduction. 2010 Nov 1;25(11):2901-6.

- 67 Ramlau-Hansen CH, Thulstrup AM, Storgaard L, Toft G, Olsen J, Bonde JP. [Is prenatal exposure to tobacco smoking a cause of poor semen quality? A follow-up study.](#) American journal of epidemiology. 2007 Jun 15;165(12):1372-9.
- 68 Mamsen LS, Lutterodt MC, Andersen EW, Skouby SO, Sørensen KP, Andersen CY, Byskov AG. [Cigarette smoking during early pregnancy reduces the number of embryonic germ and somatic cells.](#) Human reproduction. 2010 Nov 1;25(11):2755-61.
- 69 Hammadeh ME, Hamad MF, Montenarh M, Fischer-Hammadeh C. [Protamine contents and P1/P2 ratio in human spermatozoa from smokers and non-smokers.](#) Human reproduction. 2010 Nov 1;25(11):2708-20.
- 70 Virtanen HE, Sadov S, Toppari J. [Prenatal exposure to smoking and male reproductive health.](#) Current Opinion in Endocrinology, Diabetes and Obesity. 2012 Jun 1;19(3):228-32.
- 71 Jensen MS, Mabeck LM, Toft G, Thulstrup AM, Bonde JP. [Lower sperm counts following prenatal tobacco exposure.](#) Human Reproduction. 2005 Sep 1;20(9):2559-66.
- 72 Leonardi-Bee J, Britton J, Venn A. [Secondhand smoke and adverse fetal outcomes in nonsmoking pregnant women: a meta-analysis.](#) Pediatrics. 2011 Apr 1;127(4):734-41.
- 73 Hackshaw A, Rodeck C, Boniface S. [Maternal smoking in pregnancy and birth defects: a systematic review based on 173 687 malformed cases and 11.7 million controls.](#) Human reproduction update. 2011 Sep 1;17(5):589-604.
- 74 Gunnerbeck A, Edstedt Bonamy AK, Wikström AK, Granath F, Wickström R, Cnattingius S. [Maternal snuff use and smoking and the risk of oral cleft malformations-a population-based cohort study.](#) PloS one. 2014 Jan 15;9(1):e84715.
- 75 Suarez L, Ramadhani T, Felkner M, Canfield MA, Brender JD, Romitti PA, Sun L. [Maternal smoking, passive tobacco smoke, and neural tube defects.](#) Birth Defects Research Part A: Clinical and Molecular Teratology. 2011 Jan;91(1):29-33.
- 76 Wang M, Wang ZP, Zhang M, Zhao ZT. [Maternal passive smoking during pregnancy and neural tube defects in offspring: a meta-analysis.](#) Archives of gynecology and obstetrics. 2014 Mar 1;289(3):513-21.
- 77 Agrawal A, Scherrer JF, Grant JD, Sartor CE, Pergadia ML, Duncan AE, Madden PA, Haber JR, Jacob T, Bucholz KK, Xian H. [The effects of maternal smoking during pregnancy on offspring outcomes.](#) Preventive medicine. 2010 Jan 1;50(1-2):13-8.
- 78 Boutwell BB, Beaver KM. [Maternal cigarette smoking during pregnancy and offspring externalizing behavioral problems: a propensity score matching analysis.](#) Int J Environ Res Public Health. 2010 Jan;7(1):146-63. doi: 10.3390/ijerph7010146.
- 79 Power C, Atherton K, Thomas C. [Maternal smoking in pregnancy, adult adiposity and other risk factors for cardiovascular disease.](#) Atherosclerosis. 2010 Aug;211(2):643-8. doi: 10.1016/j.atherosclerosis.2010.03.015.
- 80 Thiering E, Brüske I, Kratzsch J, Thiery J, Sausenthaler S, Meisinger C, Koletzko S, Bauer CP, Schaaf B, von Berg A, Berdel D. [Prenatal and postnatal tobacco smoke exposure and development of insulin resistance in 10 year old children.](#) International journal of hygiene and environmental health. 2011 Sep 1;214(5):361-8. [View abstract](#)
- 81 Anderko L, Braun J, Auinger P. [Contribution of tobacco smoke exposure to learning disabilities.](#) J Obstet Gynecol Neonatal Nurs. 2010 Jan-Feb;39(1):111-7. doi: 10.1111/j.1552-6909.2009.01093.x.
- 82 Toriola AT, Vääräsmäki M, Lehtinen M, Zeleniuch-Jacquotte A, Lundin E, Rodgers KG, Lakso HA, Chen T, Schock H, Hallmans G, Pukkala E. [Determinants of maternal sex steroids during the first half of pregnancy.](#) Obstetrics and gynecology. 2011 Nov;118(5):1029.
- 83 Baron-Cohen S, Auyeung B, Nørgaard-Pedersen B, Hougaard DM, Abdallah MW, Melgaard L, Cohen AS, Chakrabarti B, Ruta L, Lombardo MV. [Elevated fetal steroidogenic activity in autism.](#) Molecular psychiatry. 2015 Mar;20(3):369-76.
- 84 Lombardo MV, Ashwin E, Auyeung B, Chakrabarti B, Lai MC, Taylor K, Hackett G, Bullmore ET, Baron-Cohen S. [Fetal programming effects of testosterone on the reward system and behavioral approach tendencies in humans.](#) Biological psychiatry. 2012 Nov 15;72(10):839-47.
- 85 Motlagh MG, Sukhodolsky DG, Landeros-Weisenberger A, Katsochis L, Thompson N, Scahill L, King RA, Peterson BS, Schultz RT, Leckman JF. [Adverse effects of heavy prenatal maternal smoking on attentional control in children with ADHD.](#) Journal of attention disorders. 2011 Oct;15(7):593-603.
- 86 Nomura Y, Marks DJ, Halperin JM. [Prenatal exposure to maternal and paternal smoking on attention deficit hyperactivity disorders symptoms and diagnosis in offspring.](#) J Nerv Ment Dis. 2010 Sep;198(9):672-8. doi: 10.1097/NMD.0b013e3181ef3489.
- 87 Max W, Sung HY, Shi Y. [Attention deficit hyperactivity disorder among children exposed to secondhand smoke: a logistic regression analysis of secondary data.](#) Int J Nurs Stud. 2013 Jun;50(6):797-806. doi: 10.1016/j.ijnurstu.2012.10.002.
- 88 Brion M. [Maternal Smoking and Child Psychological Problems: Disentangling Causal and Noncausal Effects.](#) Paediatrics Volume 126, Number 1, July 2010
- 89 Dolan CV, Geels L, Vink JM, van Beijsterveldt CE, Neale MC, Bartels M, Boomsma DI. [Testing causal effects of maternal smoking during pregnancy on offspring's externalizing and internalizing behavior.](#) Behavior genetics. 2016 May 1;46(3):378-88.
- 90 Murray J, Irving B, Farrington DP, Colman I, Bloxson CA. [Very early predictors of conduct problems and crime: results from a national cohort study.](#) Journal of child psychology and psychiatry. 2010 Nov;51(11):1198-207.
- 91 Paradis AD, Fitzmaurice GM, Koenen KC, Buka SL. [Maternal smoking during pregnancy and criminal offending among adult offspring.](#) J Epidemiol Community Health. 2011 Dec 1;65(12):1145-50.
- 92 Cornelius MD, Goldschmidt L, Day NL. [Prenatal cigarette smoking: Long-term effects on young adult behavior problems and smoking behavior.](#) Neurotoxicol Teratol. 2012 Nov-Dec;34(6):554-9. doi: 10.1016/j.ntt.2012.09.003.
- 93 Liu J, Leung PW, McCauley L, Ai Y, Pinto-Martin J. [Mother's environmental tobacco smoke exposure during pregnancy and externalizing behavior problems in children.](#) Neurotoxicology. 2013 Jan 1;34:167-74.
- 94 Cornelius MD, Goldschmidt L, De Genna NM, Larkby C. [Long-term effects of prenatal cigarette smoke exposure on behavior dysregulation among 14-year-old offspring of teenage mothers.](#) Maternal and child health journal. 2012 Apr 1;16(3):694-705.

- 95 Rydell M, Cnattingius S, Granath F, Magnusson C, Galanti MR. [Prenatal exposure to tobacco and future nicotine dependence: population-based cohort study](#). *The British Journal of Psychiatry*. 2012 Mar;200(3):202-9.
- 96 O'Callaghan FV, Al Mamun A, O'Callaghan M, Alati R, Najman JM, Williams GM, Bor W. [Maternal smoking during pregnancy predicts nicotine disorder \(dependence or withdrawal\) in young adults—a birth cohort study](#). *Australian and New Zealand journal of public health*. 2009 Aug;33(4):371-7.
- 97 Monshouwer K, Huizink AC, Harakeh Z, Raaijmakers QA, Reijneveld SA, Oldehinkel AJ, Verhulst FC, Vollebregt WA. [Prenatal smoking exposure and the risk of behavioral problems and substance use in adolescence: the TRAILS study](#). *European Addiction Research*. 2011;17(6):342-50.
- 98 Goldschmidt L, Cornelius MD, Day NL. [Prenatal cigarette smoke exposure and early initiation of multiple substance use](#). *Nicotine Tob Res*. 2012 Jun;14(6):694-702. doi: 10.1093/ntr/ntr280.
- 99 Nomura Y, Gilman SE, Buka SL. [Maternal smoking during pregnancy and risk of alcohol use disorders among adult offspring](#). *J Stud Alcohol Drugs*. 2011 Mar;72(2):199-209.
- 100 Ekblad M, Gissler M, Lehtonen L, Korkeila J. [Prenatal smoking exposure and the risk of psychiatric morbidity into young adulthood](#). *Archives of general psychiatry*. 2010 Aug 1;67(8):841-9.
- 101 Mikael Ekblad, Liisa Lehtonen, Jyrki Korkeila, Mika Gissler, [Maternal Smoking During Pregnancy and the Risk of Psychiatric Morbidity in Singleton Sibling Pairs](#). *Nicotine & Tobacco Research*, Volume 19, Issue 5, 1 May 2017, Pages 597–604.
- 102 Liu T, Gatsonis CA, Baylin A, Buka SL. [Prenatal exposure to cigarette smoke and benign breast disease](#). *Epidemiology*. 2010 Sep 1:736-43.
- 103 U.S. Department of Health and Human Service. *The Health Consequences of Smoking—50 Years of Progress. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014.
- 104 Meeker JD, Benedict MD. [Infertility, Pregnancy Loss and Adverse Birth Outcomes in Relation to Maternal Secondhand Tobacco Smoke Exposure](#). *Current Women's Health Reviews*. 2013 Feb;9(1):41-49. DOI: 10.2174/1573404811309010003.
- 105 Crane JM, Keough M, Murphy P, Burrage L, Hutchens D. [Effects of environmental tobacco smoke on perinatal outcomes: a retrospective cohort study](#). *BJOG: An International Journal of Obstetrics & Gynaecology*. 2011 Jun;118(7):865-71.
- 106 Salmasi G, Grady R, Jones J, McDonald SD, On behalf of the Knowledge Synthesis Group\*. [Environmental tobacco smoke exposure and perinatal outcomes: a systematic review and meta-analyses](#). *Acta obstetrica et gynecologica Scandinavica*. 2010 Apr 1;89(4):423-41.
- 107 Vardavas CI, Chatzi L, Patelarou E, Plana E, Sarri K, Kafatos A, Koutis AD, Kogevinas M. [Smoking and smoking cessation during early pregnancy and its effect on adverse pregnancy outcomes and fetal growth](#). *European journal of pediatrics*. 2010 Jun 1;169(6):741-8.
- 108 Mojibyan M, Karimi M, Bidaki R, Rafiee P, Zare A. [Exposure to second-hand smoke during pregnancy and preterm delivery](#). *International Journal of High Risk Behaviors & Addiction*. 2013;1(4):149.
- 109 Subramoney S, d'Espaignet ET, Gupta PC. [Higher risk of stillbirth among lower- and middle-income women who do not use tobacco, but live with smokers](#). *Acta Obstet Gynecol Scand*. 2010;89(4):572-7. doi: 10.3109/00016341003801656.
- 110 Nieuwenhuijsen MJ, Dadvand P, Grellier J, Martinez D, Vrijheid M. [Environmental risk factors of pregnancy outcomes: a summary of recent meta-analyses of epidemiological studies](#). *Environmental health*. 2013 Dec;12(1):1-0.
- 111 Hyland A, Piazza KM, Hovey KM, Ockene JK, Andrews CA, Rivard C, Wactawski-Wende J. [Associations of lifetime active and passive smoking with spontaneous abortion, stillbirth and tubal ectopic pregnancy: a cross-sectional analysis of historical data from the Women's Health Initiative](#). *Tobacco control*. 2015 Jul 1;24(4):328-35.
- 112 Chang JS. [Parental smoking and childhood leukemia](#). *Methods Mol Biol*. 2009;472:103-37. doi: 10.1007/978-1-60327-492-0\_5.
- 113 (US) Department of Health and Human Services. *Children and Secondhand Smoke Exposure*. Excerpts from *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General*. Excerpts from Chapter 5 - Reproductive and Developmental Effects from Exposure to Secondhand Smoke. DHHS, Centers for Disease Control and Prevention, Office on Smoking and Health, 2007.
- 114 Milne E, Greenop KR, Scott RJ, Bailey HD, Attia J, Dalla-Pozza L, de Klerk NH, Armstrong BK. [Parental prenatal smoking and risk of childhood acute lymphoblastic leukemia](#). *American journal of epidemiology*. 2012 Jan 1;175(1):43-53.
- 115 Waylen AL, Metwally M, Jones GL, Wilkinson AJ, Ledger WL. [Effects of cigarette smoking upon clinical outcomes of assisted reproduction: a meta-analysis](#). *Human reproduction update*. 2009 Jan 1;15(1):31-44.
- 116 Murin S, Rafii R, Bilello K. [Smoking and smoking cessation in pregnancy](#). *Clin Chest Med*. 2011 Mar;32(1):75-91, viii. doi: 10.1016/j.ccm.2010.11.004. [View abstract](#)
- 117 Chen X, Stanton B, Shankaran S, Li X. [Age of smoking onset as a predictor of smoking cessation during pregnancy](#). *American Journal of Health Behavior*. 2006 May 1;30(3):247-58.
- 118 Notley C, Blyth A, Craig J, Edwards A, Holland R. [Postpartum smoking relapse—a thematic synthesis of qualitative studies](#). *Addiction*. 2015 Nov;110(11):1712-23.
- 119 Bauld L, Coleman T. [The effectiveness of smoking cessation interventions during pregnancy: A briefing paper](#). London: National Institute for Health and Clinical Excellence, 2009.
- 120 Benjamin-Garner R, Stotts A. [Impact of smoking exposure change on infant birth weight among a cohort of women in a prenatal smoking cessation study](#). *Nicotine Tob Res*. 2013 Mar;15(3):685-92. doi: 10.1093/ntr/nts184.
- 121 Department of Health and Social Care. [New ambition to halve rate of stillbirths and infant deaths](#). 2015
- 122 National Institute for Health and Care Excellence (NICE). [Quitting smoking in pregnancy and following childbirth: NICE public health guidance PH 26](#). 2010
- 123 National institute for Health and Care Excellence. [Smoking: acute, maternity and mental health services \[PH 48\]](#). 2013.
- 124 NHS England. [Saving Babies' Lives. A care bundle for reducing stillbirth](#). 2016.
- 125 Department of Health and Social Care (DHSC). [New maternity strategy to reduce the number of stillbirths](#). 2017.
- 126 NHS England. [Saving Babies' Lives Care Bundle Version 2](#). March 2019.
- 127 NHS England. [Long Term Plan. Chapter 2 Smoking](#).



- 128 Findings from a survey of specialist stop smoking in pregnancy support provided by NHS trusts and local authorities. Survey carried out by ASH and the Smoking in Pregnancy research group at the University of Nottingham as part of the Nicotine Replacement Effectiveness and Delivery in Pregnancy (NREADY) programme. 95 NHS trusts and 99 local authorities responded to the survey. Fieldwork was carried out between July and December 2020.
- 129 Coleman T, Chamberlain C, Davey MA, Cooper SE, Leonardi-Bee J. [Pharmacological interventions for promoting smoking cessation during pregnancy](#). Cochrane Database Syst Rev. 2015; (12):CD010078.
- 130 Forinash AB, Jamie M Pitlick, Kylie Clark, Valerie Alstat. [Nicotine replacement therapy effect on pregnancy outcomes](#). Ann Pharmacother. 2010 Nov;44(11):1817-21. doi: 10.1345/aph.1P279.
- 131 Bowker K., Lewis S., Coleman T., Cooper S. [Changes in the rate of nicotine metabolism across pregnancy: A longitudinal study](#). Addiction. 2015; 110:1827–1832. doi: 10.1111/add.13029.
- 132 National Institute for Health and Clinical Evidence (NICE). [Smoking: supporting people to stop](#)[QS43]. 2013.
- 133 Stead LF, Buitrago D, Preciado N, Sanchez G, Hartmann-Boyce J, Lancaster T. [Physician advice for smoking cessation](#). Cochrane Database of Systematic Reviews 2013, Issue 5. Art. No.: CD000165. DOI: 10.1002/14651858.CD000165.pub4.
- 134 Hartmann-Boyce J, Hong B, Livingstone-Banks J, Wheat H, Fanshawe TR. [Additional behavioural support as an adjunct to pharmacotherapy for smoking cessation](#). Cochrane database of systematic reviews. 2019(6).
- 135 Tappin D, Bauld L, Purves D, Boyd K, Sinclair L, MacAskill S, McKell J, Friel B, McConnachie A, De Caestecker L, Tannahill C. [Financial incentives for smoking cessation in pregnancy: randomised controlled trial](#). Bmj. 2015 Jan 27;350.
- 136 Notley C, Gentry S, Livingstone-Banks J, Bauld L, Perera R, Hartmann-Boyce J. [Incentives for smoking cessation](#). Cochrane Database of Systematic Reviews. 2019(7).
- 137 Boyd K, Briggs A, Bauld L, Sinclair L & Tappin D (2016) [Are financial incentives cost-effective to support smoking cessation during pregnancy?](#). Addiction, 111 (2), pp. 360-370. <https://doi.org/10.1111/add.13160>
- 138 Jones M, Lewis S, Parrott S, Wormall S, Coleman T. [Re-starting smoking in the postpartum period after receiving a smoking cessation intervention: a systematic review](#). Addiction. 2016 Jun;111(6):981-90.
- 139 Fitzpatrick KE, Gray R, Quigley MA. [Women's longitudinal patterns of smoking during the pre-conception, pregnancy and postnatal period: evidence from the UK infant feeding survey](#). PLoS One. 2016;11(4).
- 140 Brown, T, Hardeman, W, Bauld, L, Holland, R, Maskrey, V, Naughton, F, Orton, S Ussher, M & Notley, C. [Re-Configuring Identity Postpartum and Sustained Abstinence or Relapse to Tobacco Smoking](#). *Int. J. Environ. Res. Public Health* 2019, 16(17), 3139;
- 141 Smoking in Pregnancy Challenge Group. Evidence into Practice. [Supporting partners to quit smoking](#). 2020
- 142 National Centre for Smoking Cessation and Training (NCST). [Smoking cessation interventions involving significant others: the role of social support](#). 2012.
- 143 Smoking in England. [Latest Statistics 2020](#).
- 144 McNeill A, Brose LS, Calder R, Bauld L, Robson D. [Evidence review of e-cigarettes and heated tobacco products 2018](#). A report commissioned by Public Health England. London: Public Health England. 2018 Feb;6.
- 145 Royal College of Physicians. [Nicotine without smoke: Tobacco harm reduction](#). London: RCP, 2016.
- 146 Hartmann-Boyce J, McRobbie H, Lindson N, Bullen C, Begh R, Theodoulou A, Notley C, Rigotti NA, Turner T, Butler AR, Hajek P. [Electronic cigarettes for smoking cessation](#). Cochrane Database of Systematic Reviews 2020, Issue 10. Art. No.: CD010216. DOI: 10.1002/14651858.CD010216.pub4.
- 147 McNeill A, Brose LS, Calder R, Bauld L, Robson D. [Vaping in England: an evidence update including mental health and pregnancy](#). Public Health England: London, UK. 2020.
- 148 Smoking in pregnancy challenge group. [Use of electronic cigarettes before, during and after pregnancy A guide for maternity and other healthcare professionals](#). 2019.
- 149 [Smoking in Pregnancy Challenge Group Webpage](#).
- 150 ASH & the Smoking in Pregnancy Challenge Group. [Getting back on track: Delivering a smokefree start for every child](#). February 2021
- 151 Caserta D, Bordi G, Di Segni N, D'Ambrosio A, Mallozzi M, Moscarini M. [The influence of cigarette smoking on a population of infertile men and women](#). Archives of gynecology and obstetrics. 2013 Apr 1;287(4):813-8.
- 152 Radin RG, Hatch EE, Rothman KJ, Mikkelsen EM, Sørensen HT, Riis AH, Wise LA. [Active and passive smoking and fecundability in Danish pregnancy planners](#). *Fertility and sterility*. 2014 Jul 1;102(1):183-91.
- 153 Soares SR, Melo MA. [Cigarette smoking and reproductive function](#). Curr Opin Obstet Gynecol. 2008 Jun;20(3):281-91. doi: 10.1097/GCO.0b013e3282fc9c1e.
- 154 Dechanet C., Anahory T., Mathieu J.C., Daude X., Quantin L., Reyftmann S., Hamamah B., Hedon, H. Dechaud. [Effects of cigarette smoking on reproduction](#). *Human Reproduction Update*, Volume 17, Issue 1, January-February 2011, Pages 76–95.
- 155 Sharma R, Biedenharn KR, Fedor JM, Agarwal A. [Lifestyle factors and reproductive health: taking control of your fertility](#). Reproductive Biology and Endocrinology. 2013 Dec 1;11(1):66.s
- 156 Anderson K, Nisenblat V, Norman R. [Lifestyle factors in people seeking infertility treatment—a review](#). Australian and New Zealand journal of obstetrics and gynaecology. 2010 Feb;50(1):8-20.
- 157 Soares SR, Simon C, Remohi J, Pellicer A. [Cigarette smoking affects uterine receptiveness](#). Human reproduction. 2007 Feb 1;22(2):543-7.
- 158 Shaw JL, Oliver E, Lee KF, Entrican G, Jabbour HN, Critchley HO, Home AW. [Cotinine exposure increases fallopian tube PROKR1 expression via nicotinic AChRα7: a potential mechanism explaining the link between smoking and tubal ectopic pregnancy](#). The American journal of pathology. 2010 Nov 1;177(5):2509-15.
- 159 Hahn KA, Wise LA, Riis AH, Mikkelsen EM, Rothman KJ, Banholzer K, Hatch EE. [Correlates of menstrual cycle characteristics among nulliparous Danish women](#). Clinical epidemiology. 2013;5:311.
- 160 Centers for Disease Control and Prevention (US); [National Center for Chronic Disease Prevention and Health Promotion \(US\); Office on Smoking and Health \(US\)](#). Atlanta (GA): [Centers for Disease Control and Prevention \(US\)](#); 2010.
- 161 Dechanet C, Brunet C, Anahory T, Hamamah S, Hedon B, Dechaud H. [Effects of cigarette smoking on embryo implantation and placentation and analysis of factors interfering with cigarette smoke effects \(Part III\)](#). [Article in French] Gynecol Obstet Fertil. 2011 Oct;39(10):567-74. doi: 10.1016/j.gyobfe.2011.07.023. [View abstract](#)

- 162 Lintsen AM, Pasker-de Jong PC, De Boer EJ, Burger CW, Jansen CA, Braat DD, Van Leeuwen FE. [Effects of subfertility cause, smoking and body weight on the success rate of IVF](#). Human reproduction. 2005 Jul 1;20(7):1867-75.
- 163 Van Voorhis BJ, Dawson JD, Stovall DW, Sparks AE, Syrop CH. [The effects of smoking on ovarian function and fertility during assisted reproduction cycles](#). Obstet Gynecol. 1996;88:785-791.
- 164 Roach RE, Helmerhorst FM, Lijfering WM, Stijnen T, Algra A, Dekkers OM. [Combined oral contraceptives: the risk of myocardial infarction and ischemic stroke](#). Cochrane Database of Systematic Reviews. 2015(8).
- 165 Pomp ER, Rosendaal FR, Doggen CJ. [Smoking increases the risk of venous thrombosis and acts synergistically with oral contraceptive use](#). Am J Hematol. 2008 Feb;83(2):97-102.
- 166 Shufelt CL, Bairey Merz CN. [Contraceptive hormone use and cardiovascular disease](#). J Am Coll Cardiol. 2009;53:221-31.
- 167 Saraç F, Oztekin K, Celebi G. [Early menopause association with employment, smoking, divorced marital status and low leptin levels](#). Gynecol Endocrinol. 2011 Apr;27(4):273-8. doi: 10.3109/09513590.2010.491165.
- 168 Sun L, Tan L, Yang F, Luo Y, Li X, Deng HW, Dvornyk V. [Meta-analysis suggests that smoking is associated with an increased risk of early natural menopause](#). Menopause. 2012 Feb 1;19(2):126-32. V
- 169 Kinney A, Klinec J, Levin B. [Alcohol, caffeine and smoking in relation to age at menopause](#). Maturitas. Volume 54, Issue 1, 20 April 2006, Pages 27-38.
- 170 Hyland A, Piazza K, Hovey KM, Tindle HA, Manson JE, Messina C, Rivard C, Smith D, Wactawski-Wende J. [Associations between lifetime tobacco exposure with infertility and age at natural menopause: the Women's Health Initiative](#). Observational Study. Tobacco control. 2016 Nov 1;25(6):706-14.
- 171 Matikainen T, Perez GI, Jurisicova A, Pru JK, Schlezinger JJ, Ryu HY, Laine J, Sakai T, Korsmeyer SJ, Casper RF, Sherr DH. [Aromatic hydrocarbon receptor-driven Bax gene expression is required for premature ovarian failure caused by biohazardous environmental chemicals](#). Nature genetics. 2001 Aug;28(4):355-60.
- 172 Windham GC, Mitchell P, Anderson M, Lasley BL. [Cigarette smoking and effects on hormone function in premenopausal women](#). Environmental health perspectives. 2005 Oct;113(10):1285-90. Environ Health Perspect. 2005 Oct;113(10):1285-90.
- 173 Heidelbaugh JJ. [Management of erectile dysfunction](#). American family physician. 2010 Feb 1;81(3):305-12.
- 174 Cao S, Yin X, Wang Y, Zhou H, Song F, Lu Z. [Smoking and risk of erectile dysfunction: systematic review of observational studies with meta-analysis](#). PloS one. 2013;8(4).
- 175 Mostafa, T. [Cigarette smoking and male infertility](#). 2010 Journal of Advanced Research
- 176 Schilling K, Toth B, Rösner S, Strowitzki T, Wischmann T. [Prevalence of behaviour-related fertility disorders in a clinical sample: results of a pilot study](#). Archives of gynecology and obstetrics. 2012 Nov 1;286(5):1307-14.
- 177 Sofikitis N, Takenaka M, Kanakas N, Papadopoulos H, Yamamoto Y, Drakakis P, Miyagawa I. [Effects of cotinine on sperm motility, membrane function, and fertilizing capacity in vitro](#). Urological research. 2000 Dec;28(6):370-5.
- 178 Biebel MG, Burnett AL, Sadeghi-Nejad H. [Male sexual function and smoking](#). Sexual medicine reviews. 2016 Oct 1;4(4):366-75.