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Review on: Risk Factors Associated with Tobacco Abuse During Pregnancy

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Abstract

Tobacco consumption among pregnant women remains a pressing public health challenge, particularly in India, where both smoking and smokeless tobacco (SLT) use are prevalent. Despite rigorous tobacco control policies, the socio-cultural acceptance of various tobacco products, coupled with limited awareness and cessation support, has sustained its usage among women of reproductive age. SLT dominates tobacco consumption patterns in India, with common forms including khaini, gutka, mishri, and betel quid, while smoking alternatives such as cigarettes, bidis, and hookahs persist in certain demographics.

The teratogenic effects of tobacco exposure during gestation are profound, primarily driven by nicotine-induced vasoconstriction and carbon monoxide-mediated hypoxia, leading to placental insufficiency, fetal growth restriction, and adverse perinatal outcomes. Empirical evidence underscores an elevated risk of preterm birth, low birth weight, placental abruption, stillbirth, and neurodevelopmental impairments in offspring exposed to maternal tobacco use. Furthermore, intrauterine nicotine exposure has been implicated in long-term metabolic dysregulation, predisposing children to obesity, insulin resistance, and cardiovascular anomalies.

The persistence of tobacco use among pregnant women is intricately linked to socio-economic disparities, educational deficits, traditional practices, and inadequate enforcement of tobacco cessation initiatives. Regional variations highlight a disproportionately high prevalence in rural and tribal populations, where public health interventions often fail to penetrate effectively. Despite global advancements in tobacco control, India continues to grapple with significant gaps in cessation strategies tailored for pregnant women, necessitating urgent policy recalibration.

A comprehensive approach integrating stringent regulatory enforcement, culturally sensitive behavioral interventions, enhanced prenatal screening, and evidence-based cessation programs is imperative to mitigate the maternal and fetal health burden associated with tobacco exposure. Strengthening interdisciplinary collaborations and leveraging emerging research on tobacco-related fetal programming could further refine intervention frameworks, ultimately fostering a tobacco-free generational transition.

Introduction

All the plants which contain nicotiana as a constituent of the family Solanaceae can be referred as tobacco. Any form of tobacco can be destructive or hazardous. Scientific validation has clearly confirmed that any disclosure or access to tobacco results in death, disease, or disability[1]. Tobacco smoke contains thousands of chemicals that can negatively impact the human body. The key substances of concern are nicotine and carbon monoxide[2]. Nicotine is broken down into several different compounds, with cotinine being the most prominent. Cotinine has a significantly longer half-life than nicotine and reaches much higher concentrations in the maternal bloodstream[3]. Additionally, cotinine has been detected in the fetal bloodstream at concentrations similar to those found in the mother[4]. Through the use of different animal

models, studies have demonstrated that nicotine causes a consistent reduction in uterine artery blood flow, along with inconsistent changes in umbilical artery flow. It also leads to variable effects on fetal oxygen levels and acid-base balance. Additionally, nicotine results in a lower fetal heart rate and an increase in mean arterial pressure[5]. Carbon monoxide (CO) passes through the placenta quickly and can be found in the fetal bloodstream, where its levels are typically 15% higher than in the maternal circulation[6]. Carboxyhaemoglobin forms when CO binds to haemoglobin, causing a leftward shift in the oxygen dissociation curve, which reduces the amount of oxygen available to the fetal tissues[7]. India is the one of the world's largest manufacturers and prevalent users of tobacco, smokeless tobacco (SLT) is most frequently form of tobacco used and available across the country[8]. Tobacco use, including the adoption of new tobacco products, is rising not only among men but also among children, teenagers, and women of reproductive age, making it one of the leading causes of health problems globally[9,10]. Tobacco use is responsible for 8 million deaths each year worldwide[11]. One million of these deaths happen in India[12]. Despite a long history of tobacco control, India continues to be the second-largest tobacco-consuming country[13]. The prevalence of drug abuse during pregnancy is high among women, despite being a significant risk factor for maternal health issues and newborn complications[14]. Tobacco use during pregnancy results in various harmful effects on both maternal and child health[15]. Several studies conducted among pregnant women in Nepal and India have shown that factors such as illiteracy, living in urban areas, having a spouse who smokes, manual labour occupations, being divorced, and belonging to Terai communities are all linked to a higher risk of tobacco use among women[16,17,18].

Forms of Tobbaco: In India, tobacco is primarily consumed in two forms: smoking and smokeless. The smoking forms include cigarettes, beedis, hookahs, and various pipes such as chillum, chute, dhumti, cherrot, and cigars. The smokeless forms include chewing plain tobacco, khaini, zarda, kiwam, bajjar/tap kheer (dry snuff), masheri/mishri, and gutka. In certain regions, products containing both tobacco and areca nut are also popular. Among these, chutta is the most commonly used, followed by cigarettes[19]. Tobacco smoke is a complex and ever-changing mixture, made up of approximately 5000 chemicals[20]. Tobacco smoke is an aerosol consisting of liquid droplets (the particulate phase) suspended in a blend of gases and semi-volatile compounds. The particulate phase includes various substances such as polycyclic aromatic hydrocarbons, tobacco-specific nitrosamines, phytosterols, and metals. Some compounds, known as semi-volatiles like phenol and cresols (phenolics), are found in both the particulate and gaseous phases. The gaseous phase primarily contains nitrogen and oxygen, along with combustion byproducts like carbon monoxide (CO), carbon dioxide, and nitric oxide[21]. Nicotine, an alkaloid found in the tobacco plant's roots, is the primary addictive substance in tobacco smoke[22].

Smoking Form:

Waterpipe/Hookah: The water pipe (narghile) consists of four main components. The head holds the substance to be smoked along with charcoal to aid in its combustion. Various products can be smoked, such as tobacco (tabamel or maassel, tumbak, jurak) or a blend of tobacco and hashish (tasheirah)[23]. Often with additional additives. The smoke passes through the body, which is a metal tube submerged in the water within the bowl. It bubbles through the water before being drawn through the hose to the smoker[24]. The smoke from water pipes contains many of the same compounds found in cigarette smoke, though in varying amounts. Notably, the longer duration of a water pipe smoking session results in significantly higher levels of tar, nicotine, carbon monoxide (CO), polycyclic aromatic hydrocarbons, and heavy metals compared to cigarette smoking[25].

Bidis: Bidi cigarettes are small, slender, slightly tapered smoking sticks that contain about 0.2 g of pressed tobacco wrapped in a tambourine or tendu leaf, which are plants native to India. The hand-rolled cigarette is held together with a thread at one or both ends. Bidis can be flavored (such as chocolate, cherry, or mango) or unflavored[26]. India produces an enormous number of bidis, around 800 billion annually, compared to 95 billion cigarettes. The majority of these bidis are hand-rolled at home by millions of workers, predominantly women, with some children involved as well. Bidis are mainly imported into the US from India and other Southeast Asian nations[27]. In the mainstream smoke of bidis, the levels of nicotine, tar, and carbon monoxide are higher than those found in regular cigarettes sold in the USA, with no significant difference between filtered and unfiltered bidis[28].

Kretek: Kretek cigarettes are made with a blend of hundreds of additives (such as flavours, ammonia, cocoa, etc.), along with 30 types of tobacco (including black and others), cloves, and various sauces. Cloves contain eugenol, which has a local anaesthetic effect that can lead to more intense smoking and is suspected—though not classified—of being a potential carcinogen[29]. Standardized machine-smoking tests in the USA show that kreteks produce higher levels of nicotine, carbon monoxide, and tar compared to regular cigarettes[30].

Smokeless Forms of Tobacco: "Smokeless tobacco" refers to tobacco that is consumed without being burned. It can be used either orally or nasally. Over one-third of tobacco consumed in certain regions is smokeless. Traditional forms, such as betel quid, tobacco with lime, and tobacco tooth powder, are widely used, and the use of new products is rising, not just among men but also among children, teenagers, and women of reproductive age[31].

Mishri: "Mishri" is a roasted, powdered form of tobacco created by baking it on a metal plate until it turns evenly black, after which it is ground into a powder[32,33]. Mishri is made by roasting tobacco leaves with nicotine, its main alkaloid, ranging from 1% to 7%. Different studies have estimated the prevalence of Mishri use to be between 17% and 45%[34,35]. It is linked to an increased risk of abortion, ectopic pregnancy, stillbirth, placenta previa, abruptio placentae, premature rupture of membranes, preterm birth, intrauterine growth restriction, and sudden infant death syndrome[36,37].

Chewing Tobacco: Chewing tobacco can be compacted into a tiny rectangular "plug" or left as loose leaves. Leaf curing, cutting, fermentation, and processing—which may involve flavoring and sweetening—are the methods used to make almost all contemporary chewing tobaccos. Historically, cigar cuttings were used to make a large number of chewing tobacco brands that were popular during the American Civil War[38].

Plug: Tobacco leaves are compressed into a square, brick-like mass known as a plug to make plug chewing tobacco. Pieces are then consumed after being bitten off or sliced from the plug. Since plug tobacco is becoming less popular, loose-leaf chewing tobacco is more widely available. In the past, plug tobacco could be eaten or smoked in a pipe, but these days, they are two different items[39].

Twist: The leaves of twist chewing tobacco are twisted into a mass that resembles a rope. Twist chewing tobacco is typically not sweetened, in contrast to the majority of loose-leaf tobaccos. Twist fragments are either cut or bitten off before being chewed. Twist chewing tobacco is mostly found in Appalachia and is not generally accessible. In the past, twists might also be pulverized into nasal snuff or smoked in a pipe[40].

Snuff: Snuff tobacco is a form of smokeless tobacco made from finely ground or shredded tobacco leaves, which can come in various scents and flavors and may be either moist or dry. Moist snuff is typically placed in the mouth, often between the cheek and gum or behind the lip,

while dry snuff is inhaled through the nose. It contains nicotine and numerous harmful, cancer-causing chemicals. Using snuff tobacco can lead to nicotine addiction and increase the risk of cancers in the mouth, esophagus, and pancreas. Additionally, it can cause gum disease, heart disease, stroke, and other serious health issues. This practice is also referred to as "dipping"[41].

Prevalence of Tobacco Abuse During Pregnancy:

Smoking during pregnancy has been linked to various complications, including placenta previa, abruptio placentae, premature rupture of membranes, preterm birth, intrauterine growth restriction, and sudden infant death syndrome (SIDS). The perinatal mortality rate for smokers is 1.5 times higher compared to non-smokers[42]. It is commonly known that smoking by the mother during pregnancy increases the chance of miscarriage, perinatal death, low birth weight, preterm deliveries, and undersized fetuses[43]. In-depth human and laboratory investigations have investigated the biological pathways by which baccosmoke affects fetal development, revealing that many of the 7000 compounds can pass through the placental barrier and directly injure the unborn child[44].

Epidemiology:

Using tobacco products while pregnant increases the risk of numerous health issues for both the mother and the fetus. About 5.8% of Indian women aged 15 to 49 use tobacco in any form, with a significant rural-urban split, according to the National Family Health Survey (NFHS-5), which was carried out between 2019 and 2021. While figures vary by location and community, the prevalence of tobacco use among pregnant women in particular is estimated to be between 2% and 4% of pregnant women who smoke or use smokeless tobacco. 6.2% of pregnant women in a Rajasthani study by Sharma et al. (2023) reported using smokeless tobacco products, including gutka and paan masala, whereas 1.8% acknowledged smoking cigarettes. Despite governmental attempts to reduce tobacco use, this implies that pregnant women continue to use tobacco, particularly smokeless tobacco[45].

However, Rao et al.'s survey from 2022 in metropolitan Bengaluru revealed a significantly lower prevalence, with only 1.2% of pregnant women consuming tobacco. This demonstrates the regional differences in tobacco usage as well as the discrepancies in healthcare availability and awareness across the nation[46]. Approximately 100,000 people aged 35 and older participated in a house-to-house cross-sectional study in 1992–1994 in the city of Mumbai (formerly Bombay). The percentage of men and women who had ever smoked was 15.4% and 0.3%, respectively, while the rate of use of various smokeless tobacco products was higher (47.8% and 59%, respectively). Among the entire study population, current bidi smokers made up 13.3% of men and 0.3% of women, compared to 9.9% of men and 0% of women who smoked cigarettes. Compared to 46.5%, 33.9%, 15.1%, and 4.5% for industrial cigarettes, the daily number of bidis used by male current smokers was 1–5 in 20.8%, 6–10 in 18.0%, 11–20 in 25.4%, and d21 in 35%[47]. The World Health Organization estimates that 400 million people smokeless tobacco, mostly in Central and South India, with usage of the product rising in certain of these nation[48] Asia, especially India, has a long history of using tobacco leaves. In South Africa today, dry snuff is utilized. In India, the usage of oral tobacco, including betel quid, is more common than smoking. Tobacco use in all its forms is very common in rural areas, with varying rates of 33–80% among males and 15–67% among women[49,50,51].

Risk Factors for Tobacco Use During Pregnancy:

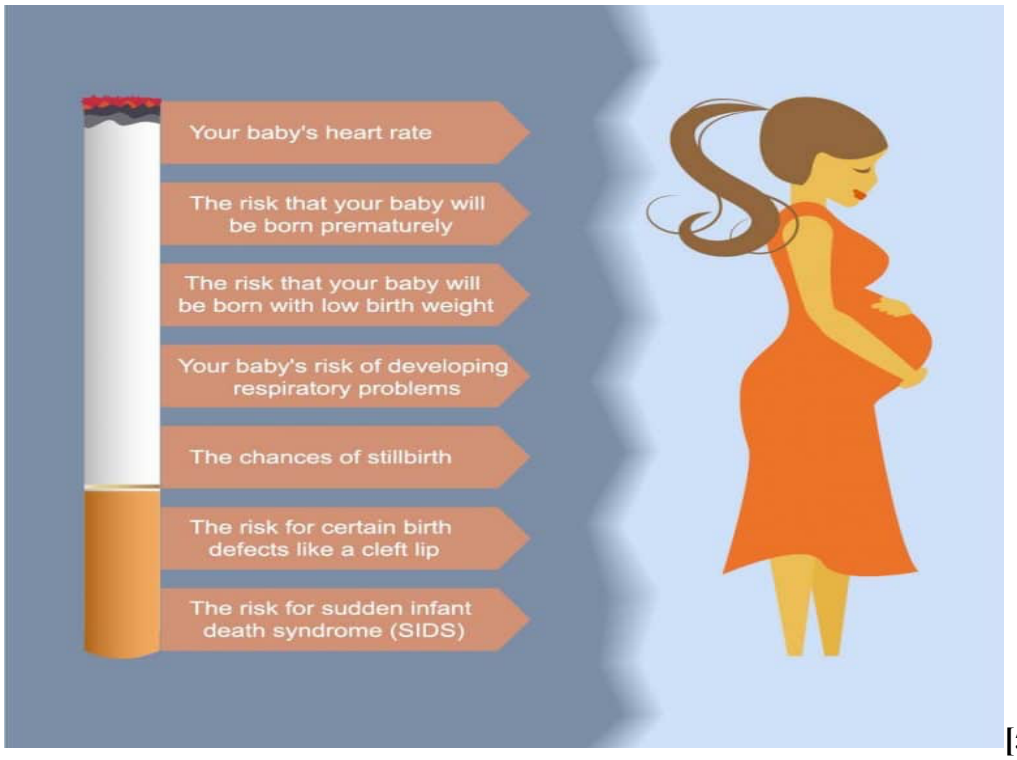
Socioeconomic Factors: Pregnant women who come from poorer socioeconomic origins are more prone to smoke. Financial stress, low educational attainment, and restricted access to healthcare are major causes. According to research by Singh et al. (2022) in Uttar Pradesh,

pregnant women from lower-income households were substantially more likely to smoke[52].

Cultural Factors: Smokeless tobacco consumption is encouraged by cultural customs in several regions of India, especially for women. Chewing tobacco and betel is considered an integral component of daily life in some societies, even during pregnancy. More than 12% of pregnant women in tribal communities in West Bengal smoked smokeless tobacco due to cultural customs, according to a 2021 study by Bhattacharya et al[53].

Lack of Awareness: One reason why tobacco usage persists throughout pregnancy is a lack of knowledge about the dangers of doing so. Just 38% of women in rural Madhya Pradesh were aware of the negative effects of tobacco use during pregnancy, according to a study by Jain et al. (2023). One major obstacle to smoke cessation efforts is this ignorance[54].

Risk of Smoking For Pregnant Women and Foetus:



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Birth Difficulties: Pregnant women who smoke are more likely to experience nutritional deficiencies, psychological problems, and obstetric issues. Early prenatal exposure to tobacco products probably has an impact on placental development, either directly or indirectly, by lowering blood flow, which produces an environment that is pathologically hypoxic[56].

Preterm Birth: In 1957, Simpson made the initial suggestion that smoking was linked to premature labor and delivery [57]. She discovered a premature birthrate that was almost twice as high as that of non-smokers (defined as birthweight <2500 g). There is additional evidence of a dose-response link between smoking cigarettes and preterm birth.

Similar findings have been reached by other investigations. Meyer examined data from the Ontario Perinatal Mortality Study and found that, in comparison to non-smokers, women who smoked had a twofold higher rate of preterm

deliveries occurring before 36 weeks of gestation[58]. Programs to help people quit smoking have received a lot of attention. In comparison to women who continued to smoke, Mainous found that the rate of preterm delivery was significantly lower among women who stopped smoking during the first trimester (5.9 vs. 8.2%, p=0.003) [59].

Premature Rupture of Membrane: The Collaborative Perinatal Project data indicates that smoking is linked to a higher incidence of PROM but not PPROM. Additionally, women who smoke more than 22 cigarettes a day were found to be at a lower risk of developing PROM[60]. Five to fifteen percent of pregnancies are complicated with premature rupture of the membranes (PROM). 0.7–2.0% of pregnancies end in preterm (less than 37 weeks) premature rupture of the membranes (PPROM)[61]Smokers may experience burst membranes due to a variety of mechanisms. PROM risk has been found to be increased by nutritional deficiencies, which are mostly caused by smoking's impact on ascorbic acid levels[62]. The "immunologic response" is lowered by smoking, which reduces the body's reactivity to viral and bacterial infections that might result in PROM[63].

Abnormalities Of Fetal Growth: The link between smoking and reduced fetal growth is widely recognized, as highlighted in the 1990 Surgeon General's report. The report indicates that smoking during pregnancy slows fetal development, leading to an average decrease in birthweight of 200 grams and a twofold increase in the likelihood of delivering a low-birthweight baby[64]. Smoking during pregnancy significantly impacts fetal growth. Research has demonstrated that maternal smoking can reduce birth weight and notably raise the risk of low birth weight (<2500 g) and preterm births. These effects are also found to be dose-dependent and vary based on the timing of smoking during pregnancy[65,66,67]. Recent findings indicate that for every additional pack of cigarettes smoked during pregnancy, neonatal body mass decreased by 2.8 grams (with a 0.7-gram reduction in fatty mass and a 2.1-gram reduction in free-fatty mass). This highlights a dose-dependent relationship between prenatal smoking and neonatal body mass composition[68]. Various mechanisms have been proposed to explain how maternal smoking impacts fetal growth and birth weight. Carbon monoxide (CO) in tobacco has a strong affinity for hemoglobin, leading to higher levels of carboxyhemoglobin in the umbilical arteries. This reduces oxygen delivery to the fetus, resulting in fetal hypoxia[69]. Additionally, maternal smoking may affect the supply of docosahexaenoic acid (DHA) to the fetus. Smoking during pregnancy can gradually hinder DHA synthesis and/or its transfer from the mother, which has been linked to restricted fetal growth[70]. Finally, fetal growth restriction caused by tobacco smoking during pregnancy may also result from epigenetic mechanisms. In fact, in utero exposure to tobacco smoke has been linked to alterations in DNA methylation of genes associated with growth restriction, such as the CYP1A1 promoter[71,72,73].

Low Birth Weight: Low birth weight (LBW) refers to infants born with a weight of 2500 grams or less, irrespective of their gestational age or the underlying cause of the low weight[74]. Low birth weight (LBW) can be divided into three categories:

1. **Premature or Preterm LBW:** Infants born before 37 full weeks of gestation or fewer than 259 days of pregnancy.
2. **Term LBW:** Infants born between 37 and 42 full weeks of gestation, or between 259 and 293 days of pregnancy.
3. **Post term LBW:** Infants born after 42 weeks or 294 days of gestation.

LBW infants can also be classified further into:

- Very low birth weight (VLWB): Weighing between 1000 and 1499 grams.
- Extremely low birth weight (ELBW): Weighing between 500 and 999 grams.

Small-for-gestational-age (SGA) refers to infants whose weight falls below the lower limit of the normal weight curve for their gestational age, based on statistical data[75].Pregnancy-related smoking impacts fetal development by lowering oxygen levels, impairing placental function, and limiting blood flow, all of which lead to low birth weight[76].

Brain Development: Maternal smoking can influence fetal brain development and function. Infants exposed to prenatal smoking showed smaller brain size and changes in brain functions compared to those who were not exposed. The mechanisms behind these effects may involve nicotine affecting axonal guidance and synapse formation in neurons, while carbon monoxide (CO) causes fetal hypoxia, disrupting brain development. Additionally, epigenetic changes, such as DNA methylation regulating the brain-derived neurotrophic factor (BDNF) gene, which is crucial for normal brain development, may also play a role[77].

Later Obestiy and Related Comorbidities:

There is increasing worry that exposure to chemicals during the perinatal period may significantly contribute to the rising rates of obesity and metabolic disorders. Children of pregnant women who smoked had a higher chance of being obese at a mean age of nine years old than children of non-smoking mothers, according to a recent meta-analysis of 17 research[78]. Children whose mothers smoked during pregnancy had a 50% higher chance of being overweight later in life than children whose mothers did not smoke during pregnancy, according to a similar meta-analysis[79]. Various mechanisms and pathways have been suggested to explain the link between smoking during pregnancy and the increased risk of overweight and obesity, including the thrifty phenotype theory, postnatal catch-up growth, and imbalances in neurotransmitters or hormones[80].In addition, Ino proposed two mechanisms to explain the development of obesity in children of mothers who smoked. First, obesity in these offspring may result from changes in hypothalamic regulation of energy intake and expenditure caused by nicotine-induced starvation during early pregnancy. Second, fetal exposure to nicotine appears to disrupt cell proliferation, differentiation, and synaptic activity in the brain, as well as affect peripheral autonomic pathways [81].

Respiratory Outcomes: Maternal smoking during pregnancy has been linked to a higher risk of wheezing, asthma, airway hyperresponsiveness, reduced lung function, and bronchitis[82]. A recent systematic review and meta-analysis[83] found that prenatal tobacco exposure is linked to an increased risk of asthma and wheezing in children and adolescents up to 18 years old, with the most significant impact on asthma incidence in children under 2 years old. Childhood asthma is a chronic inflammatory airway condition characterized by an abnormal T-helper (TH) type-2 immune response to inhaled allergens, leading to IgE production. Studies have shown that maternal smoking during pregnancy is associated with stronger neonatal TH2 cytokine responses to allergens[84] and that nicotine may stimulate the production of cellular mediators that enhance TH2 activity and increase immunoglobulin production. This suggests that in utero tobacco exposure could amplify allergic inflammatory responses [85].

Later Cardiovascular Outcomes: Maternal smoking during pregnancy may have a lasting impact on the cardiovascular health of offspring. In fact, prenatal tobacco exposure has been linked to reduced Fetal Heart Rate Variability (HRV) in the womb[86]. Hypertension is another health issue linked to prenatal exposure to tobacco smoking[87]. Additionally, it has been proposed that prenatal maternal smoking may impact a child's blood pressure, with lasting effects even if the mother stops smoking months before pregnancy[88]. The mechanisms that may explain elevated blood pressure in offspring linked to maternal tobacco smoking include endothelial dysfunction, changes in kidney

structure and function, and alterations in perivascular adipose tissue, which plays a key role in regulating vascular function[89].

Alterations in Neurology and Psychological Behaviour: Numerous studies have established a connection between maternal smoking during pregnancy and restricted fetal growth, as well as a reduction in the size of the fetal brain. Research indicates that key areas of the fetal brain, such as the cerebellum and corpus callosum, exhibit reduced density. These findings suggest a decline in coordination between different parts of the fetal brain when processing information, slower response times to external stimuli, and a slight decrease in motor skills, particularly on the non-dominant side.[90,91,92].

Tobacco Abuse During Lactation: One of the most critical periods after birth when parental tobacco smoke can have harmful effects is during lactation and breastfeeding. When a mother who smokes breastfeeds, it becomes a primary source of infant exposure to tobacco substances, as nicotine is easily transferred into breast milk[93]. The harmful effects of nicotine in breast milk may vary based on the mother's daily cigarette consumption and the duration between the last inhaled cigarette and the start of nursing. Tobacco smoking can cause early-life symptoms including as irritability, weeping, lassitude, pallor, sleep deprivation, and memory and learning deficiencies[94,95].

Tobacco Cessation Strategies And Anti-Smoking Program:

Smokers often try to quit by switching to cigarettes with lower tar and nicotine content, which they perceive as less harmful, or by choosing cigarettes that are marketed as having reduced toxicity, like light cigarettes[96]. Imposing high excise taxes on tobacco products increases their prices, making them less affordable for many consumers, which could potentially result in a decline in cigarette smoking[97]. Strict enforcement of legislative policies regarding tobacco use, implemented by various countries, can contribute to encouraging tobacco cessation[98]. A comparative study from the UK found that pregnant women who smoke are receptive to receiving advice on quitting or reducing smoking from midwives. However, the study also revealed that these women often have negative expectations of smoking cessation programs despite the positive experiences reported by those who have taken part in them[99]. A South African study on midwives found that the manner in which medical professionals discuss smoking during pregnancy is crucial. The most positive responses from pregnant women came from a patient-centered approach, which involved brief motivational interviewing and fostering a trusting, cooperative relationship between the midwife and the patient. Medical professionals using this modern approach were more effective in supporting smoking cessation programs[100].

Conclusion:

Tobacco use during pregnancy in India remains a serious health concern, leading to adverse maternal and fetal outcomes. Despite regulations, socio-cultural factors and limited cessation support hinder progress. Effective intervention requires stronger enforcement, accessible cessation programs, and culturally sensitive health education. Community-based strategies and interdisciplinary collaboration can enhance tobacco control efforts. Bridging research and policy gaps is crucial to reducing maternal tobacco use and ensuring a healthier future for both mothers and children.

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