ENCYCLOPEDIA
on Early Childhood
Development

Tobacco Consumption During Pregnancy and its Association with Psychosocial Child Development

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November 2023, 3e éd. rév.

Introduction

Self-report studies reveal that 7 to 25% of women of childbearing age in the United States endorse current smoking, including the use of electronic nicotine delivery systems (ENDS), which have recently increased in popularity.[1-2] Meta-analyses suggest that maternal tobacco consumption during pregnancy is associated with negative child behavioural and mental health outcomes, including attention deficit hyperactivity disorder, conduct problems, mood disorders, and schizophrenia.[3-6] Given the fact that almost half of the women who consume tobacco prior to pregnancy continue to do so throughout pregnancy,[7] these tobacco–behavioural linkages may have far-reaching implications for development and mental health in children.

Subject

Studies have linked maternal tobacco consumption during pregnancy to a number of adverse medical outcomes. Meta-analytic reviews report significant associations between maternal tobacco use in pregnancy and negative child health outcomes including low birthweight, sudden infant death syndrome, asthma, and obesity.[8] As noted above, the deleterious effects of maternal prenatal smoking on child development appear to extend to the psychosocial realm as well. This report reviews the evidence for the connection between maternal tobacco consumption and psychosocial child development and discusses relevant implications for interventions and public health policy.

Problems

The study of maternal tobacco consumption and its effect on child behavioural or psychosocial outcomes is fraught with methodological problems. The most serious methodological concern is the difficulty in establishing a causal connection due to the potential role of confounds in this process.[9] Research in this area is quasi-experimental. For obvious ethical reasons, women are not randomly assigned to smoke or not to smoke during pregnancy. However, the factors identified with women who do smoke typically differ from those of women who do not in a number of different areas, including genetic and cultural background, childhood history of antisocial behaviour, socioeconomic status, mental health, personality traits, parenting styles, and exposure to stressful life events. These factors, in turn, are associated with greater risk for problematic child psychosocial development. However, no single study has been able to control for all of these potential confounds. Another methodological concern is the common use of retrospective rather than prospective reports of maternal smoking. The finding that maternal self-reports of smoking during pregnancy are highly correlated with direct biochemical measures[10] alleviates major concerns about the exclusive use of self-reports of maternal smoking in this research area. However, there remains a lingering concern regarding the capacity of self-report to detect exposure from various sources (i.e., second-hand exposures). Recent findings indicate that self-reported data should be supplemented with biological measurements of exposure. These data find that integrative assessments, that combine multiple measures of use, better reflect overall exposure and are most proficient in identifying the behavioural consequences associated with substance use.[11]

Research Context

Maternal prenatal smoking and its relationship to child psychosocial outcomes has been examined in both cross-sectional and longitudinal studies, and in both clinical and community samples. Animal studies have examined the effect of nicotine exposure on behavioural outcomes and brain functioning and neurobiological deficits have been suggested as a likely mediator for negative behavioural outcomes.[12] Human studies support this contention, noting associations between maternal prenatal smoking and reductions in frontal lobe volumes in infants,[13] decreased cortical thickness in children,[14] and a thinning of the cerebral and, potentially, orbitofrontal cortices in adolescents.[15] Nevertheless, there remains disagreement in the field concerning the relative importance of the direct effects of prenatal tobacco smoking, its associated familial background factors, and potentially moderating environmental or genetic vulnerabilities in the prediction of negative child behavioural outcomes.

Key Research Questions

The key research questions in this area are as follows:

- Is maternal tobacco consumption during pregnancy associated with deleterious behavioural outcomes in youth? And, if so:
- Can potential methodological confounds account for this association? And, if not:
- Are these risks specific to particular behavioural outcomes?
- Are these risks moderated by other factors including genetics, the biological sex of the child, co-exposures, or the environmental context of development?

Recent Research Results

Maternal prenatal smoking has been associated with increased risk for Attention Deficit Hyperactivity Disorder, oppositional behaviour, aggression, conduct disorder, problematic language and cognitive development, and substance misuse outcomes in youth.[16-21] A majority of studies suggest that statistical control for a range of potential confounds, including parental criminality, maternal mental health, parenting behaviour, socioeconomic status, prenatal exposure to drugs and alcohol, and other perinatal complications, does not change the general pattern of results. However, a few studies have found that the maternal prenatal smoking child outcome relationship is no longer significant when maternal background characteristics (e.g., childhood history of conduct disorder) and mother-child relationship qualities are taken into

account.[22-24] Although evidence from twin studies suggests that the relationship between maternal smoking during pregnancy and child behaviour problems cannot be entirely accounted for by genetic influences,[22,25] recent studies using innovative design strategies have suggested that genetic or familial background factors may be essential components of the prenatal smoking and child externalizing behaviour association.[26,27]

The noted maternal prenatal smoking child behaviour outcome association appears stronger for externalizing or acting out behaviours; results from studies examining the associations between maternal prenatal smoking and child internalizing problems have been mixed.[9,28-30]

In addition, offspring biological sex appears to moderate the effects of maternal prenatal smoking on child psychosocial outcomes. Specifically, results are stronger for males in terms of the outcomes of conduct disorder, and stronger for females in terms of the outcome of substance misuse.[20,31] Family and socioeconomic context has been shown to moderate the effect of maternal prenatal smoking on child outcomes.[16,32,33] Gene by environment interaction studies also suggest that several distinct genetic polymorphisms, (including one that effects the metabolism of smoking-related carcinogens), may moderate the association between maternal prenatal smoking and child externalizing behaviour.[34-36] Furthermore, maternal genetic profiles have been associated with the reduction or spontaneous quitting of smoking during pregnancy.[37] Epigenetic processes have also been identified as potential mechanisms through which maternal prenatal smoking may confer risk for vulnerabilities in child development. For instance, maternal smoking can affect embryonic DNA methylation which, in turn, can impact gene expression, phenotyping, and ultimately offspring behaviour later in life.[38] Moreover, DNA methylation has been found to mediate outcomes such as offspring neurodevelopment, memory, cognition, and attention, all of which can influence psychosocial development.[39-42] Further study of maternal psychosocial and genetic characteristics associated with cessation of smoking during pregnancy is needed to more effectively design intervention programs focused on pregnant women.

Conclusions

There are several possible mechanisms or explanations for the noted relationship between maternal prenatal smoking and behavioural problems in offspring. One possible explanation is that prenatal exposure to this teratogen increases the risk for child externalizing problems, but only in genetically or otherwise environmentally vulnerable individuals. Alternatively, maternal prenatal smoking may serve as a marker for other environmental effects that increase the risk of

externalizing problems in children. For example, maternal prenatal smoking may be an indicator of a passive, neglectful parenting style. It may not reflect abuse or overt parental hostility but rather a subtle disruption in the parent-child relationship that is difficult to measure via questionnaires or short-term observations, but that nevertheless increases the risk for externalizing problems in children. An additional possibility is that maternal cigarette smoking may set off a chain of transactional biological and environmental factors that act together to increase risk for deleterious child development. Our understanding of this transactional process is rudimentary at this time.

Implications

Not all children whose mothers smoked during pregnancy will manifest deficits in behaviour or developmental outcomes. Future studies aimed at assessing the potentially moderating risk and protective factors in this process would be useful in designing effective prevention and intervention programs. A public health approach calls for prevention and intervention strategies designed to reduce the known risk factors for these deleterious psychosocial outcomes in children. Maternal prenatal smoking is a relatively modifiable perinatal risk factor. Smoking cessation programs for pregnant women,[43] which may include novel mobile phone-based interventions,[44] financial incentives,[45] short-term and long-term nicotine replacement therapies,[46,47] and even low-intensity counselling interventions by general practitioners,[48] have been found to reduce or eliminate maternal smoking during pregnancy. An examination of the behavioural profiles of the children whose mothers successfully completed such programs would help provide important experimental evidence concerning the potentially causal role of maternal prenatal smoking on child behaviour problems.

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