

Consequences and Possible Predictors of Health-damaging Behaviors and Mental Health Problems in Pregnancy – A Review

Auswirkungen und mögliche Prädiktoren gesundheitsschädigender Verhaltensweisen und psychischer Beeinträchtigungen in der Schwangerschaft – ein Überblick

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Abstract

In recent decades, the understanding of the short and longer term effects of health-damaging behaviors and mental health problems in pregnant women and the underlying mechanisms of these behaviors and illnesses has significantly increased. In contrast, little is known about the factors affecting individual pregnant women which contribute to health-damaging behaviors and mental illness. The aim of this paper was therefore to summarize the current state of research into the consequences of nicotine and alcohol consumption, malnutrition, excessive weight gain or obesity, and impaired mental health (depression and anxiety) during pregnancy. In addition, the characteristics of pregnant women which increase their risk of developing such behaviors or mental disorders are described. A better knowledge of these risks should make it easier for clinicians to identify cases at risk early on and put measures of support in place. A review of the literature has shown that certain characteristics of pregnant women (e.g. her relationship with her partner, a previous history of mental illness prior to pregnancy) are associated with various health-damaging behaviors as well as with impaired mental health. Affected women often show an accumulated psychosocial stress which was already present prior to the pregnancy and which may persist even after the birth of the child.

Introduction

Because of their high developmental plasticity children are particularly sensitive to environmental factors in the early stages of their life [1,2]. Extensively investigated factors which can have last-

Zusammenfassung

In den letzten Jahrzehnten hat sich das Wissen über die kurz- und langfristigen Effekte von gesundheitsschädigenden Verhaltensweisen und Beeinträchtigungen im psychischen Befinden der Schwangeren und deren zugrunde liegenden Mechanismen zunehmend verbessert. Weniger bekannt ist demgegenüber, welche Faktoren aufseiten der Schwangeren diese Risiken begünstigen können. Das Ziel dieses Beitrags ist es, den aktuellen Forschungsstand zu den Folgen eines Nikotin- und Alkoholkonsums, einer Fehlernährung, einer starken Gewichtszunahme bzw. einer Adipositas sowie psychischer Beeinträchtigungen (Depression und Ängste) zusammenzufassen. Darüber hinaus werden Merkmale der schwangeren Frauen bestimmt, die das Auftreten dieser Risiken erhöhen können. Kenntnisse hierzu erleichtern es dem Kliniker, kritische Fälle frühzeitig zu identifizieren und bedarfsgerechte Unterstützungsangebote einzuleiten. Die Literaturdurchsicht hat gezeigt, dass bestimmte Merkmale der Schwangeren (z.B. Merkmale der Partnerschaft, psychische Belastungen vor dem Einsetzen der Schwangerschaft) sowohl mit verschiedenen gesundheitsschädigenden Verhaltensweisen als auch mit Beeinträchtigungen im psychischen Befinden assoziiert sind. Die betroffenen Frauen weisen dabei zumeist eine Kumulation von psychosozialen Belastungen auf, die bereits vor der Schwangerschaft vorhanden sind, aber auch nach der Geburt des Kindes weiterhin bestehen bleiben können.

ing effects on pregnancy and birth and may result in long-term health impairments and mental disorders in children and adolescents include nicotine and alcohol consumption [3], nutritional deficiencies and malnutrition [4], excessive maternal weight gain or obesity during pregnancy [5],

and impaired maternal mental health during pregnancy, for example as a result of high levels of stress or anxiety [6].

The association between early environmental influences and subsequent illnesses in children has justified the assumption of *fetal or perinatal programming*, whereby conditions in the womb such as suboptimal nourishment or increased concentrations of stress hormones at critical developmental stages trigger complex adaptation processes. This may result in permanent changes to the structure and functioning of various organs (e.g. the digestive, cardiovascular and central nervous system) [7,8]. This assumption is supported by an increased understanding of epigenetics which examines the molecular, immunological and endocrine mechanisms. These mechanisms are triggered by environmental factors (e.g. stress hormones) and lead to changes in gene activities but not to changes in the DNA sequence [9]. Maternal experiences and environmental factors in the perinatal period can increase or reduce gene expression, for example through DNA methylation or histone modification, thereby inducing long-term changes to various biological systems [2,10]. However, the understanding of the precise relationship between adverse intrauterine environmental factors and their potential impact on the physical or mental health of the child as well as the specific underlying mechanisms is still very limited and is far from fully elucidated. This is due to the fact that risk factors act in complicated ways, and that complex interrelations between genetic factors and environmental effects also have to be taken into account [7].

Despite these limitations, understanding the effects of intrauterine influences is of great practical relevance as it contributes to a better understanding of developmental psychopathological processes and shows how important it is to ensure that preventive measures are initiated as soon as possible [9]. The majority of health-damaging behaviors and psychological disorders are avoidable or can be changed by targeted preventive support and interventions in the perinatal period [1]. An understanding of the factors which promote health-damaging behaviors on the part of the pregnant woman or which increase her risk of developing a mental illness during pregnancy is particularly useful for early and effective detection and appropriate prevention measures and the promotion of better health. Previous research has focused on the impact of inequality due to social factors (e.g. low levels of education, low incomes) on physical and mental health [11–14]. However, what affects the pregnant woman's physical and psychological state of health is not so much her actual social status but instead the (socially determined) differences which manifest as specific burdens (e.g. housing conditions and conditions of employment) in the availability or lack of resources, in the prevalence of health-damaging behaviors, and in her medical care [11–12]. These factors, in their turn, can affect the capacity of the expectant mother to adjust to a variety of physiological, psychological and social changes during the perinatal period [15]. Previous reviews have devoted little attention to this aspect. This article aims to start by summarizing previous findings on the consequences of health-damaging behaviors (nicotine and alcohol consumption, nutritional deficiencies or malnutrition, excessive weight gain and obesity) and psychological disorders for the pregnant woman and her unborn child and to provide an overview of the prevalence of these risks. In a second step, the results for possible factors which may promote health-damaging behaviors and mental health problems in pregnant women will be discussed. The paper focuses on those contributing factors which are linked primarily to the pregnant woman herself (e.g.,

age, stress, critical life events, pregnancy-specific factors) or to her immediate environment (e.g. aspects of her relationship with her intimate partner, the availability of social support). An extensive literature search was done using the Web of Science and PubMed. The following words or pairs of words were used as search terms:

- ▶ Pregnancy: ["pregnancy", "prenatal", "antenatal", "perinatal"];
- ▶ Nicotine and alcohol consumption: ["alcohol" OR "drinking" OR "smoking" OR "nicotine"];
- ▶ Nutrition and weight gain: ["nutrition" OR "malnutrition" OR "eating behavior", "obesity" OR "overweight" OR "weight gain"];
- ▶ Impaired mental health: ["depression" OR "anxiety" OR "mental health/illness" OR "stress"];
- ▶ Outcome: ["complications" OR "preterm delivery" OR "prematurity" OR "fetal growth", "birth weight" OR "behavior problems" OR "internalizing behavior" OR "externalizing behavior", "development"].

To determine influencing factors the words chosen as search terms were "correlates", "predictors" and "risks". The bibliographies of articles were also reviewed to find additional relevant articles.

Selected Studies



Because of the abundance of studies, this review primarily looked at systematic reviews and meta-analyses. Individual studies were also included if, after reviewing their title and abstract, the studies met the following criteria:

- ▶ The study discussed either the impact of health-damaging behavior and/or mental health problems on the expectant mother (e.g. medical complications) or on her child.
- ▶ The study aimed to determine factors which promoted health-damaging behaviors and/or mental disorders in the pregnant woman.
- ▶ Data was collected during pregnancy or at the time of giving birth at the latest.
- ▶ Only freely available publications in English or German were selected.
- ▶ The search was limited to journal articles published from January 2005 to July 2016 to ensure that all included studies were current.
- ▶ Studies which reported on infertility, multiple births, in vitro fertilization or surrogacy were excluded.
- ▶ Studies which analyzed the above-mentioned risk factors in the context of medical examinations (e.g. amniocentesis) or in high-risk groups (e.g. HIV infection) and studies which reported on the results of preventive programs and interventions were also disregarded.

Nicotine and Alcohol Consumption



Nicotine and alcohol consumption are the most important modifiable risks for pregnant women and their unborn children [7, 16]. There is now a lot of evidence linking maternal nicotine consumption during pregnancy with permanent morphological changes (e.g. early termination of cell differentiation) and disorders of the neural transmitter systems in the fetal brain [17]. It is now also generally assumed that nicotine consumption impairs normal placental function and can result in oxygen deficiency

(fetal hypoxia) and may reduce the supply of nutrition to the fetus [3]. Similar to nicotine, alcohol and its metabolites can pass across the placenta into the fetal blood stream and have a long-term negative effect on the organ development and brain maturation of the fetus [3].

Effects of nicotine and alcohol consumption in pregnancy

Medical complications affecting pregnant women as a result of *nicotine consumption* include premature rupture of membranes, placental abruption and placenta previa [18] as well as an increased risk of spontaneous abortion, stillbirth or premature delivery [16, 19, 20]. Intrauterine growth disorders [21], congenital anomalies [22], low birth weight, and the risk of sudden infant death syndrome [23] have also been linked to prenatal exposure to nicotine. Over the longer term maternal nicotine consumption during pregnancy is associated with an increased risk of health problems in later life, for example, cardiac and respiratory disease or overweight [16] but also with behavioral disorders (particularly ADHD and aggressive behavior) [24, 25] and cognitive deficits [26] during the child's further development.

The harmful impact of *chronic or high alcohol consumption* as well as substance abuse and addiction during pregnancy on the unborn child have long been known [3]. The consequences for affected children can include prenatal and postnatal growth disorders, alcohol-related birth defects, developmental and behavioral disorders of varying severity, mental retardation and neuropsychological disorders [27]. Recent studies have increasingly focused on the impact of *low to moderate alcohol consumption* (> 0 to 6 alcoholic drinks per week) and of *episodic excessive alcohol consumption* (so-called binge drinking; more than 4 to 5 alcoholic drinks per event). If women consume more than one or 1½ drinks containing alcohol per day during pregnancy, there is an increased risk of premature birth, intrauterine growth restriction and low birth weight [28]. A recent meta-analysis of 34 empirical studies published between 1988 and 2012 investigated the long-term effects of mild, moderate and binge-drinking prenatal exposure to alcohol on the neuropsychological functions of the affected children and the impact on the children's attention span, reading skills, executive function, and behavior [29]. The authors were able to show that even moderate quantities of alcohol were associated with adverse effects on the capacity to self-regulate behavior and on the capacity for interactive play, although the clinical relevance of these impairments were low to moderate. The cognitive functions of children aged between six months and 14 years were commonly found to be significantly adversely affected by maternal binge drinking during pregnancy [29]. Recent studies have made it clear that heavy episodic drinking on the part of the expectant mother in early and late pregnancy may be correlated with externalizing behaviour symptoms in affected children aged between five and seven years, even after controlling for additional variables (e.g. maternal level of education and maternal psychiatric disorder) [30, 31].

Prevalence of nicotine and alcohol consumption in pregnancy

Despite these adverse effects on the health of pregnant women and their unborn children, women continue to smoke and drink alcohol during pregnancy. In Germany there are only a few isolated recent prospective studies on the prevalence of nicotine and alcohol consumption by pregnant women. Depending on the time of the survey, the reported rates range from 11.2 to

12.4% for maternal *nicotine consumption* during pregnancy [32, 33]. As far as we know, there are no recent prospective studies where the data was collected during pregnancy which investigated the prevalence of maternal *alcohol consumption* in Germany. The results of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS study) were instructive, with the study showing that 13.5% of surveyed mothers reported having drunk alcohol during pregnancy [34].

Correlates of nicotine and alcohol consumption in pregnancy

The literature search showed that there are only two reviews which have looked at the different *factors affecting* maternal nicotine and/or alcohol consumption or abstinence during pregnancy, one from 2010 and one from 2011 (cf. ● Table 1). Another review focused entirely on the importance of social support during pregnancy on the pregnant woman's health-related behavior (particularly the impact of social support on nicotine and alcohol consumption). This prompted a search for other recent studies investigating factors which could be linked to continued nicotine and/or alcohol consumption. Overall, the results of a further 19 studies for the period from 2012 to 2015 were included in this review (cf. ● Table 2). The results for nicotine consumption and for alcohol consumption are reported below.

The pregnant woman's marital status and level of education were the most important socio-demographic and economic factors associated with maternal *nicotine consumption* during pregnancy (cf. ● Table 2). According to the data, single women with low levels of education were most likely to continue smoking during pregnancy [32, 35, 51, 56–58, 61, 65, 67–68]. Three studies found that women aged less than 25 years were the most likely to continue smoking despite their pregnancy [32, 61, 62], while the findings of Kharkova et al. [57] showed the opposite. Social integration and the availability of emotional support, and of informal and practical help were important resources for successfully managing stressful events and had a correspondingly positive impact on the physical and mental health [88]. Social support also played an important role in helping pregnant women stop smoking [89]. Pregnant women who continued to smoke were more likely to experience conflicts with their partner [54, 59] and were less likely to feel they were supported by their partner or by close relatives or friends or were less satisfied with the perceived support they received from their partner [37]. It was particularly difficult for the pregnant woman to stop smoking if her partner smoked [35].

In addition to social characteristics there was repeated evidence for the existence of mental health problems or stress among pregnant women who smoked, usually in the form of increased depression and anxiety scores [51, 53, 54, 59, 68]. Women who continued to smoke during pregnancy were almost twice as likely to be depressed compared to women who had stopped smoking [68]. Critical life events and high levels of perceived stress could also make it more difficult to quit smoking during pregnancy [54]. Pregnant immigrant women appeared to smoke less than non-immigrant women [32]; psychological problems were a major factor associated with prenatal nicotine consumption by immigrant women [61].

Women's smoking behavior, the amount of nicotine consumed and frequency with which it was consumed prior to becoming pregnant were not unimportant health-related factors [35]. Women who smoked more than 10 cigarettes daily before pregnancy found it much more difficult to quit or reduce their smok-

Table 1 Findings of reviews and meta-analyses on factors affecting the health and behavioral risk-taking by pregnant women.

| Authors | Maternal risk factor | Influencing factors | Information about the study | Main findings and comments |
|---|----------------------------------|--|--|---|
| Nicotine and alcohol consumption | | | | |
| [35] ^a | Nicotine consumption | Social factors, nicotine consumption behavior, social relationships, pregnancy-specific factors | n = 19 studies from 1997 to 2008 | Significant correlation between prenatal nicotine consumption and the following factors: income (4 of 5 studies); partner who smokes (6 of 6 studies); high number of children (11 of 12 studies); high nicotine consumption (7 of 8 studies); prenatal care appointments attended less often and only during the later stages of pregnancy (4 of 5 studies). |
| [36] ^a | Alcohol consumption | Psychosocial and behavioral factors | n = 14 studies (n = 11 cross-sectional studies; n = 3 longitudinal studies) from 2002 to 2009 | Significant and consistent correlations between prenatal alcohol consumption and pre-pregnancy alcohol consumption (7 of 7 studies) and experience of abuse/violence (3 of 3 studies). Significant correlation with higher age (7 of 12 studies), nicotine consumption (5 of 10 studies) and larger number of children (4 of 10 studies). Inconsistent findings with regard to socio-economic status, level of education, unemployment, marital status and alcohol dependency. |
| [37] ^a | Nicotine and alcohol consumption | Social support | n = 13 studies 2003–2013 | Significant correlations between prenatal nicotine consumption and social support (7 of 10 studies); no consistent correlation with prenatal alcohol consumption (1 of 3 studies). |
| Diet and weight gain/obesity | | | | |
| [37] ^a | Nutrition | Social support | n = 3 studies 2003–2013 | Significant correlations between social support and satisfaction with social support and nutrition for women on low incomes and with an immigrant background (2 of 3 studies). No meaningful results possible because of the limited number of studies. |
| [38] ^a | Quality of food | Mental health of the mother in the perinatal period | n = 9 studies (n = 4 cohort studies; n = 5 cross-sectional studies) 2005–2013 | Significant correlations between unhealthy diet and poor quality food and prenatal depressive symptoms (3 of 3 studies) and stress symptoms (3 of 3 studies). Only limited significance because of the low number of studies. No statements can be made on the impact of factors. Other factors such as social support, mental illness prior to pregnancy and socio-economic factors could be important. |
| [39] ^a | Excessive weight gain | Anxiety, depression, stress, social support, dissatisfied with body image, self-esteem and self-efficacy | n = 12 studies (n = 2 cross-sectional studies; n = 8 longitudinal studies; n = 2 randomized control group studies) 2000–2014 | Significant correlations between excessive weight gain and depression (2 of 2 studies); dissatisfaction with own body image (4 of 6 studies) and social support (1 study). No statements possible on the impact of factors. |
| [40] ^a | Excessive weight gain | Psychological characteristics (affective state, cognition, motive for weight gain and diet) | n = 35 studies (n = 8 cross-sectional studies; n = 25 cohort studies; n = 2 case control studies) | Significant correlations between excessive weight gain and weight-related and diet-related cognition: dissatisfaction with own body image (2 of 4 studies); negative attitude to weight gain (4 of 6 studies); inaccurate perceptions of own weight both in women with normal weight and in overweight women (1 of 2 studies); higher levels of cognitive dietary restraint (2 of 3 studies). Additional predictors which will need further study include perceived barriers to healthy eating (1 study); concern about weight gain (1 study); limited knowledge about weight gain (1 study). Negative affective states (anxiety, depression and stress) were not found to be related to weight gain. |
| [41] ^{a, b} | Obesity and overweight | Mental health problems during pregnancy and post partum | n = 62 studies | Obese/overweight pregnant women had an increased risk of prenatal depression (obese pregnant women OR = 1.43; overweight pregnant women OR = 1.19); of postpartum depression (obese pregnant women: OR = 1.30; overweight pregnant women: OR = 1.09), and an increased risk of anxiety symptoms during pregnancy (OR = 1.41). |
| [42] ^a | Excessive weight gain | Maternal symptoms of anxiety | n = 13 studies (n = 10 longitudinal studies; n = 3 interventional studies) from 2000 to 2015 | Significant correlation between obesity and anxiety experienced by the expectant mother (5 of 7 studies). Results should be viewed as a comorbidity as anxiety symptoms were not recorded prior to the pregnancy. |
| Mental health problems | | | | |
| [43] ^{a, b} | Perinatal depression | Unwanted pregnancy | n = 10 studies (n = 5 cross-sectional studies; n = 4 longitudinal studies; n = 1 randomized control group study) from 1991 to 2014 | Prevalence of maternal perinatal depression associated with unwanted pregnancy: 21% Note: Only 3 studies collected data at the time of the pregnancy itself. Different instruments were used to record or measure depression. |

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Table 1 Findings of reviews and meta-analyses on factors affecting the health and behavioral risk-taking by pregnant women. (Continued)

| Authors | Maternal risk factor | Influencing factors | Information about the study | Main findings and comments |
|----------------------|-----------------------------------|---|--|--|
| [44] ^a | Perinatal depression | Experience of abuse | n = 43 studies (n = 29 cross-sectional studies; n = 14 longitudinal studies) to 2011 | Every form of abuse (direct, indirect, physical, sexual or emotional abuse) was found to be positively correlated with prenatal and postnatal depression (only 5 studies found no significant association). |
| [45] ^a | Prenatal anxiety and depression | Psychosocial, gynecological and behavioral factors | n = 97 studies from 2003 to 2015 | Significant association between prenatal depression/anxiety and the following factors: lack of support by intimate partner or lack of social support (sign. predictor in 29 studies vs. not a sign. predictor in 0 studies); experience of previous abuse or violence by partner (sign. predictor in 28 studies vs. not a sign. predictor in 0 studies); adverse life events and high levels of perceived stress (sign. predictor in 21 studies vs. not a sign. predictor in 0 studies); previous mental illness (sign. predictor in 23 studies vs. not a sign. predictor in 0 studies); unplanned or unwanted pregnancy (sign. predictor in 22 studies vs. not a sign. predictor in 2 studies); current/previous pregnancy complications/pregnancy loss (sign. predictor in 17 studies vs. not a sign. predictor in 4 studies); nicotine consumption during pregnancy (sign. predictor in 11 studies vs. not a sign. predictor in 1 study). More research is needed with regard to the following risk factors: alcohol abuse; substance abuse; familial history of mental illness; partner unemployed; quality of upbringing; mode of delivery. |
| [46] ^a | Perinatal psychological disorders | Psychosocial and gynecological factors | n = 47 studies (n = 13 studies where data was collected during pregnancy; n = 34 studies where data was collected after the birth) to 2010 | Significant associations between perinatal mental disorders (mainly anxiety/depression) and the following factors: socio-economic disadvantage (OR = 2.1–13.2); unintended pregnancy (OR = 1.6–8.8); young maternal age (OR = 2.1–5.4); unmarried (OR = 3.4–5.8); lack of intimate partner empathy or support (OR = 2.0–9.4); hostile in-laws (OR = 2.1–4.4); experienced intimate partner violence (OR = 2.11–6.75); lack of practical and emotional support (OR = 2.8–6.1); child is female (OR = 1.8–2.6); previous maternal history of mental illness (OR = 5.1–5.6). |
| [47] ^{a, b} | Perinatal psychological disorders | Domestic violence | n = 67 studies (n = 51 cross-sectional studies; n = 16 longitudinal studies) up to 2011 | Women with prenatal or postpartum depression had a three to five times higher risk of experiencing violence: experience of violence for women with prenatal depression (experienced violence over the patient's lifetime: OR = 3.0, during the previous year: OR = 2.8, or during the pregnancy: OR = 5.0); Violence experienced by women with postpartum depression: (experienced violence during the previous year: OR = 2.9; or during the pregnancy: OR = 3.1). Women with prenatal symptoms of anxiety had an up to 2.9-times higher risk of experiencing violence. Women with prenatal or postnatal PTSD had a 4.6- to 6.4-times higher risk of experiencing violence. |
| [48] ^a | Prenatal depression | Psychosocial, gynecological and behavioral factors | n = 57 studies from 1980 to 2008 | Significant correlations between prenatal depressive symptoms and the following factors: stressful life events; lack of social support, and domestic violence. |
| [49] | Perinatal anxiety disorders | Psychosocial, gynecological and behavioral factors | n = 98 (n = 47 studies on predictors) from 2006 to 2014 | Young age (5 studies); single/no partner (6 studies); low socio-economic status (5 studies), low level of education (9 studies); lack of social support (7 studies); conflicts in relationship with partner (5 studies), previous mental illness (3 studies); obstetrical complications: previous miscarriage/spontaneous abortion (5 studies); unplanned pregnancy; poor health/pregnancy complications (3 studies). |
| [50] ^{a, b} | Perinatal depression and anxiety | Risk factors and protective factors affected by partner | n = 120 studies (62% cross-sectional studies; 37% longitudinal studies) from 1980 to 2013 | Partner factors associated with a risk of prenatal depression or anxiety: conflicts (depression r = 0.30; anxiety r = 0.35); partner consumes alcohol and drugs (for depression r = 0.16); emotional withdrawal of partner (for depression r = 0.32). Partner factors which reduce the risk of prenatal depression or anxiety: emotional closeness (for depression r = -0.25; for anxiety r = -0.22); emotional support (for depression r = -0.26; for anxiety r = -0.20), and global support (for depression r = -0.28; for anxiety r = -0.32). Additional factors specifically associated with prenatal depression: positive communication (r = -0.31); instrumental support (r = -0.16), and relationship satisfaction (r = -0.29). |

OR: odds ratio. PTSD: post-traumatic stress disorder. r = correlation coefficient. sign.: significant.

^a: Systematic review.

^b: Meta-analysis.

Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women.

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---|-------------|--|---|--|--|--|
| Nicotine and alcohol consumption | | | | | | |
| [32] | Germany | n = 647 392 pregnant women | Population-based cross-sectional study | Information obtained from maternity log 2005 | 12.4% of pregnant women smoked (M = 10 cigarettes per day). | Factors associated with continued consumption of nicotine: socio-economic status (housewife: OR = 3.09; unskilled worker: OR = 4.44); age (< 20 years: OR = 5.96); number of previous births (more than 2 children: OR = 2.64); inadequate prenatal care (fewer than 5 antenatal care appointments: OR = 1.76) |
| [51] | Netherlands | n = 6 104 pregnant women (M = 30.4 years; SD = 4.6) | Prospective population-based cohort study (DELIVER study) | 34th GW (median = 19th GW) 2009–2011 | 9.2% of pregnant women continued smoking. Maternal smokers smoked an average of 7.8 cigarettes per day (SD = 4.4, range 1.5–20); occasional smokers consumed 8.8 cigarettes per week (SD = 8.1, range 0–50). | Predictors for any amount of nicotine consumption: low level of education (OR = 10.3); Turkish ethnicity (OR = 3.9); no partner (OR = 3.7); unplanned pregnancy (OR = 1.4); underweight (OR = 2.1); alcohol consumed during pregnancy (OR = 1.4); low health-related locus of control (OR = 1.4); increased anxiety and depression scores (OR = 1.8). Women who smoked every day were more likely to have an unplanned pregnancy (OR = 1.5), be underweight (OR = 2.6) and not take folic acid supplements (OR = 1.6). |
| [52] | Netherlands | n = 2 287 pregnant women (n = 113 smokers; M = 30.5 years; SD = 5.6); (n = 290 former smokers; M = 30.6 years; SD = 4.9); (n = 1 863 non-smokers; M = 31.8 years; SD = 4.4); (n = 124 women who continued to consume alcohol; M = 32.8 years; SD = 4.4); (n = 1 403 women who stopped drinking alcohol; M = 31.7 years; SD = 4.5); (n = 760 teetotalers; M = 31.2 years; SD = 4.7) | Prospective population-based cohort study (PAD) | 19th GW 2011–2013 | 28% of pregnant women continued smoking; 8.1% of pregnant women continued to consume alcohol. | Continued alcohol consumption was associated with the following factors: Conflict with loved ones (OR = 10.4); crime-related events (OR = 35.7); pregnancy-specific events (OR = 13.4), and number of stressful events (OR = 17.2). No association was found with anxiety/depression. |
| [53] | Belgium | n = 523 pregnant women (M = 29 years; SD = 4.38) | Prospective longitudinal study | t ₀ : 16th GW t ₁ : 32nd to 34th GW t ₂ : 96 weeks postpartum 2008–2010 | 16.3% of pregnant women smoked. | Smokers reported significantly more depressive symptoms at all three time-points of data collection compared to non-smokers and women who had stopped smoking. The differences were particularly apparent among women with low levels of education. |
| [54] | Norway | n = 73 418 pregnant women (no data given regarding age) | Prospective population-based cohort study (MoBa) | t ₁ : 17th and 30th GW t ₂ : 6 months postpartum 1999–2008 | 27.5% of women smoked prior to pregnancy; 44.2% of them continued smoking. | Women with high anxiety and depression scores were less likely to quit smoking during pregnancy (OR = 0.80) and more likely to smoke before becoming pregnant (OR = 1.45). Relationship conflicts (OR = 0.82) and negative life events (OR = 0.93) also had a negative effect on the likelihood of quitting smoking. |
| [55] | Denmark | n = 3 238 pregnant women (M = 32 years; SD = 5) | Prospective population-based cohort study (Copenhagen Pregnancy Cohort Study) | 10th GW 2012–2013 | 3% of women drank alcohol every week during early pregnancy; 35% of them reported binge drinking in early pregnancy. | Factors which facilitated binge drinking: Alcohol consumption prior to pregnancy (one glass per week: aOR = 4.48; 2–7 glasses per week: aOR = 10.23; ≥ 8 glasses per week: aOR = 33.18); nicotine consumption prior to pregnancy (aOR = 2.24), and unplanned pregnancy (aOR = 2.74). |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---------|-------------------|--|--|---|---|--|
| [56] | Brazil | n = 1744 pregnant women (n = 549 from Niterói; 60.8% aged 20–34 years); (n = 1195 from Rio de Janeiro; 65.4% aged 20–34 years) | Cross-sectional study data from 2011 | 12 hours after birth 2011 | 17.9–24.8% of women smoked during pregnancy. | Factors associated with continued nicotine consumption: low level of education (OR = 2.14 Niterói; OR = 1.61 Rio de Janeiro); multiparity (OR = 3.48 Niterói; OR = 1.58 Rio de Janeiro). |
| [57] | Russia (Murmansk) | n = 12871 pregnant women, 34.9% aged 20–24 years, 29.4% aged 25–29 years, 16.6% aged 30–34 years) | Population-based cross-sectional study | Survey carried out while women were in the maternity hospital 2006–2011 | 25.2% women smoked prior to becoming pregnant and 18.9% of women smoked during pregnancy. | Factors which facilitated the cessation of smoking: Younger women (≤ 20 –24 years: OR = 1.19) were more likely to reduce their nicotine consumption than older women (30–34 years: OR = 0.98; ≥ 35 years: OR = 0.82); nullipara and secundigravida were more likely to reduce their nicotine consumption than multipara (nullipara: OR = 2.21 or already one child: OR = 1.69). Factors which made it less likely that the pregnant woman would reduce or quit smoking: low level of education (OR = 0.39); marital status (single: OR = 0.53 or with partner: OR = 0.49); place of residence (rural area: OR = 0.76), and ethnicity (non-Russian ethnicity: OR = 0.90). |
| [58] | USA | n = 902 pregnant women (M = 24.8 years; SD = 5.9) | Cross-sectional study | 1st prenatal care appointment (M = 15.1 GW; SD = 8.3) 2009–2011 | 17% of pregnant women smoked at the time of the prenatal care appointment. | Factors associated with continued nicotine consumption: maternal age (OR = 1.08); low level of education (OR = 4.30); unemployed (OR = 2.33); criminal history (OR = 1.66); in receipt of social services (OR = 2.26); alcohol consumption (OR = 2.73), and consumption of illegal drugs (OR = 1.97) during pregnancy. |
| [59] | USA | n = 1518 pregnant women (73.1% aged 20–34 years) | Cross-sectional study | Between 18th and 28th GW | 17.6% of women smoked during pregnancy. | Factors associated with continued nicotine consumption: Higher levels of perceived stress (OR = 1.76); depression (OR = 1.48); neuroticism (OR = 1.58); negative behavior by partner (control, criticism, abuse) (OR = 1.15), and perceived racism (OR = 1.15) were associated with nicotine consumption. |
| [60] | Canada | n = 2246 pregnant women (71.5% aged 25–34 years) | Prospective cohort study (AOB) 2008 | <25th GW 34th–36th GW 4 months postpartum | 46% of women continued to drink alcohol after becoming aware of their pregnancy; usually low (< 1 drink per occasion on ≤ 7 days per week) to moderate amounts of alcohol (1 drink per occasion on ≤ 7 days per week or 2 drinks per occasion on ≤ 3 days per week); 13% continued binge-drinking behavior (5 or more alcoholic drinks per occasion) in early pregnancy. | Predictors for binge drinking prior to recognition of pregnancy: Low level of education (OR = 3.61); nulliparity (OR = 1.62); unplanned pregnancy (OR = 1.93); nicotine consumption (OR = 1.90) and binge drinking in the 12 months prior to pregnancy (OR = 10.83); low dispositional optimism (OR = 1.73). Predictors for low to moderate amounts of alcohol consumed after recognition of pregnancy: unplanned pregnancy (OR = 1.91); pre-pregnancy BMI < 25.0 kg/m ² (OR = 1.41); nicotine consumption (OR = 1.90) and binge drinking in the 12 months prior to pregnancy (OR = 2.62). |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---------|-------------------------------------|---|---------------------------------|--|--|---|
| [61] | France | n = 18 014 pregnant women (14.2% < 25 years, 31.3% aged 25–29 years, 33.3% aged 30–34 years, 21.3% aged ≥ 35 years) | Birth cohort study (ELFE study) | No data provided 2011 | Nicotine consumption: 21.7% alcohol consumption: 34.8% (binge drinking: 3.4%) Women with immigration status were less likely to consume nicotine (8.8 vs. 21.9%) and alcohol (23.4 vs. 40.7%); there were no differences with regard to binge drinking (2.9 vs. 3.3%). | 1. Factors associated with continued nicotine consumption: general factors: age ≤ 25 years; single parenthood; irregular attendance at prenatal care appointments. Non-immigrant smokers had lower educational levels (completed secondary school: OR = 3.09) and were not employed (OR = 1.45); weaker or inverse correlation in immigrant women (completed secondary school: OR = 1.86; not employed: OR = 0.68); however psychological problems (OR = 1.95) and comorbid alcohol consumption (OR = 1.92) were more strongly correlated with nicotine consumption in immigrant women. 2. Factors associated with continued alcohol consumption: general factors: women aged ≥ 25 years; higher levels of education and employment; more than one previous birth. Migration-specific factors: single parenthood (OR = 2.12); psychological problems (OR = 1.46). Binge-drinking was associated with age ≥ 35 years (OR = 1.89) and higher educational qualifications (OR = 1.32) in non-immigrant women. Migration-specific risk factors for binge-drinking: single parenthood (OR = 2.78); nicotine consumption (OR = 4.04). |
| [62] | Ireland | n = 907 pregnant women (25.9% aged 25–29 years, 36.8% aged 30–34 years, 20.7% aged 35–39 years) | Prospective cohort study | 10th to 14th GW 28th GW Birth 2010–2011 | 30% smoked in the last six months prior to the pregnancy; 41% of smokers continued to smoke during pregnancy. | Pregnant smokers differed from non-smokers with regard to the following factors: Irish nationality (OR = 3.23); unplanned pregnancy (OR = 1.90); younger age (for age 30–39 years: OR = 0.50); alcohol consumption during the first trimester of pregnancy (OR = 3.38) and previous history of consuming illegal drugs (OR = 3.56). |
| [63] | Ireland | n = 6 725 pregnant women | Cross-sectional study | From the 12th GW | 5% of pregnant women drank alcohol; of these, 92% drank less than 5 glasses of alcohol per week; 8% drank between 6 and ≥ 20 glasses of alcohol per week. | Pregnant women who continued to drink alcohol in early pregnancy were characterized by the following factors: higher maternal age (30 to 39 years: OR = 1.64; > 40 years: OR = 3.27); Irish nationality (OR = 3.05); concurrent nicotine consumption (OR = 2.58), and previous history of consuming illegal drugs (OR = 2.67). |
| [64] | UK, Ireland, Australia, New Zealand | n = 17 244 women | GUI, PRAMS Ireland and SCOPE | GUI: 2008–2009 PRAMS: 2012 register of births SCOPE: 15th and 20th GW 2004–2011 | Alcohol consumption: 20% (GUI) and up to 82% (SCOPE); 30% (SCOPE) and up to 85% (PRAMS) of women reported consuming one to two glasses of alcohol per week. | Predictor for alcohol consumption: concurrent nicotine consumption during pregnancy: SCOPE: RR = 1.17; GUI: RR = 1.50; PRAMS: RR = 1.42. |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|-------------------------------------|--------------|---|----------------------------------|---|--|---|
| [65] | Australia | n = 1 591 pregnant women (61.3% aged 25–29 years) | Prospective cohort study (ALSWH) | No precise data given 2000, 2003, 2006 | 72.7% of women drank alcohol during pregnancy (at least 1–2 drinks per occasion); 1.8% of women smoked during pregnancy. 8.2% of women concurrently consumed nicotine and alcohol. | Women who drank more than 2 alcoholic drinks per day or drank more than once a week were more likely to reduce their alcohol consumption. Quitting smoking was more difficult if the women had financial problems (RR = 0.78); experienced violence by their partner (RR = 0.76); had other children (RR = 0.87), and if their pre-pregnancy nicotine consumption was more than 10 cigarettes per day (RR = 0.75). The decrease in the concurrent consumption of nicotine and alcohol was sign. higher for women who had attended school for at least 12 years (RR = 1.5–1.6); who drank alcohol at least 1–2 days/week prior to being pregnant (RR = 1.5–1.6), and who consumed 3 or more alcoholic drinks per occasion (RR = 1.6–1.8) and sign. lower for women who smoked more than 10 cigarettes; for women with other children (RR=0.79), and for women with financial problems (RR = 0.74), and women who had experienced partner violence (RR = 0.71). |
| [66] | Sweden | n = 1 594 pregnant women (32.8% aged 25–29 years, 34.2% aged 30–34 years) | Cross-sectional study | ≥ 18th GW 2009–2010 | 6% of pregnant women drank at least once a week. | Factors associated with continued alcohol consumption: increased maternal age (30–34 years: OR = 4.54; 35–39 years: OR = 8.51; ≥ 40 years: OR = 11.32); place of residence (large city: OR = 1.69); daily consumption of nicotine prior to pregnancy (OR = 3.76); less social support (OR = 0.86); drinking habits (OR = 0.86); social reasons for drinking (OR = 1.12). |
| [67] | 15 countries | n = 8 344 pregnant women and mothers of infants under the age of one year | Cross-sectional study | No data 2011–2012 | 35.3% of women smoked prior to the pregnancy and 26.2% smoked during pregnancy. | Factors associated with continued consumption of nicotine: no spouse or partner (aOR = 1.75); low level of education (aOR = 3.64); being a housewife (aOR = 1.43); other children (aOR = 1.24); unplanned pregnancy (aOR = 1.31); did not take folic acid supplements (aOR = 1.59); low health literacy (aOR = 1.43) |
| [68] | 15 countries | n = 4 295 pregnant women | Cross-sectional study | No data 2011–2012 | 34.5% of women smoked prior to the pregnancy and 26.4% continued to smoke during pregnancy. | Factors associated with continued consumption of nicotine: Women who continued to smoke during pregnancy were more likely to be depressed than women who quit smoking (32.5 vs. 18.9%; $p < 0.001$). Predictors for continued consumption of nicotine: lower level of education (OR = 4.46); depression (OR = 2.02). |
| Diet and weight gain/obesity | | | | | | |
| [69] | Netherlands | n = 144 pregnant women (M = 31.2 years; SD = 4.7) | Prospective study | 30th GW (M = 30.4 GW; SD = 1.9) 2003–2007 | 38% of pregnant women gained more weight than recommended (particularly overweight and obese women). | Predictors of excessive weight gain: Overweight pre-pregnancy (OR = 6.33); low level of physical activity (OR = 3.96); elevated food intake (OR = 3.14). The risk was reduced when women had more than nine hours' sleep daily (OR = 0.35). |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---------|-------------|--|---|--|---|---|
| [70] | USA | n = 1 100 pregnant women | Cross-sectional study (WISH) | 32nd to 36th GW | 14% of pregnant women had insufficient weight gain and 53% had excessive weight gain. | Predictors of excessive weight gain: overweight pre-pregnancy (OR = 2.26); nullipara vs. multipara (OR = 1.4). Predictors of insufficient weight gain: chronic or gestational diabetes (OR = 2.70); higher or lower consumption of dairy products (OR = 1.74); nullipara vs. multipara (OR = 0.62). |
| [71] | USA | n = 770 Hispanic pregnant women (35% < 20 years; 37.4% aged 20–24 years; 17.9% aged 25–29 years) | Prospective cohort study | M = 15th GW | 22% of pregnant women had insufficient weight gain and 45% had excessive weight gain. | Predictors for excessive weight gain: women aged more than 30 years (OR = 2.5) compared to women aged 20–24 years; overweight compared to normal weight (OR = 2.2). Lower risk for women who had already born more than two children (OR = 0.2) and who had resided less than 10 years in the USA (OR = 0.5). |
| [72] | Netherlands | n = 6 959 pregnant women (M = 30.3 years; range: 20.4–37.9 years) | Prospective cohort study (Generation R study) | No information provided on the time-point in the when data was collected 2001–2005 | 16.2% of pregnant women were underweight, 55.8% of pregnant women were normal weight, 19.2% were overweight, 8.8% were obese 44.5% of pregnant women had excessive weight gain. | Factors associated with obesity: low level of maternal education (OR = 2.48); household income < 1 600 Euros (OR = 1.36); multipara (OR = 1.68). Risk factors for excessive weight gain: European ethnicity (Ref.: non-European ethnicity, OR = 0.78); nulliparity (Ref.: multipara, OR = 0.71); higher energy intake (OR = 1.13); nicotine consumption during pregnancy (OR = 2.08); BMI of the father was a risk factor for maternal obesity (OR = 1.53) and for excessive weight gain (OR = 1.12). |
| [73] | USA | n = 94 pregnant women (73% aged < 25 years) | Prospective cohort study | M = 21st GW 2008 | 60% of pregnant women were overweight and 41% of pregnant women had excessive weight gain. | Predictors for excessive weight gain: overweight or obese pre-pregnancy (BMI \geq 25: aOR = 4.20); nulliparity (aOR = 3.35). Less than 2 h daily television viewing (aOR = 0.18) and regular physical activity (aOR = 0.35) were associated with a lower risk of excessive weight gain. |
| [74] | USA | n = 3 006 pregnant women (M = 27.0 years; SD = 5.9) | Prospective cohort study | 34th GW 2009–2011 | 78.7% of overweight, 65% of obese and 42.4% of normal weight pregnant women exceeded recommendations on weight gain. | Predictors for excessive weight gain: older age (30–36 years: aOR = 1.45); unmarried and living with partner (aOR = 1.48) or with no partner (aOR = 1.46); overweight (aOR = 5.11) or obese (aOR = 2.35); smoking status (aOR = 1.49). Physical activity of at least 150 min per week reduced risk of excessive weight gain. |
| [75] | USA | n = 2 994 (n = 855 nullipara; n = 2 139 multipara) | Cross-sectional study (IFPS II) | Prior to the birth of the child 2005–2007 | | Predictors for excessive weight gain/obesity: Nullipara gained significantly more weight than multipara; multipara were far more likely to be overweight or obese than nullipara. |
| [76] | USA | n = 279 pregnant women (M = 27.0 years; SD = 5.9) | Prospective longitudinal studies | t ₁ : 10th to 22nd GW (M = 16.6 GW; SD = 4.4) t ₂ : 21st to 30th GW (M = 26.1 GW; SD = 3.8) t ₃ : after 30th GW (M = 34.1 GW; SD = 2.4) | | Pregnancy-specific stress was a predictor for the following health-damaging behaviors: nicotine consumption (B = 0.22); caffeine consumption (B = 0.16); unhealthy diet (B = 0.29). |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---------|------------|---|---|--|--|--|
| [77] | UK, Canada | n = 2 282 pregnant women (M = 29.6 years; SD = 5.0) | Cross-sectional study | No data provided | | Predictors of an unhealthy diet: Immigrant status, unmarried women in a permanent relationship; nulliparity; low level of physical activity; smoker; higher anxiety scores; lack of familial support. |
| [78] | Italy | n = 2 189 pregnant women (M = 33 years) | Cross-sectional study | No data on the time-point of data collection during pregnancy 2012 | 23.5% of women took folic acid supplements pre-pregnancy | Predictors of folic acid use: higher age (35–39 years: aPR = 1.05); higher level of education (university degree: aPR = 1.90), married/in a relationship (aPR = 1.44); planned pregnancy (aPR = 2.4); chronic illness (aPR = 1.22). Predictors for insufficient folic acid use: Aged less than 25 years (aPR = 0.31); more than three previous births (aPR = 0.66). |
| [79] | Norway | n = 225 000 pregnant women (age at delivery: 72.4% aged 25–34 years) | Prospective cohort study (MoBa) | 17th to 18th GW 2000–2003 | 11.8% women took folic acid supplements two months prior to pregnancy, increasing to 46.9% in the third trimester of pregnancy | Predictors of folic acid use: higher level of education (aRR = 4.1); higher age (age from 25–34 years: aRR = 1.6); higher income (aRR = 1.3); married (aRR = 2.4); planned pregnancy. Predictors for insufficient intake of folic acid supplements: Nicotine consumption (aRR = 0.6); number of previous births (< 2: aRR = 0.8). |
| [80] | Denmark | n = 60 892 pregnant women | Prospective cohort study (DNBC) | 16th and 18th GW 6 and 18 months postpartum 1996–2002 | 4.3% underweight; 68.3% normal weight; 19.5% overweight; 7.9% obese 21.9% of the total sample had excessive weight gain. Insufficient weight gain was more likely among overweight (17.7%) and obese women (42.0%). | Underweight, overweight and obese pregnant women were slightly younger and more likely to be multipara compared to pregnant women who were normal weight. Determinants of insufficient weight gain (< 10 kilos): higher age (≥ 35 years); lower social status; short stature; multipara; smoking more than 10 cigarettes per day, and drinking more than three alcoholic drinks during pregnancy. Determinants of higher to excessive weight gain (16–19 or more than 20 kilos): Aged less than 30 years and primiparity; low social status; taller; smoking less than 10 cigarettes per day; no alcohol consumption during pregnancy; lack of exercise. |
| [81] | UK | n = 12 053 pregnant women (39.1% aged < 20 years, 39% aged 20–24 years, 17.9% aged 25–29 years) | Prospective cohort study (ALSPAC) | 8th, 18th and 32nd GW 1991–1992 | | Predictors of diet: Health-conscious diet correlated positively with higher education and age. There was a negative correlation with increased parity, single parenthood; unemployment; smoking status and being overweight pre-pregnancy. Traditional diet (e.g. consumption of red meat, potatoes, green vegetables, etc.) was associated with physical activity; being overweight pre-pregnancy, and increased parity. The consumption of high-fat processed foods (e.g. pizza, chips) was associated with younger age; low level of education; financial difficulties; smoking status; increased parity. Consumption of high-sugar foods was associated with younger age; ethnicity, higher anxiety scores; multiparity. |
| [82] | France | n = 903 pregnant women (M = 31.7 years; SD = 4.7) | Prospective cohort study (NutriNet-Santé study) | 31% in the first trimester of pregnancy, 36% in the second trimester and 33% in the third trimester 2009 | 64.9% of pregnant women took dietary supplements (45% folic acid, 42.1% iron and 15.5% vitamin D supplements). | Factors associated with use of dietary supplements: higher age (aOR = 1.06) and income (> 3 130 Euros per month: aOR = 2.09). Factors associated with no use of dietary supplements: occupational category (working class aOR = 0.42; unemployed: aOR = 0.45); multiparity (aOR = 0.52). |

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Table 2 Findings of empirical studies on factors influencing health-damaging behaviors and mental health problems by pregnant women. (Continued)

| Authors | Country | Sample | Study design | Time of data collection | Prevalence | Factors which influenced behaviors |
|---------|------------------------------------|---|--|--|--|--|
| [83] | Australia, New Zealand and Ireland | n = 1 950 nullipara (Australia n = 475; M = 24.3 years; SD = 5.0); (New Zealand n = 264; M = 30.4 years; SD = 4.9); (Ireland n = 1 211; M = 29.9 years; SD = 4.5) | SCOPE | 14th to 16th GW | 17% of pregnant women had sufficient weight gain, 74% of pregnant women had excessive weight gain and 9% had insufficient weight gain. | Factors associated with excessive weight gain: younger maternal age (≤ 24 years: aOR = 1.92; 25–29 years: aOR = 1.88 and 30–34 years: aOR = 1.59); Irish nationality (aOR = 2.31); being overweight (aOR = 2.9) or obese (aOR = 2.5) pre-pregnancy; higher maternal birth weight (aOR = 1.15); cessation of smoking in the 14th to 16th GW (aOR = 1.67); immigrant status (aOR = 1.57); nightly sleep duration ≥ 10 h (aOR = 1.83); decreased exercise in the 14th to 16th GW (aOR = 1.30). |
| [84] | USA | n = 1 777 pregnant women (M = 32.4 years; SD = 4.9); 49% nullipara | Prospective study | 1st prenatal appointment (M = 11.7 GW; SD = 3.1) 26th–28th GW | | Predictors for poorer quality diet: younger maternal age; lower level of education; higher BMI pre-pregnancy; higher number of previous births. |
| [85] | USA | n = 795 pregnant women (n = 355 aged ≤ 25 years; n = 20–35 years; n = 63 aged ≥ 35 years) | Cross-sectional study | 2003–2012 | | Predictors of an unhealthy diet: being overweight (aOR = 3.8) or obese (aOR = 5.4) before pregnancy. Significantly higher HEI-2010 scores were reported for women with higher incomes; higher level of education; aged ≤ 35 years; married women, and non-smokers. |
| [86] | Netherlands | n = 6 959 pregnant women (4.0% aged < 20 years, 43.1% aged 20–29.9 years, 37.9% aged 30–35 years; 15.0% aged > 30 years) | Prospective cohort study (Generation R study) | Median: 14.4 GW 2002–2006 | 37% of pregnant women took sufficient folic acid supplements pre-pregnancy. | Predictors for insufficient intake of folic acid supplements: low level of education (aOR = 2.5); younger age (< 20 years: aOR = 1.5; 20–29.9 years aOR = 1.4); single (aOR = 2.0); non-Western European ethnicity (aOR = 3.5); nicotine (aOR = 2.3) and alcohol consumption during pregnancy (aOR = 1.5); unplanned pregnancy (aOR = 9.5); multiparity (aOR = 1.6). |
| [87] | New Zealand | n = 5 664 pregnant women (median: 31 years; range: 15 to 47 years) | Prospective cohort study (Growing up in New Zealand) | Third trimester of pregnancy 2009–2010 | | Predictors of diet: Junk food diet was associated with younger age; lower level of education; poorer self-rated health, and depressive symptoms; continued consumption of nicotine and alcohol and no intake of folic acid supplements. Higher scores for a healthy diet were associated with increasing age (> 40 years); better self-rated health; lower pre-pregnancy BMI; physical activity, and not smoking. Traditional diet (consumption of milk, white bread, etc.) was associated with younger age; lower levels of education; socio-economic disadvantage; continued consumption of nicotine; no folic acid supplement use; unplanned pregnancy; multiparity. Higher levels of consumption of high-protein foods was associated with higher age; better self-rated health; abstaining from smoking; physical activity; nulliparity. |

ALSPAC: Avon Longitudinal Study of Parents and Children. ALSWH: Australian Longitudinal Study on Woman's Health. AOB: All Our Babies. aOR: adjusted odds ratio. aPR: adjusted prevalence ratio. B: coefficient. DNBC: Danish National Birth Cohort. GUI: Growing up in Ireland. GW: week of gestation. HEI-2010: Healthy Eating Index 2010. IFPS II: Infant Feeding Practices Study II. M: mean. MoBa: Norwegian Mother and Child Cohort Study. NHANES: National Health and Nutrition Examination Survey. PRAMS: Pregnancy Risk Assessment Monitoring System. OR: odds ratio. PAD study: Pregnancy, Anxiety and Depression Study. RR: relative risk. SCOPE: Screening for Pregnancy Endpoints. SD: standard deviation. sign.: significant. WISH: Woman and Infants Starting Healthy.

ing during pregnancy [65]. Nicotine consumption was often also associated with concurrent consumption of alcohol and illegal drugs, either prior to or during pregnancy [51, 58, 62, 65]. Pregnant women who smoked were also more likely to have an unplanned pregnancy [51, 62, 67] and these women also attended routine antenatal medical checkups less often or only in the advanced stage of pregnancy compared to non-smokers [32, 35, 61]. Multipara were found to be a group at particular risk of continuing to smoke during pregnancy compared to women who were pregnant with their first child or women who had previously given birth to only one child [32, 35, 56–57, 65, 67].

In contrast to maternal nicotine consumption the consumption of low to moderate amounts of *alcohol* during pregnancy is a risk factor which was more likely to affect women with a higher socio-economic status and women who were older (aged > 30 years) [34, 61, 63, 66]. Skagerström et al. [36], who summarized the findings of 14 studies published between 2002 and 2009, did not come to a definitive conclusion with respect to the impact of the pregnant woman's social status on her prenatal consumption of alcohol. Melchior et al. [61] showed a number of different predictors for occasional excessive alcohol consumption during pregnancy depending on the pregnant woman's immigrant status. Binge-drinking behavior during pregnancy was only associated with non-immigrant pregnant women who were older and had higher educational qualifications.

Prior experience of abuse or violence by the intimate partner or other persons is considered to be an important psychological factor associated with the continued consumption of alcohol during pregnancy [36]. However, Skagerström et al. [36] only identified three studies which looked at this issue (cf. **Table 1**). Powers et al. [65] reported that the expectant mother's experience of violence by her partner was more closely associated with continued alcohol and nicotine consumption. Beijers et al. [52] found that critical life events such as crime-related events (e.g. involved in an accident), conflicts with her partner or pregnancy-specific events (e.g. bleeding, prenatal diagnosis to investigate potential abnormalities/malformations) could also substantially increase the risk of continued alcohol consumption during pregnancy (cf. **Table 2**), although the authors found no correlation between prenatal alcohol consumption and increased depression or anxiety scores. It is possible that consuming alcohol or nicotine in this context could be viewed as a simple, albeit maladaptive, strategy used by affected women to deal with negative emotions and cope with traumatic events [36, 52], particularly if the affected women do not receive support from their partner to process emotional stresses [65].

To what extent pregnant women managed to stop drinking alcohol depended, essentially, on the amount of alcohol and the frequency with which it was consumed before she became pregnant [36]. Women who drank more than two alcoholic drinks per week or more than five alcoholic drinks per occasion (binge drinking) before they became pregnant, found it significantly more difficult to abstain entirely from drinking alcohol during pregnancy [55, 60, 65]. The same applied to pregnant women who had additionally smoked before or during pregnancy [55, 63–66]. Two of the studies found a correlation between continued maternal alcohol consumption and unplanned pregnancy [55, 60]; it was not clear, however, whether nullipara or multipara found it more difficult to abstain from drinking alcohol [36]. McDonald et al. [60] reported, for example, that women who had not previously given birth were more likely to binge drink during the early stages of pregnancy, i.e., before they knew

they were pregnant. In contrast, continued low to moderate alcohol consumption during pregnancy was more common among women who had already previously given birth to several children [36, 61, 65].

Dietary Habits and Weight Gain

▼ Dietary habits and sufficient weight gain during pregnancy play an important role in the physical and mental health of expectant women as well as for the development and the later health of the child [90–91]. The rapid growth and neural development of the unborn child places special demands on the nutrition ingested by pregnant women [4, 92]. While the energy needs of pregnant women do not change much over the course of pregnancy, the pregnant woman has an increased need of micronutrients (e.g. vitamins and minerals) [91]. When pregnant women are malnourished or have nutritional deficiencies this can be due to an undersupply or oversupply of calories along with a corresponding weight gain or it may be due to the inadequate quality of the food consumed and a low supply of micronutrients [4]. In addition to dietary habits, the pregnant woman's pre-pregnancy weight can also affect weight gain during pregnancy and have a lasting impact on the further course of her pregnancy and on the course of the birth. It is therefore recommended that women of normal weight (BMI 18.5–24.9 kg/m²) should not gain more than a maximum of 16 kilos over the course of the pregnancy, while the upper limit for underweight women (BMI < 18.5 kg/m²) is 18 kilos and for overweight or obese women (BMI ≥ 30 kg/m²) is 11.5 kilos or should not exceed 9 kilos, respectively [93].

Effects of malnutrition and of excessive weight gain including obesity in pregnancy

The short and long-term effects of maternal dietary behavior during pregnancy are currently being intensively studied. The consumption of large amounts of meat, sweetened beverages, sweetened or salty foods may potentially increase the risk of gestational hypertensive disorders (e.g. pre-eclampsia), or lead to premature delivery and small-for-gestational age (SGA) infants [4, 94]. Two prospective population-based cohort studies have provided initial evidence of the long-term importance of pregnant women's diets on the development of their children, whereby unbalanced and unhealthy nutritional patterns of pregnant women (e.g. the consumption of large amounts of meat, sweetened beverages and salty snacks, low amounts of vegetables and fruit) were associated with later externalizing but not internalizing behavioral problems in their children [95, 96].

An inadequate dietary intake of *micronutrients* (e.g. iron or calcium deficiency) is associated with many medical complications [97]. On the other hand, the intake of micronutrients (i.e. taking vitamin, folic acid or iron supplements) in addition to the pregnant woman's regular intake of food can reduce the risk of neural tube defects, premature delivery, low birth weight and the risk of giving birth to a SGA baby [98]. A recent study showed that taking multiple micronutrients resulted in significantly superior outcomes compared to taking individual iron supplements with or without the addition of folic acid [99]. The late sequelae of a lack of micronutrients (primarily iron and iodine deficiency) in pregnancy can include impaired motor, cognitive and social-emotional development in affected children [92, 100].

Consequences of *excessive maternal weight gain* during pregnancy include birth complications (e.g. cesarean section) and

postpartum maternal weight retention [93]. Excessive maternal weight gain can also affect fetal growth; consequences can include excessive fetal growth (LGA) or high birth weight [101]. Excessive weight gain can increase the subsequent risk of obesity for the child [102]. Women who were underweight before becoming pregnant or who did not gain sufficient weight during pregnancy have a higher risk of premature delivery and of giving birth to low birth weight or small-for-gestational-age children [101, 103–105]. Other suggested long-term consequences of intrauterine malnutrition include postnatal catch-up growth, which has an associated increased risk of obesity but also of renal and cardiovascular disease in adulthood (e.g. arterial hypertension) [4, 106].

Maternal *obesity* which existed prior to the pregnancy has been investigated in many studies and is in itself a risk factor for perinatal complications. Marchi et al. [5] analyzed 22 reviews and meta-analyses on this issue published between 2007 and 2014. Complications arising as a consequence of maternal obesity can include an increased risk of spontaneous miscarriage and malformation in early pregnancy (e.g. neural tube defects), gestational diabetes, gestational hypertension, pre-eclampsia, delivery by caesarean section, strong bleeding post partum, a higher risk of congenital anomalies, premature delivery, and a risk of LGA children [5]. Over the long term, children of mothers who were already overweight or obese during pregnancy are themselves at increased risk of becoming overweight or obese [103] and of developing hypertension and diabetes mellitus type II in later life [107]. In addition, there are initial indications pointing to a link between later cognitive impairments as well as externalizing and internalizing behavioral disorders and maternal obesity during pregnancy [108–109].

Prevalence of malnutrition and excessive weight gain/obesity during pregnancy

An inadequate intake of macro- and micronutrients is not just a significant health problem in low income countries [109]. According to recent meta-analyses, pregnant women in the USA, Canada, the United Kingdom, Japan, Australia and New Zealand are ingesting too much fat and saturated fatty acids [110] while the intake of folic acid, iron, iodine, and vitamin D supplements is too low and does not match national recommendations [111]. Moreover, there has been a significant increase in the number of overweight and obese women of child-bearing age worldwide [109]. The results of a perinatal survey in Germany showed that the percentage of pregnant women with a BMI of 30–40 kg/m² increased from 8.2% in 1995 to 13.0% in 2011; the percentage of women with a BMI \geq 40 kg/m² even tripled to 1.8%, while the percentage of underweight pregnant women (BMI < 18.5 kg/m²) remained almost constant at 4% [33].

Correlates of malnutrition and of excessive weight gain/obesity

A search of the literature identified six systematic reviews (one which included a meta-analysis) which summarized potential predictors of malnutrition or excessive weight gain and obesity. In addition, a further search of the literature revealed 19 empirical individual studies (n = 5 studies on dietary habits; n = 4 studies on the intake of micronutrients using the intake of folic acid supplements as an example; n = 10 studies on weight gain) published between 2005 and 2016 (cf. [Table 2](#)). The findings on dietary habits are presented as a first step below; in a second step

the findings on the determinants of excessive weight gain and obesity are summarized below.

Dietary habits and quality are significantly affected by socio-demographic, socio-economic, socio-cultural, psychosocial and behavioral factors [112]. These factors are also important for dietary behavior during pregnancy. Studies have shown that malnutrition during pregnancy caused either by a frequent intake of fatty or sugar foods, an insufficient intake of healthy foods (e.g. fruit, vegetables, rice, fish) or an insufficient intake or lack of important micronutrients (e.g. folic acid) is commonly associated with a younger maternal age, immigrant status, a lower level of education, and being unemployed [77–78, 81–82, 84, 86–87]. Single women or unmarried women in a steady relationship were also more prone not to eat health-consciously [77, 81, 86]. It is possible that a lack of integration in social relationships and a lack of social support encourages unhealthy eating habits [37, 77], but because of the limited number of studies it is not possible to draw clear conclusions on this point.

Attention is increasingly being focused on the associations between nutritional quality and high levels of stress or mental health problems. There are some initial indications that pregnant women who either have increased depression scores or who often suffer from stress tend to have a more unhealthy and unbalanced diet [38, 76, 87]. Wall et al. [87] reported that pregnant women with symptoms of depression tended to mainly eat a diet of junk food. Pregnant women with anxiety symptoms also appeared to have a tendency to eat less healthily (e.g. frequent consumption of sugary foods) [77, 81]. Baskin et al. [38] interpreted the correlations between poor quality nutrition and mental health problems analogously to nicotine and alcohol consumption as constituting a type of coping mechanism; on the other hand the authors speculated that limited drive and low motivation to pay attention to one's own diet over the course of the entire pregnancy could play an important role.

Important health-related factors and behaviors which are associated with malnutrition include reduced physical activity [77], being overweight or obese pre-pregnancy [81, 84, 85] and the continued consumption of nicotine or alcohol during pregnancy [51, 67, 77, 79, 81, 86, 87]. Pregnant smokers, for example, were more likely to live on a diet of fatty foods (e.g. junk food, chips) [81, 87] compared to pregnant non-smokers and also were much less likely to take folic acid supplements [51, 67, 79, 86]. A diet lacking in micronutrients was more common among women who had already given birth to several children [78, 79, 82, 86], while indications of an unhealthy and unbalanced diet were reported for both nullipara and multipara [77, 81, 84, 87].

The possible determinants for *excessive weight gain* have often been investigated. Recent reviews have focused exclusively on the psychosocial predictors of excessive weight gain (cf. [Table 1](#)). Ten empirical studies which examined the importance of socio-demographic, lifestyle-related and health-related factors published between 2005 and 2016 were also included in this review (cf. [Table 2](#)).

Socio-demographic risk factors (e.g. age of the expectant mother) are often discussed in the context of excessive weight gain in pregnancy; however, recent studies have not shown a consistent picture (cf. [Table 2](#)). A much greater importance is attached to modifiable psychosocial and health-related factors [39, 40]. For example, studies have shown a correlation between excessive weight gain in pregnancy and dissatisfaction with body image prior to becoming pregnant (e.g. a preference for being thin) or an inadequate perception of one's own bodyweight. There are

also indications that women with excessive weight gain in pregnancy often also show symptoms of depression, which may be based on an association between dissatisfaction with their own body image and excessive weight gain in pregnancy [39]. Overweight and obese women were also more likely to have symptoms of depression during pregnancy and after the birth compared to normal-weight women [41]. Likewise, obese pregnant women appeared to have more symptoms of anxiety, although the overall findings on this point are less conclusive because of the limited number of studies and their lack of methodological quality [42].

Pre-pregnancy body mass index is the most important health-related risk factor for excessive weight gain during pregnancy and can easily be measured during a routine antenatal check-up. Overweight and obese women are particularly at risk of gaining too much weight during pregnancy [69–71, 73–74, 83]. But an expectant mother who herself had a high birth weight [83] and the body mass index of the expectant father were also found to be associated with excessive weight gain during pregnancy [72]. In addition, continued nicotine consumption [72, 74], quitting smoking, and lack of physical activities [69, 80, 83] can also lead to excessive weight gain [83]. In contrast, regular physical activity during pregnancy can have a preventive effect on weight gain in pregnancy. Women who are physically active over a period of at least two hours per week are less likely to exceed the recommended guideline values for weight gain in pregnancy compared to women who are physically inactive [73–74]. The number of previous births can also affect the amount of weight gained in pregnancy. Women who have not previously given birth have a higher risk of excessive weight gain during pregnancy than multipara [70, 72–73, 75, 80]. Conversely, multipara are more likely to be overweight or obese but less likely to have excessive weight gain in pregnancy [72, 75].

Mental State

In the last three decades, interest in investigating the effects of the pregnant woman's mental state on the pregnancy and birth as well as on the development of the fetal and child has increased [6]. A search of the literature has shown that the overwhelming majority of systematic reviews and meta-analyses have focused on the relationship between emotional disturbances, i.e. stress, depression or anxiety experienced by the expectant mother and the birth parameters of the child. This review will therefore also limit itself to looking only at these factors. It is basically assumed that chronic, excessively emotional stress experienced by the pregnant woman can lead to dysregulation of maternal and fetal hypothalamic-pituitary-adrenal axis activity [113]. In the placental barrier, the presence of 11 β -hydroxysteroid dehydrogenase (11 β -HSD) type 2, an enzyme that catalyzes the conversion of cortisol into biologically inactive cortisone, normally protects the fetus from excessive concentrations of cortisol [15]. However, it has been postulated that chronically increased levels of stress hormones could result in increased permeability through down-regulation of the 11 β -HSD2 enzyme, allowing more cortisol to reach the fetal blood stream [113]. Prenatal exposure to excessively high levels of stress hormones can adversely affect the neural, immunological and behavioral development of the child, predisposing it to be more susceptible to psychological and physical disease(s) in later life [114].

Effects of stress, depression and anxiety in pregnancy

Pregnant women with depression and anxiety are more likely to suffer from pregnancy symptoms such as nausea and vomiting [115]. While Grigoriadis et al. [116] found no correlation between depression and pre-eclampsia, a more recent study [117] showed that depressive symptoms in pregnant women may be associated with an increased risk of pre-eclampsia. Moreover, a number of studies have noted that depressive and anxious pregnant women consulted their doctors more often and were more likely to require pain relief during the birth [115]. Other perinatal complications arising from mild to clinically relevant symptoms of prenatal maternal stress, depression or anxiety can include premature delivery and low birth weight of the child [118–120]. There were also indications that depression in the mother can predispose to intrauterine growth retardation [121–122]. If maternal mental health problems remain untreated, there is a risk that these symptoms will continue even after the birth of the child [123–124], which can seriously limit the maternal care given to the infant and the interaction between mother and infant [125–127]. Children of mothers affected prenatally by stress and depression often have difficulties adapting to new and stressful events in early childhood, are more easily agitated and more likely to show deficits in regulating their attention, behavior and emotions [128–129]. There is evidence that maternal psychological distress can result in developmental delays which affect the infant's motor skills and cognitive development [130–132]. In the long term, maternal depression and anxiety during pregnancy can increase the child's risk of developing emotional and behavioral disorders [129]. Prenatal maternal depressive disorders are a significant risk factor for later aggressive behavior on the part of the child [133].

Prevalence of stress, depression and anxiety in pregnancy

Because of the wide-ranging physiological, psychological and social changes experienced by the expectant mother, the time of pregnancy and birth are a stage in which women may be much more vulnerable to stress and mental health problems [15, 123]. A survey of 1522 pregnant women showed, for example, that up to 78% of women had slight to moderate stress and 6% of pregnant women experienced high levels of stress during pregnancy [134]. Uncertainty, anxiety and worries about the health of the unborn child or the forthcoming birth are part of the normal adjustment processes of women to pregnancy and their future maternal role, but the symptoms become clinically relevant if they continue to be experienced inordinately powerfully over a longer period of time and result in a significant functional impairment of the pregnant woman [123]. Depression and anxiety are the most common psychological disorders found in pregnancy. Up to 18.4% of women develop depressive symptoms during pregnancy, and around 12.7% of pregnant women suffer from major depression requiring treatment [135]. The figures for the prevalence of anxiety disorders in pregnancy range from 4.4 to 39% [136]. Pregnancy-specific anxiety is very common; approximately 34% of pregnant women are anxious about the impending birth, 32.4% of women are afraid of perineal tears or an episiotomy, and 26.8% are scared of the labor pains [137].

Correlates of depression and anxiety in pregnancy

The literature search located four systematic reviews which looked at potential risk factors in various areas (e.g. socio-demographic factors, psychological/psychiatric or obstetrical/preg-

nancy-specific factors) for prenatal symptoms of depression and anxiety and maternal psychological disorders during pregnancy which required treatment (cf. [Table 1](#)). Four more systematic reviews and/or meta-analyses published between 2013 and 2016 were identified which investigated specific individual risk factors (e.g. domestic violence, unintended pregnancy) in connection with maternal depression and anxiety during pregnancy. No further searches for recent empirical individual studies were carried out.

Frequently investigated socio-demographic and economic factors which can contribute to the development of depression and anxiety disorders during pregnancy include a young maternal age, being single, a low income, and a low level of education [45, 46, 48–49]. Conclusive findings were most likely to be correlated to prenatal anxiety disorders [49], while the association between depressive symptoms and socio-demographic or economic factors were potentially affected by the country in which the data were collected [45–46, 48]. No conclusive findings have yet been identified regarding the immigration status or ethnicity of pregnant women [46, 48]. Consistent social risk factors for symptoms of depression or anxiety in pregnancy were lack of or inadequate social support by the woman's partner and conflicts with their partner [46, 48–50]. The emotional support and practical help given by the partner or by close friends or relatives plays an important role in adjusting to motherhood, managing events and coping with difficulties which can develop in the context of pregnancy and the birth of a child [45]. Frequent conflicts in their intimate relationship or dissatisfaction with their partner may be perceived as distressing by the pregnant woman and can significantly affect her adjustment to motherhood. Appreciative and sympathetic support by the partner and emotional closeness are an important resource during the transition to parenthood which can reduce the risk of perinatal depression or anxiety [50].

Previous psychiatric illnesses of the pregnant woman – both illnesses experienced during prior pregnancies or at other stages in the woman's life – play an important role for the development of depression and anxiety in pregnancy [45–46, 49]. But there are also indications that the majority of affected women never had a previous mental illness [45]. Depression and anxiety often occur as co-morbidities, whereby pronounced symptoms of anxiety in the pregnant woman can predispose her to go on to develop depression [45]. Critical life events (e.g. the loss of a close relative or friend) and the perception of high levels of stress by the pregnant woman can increase the risk of prenatal depression and anxiety [45, 48]. Affected women may often suffer from feelings of guilt or worry about the health and development of their unborn child.

Women who have experienced various forms of abuse (e.g. abuse in childhood, experience of intimate partner violence) are a group with a particularly high risk of depression or anxiety during pregnancy [44]. Between 1.8 and 31.7% of pregnant women are victims of violence, although the number of unrecorded cases is likely to be far higher [138]. Women with symptoms of depression or anxiety have a three to five times higher risk of experiencing partner violence [47]. It is generally assumed that physically violent conflicts in a relationship often persist after the birth of a child and these conflicts, in their turn, have a lasting impact on the development of the child [139]. Women who have experienced violence tend to have a more negative attitude toward pregnancy and more difficulty in bonding with their unborn child than pregnant women who have not experienced violence [140]. After the birth women with a prior history of experiencing violence during pregnancy may have difficulty in establishing a

close relationship with their infant which can increase the potential risk of child neglect and abuse by the mother [141], particularly if additional psychosocial risk factors are also present [142]. The previous sections have demonstrated that women who continued to smoke during pregnancy, who had an unhealthy or unbalanced diet, or who gained an excessive amount of weight, usually also had symptoms of depression and/or anxiety [38, 39, 41]. But it is still unclear whether mental health problems and stress affect the health behavior or pregnant women or whether health-damaging behaviors lead to depression or anxiety [45]. As manifestations of depressive or anxious symptoms were not usually collected prior to pregnancy, the findings described here must be interpreted, for the time being, as co-morbidities [42]. Obstetrical and pregnancy-specific factors can also play an important role in the development of depression and anxiety. Studies have shown that an unintended pregnancy can predispose the pregnant women to develop depression or anxiety (cf. [Table 1](#)). According to the findings of Abajour et al. [43], up to 21% of women with an unwanted or unplanned pregnancy develop depression during pregnancy or around the time of the birth. A sudden, unexpected perinatal loss of a child (e.g. due to miscarriage or stillbirth) can trigger complicated grief reactions as well as promoting the development of mental disorders [143]. Previous pregnancy loss (e.g. miscarriage and stillbirth), neonatal death, and current or previous pregnancy complications can lead to increased anxiety and depression scores, culminating in anxiety and/or depression disorders requiring treatment in subsequent pregnancies [45, 49]. An interval of less than six months between the loss of a pregnancy and a new pregnancy may be particularly important in this context [45].

Conclusions for Clinical Practice



Pregnancy and the birth of a child are an especially good time for preventive healthcare measures (e.g. weight normalization, smoking cessation, stress reduction, nutritional counselling) [1]. Pregnant women usually are very aware of the potential risks for their unborn child [144] and are correspondingly open to changes which would positively affect the health of their unborn child. The majority of pregnant women are prepared to reduce the amount of nicotine and/or alcohol they consume or even to stop smoking or drinking completely and are prepared to eat a healthy diet [145]. Nevertheless, a considerable percentage of pregnant women continue to display health-damaging behaviors, although the data on the incidence of this risky behavior, particularly with respect to nicotine and alcohol consumption in pregnancy, varies considerably depending on the country where the data was collected (cf. [Table 2](#)). It is generally assumed that maternal nicotine and alcohol consumption during pregnancy is underreported [146]. There are many reasons for this [146, 147]. The experience of emotional stress is also very common among pregnant women. Mental health problems usually go undetected as the symptoms of depression and anxiety (e.g. increased fatigue, exhaustion, lack of energy, worries) cannot be clearly differentiated from pregnancy-specific problems. A knowledge of the predisposing factors could therefore provide early indications, making it easier for gynecologists to identify affected women early on during routine antenatal check-ups and take appropriate steps. The main aim of this article was therefore to give an overview of the potential factors predisposing to health-damaging behaviors and mental health problems in pregnancy.

Table 3 Summary of the findings on factors affecting health-damaging behaviors and mental health problems during pregnancy.

| Health-damaging behaviors | | | Mental disorders | | |
|--|--|--|--|---|--|
| Nicotine consumption | Alcohol consumption | Malnutrition | Excessive weight gain/obesity | Depression | Anxiety disorder |
| Social factors | | | | | |
| <ul style="list-style-type: none"> ▶ younger maternal age (aged less than 25 years) [32, 61, 62] ▶ lower socio-economic status/ level of education/ income [32, 35, 51, 56–58, 61, 65, 68] ▶ single [57, 61, 67] ▶ characteristics of relationship with intimate partner (lack of support by partner [37], relationship conflicts [54], violence [65]) ▶ partner smokes [35] | <ul style="list-style-type: none"> ▶ higher maternal age (aged more than 30 years) [36, 61, 63, 66] ▶ high level of education [60, 61] ▶ characteristics of relationship with intimate partner (partner is violent [65]) | <ul style="list-style-type: none"> ▶ younger maternal age (aged less than 25 years) [78, 81, 84, 86, 87] ▶ immigrant background [77, 81, 86] | <ul style="list-style-type: none"> ▶ inconsistent data with regard to age [71, 74, 80, 83] ▶ single [74, 77, 81, 86] ▶ lack of social support [39] | <ul style="list-style-type: none"> ▶ inconsistent data with regard to age [45, 46, 48] ▶ single [46] ▶ characteristics of relationship with intimate partner (lack of support by partner [45, 46, 50], conflicts [50], violence [45, 47, 48]) ▶ partner smokes/ drinks [50] ▶ lack of social support [46, 48, 50] | <ul style="list-style-type: none"> ▶ young maternal age (aged less than 25 years) [49] ▶ single [46, 49] ▶ characteristics of relationship with intimate partner (lack of support by partner [45, 46, 50], conflicts [49, 50], violence [45, 47]) ▶ lack of social support [46, 49, 50] |
| Psychological factors | | | | | |
| <ul style="list-style-type: none"> ▶ prenatal depression/anxiety [51, 53, 54, 59, 68] ▶ stress/critical life events [54] | <ul style="list-style-type: none"> ▶ experience of abuse/ill-treatment [36] ▶ stress/critical life events [52] | <ul style="list-style-type: none"> ▶ prenatal depression/anxiety [38, 81, 87] ▶ stress/critical life events [38, 76] | <ul style="list-style-type: none"> ▶ prenatal depression/anxiety [41, 42] | <ul style="list-style-type: none"> ▶ stress/critical life events [45, 48] ▶ experience of ill-treatment/ abuse [44, 47] ▶ prior psychiatric disorder [45, 46, 49] | <ul style="list-style-type: none"> ▶ stress/critical life events [45] ▶ experience of ill-treatment/ abuse [47] ▶ prior psychiatric disorder [45, 46, 49] |
| Health-related factors prior to the pregnancy | | | | | |
| <ul style="list-style-type: none"> ▶ frequency and amount of nicotine consumption [35, 54, 65] ▶ consumption of drugs [62] | <ul style="list-style-type: none"> ▶ frequency and amount of alcohol consumed [36, 55, 60, 66] ▶ consumption of drugs [63] | <ul style="list-style-type: none"> ▶ overweight/obese [81, 84, 85] | <ul style="list-style-type: none"> ▶ overweight/obese [69–71, 73, 74, 83] | | |
| Health-related factors during pregnancy | | | | | |
| <ul style="list-style-type: none"> ▶ alcohol consumption [51, 58, 62] | <ul style="list-style-type: none"> ▶ nicotine consumption [36, 55, 63–65] | <ul style="list-style-type: none"> ▶ nicotine consumption [51, 67, 72, 74, 77, 79, 81, 86, 87] ▶ alcohol consumption [86, 87] | <ul style="list-style-type: none"> ▶ nicotine consumption [72, 74] ▶ lack of exercise [69, 80, 83] | <ul style="list-style-type: none"> ▶ nicotine consumption [45] | |
| Pregnancy-specific factors | | | | | |
| <ul style="list-style-type: none"> ▶ high number of previous births (more than 2) [32, 35, 56, 57, 65, 67] ▶ unplanned pregnancy [51, 62, 67] ▶ inadequate prenatal care [32, 35, 61] | <ul style="list-style-type: none"> ▶ high number of previous births (more than 2) [36, 61, 65] ▶ unplanned pregnancy [55, 60] ▶ pregnancy complications [51] | <ul style="list-style-type: none"> ▶ high number of previous births (more than 2) [78, 79, 81, 82, 84, 86] ▶ unplanned pregnancy [86] | <ul style="list-style-type: none"> ▶ no prior births [70, 72, 73, 75, 80] | <ul style="list-style-type: none"> ▶ unintended pregnancy [43, 45, 46] ▶ previous pregnancy complications/ pregnancy loss [45] | <ul style="list-style-type: none"> ▶ unintended pregnancy [45, 46, 49] ▶ previous pregnancy complications/ pregnancy loss [45, 49] |

Note: Figures in square brackets refer to the sources. Systematic reviews and meta-analyses are indicated in bold.

The review of the literature showed that the continued consumption of substances such as alcohol or nicotine, malnutrition, excessive weight gain culminating in obesity, and impaired mental health all occur more frequently when certain psychosocial, health-related or pregnancy-specific features are present in the expectant mother, most of which existed already prior to the pregnancy. It also became clear that there are complex interactions between individual health-damaging behaviors as well as

links to mental health problems, although the direction of these interactions is not yet clear. The results of this review are summarized in **Table 3**.

Many of the factors described as affecting the health-related behavior or mental condition of pregnant women can easily be identified during routine antenatal check-ups or even prior to the pregnancy. The focus of antenatal care should therefore not be exclusively on assessing potential medical risks for the preg-

nant women and her unborn child. Instead, gynecologists should take enough time when taking the medical history of their pregnant patients to record social and psychological factors in addition to medical risks and also to frankly address the pregnant woman's consumption of alcohol and nicotine and her diet. Antenatal care appointments should also be used to regularly broach the topic of possible psychosocial and pregnancy-related problems during the course of the pregnancy [148]. This article has provided a broad overview of possible factors which can predispose to health-damaging behaviors and mental health problems during pregnancy. As this article is not a systematic review and the focus is not on a specific individual risk factor in pregnancy it was impossible to include all relevant empirical studies dedicated to this topic. It is possible that further important predictors such as the characteristics of the woman's partner (e.g. psychiatric illness, consumer behavior or unemployment) or the pregnant woman's health-related attitudes, convictions or intention to modify her behavior have been overlooked.

Conflict of Interest



None.

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