

Overweight and Obesity before, during and after Pregnancy

Part 2: Evidence-based Risk Factors and Interventions

Übergewicht und Adipositas in der Peripartalperiode

Teil 2: Evidenzbasierte Untersuchungen der Risiken und Interventionen

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Key words

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- metabolic syndrome
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Schlüsselwörter

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Abstract

Overweight and obesity have become a global health problem. Obesity and excessive weight gain during pregnancy have a serious impact on maternal, fetal and neonatal outcomes. Pre-conceptional obesity and excessive weight gain during pregnancy are associated with weight gain in women following childbirth leading to associated risks such as metabolic syndrome, cardiovascular disease and diabetes. Long-term risks for the offspring are an increased risk for early cardiovascular events, metabolic syndrome and decreased life expectancy as adults. German health care has not yet adequately responded to this development. There are no clinical guidelines for obesity before, during or after pregnancy, there are no concerted actions amongst midwives, obstetricians, health advisors, politicians and the media. Research projects on effective interventions are lacking although health care concepts would be urgently needed to reduce future metabolic and cardiovascular risks for women and children as well as to minimize the associated costs for the society.

Zusammenfassung

Adipositas ist inzwischen ein globales gesundheitliches Problem. Adipositas und starke Gewichtszunahme in der Schwangerschaft haben in Industrieländern zu einer Zunahme von Komplikationen während der Gravidität geführt, die mütterliches und kindliches Outcome beeinträchtigen. Nicht nur die präkonzeptionelle Adipositas, sondern auch die übermäßige Gewichtszunahme während der Gravidität sind verantwortlich für eine Gewichtszunahme von Frauen nach der Geburt sowie den assoziierten Risiken wie metabolisches Syndrom, kardiovaskuläre Erkrankungen und Diabetes, aber auch für Langzeitriskien der Kinder wie Adipositas, höhere Morbidität und frühere Sterblichkeit als Erwachsene. In Deutschland hat man bisher nicht adäquat auf diese Entwicklung reagiert – es gibt weder klinische Richtlinien für die Schwangerschaft, noch konzertierte Aktionen von Hebammen, Geburtsmedizinern, Gesundheitsberatern, Politik und Medien. Untersuchungsprojekte über effektive Interventionen fehlen. Dies alles wäre jedoch erforderlich, um die gesundheitlichen Risiken für Frauen und Kinder sowie die damit verbundenen Kosten für das Gesundheitssystem und letztlich für unsere Gesellschaft einzuschränken.

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Introduction

Overweight and obesity have become epidemic in industrialized nations and even in developing countries [1,2]. Obstetric care givers should be concerned about the increased rate of maternal complications and mortality, the immediate risks for fetus and newborn, the long-term effects on women's health and the life expectancy of future generations.

Ad 1) Overweight or obesity increase the rate of maternal complications and of maternal mortal-

ity. Between 2003 and 2005, more than 50% of maternal deaths in the UK were associated with overweight or obesity [3]. Unfortunately, the aetiology and risk factors of maternal deaths are not evaluated in Germany, but there seems to be a similar trend.

Ad 2) Pre-conceptional obesity is associated with an increased rate of congenital defects, regardless of the malformations which are difficult to recognize [4]. According to a British cohort study of 287213 pregnancies, the risk of stillbirth increases from 4/1000 with a normal BMI to 6.9/

Table 1 Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care.[13].

Criteria	Measures
I: Evidence obtained from at least one properly randomized controlled trial	A. There is good evidence to recommend the clinical preventive action
II-1: Evidence from well-designed controlled trial without randomization	B. There is fair evidence to recommend the clinical preventive action
II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group	C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may have an influence on decision-making
II-3: Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in this category	D. There is fair evidence to recommend against the clinical preventive action E. There is good evidence to recommend against the clinical preventive action
III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees	L. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making

Table 2 Weight classification/WHO [17], with modified criteria of the Canadian guidelines [13] and recommended weight gain according to the Institute of Medicine (IOM) [19], commented by Rasmussen [18,40].

Criteria	BMI (kg/m ²)	Recommended weight gain		
		Course of pregnancy		2nd and 3rd trimester
		Singleton pregnancy	Twin pregnancy	Singleton pregnancy
Underweight	< 18,5	12.5–18 kg	no information	0.51 (0.44–0.58) kg/gestational week
Normal weight	18.5–24.9	11.5–16 kg	17–25 kg	0.42 (0.35–0.50) kg/gestational week
Overweight	25–29.9	7–11.5 kg	14–23 kg	0.28 (0.23–0.33) kg/gestational week
Obesity class I	30–34.9	5–9 kg	11–19 kg	0.22 (0.17–0.27) kg/gestational week
Obesity class II	35–39.9	5–9 kg	11–19 kg	0.22 (0.17–0.27) kg/gestational week
Obesity class III	> 40	5–9 kg	11–19 kg	0.22 (0.17–0.27) kg/gestational week

1000 with a BMI > 30, even after adjusting for diabetes, pre-eclampsia, maternal age, parity or nicotine abuse [5]. In a meta-analysis, the risk was judged to be twice as high [6]. A dramatic increase in prenatal mortality has been observed in the case of a combination of poor fetal growth and a maternal BMI > 25 with an odd ratio (OR) of 75, and a 95% confidence interval (CI) of 14–350 [7]. Furthermore, (iatrogenic) prematurity and the risk of neonatal injuries and hypoglycaemia are increased.

Ad 3) Pregnant women with a high BMI have an increased risk of metabolic syndrome [8], type 2 diabetes and cardiovascular disease in their later life [9].

Ad 4) As concluded from 37709 birth records from 1950 up to now, cause mortality was increased in offspring of obese mothers (BMI > 30) compared with mothers with normal BMI even after adjustment for maternal age at delivery, socioeconomic status, sex of offspring, current age, birth weight, gestation at delivery, and gestation at measurement of BMI (OR 1.35, 95% CI 1.17–1.55). Adult offspring of obese mothers also had an increased risk of hospital admission for a cardiovascular event and a higher risk of adverse outcomes [10]. They also suffer from health problems in early life, even after adjusting for age, socioeconomic status, gender, birth weight and gestational age at birth [11]. Similarly, “programming of a shortened life” was found in the offspring of animals who were exposed to a high caloric diet during pregnancy whereby the effect could be reversed by “exercise” [12].

This overview is alarming. Although there is a German guideline on gestational diabetes of more than 90 pages, there is no guideline on how to prevent or treat obesity during pregnancy, although it is combined with a higher risk for subsequent metabolic syndrome than gestational diabetes [8].

We therefore have accepted the invitation to write this review integrating the expertise from guidelines used in Canada, the US, the UK and the Netherlands (Table 1) [13–16].

Pre-conceptional Obesity/Interventions



Definition

Obese patients suffer from an elevated body mass index (BMI) which is defined as weight/height (kg/m²). The WHO classifications and corresponding recommendations for weight gain are shown in Table 2 [17–19]; recommendations for patients with a BMI greater than 35 are not yet completely based on clear evidence [18]. Women should set pregnancy weight gain goals based on their pre-pregnancy BMI or the BMI during the first antenatal visit.

Ethnic differences exist [20]. The physiologic increase of BMI during pregnancy in about 50% of women caused by an increase of intra- and extravascular fluid cannot be used as an indicator of body fat [13]. In 2009, the Institute of Medicine (IOM) in the US revised the pregnancy recommendations not regarding ethnicity, age, smoking behaviour and parity (Table 2) [19]. Trimester-specific recommendations for weight gain were defined and evidence-based absolute and relative risks (RR) for mother and child were finally used for recommendations [21]. Morbid obesity identifies patients with a BMI of > 40 kg/m². Other definitions refer to a weight that is 50–100% above the ideal weight.

In new guidelines, waist circumference and co-morbidity are used as criteria for weight reduction in obese non-pregnant patients. Regardless of the BMI, women who followed the weight gain guidelines (Table 2) had fewer adverse outcomes (Caesar-

ean delivery, gestational hypertension, birth weight <2500 g or >4000 g) [13].

Unfortunately, the identification of women at risk is not routinely followed by interventions. Suggested strategies include behavioural weight loss treatment and counselling regarding exercise, diet, and pregnancy weight gain. So far, no diet offers clear advantages [22]. Early counselling by paediatricians, general practitioners, at schools and universities should be promoted. In adolescents between 11 and 15 years of age, a good breakfast and physical activity were the main negative predictors for obesity [23].

Pre-conceptional counselling/interventions

It is critical that women are informed prior to pregnancy about the need to be as healthy as possible before becoming pregnant, which includes having a normal BMI, eating a balanced diet, and participating in regular exercise. According to international guidelines it is encouraged that overweight and obese women who are planning a pregnancy should be referred to pre-conception assessment and counselling (II-B). Weight reduction is essential prior to infertility treatment (I-A). A pregnancy should only be considered with a BMI <30, and ideally with a BMI <25 kg/m² (I-B). In comparison to women of normal weight, women with a BMI >50 are at risk of pregnancy-induced hypertension (19.7 vs. 4.8%, OR 1.56; 95% CI 1.33–1.82), gestational diabetes (21.1 vs. 1.5%, OR 2.04; 95% CI 1.74–2.38), shoulder dystocia (7.1 vs. 1.4%, OR 1.51; 95% CI 1.05–2.19), Caesarean delivery (60.6 vs. 25.0%, OR 1.46; 95% CI 1.29–1.65), long duration of hospital stay (14.3 vs. 4.7%, OR 1.42; 95% CI 1.07–1.89), child's birth weight ≥4000 g (38.0 vs. 11.9%, OR 1.58; 95% CI 1.38–1.80) or ≥4500 g (16.9 vs. 2.1%, OR 1.87; 95% CI 1.57–2.23), for neonatal metabolic problems (8.5 vs. 2.0%, OR 1.50; 95% CI 1.20–1.86), for admission of the child (16.9 vs. 7.8%, OR 1.28; 95% CI 1.07–1.52) or stillbirth (1.4 vs. 0.2%, OR 1.68; 95% CI 1.00–2.82) (I) [24]. Long-term maternal risks include osteoarthritis, malignant disease and sleep apnoea. These risks can be limited by regular exercise (II-B) [11]. Nutrition consultation should be offered prior to conception [25]. Women with a BMI >50 frequently smoke (II-2) [26] but vice versa, women who stop smoking are at an increased risk of weight gain [27].

First Trimester Risks/Impact for Clinical Practice

Risk of miscarriage

The risk of spontaneous abortion is higher in obese women compared to pregnant women with a normal BMI (OR 3.98; 95% CI, 1.06–14.92). However, no significant differences have been found in overweight pregnant women (OR 1.02; 95% CI 0.72–1.45) [28]. The risk of miscarriage increases from 13.3% in normal weight to 38.7% in obese women (I) [29]. The association between obesity and increased rates of spontaneous abortion (OR 1.2, 95% CI 1.01–1.46) and recurrent (>3) early miscarriages (OR 3.5, 95% CI 1.03–12.01) have been described by a retrospective case-control study (II-2) [18]. Several cohort studies have shown that overweight and obese women have a higher risk of miscarriage in patients with infertility treatment (I) [29–31].

Malformations

The rate of malformations is increased in pregnancies of overweight and obese mothers. Although most malformations develop during the first trimester, they are frequently diagnosed at an

advanced stage of pregnancy, or even post partum due to decreased visibility [32]. Women with a high BMI are at increased risk for neural tube defects (NTD) even after adjusting for diabetes with an OR of 1.22 (95% CI 0.99–1.49), 1.70 (95% CI 1.34–2.15) and 3.11 (95% CI 1.75–5.46) for overweight, obese and severely obese women compared with women and normal BMI (II-1) [33–35].

Interventions

Obese pregnant women should be counselled with regard to diet, supplements, exercise, and weight gain (II-2-B). Compared to women with a BMI <27, women with a BMI ≥27 have lower serum folate levels even after controlling for folate intake (II) suggesting that obese women should receive higher doses of folate supplementation in order to minimize the risk of fetal NTD. It is uncertain to what extent folic acid >400 micrograms has a beneficial effect on reducing congenital malformations (III-C) [35].

Pre-pregnancy BMI is inversely associated with serum vitamin D concentrations in pregnant women. Health professionals should therefore check that women with a booking BMI >30 take 10 micrograms Vitamin D supplementation daily during pregnancy and while breastfeeding (III-C) [15].

Women should set pregnancy weight gain goals based on the BMI as shown in **Table 2** at their first antenatal visit. In addition, they should be advised that regular exercise reduces future risks for herself and the offspring unless there are contraindications (II-1-B) [36]. Right from the first visits women can be questioned and advised about their diet and if the BMI is >30 they should be screened for gestational diabetes already at the first visit [15]. Exercise habits and nutritional counselling can be a helpful adjunct for women not meeting the weight gain guidelines (I-B) [37]. In addition, they may be motivated by knowing that following these guidelines would reduce their risks for a Caesarean, hypertension and abnormal birth weights in their children [36]. Up to now, randomized trials on behavioural interventions in obese mothers have not been convincing [38] and a diet restricting protein and any energy intake should be avoided (III-C) [39].

Second and Third Trimester/Impact for Clinical Practice

Obesity is associated with an increased risk of a number of serious adverse outcomes during the second and third trimester including stillbirth, hypertension, pre-eclampsia and gestational diabetes. From the second trimester onwards, weekly weight gain can be used to predict total weight gain [19,40] and, if necessary, to prompt interventions [41]. Re-assessment of maternal weight during the second and third trimester will allow to consider future risks and to make appropriate plans for equipment and personnel required during labour and delivery.

Unexplained stillbirth

Pre-pregnancy obesity is the most prevalent risk factor for unexplained stillbirth [42]. In women with a BMI >35 the OR was 2.79 (95% CI 1.94–4.02) compared to normal-weight women (II-1) [43]. To determine the risks of stillbirth after 22 gestational weeks, 96/6963 population-based studies were selected. A BMI >25 was the most significant risk factor (more than age and cigarette smoking) and contributed to around 8000 stillbirths per year in studies from 5 countries (II-1) [44]. In a recent Scandinavian study, these differences were less pronounced [45]. Reasons

for the increased risk may include that fetal movements are not recognized, that hyperlipidaemia limits placental blood flow and that sleep apnoea could be associated with fetal hypoxia [46]. Pre-conceptional care and audits of perinatal deaths are steps towards reducing stillbirth rate in high-income countries (II-2-C) [47].

Hypertension

An appropriate size of arm cuff should be used for blood pressure measurements during all antenatal consultations. The cuff size used should be documented in the medical records (II-B) [48]. A retrospective study compared 79 005 women stratified by maternal pre-pregnancy weight between 55 and 75 kg, 9355 women between 90 and 120 kg (moderate obesity) and 779 women of more than 120 kg (severe obesity). The risk of pregnancy-induced hypertension rose significantly in moderate obesity: OR 2.38, 95% CI 2.24–2.52 and severe obesity: OR 3.00, 95% CI 2.49–3.62. Accordingly, obesity also increased the likelihood that women would experience severe hypertension and HELLP syndrome with an OR of 1.56, 95% CI 1.35–1.8 in moderate obese and an OR of 2.34, 95% CI 1.59–3.46 in severely obese women. One in every 10 moderately obese and in every 7 severely obese women had serious complications (II-2) [49]. These findings have been confirmed by a prospective study with > 2000 (seriously) obese women (II-1) [50].

Gestational diabetes

Maternal obesity is known to be an important risk factor for gestational diabetes (GDM) with a number of large cohort studies reporting a three-fold increased risk compared to women with a healthy weight [15]. In women with a BMI > 35 the OR was 2.6, 95% CI 2.1–3.4, and increased to an OR of 4.0, 95% CI 3.1–5.2 in women with a BMI > 40 compared to women with a BMI < 30 (II-2) [50]. This also increased the risk for children > 4000 g: OR 1.7, 95% CI 1.4–2.0, for obese mothers: OR 2.0, 95% CI 1.5–2.3, for very obese pregnant women and for children > 4500 g: OR 2.0, 95% CI 1.4–3.0 and OR 2.4, 95% CI 1.5–3.8 (II-1) [29].

Malformations and ultrasound

The ability to evaluate fetal structures is largely dependent on maternal size. Approximately 15% of normally visible structures will be suboptimally seen in women with a BMI above the 90th percentile; in women with a BMI above the 97.5th percentile, only two thirds of structures are well visualized. As a result, repeat examinations 2 to 4 weeks later or second opinion examinations will reduce the number of poorly viewed fetuses; however, up to 20% (depending on BMI class) will remain poorly visualized [52]. Obstetric care providers consider the BMI when arranging for fetal anatomic assessment, since there is a two-fold increase in the rate of NTD in children of mothers with a high BMI [53, 54] and an increased rate of cardiac malformations, abdominal wall defects, cleft lips and cleft palates [53].

Twin pregnancy

According to a population-based cohort study, a high BMI and excessive weight gain during pregnancy (● **Table 2**) are associated with poorer outcomes in twin pregnancies [55]. In a French cohort study of 514 twin pregnancies, obese mothers reported an increased rate of pregnancy-induced hypertension (34.1% vs. 17.9%, $p=0.011$), pre-eclampsia (27.3% vs. 14.4%, $p=0.028$) and gestational diabetes (22.2% vs. 4.7%, $p<0.001$) compared to mothers of normal weight (II-2) [56].

Interventions in the second and third trimester

Retrospective cohort studies have shown a 24–60% reduction in pre-eclampsia in nulliparous women who had increasing levels of exercise both in the year prior to conception and during the pregnancy (II-1) [43, 44]. The protective mechanisms include enhanced placental growth and vascularity, prevention and reduction of oxidative stress and correction of vascular endothelial function [45]. Exercise reduces medical problems of diabetes – also during pregnancy. More relevant, a 34% reduction in the development of gestational diabetes was reported in obese women who did not participate in vigorous exercise but who did participate in brisk walking compared to easy pace walking [47]. Dietary advice should potentially be continued in relation to gestational diabetes and weight gain. Social stress factors should be discussed and support should be offered appropriately.

Risks and Interventions during Delivery



Overweight and obese pregnant women have an increased rate of Caesarean delivery, shoulder dystocia, problems of anaesthesia, blood loss, thromboembolism and impaired wound healing. Antenatal consultation of pregnant women with a BMI > 30 should be performed and documented. Delivery in a perinatal centre is indicated, as children of obese mothers are more likely to require neonatal intensive care (II-C) [57, 58].

Caesarean section and Vaginal Birth after Caesareans (VBAC)

The risk of Caesarean delivery is increased in obese parturients as analyzed in 24 423 nulliparous women stratified by pre-pregnancy BMI and pregnancy complications. The Caesarean rate was 14.3% for lean women with a BMI < 19.8, 26.5% in women with a BMI of 20–25, 32.8% in women with a BMI between 25 and 30, and 42.6% in women with a BMI > 35. The risk of Caesareans rose gradually even in women without any other complications: OR 1.4, 95% CI 1.0–1.8 (BMI of 25–29.9), OR 1.5, 95% CI 1.1–2.1 (BMI 30–34.9) and OR 3.1, 95% CI 2.3–4.8 (BMI ≥ 35) [3]. Other studies have shown similar results [29, 59].

The increase in the rate of Caesarean deliveries may be partly due to the fact that overweight and obese nulliparous women progress more slowly through the first stage of labour. Obstetricians might be afraid of legal consequences of shoulder dystocia during a vaginal (operative) delivery, although its rate is even lowered in one study [60]. The clinical assessment of progression during vaginal delivery is more complex in obese women. If fully dilatation is achieved, transperineal ultrasound allowing to determine the “angle of progression” can facilitate the indication for vaginal (operative) delivery or in other words prevent a Caesarean delivery [61] (III-B), which is combined with high risks of prolonged operative time and wound healing, increased blood loss, endometritis despite antibiotic prophylaxis and thromboembolism [62, 63]. Wound infection in women undergoing Caesareans is extremely common in obese women mainly if it is combined with gestational diabetes: OR 9.3, 95% CI 4.5–19.2; women who require a vertical skin incision have a 12% rate of wound complications serious enough to require opening the incision [62, 64]. Hospitals should ensure that the equipment of the operating theatre can accommodate obese parturients (appropriate instrumentation and operating tables).

Obese women are less likely to be successful in delivering vaginally after previous Caesarean delivery. In women with a BMI

< 29 the success rate was 54–68% [65,66]; the rate is further reduced in heavier women – it was only 13% in women of > 136 kg [67].

In case of an emergency Caesarean delivery, the time from decision and from incision to delivery is prolonged due to a more complex set-up of anaesthesia and logistics. In case of a subcutaneous layer of > 2 cm, the application of a subcutaneous suture is recommended (I-A) [68].

Some studies suggest that a Caesarean delivery is associated with an increased rate of diabetes and obesity of the child in later life, although these results are still debated [69,70]. A high maternal BMI and/or poor intrauterine growth are associated with obesity and type 2 diabetes in adulthood [71].

Vaginal birth

The increased rate of post-term pregnancies suggests that obesity is associated with impaired myometrial function [43]. In a retrospective cohort study in singleton pregnancies from the Danish Medical Birth Registry, women with a preconceptional BMI > 50 required induction of labour more frequently than mothers with BMI ≤ 50: 38.4% vs. 13.2% with a RR of 2.91 and a 95% CI of 2.33–3.63. Requiring oxytocin during labour was also increased: RR 1.41, 95% CI: 1.13–1.77 (II-1) [26]. Examination of the case records showed that the rate of emergency Caesareans was nearly doubled (21% vs. 12%).

The precise risks of secondary Caesareans depend on the knowledge and skills of the whole obstetric team how to balance oxytocin, encouragement and decisions during first and second stage of labour including the use of transperineal ultrasound.

In nulliparous women with spontaneous onset of labour and a high BMI, the first stage of labour is prolonged while the second stage may be shorter which should be considered for future protocols. External monitoring of fetal heart rate (FHR) and contractions is impaired and may require internal monitoring (III–C). Recently, electromyographic monitoring was performed in obese women showing a better recording quality compared to conventional tocography [72].

In a cohort of 126 080 pregnancies without hypertension or diabetes obese women (BMI > 30) had an increased risk of fetal macrosomia with an OR of 1.4 (95% CI 1.2 to 1.7) (II-1). Nevertheless, the risk for shoulder dystocia did not increase [73]. Similar results were found in another cohort [74].

It has been reported that the estimated fetal weight (> 4000 g, delivery within 3 days) was greater than the actual birth weight in 77% of obese women [75]. When fetal macrosomia was incorrectly predicted, the rate of Caesarean deliveries was significantly greater compared to normal fetal weight prediction: 42.3% versus 24.3%, RR 1.74 (95% CI, 1.09 to 2.78) (II-1) [76]. Although fetal macrosomia is a risk factor for shoulder dystocia, the absolute risk of a severe shoulder dystocia associated with permanent impairment or death, remains low. Considering the sensitivity and specificity of ultrasound to predict a birth weight > 4500 g, 3695 non-diabetic women would have to undergo a Caesarean in order to prevent one plexus paralysis [77]!

Injuries of the maternal pelvic floor have not yet been studied with regard to maternal BMI and seem to depend rather on fetal size than on the phenomenon of obesity.

Complications during delivery

Both immobility and obesity are independent risk factors of thromboembolism; in combination, however, they may pose a much greater risk. This interaction has been demonstrated by a

case-control study that reported an OR of 62.3 (95% CI 11.5–337.6) for *antenatal* venous thromboembolism (VTE) and 40.1 (95% CI 8.0–201.5) for *postnatal* VTE in women with a BMI ≥ 25 where there was evidence of immobilisation, compared with women with a BMI < 25 and no immobilisation. In contrast, women with a BMI ≥ 25 without evidence of immobilisation had a much lower OR of 1.8 (95% CI 1.3–2.4) for *antenatal* VTE and 2.4 (95% CI 1.7–3.3) for *postnatal* VTE [78].

A case-control study conducted in the United Kingdom reported that a BMI ≥ 30 was associated with an OR of 2.65 (95% CI 1.09–6.45) for antenatal pulmonary thromboembolism (PTE) (II) [15]. Obese women requiring pharmacological thromboprophylaxis should be prescribed appropriate doses of low molecular weight heparin (LMWH) according to national guidelines and additional risk factors and should be encouraged to mobilize as early as possible following childbirth (IIB) [15]. Women with a BMI ≥ 30 who have two or more additional persisting risk factors should be given graduated compression stockings in addition to LMWH mainly in the case of immobilisation (III–C) [15].

Regardless of BMI, all women undergoing Caesarean delivery should be offered a single prophylactic dose of first generation cephalosporin or ampicillin to reduce postoperative infections (endometritis, urinary tract or wound infections) (I) and in obese women the dose should be adapted (IIIC).

Obese mothers have an increased risk of postpartum haemorrhage, post partum anaemia and the need for blood transfusion, therefore active management during the third stage of labour is recommended [15,57].

Obstetric anaesthesia

Rates of difficult or failed intubation are increased in obese patients. A 6-year review of failed intubations in obstetric patients with an average BMI of 33 in a region of the United Kingdom reported 36/8970 (1/249) cases of failed intubation [79]. The equipment and expertise required to manage a difficult intubation should be readily available. In obese patients, also the risk of epidural failure is increased. The initial failure rate for epidural catheter placement was reported to be 42% [80]; multiple attempts at catheter placement may be required in up to 75% of very obese patients [62]. It is not yet clear, whether ultrasound diagnosis may facilitate the placement in these women [81]. According to a Danish cohort study, regional anaesthesia was impossible in 25% of all women with a BMI > 50 [26]. In the case of failed epidural or spinal anaesthesia, the patient has to be treated with general anaesthesia; however, this is associated with elevated risks for both mother and child. Therefore, early epidural anaesthesia during the first stage of labour should be considered in order to avoid time delay in case of emergency (III–C).

Postnatal Care and Follow-up after pregnancy

▼ Breastfeeding

Obesity is associated with low breastfeeding initiation and maintenance rates [82,83]. Obese women should receive dedicated breastfeeding support regarding the benefits, initiation and maintenance of breastfeeding (II-2). Anatomical problems during breastfeeding and reduced prolactin levels could play a role why breastfeeding is more difficult [84]. Randomized trials have shown that prenatal breastfeeding support may increase the rate and duration of breastfeeding (I-A) [85]. Reduced cognitive abilities were demonstrated up to school age in the children of moth-

ers with a BMI > 30; the mechanisms – and whether it is a reduced breastfeeding rate – are still unclear [86].

Lifestyle interventions/surgical and pharmacological therapy

A small number of randomized trials have assessed the effect of postnatal lifestyle interventions on weight reduction. Maternity services need to identify what services are available locally to provide this follow up. A Swedish population-based study of > 150 000 women examined the inter-pregnancy weight gain showing that an increased BMI in the second pregnancy was linearly correlated to the risk of pre-eclampsia, gestational diabetes, macrosomia, Caesarean delivery and stillbirth (II-2) [77].

An inter-pregnancy weight loss of 4.5 kg in > 4000 mothers showed a reduction of gestational diabetes by 40% in the next pregnancy [78]. Women with a BMI > 30 should be offered professional advice to modify dietary and physical activity leading to weight loss (I-A) [87–89]. Several systematic reviews of randomized and non-randomized trials [4] form the basis for evidence-based recommendations [84,85]. Diet and increased activity contribute to weight loss; diet alone bears the risk that fat-free tissue will be reduced, which is prevented with parallel activity [90]. Unfortunately, obese mothers are less aware of their pregnancy risks compared to women with gestational diabetes (15.5 vs. 75.0%, $p < 0.01$) and are frequently not sufficiently informed about modifications of their lifestyles [91].

In a randomized trial (“lifestyle in pregnancy”, LIP study), 360 obese pregnant women were offered life style interventions during pregnancy such as regular dietary counselling by trained dieticians and physical activity such as to be moderately active 30–60 min/day equipped with a pedometer, free full-time membership in a fitness centre with physiotherapists for 1 h each week. A total of 304 (84%) women were followed up until delivery. The intervention group had a significantly lower gestational weight gain (GWG) compared with the control group of 7.0 (4.7–10.6) vs. 8.6 kg (5.7–11.5; $p = 0.01$). The IOM recommendations on GWG were exceeded in 35.4% of women in the intervention group compared with 46.6% in the control group ($p = 0.058$). Overall, the obstetric outcomes between the two groups were not significantly different [4].

Investigations during breastfeeding are lacking. A meta-analysis demonstrated that women with obesity and gestational diabetes have an increased risk of type-2 diabetes compared to women without gestational diabetes (I): RR 7.43, 95% CI 4.79–11.51 [92] until 5 years after birth [93].

Systematic reviews show that obese patients may benefit from surgical interventions such as bariatric or gastric bypass surgery [94]. Whether it can be concluded to recommend surgery for pre-pregnancy weight loss and to refer patients to pre-pregnancy surgery is contradictory. Patients should be informed that surgical (band dislocation, maternal bowel obstruction) and internal (nutrient deficiency, severe growth restriction) problems may arise during pregnancy [95]. After inserting a duodenal bypass between two pregnancies, some offspring showed reduced rates of obesity until puberty from 60% to 35% which was more pronounced in boys than in girls [96]. More recently, 340 followed children of 230 mothers who had undergone bariatric surgery showed no significant differences before and after maternal surgery; by 10 years of age, girls even had a higher weight compared to controls. Consequently, obese women should be informed risks and benefits (II-D) [97].

With regard to pharmacological treatment, a double blind study was performed on 564 non-pregnant patients with a BMI between 30 and 40 using different doses of the glucagon-like peptide-1 receptor agonist liraglutide (1.2 mg, 1.8 mg, 2.4 mg, and 3.0 mg) as well as orlistat and a placebo. All patients followed the same diet and fitness program. Weight loss in patients with liraglutide was more pronounced (up to 4.4 kg, 95% CI 2.9–6.0) compared to those taking the placebo and orlistat; 76% of patients taking 3 mg liraglutide vs. 30% in the placebo group had a weight loss of more than 5%. In addition, they had a lower blood pressure and the prevalence of pre-diabetes was reduced (I-A) [98]. It is currently investigated to what extent liraglutide may also prevent pre-diabetes (I) [99].

Regional and national interventions

The problems combined with obesity before, during and after pregnancy require guidelines at a local and national level [100]. The Royal College of Obstetrics and Gynaecology (RCOG) recommends that maternity units should have accessible multidisciplinary guidelines which are communicated to individuals and organisations providing care to pregnant women with a booking BMI > 30. These guidelines should include facilities and equipment, care in pregnancy, place of birth and care in labour, provision of anaesthetic services, management of obstetric emergencies and postnatal follow-up.

In Germany, there are no systematic investigations with respect to the early diagnosis or interventions. There is not even a guideline. National campaigns and intervention strategies are urgently needed. It has been shown that maternal obesity is recognized as a public problem, but that counselling frequently fails if the counsellors are also overweight [101]. Increased parity, low income and insufficient education are associated with maternal obesity [102]. This makes efficient interventions more complex. Stigmatisation of patients should be avoided, but the consequences of further weight gain should be pointed out. Gynaecologists and midwives are inadequately trained for structured interviews and effective nutritional counselling [103]. A referral to a dietician might help to concentrate on diet and lifestyle, rather than only on weight gain. Even in countries with well-established guidelines, the required information is not provided to patients in more than 25% of cases [104]. Self-assessment is difficult, as 74% of obese women estimate their BMI to be lower and 64% the permitted weight gain to be higher [105]. A meta-analysis of 12 international studies showed that a so-called sugar-tax can lead to a weight reduction in the population (II-B) [106].

Public “campaigns” on TV and in social media could support the efforts of patients and their caregivers. In English-spoken media, there are already more than 1500 informative and interactive iTunes and Google Plays on the topic of pregnancy (“shared maternity care”) [107]. Health care politicians could use these opportunities. Evidence-based interventions and respectful communication are essential since the costs may rise by around 2 trillion pounds annually in the US and England, and are expected to increase to more than 50 trillion pounds per year by 2020 [108]. Clinical admissions of overweight, obese and very obese women are increased by 16%, 45% and 88% respectively. The average additional costs during pregnancy were 350.75 (95% CI £284.82–416.69) pounds for women with a BMI > 40 (II-2) [108].

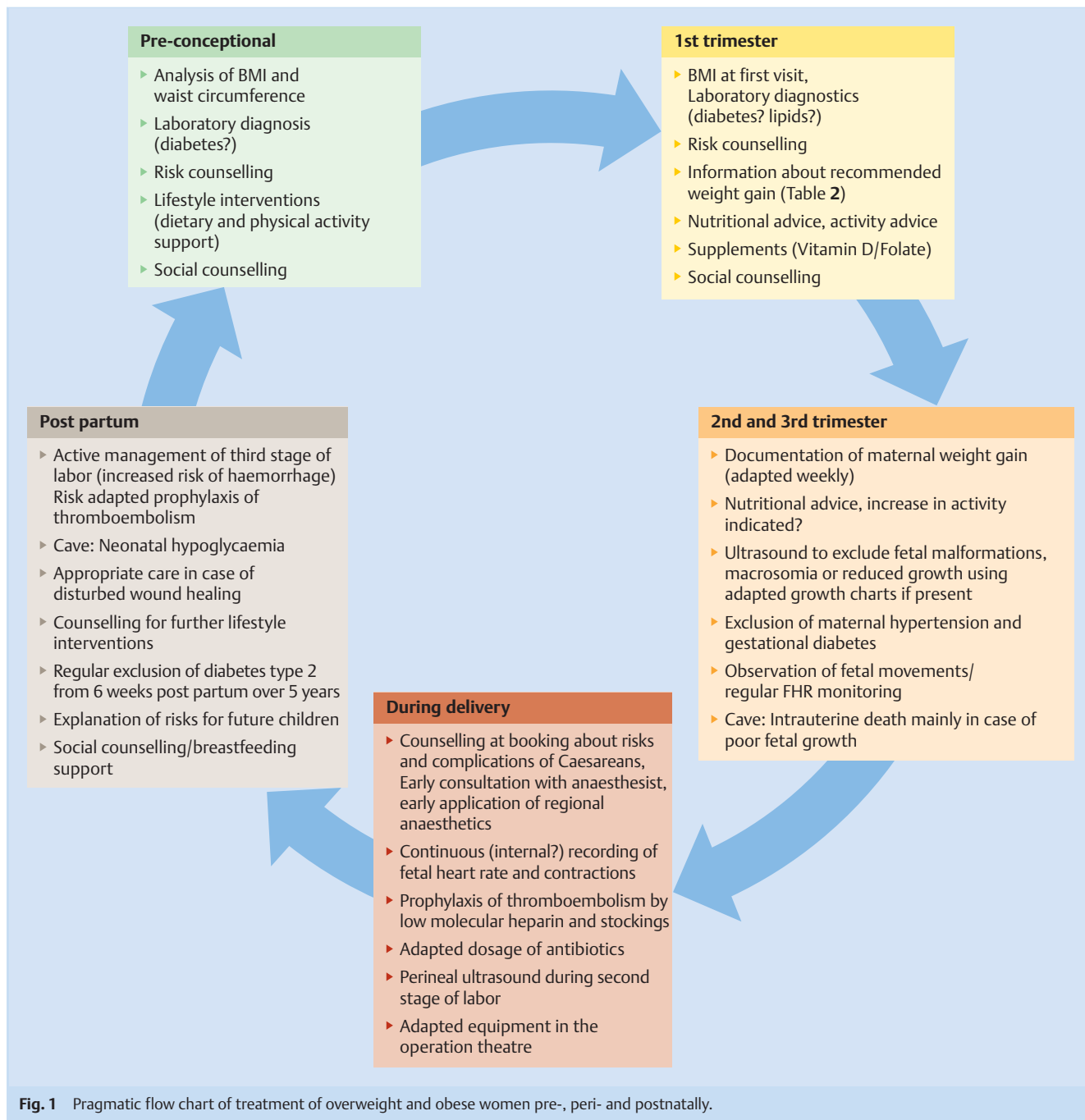


Fig. 1 Pragmatic flow chart of treatment of overweight and obese women pre-, peri- and postnatally.

Conclusions for Clinical Practice

The time before, during and after pregnancy should be viewed a window of opportunities to minimize the short- and long-term health risks for women and their children at an early stage in their life span. Pragmatic proposals are suggested according to international studies (► Fig. 1). No other pregnancy risk is associated with such a high rate of miscarriage and stillbirth. Both mother and child suffer irreversible short- and long-term risks. Obstetric *medicine* is a predominantly preventive discipline; otherwise it would be called obstetric *surgery*. It is doubtful whether efforts, which are offered by individual colleagues or professional organizations may (want to) cope with this problem. Therefore patients have to continue to rely on their own initiatives or to

wait for social and political efforts, which usually take too much time since nobody invests in the virtual value of future health. Concerted actions of politicians, media, general practitioners, midwives and obstetricians are urgently needed as in other fields of our predominantly human, intellectual and preventive specialty with a view to future generation.

Conflict of Interest

None.

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