The Effects of Obesity on Prenatal, Pregnant, and Postnatal Women

by

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INTRODUCTION

According to The State of Obesity, American obesity has been steadily climbing since 1990 and, as of August 2017, the adult obesity[1] rate now exceeds 25% in 46 states. Once classified as an epidemic, obesity is now considered a pandemic (Kanter and Caballero, 2012, p. 491). Medical professionals, public health officials, and health-conscious individuals are desperately trying to reverse this worrying trend due to its impact on the individual, public health, and even the economy. While obesity impacts all ages and genders, it has been observed that this global pandemic impacts women more than men. Kanter and Caballero (2012) observed that "gender disparities in overweight and obesity are exacerbated among women in developing countries, particularly in the Middle East and North Africa" (p. 491). However, "given these global gender disparities in the prevalence of overweight and obesity, [Kanter and Caballero] found that the majority of studies did not explain why these gender disparities exist" (p. 491). A 2017 study noted that "inmates, notably women, are a greater risk for obesity and metabolic complications than the general population according to several studies from high income countries" (Lagarrigue, et al., 2017, p. 1). Consequently, it is necessary to gain a better understanding into why women appear to be more susceptible to becoming overweight and obese, as well as the potential health risks and consequences being overweight and obese have on women.

[1] Obesity can be defined by body mass index (BMI) or percent totally body fat. In clinical terms, a BMI of 25 — 29 kg/m^2 is classified as overweight while a BMI $\geq$ 30 kg/m^2 is considered obese. In terms of percent total body fat, obesity is defined as 25% or greater in men and 35% or greater in women. (Grundy, 2004, p. 2595)

OBESITY IN WOMEN

The health risks associated with being overweight and obese are well-documented. The general risks include, but are not limited to, hypertension, dyslipidemia, Type 2 diabetes, coronary heart disease, and stroke ("The Health Effects of Overweight and Obesity," 2015). One of the emerging trends in recent obesity research is the effect obesity has on metabolism (Singla, et al., 2010). For example, metabolic syndrome is "associated with abdominal obesity, which includes insulin resistance, dyslipidemia, and elevated DRP levels, identifies subjects who have an increase in cardiovascular morbidity and mortality" (Keller, et al., 2003, p. 167). As the prevalence of metabolic syndrome is higher in women than it is men (Beigh, et al. 2012), it stands to reason that the metabolic effects of obesity would impact women more than men.

Hu ferociously wrote in the opening of his 2004 article, "The evidence for the adverse effects of obesity on women's health is overwhelming and indisputable" (p. 163). He concluded that "overweight and obesity are central to the metabolic syndrome and the single most important risk factor for type 2 diabetes. Obese women are particularly susceptible to diabetes, and diabetes, in turn, puts women at dramatically increased risk of cardiovascular disease (CVD)" (Hu, 2004, p. 163). However, while many studies have decried the metabolic effects of obesity on the health of women, obesity is not the only condition that can impact a women's metabolism. According to Herrera, et al., "maternal metabolic adaptations during pregnancy are mainly directed to maintaining a continuous availability of substrates to warrant fetal growth" (2008, p. 32). These include changes in lipid metabolism, protein metabolism, and the development of hypoglycemia (p. 32). As nearly one in two U.S. women of childbearing age[2] are

[2] Vahratian defined women 20-44 years to be of childbearing age.

either overweight or obese (Vahratian, 2009, p. 1), weight management is emerging as a serious issue for women who wish to bear children. Consequently, it begs the question: how does obesity affect prenatal, pregnant, and postnatal women?

In this paper, I aim to explore the impacts of obesity on women of childbearing age. I plan to examine the health effects of being overweight and obese have on prenatal, pregnant, and postnatal women. I will also touch upon the impact an overweight and/or obese mother has on an infant's health and wellbeing.

THE IMPACT OF OBESITY ON PRENATAL WOMEN

In addition to affecting the world at large, obesity is a common problem among women of childbearing age. In 2014, 70.7% of American adults over the age of 20 were overweight or obese. As noted above, there are general risks associated with obesity for both genders including type 2 diabetes and cardiovascular disease. Obese women, however, are also at risk for fertility-related disorders including menses irregularity, oligo-anovulation, and infertility. According to Pasquali, "the relationship between excess body fat and reproductive disturbances appears to be stronger for early-onset obesity" (2006, p. 542). While it may be hyperbolic to claim the effects of obesity on a woman's fertility may start in childhood, it may not be too far of a stretch. As childhood obesity rates are around 17%, these obese children are likely to become overweight or obese adults (Obesity Society). There is an obvious need to address the underlying causes of obesity as well as developing lifestyle interventions to aid in weight management throughout a woman's life.

Obesity has a negative impact on many systems in the female body, including the reproductive system. Obesity plays a "significant role in reproductive disorders… [and] is

associated with anovulation, menstrual disorders, infertility, difficulties in assisted reproduction, miscarriage, and adverse pregnancy outcomes" (Dağ, et al., 2015, p. 111). The complex relationship between obesity and reproductive functions is still being explored as several mechanisms are involved (Dağ, et al., 2015, p. 111). For example, obesity causes insulin resistance and leptin levels to increase, resulting in hyperandrogenemia. Obesity can also cause anovulation (when the ovaries do not release an oocyte during menstruation), impair reproductive functions by affecting the ovaries and endometrium, increase levels of adipose tissue, abnormalities adipokines (see Table 1), and lead to the development of metabolic disorders like polycystic ovarian syndrome (PCOS), and more. (Dağ, et al., 2015, p. 111).

Table 1

The effects of the adipokines on reproduction

Adipokines	Serum levels in obesity	Effects on reproduction in obesity
Leptin	Increases (leptin resistance occurred in obesity)	Inhibits insulin induced ovarian steroidogenesis
		Inhibits LH* -stimulated estradiol production by the granulosa cells
Adiponectin	Decreases	Plasma insulin levels increase
Resistin	Increases	Causes insulin resistance
Visfatin	Increases	Increased insulin sensitivity
Omentin	Decreases	Increased insulin sensitivity
Chemerin	Increases	Negatively regulates FSH§-induced follicular steroidogenesis

*luteinizing hormone
§follicle stimulating hormone

FSH: follicle stimulating hormone; LH: luteinizing hormone

Table 1. The effects of adipokines on reproduction. Copyright 2015 by Journal of the Trukish-German Gynecological Association. Reprinted with permission.

While the impact of obesity on the reproductive system in women of reproductive age is vast, it typically results in a similar outcome: infertility. While many obese women are able get pregnant, many studies have found a link between obesity and infertility. As Dağ, et al. noted, studies have shown that the risk of infertility is three times higher in obese women and the

probability of pregnancy is reduced by 5% per unit of BMI exceeding 29 kg/m^2 (2015, p. 114)! Obesity has also been shown to increase time to conception due to abnormalities that affect follicular development and ovulation (Martinuzzi, et al., 2008, p. 169). As obesity can impact the ability to conceive, many women turn to fertility treatments.

Interestingly, studies have been inconclusive regarding the success and failure rates of fertility treatments in obese women. Martinuzzi, et al. found that "obesity in young women does not adversely affect clinical pregnancy rates in patients treated with in vitro fertilization" (2008, p. 169), while Pandey, et al. concluded in 2010 that "overweight and obese women have poorer outcomes following fertility treatment" (p. 62). Still, many medical associations recommend BMI as a factor to disqualify a patient from being eligible for in-vitro fertilization. In 2017, Tremellen, et al. challenged the ethics of prohibiting obese women from assisted fertility treatments when the "livebirth rates for severely obese women… [are] still far better than that observed for many older women who are allowed access to IVF" (p. 569). All in all, obesity negatively impacts a woman's ability to conceive due to its influence on various biomechanisms regulating fertility, its effects on follicular development and ovulation, and, perhaps, the social stigma of obesity resulting in restricted access to fertility treatments.

THE IMPACT OF OBESITY ON PREGNANT WOMEN

According to Feresu, et al., obesity affects 35% of United States pregnant women (2015, p. 1; see Table 2). In addition to impacting a prenatal woman, obesity also affects the health of one who is pregnant. Consequently, it has become one of the most common risk factors seen in obstetric practice and can cause complications throughout all three trimesters of a pregnancy.

Table 2. Maternal Characteristics Among Morbidly Obese, Obese, and Normal-Weight Women

	BMI 19.8–26, *N* = 535,900		BMI 29.1–35, *N* = 69,143		BMI 35.1–40, *N* = 12,698		BMI > 40, *N* = 3,480	
	N	%	*N*	%	*N*	%	*N*	%
Maternal age (y)								
15–19	10,544	2.0	1,026	1.5	157	1.2	42	1.2
20–24	88,083	16.4	12,043	17.4	2,245	17.7	583	16.7
25–29	198,820	37.1	24,451	35.4	4,712	37.1	1,234	35.4
30–34	163,980	30.6	20,501	29.6	3,729	29.4	1,050	30.2
35–39	63,490	11.8	9,182	13.3	1,524	12.0	475	13.6
40–44	10,611	2.0	1,845	2.7	320	2.5	93	2.7
45–49	372	0.07	95	0.1	11	0.09	3	0.09
Parity								
1	229,558	42.8	23,337	33.8	4,220	33.2	1,057	30.4
2	196,483	36.7	25,053	36.2	4,560	35.9	1,222	35.1
3	79,130	14.8	12,458	18.0	2,240	17.6	670	19.2
4	30,729	5.7	8,255	11.9	1,669	13.1	531	15.3
Maternal smoking								
Unknown	12,669	2.4	1,767	2.6	358	2.8	121	3.5
No smoking	444,336	82.9	54,209	78.4	9,636	75.9	2,635	75.7
Smoking < 10 cigarettes/day	52,058	9.7	8,032	11.6	1,567	12.3	412	11.8
Smoking ≥ 10 cigarettes/day	26,837	5.0	5,135	7.4	1,137	9.0	312	9.0
Pregnancy, multiple	7,955	1.5	1,092	1.6	209	1.6	62	1.8

BMI = body mass index.

Table 2. Maternal Characteristics Among Morbidly Obese, Obese, and Normal-Weight Women. Copyright 2014 by Obstetrics and Gynecology. Reprinted with permission.

During the first trimester, obesity has been associated with an increased risk and miscarriages, maternal complications, and congenital defects. In 2004, Lashen, et al. found an association between obesity and first trimester miscarriages (p. 1644). Arabin, et al. also concluded that "the risk of miscarriage increases from 13.3% in normal weight to 38.7% in obese women" (2014, p. 646). For mothers, a higher BMI during the first trimester can lead to maternal complications like symphysis pubis dysfunction, heartburn, and chest infection (Denison, et al., p. 1467). The rate of birth defects also increases in overweight and obese mothers. Interestingly, most congenital defects (e.g. fetal neural tube defects) develop during the first trimester, yet they are not typically diagnosed until the subsequent trimesters (Arabin,et al., 2014, p. 644).

During the second and third trimesters, obesity is associated with an increased risk of negative outcomes including gestational diabetes, hypertension, pre-eclampsia, and stillbirth (see Table 3). Maternal obesity is known to be a risk factor for gestational diabetes (GDM) while

Table 3. Antenatal Complications Among Singleton Pregnancies

	Controls, *N* = 526,038 [*N* (%)]	BMI 29.1–35, *N* = 69,143 [*N* (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, *N* = 12,402 [*N* (%)]	Adjusted OR* (95% CI)	BMI > 40, *N* = 3,386 [*N* (%)]	Adjusted OR* (95% CI)
Preeclampsia	7,111 (1.4)	1,917 (2.8)	2.62 (2.49, 2.76)	421 (3.4)	3.90 (3.54, 4.30)	119 (3.5)	4.82 (4.04, 5.74)
Abruptio placenta	938 (0.2)	325 (0.5)	1.00 (0.89, 1.12)	29 (0.2)	1.01 (0.70, 1.47)	8 (0.2)	0.96 (0.80, 1.14)
Placenta previa	1,305 (0.2)	156 (0.2)	0.87 (0.73, 1.02)	19 (0.2)	0.57 (0.37, 0.89)	3 (0.09)	0.32 (0.11, 0.94)
Stillbirths after 28 weeks of gestation	1,470 (0.3)	353 (0.5)	1.79 (1.59, 2.01)	72 (0.6)	1.99 (1.57, 2.51)	28 (0.8)	2.79 (1.94, 4.02)

BMI = body mass index; OR = odds ratio; CI = confidence interval.
Controls were normal-weight women, BMI 19.8–26.
* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.

Table 3. Antenatal Complications Among Singleton Pregnancies. Copyright 2014 by Obstetrics and Gynecology. Reprinted with permission.

pre-pregnancy obesity is the most prevalent risk factor for unexplained stillbirth (Arabin,et al., 2014, p. 644). Obesity also significantly increases the risk of pregnancy-induced hypertension and, potentially, pre-eclampsia: according to Arabin, et al., one in every 10 moderately obese and one in every 7 severely obese women have serious complications due to hypertension (2014, p. 646). Additionally, obesity also impacts the ability to evaluate the developing fetus via ultrasound. For example, in women with "a BMI above the 90th percentile… up to 20% [of fetuses] will remain poorly visualized" (Arabin, et al., 2014, p. 644).

During delivery, maternal obesity is associated with a number of complications. For example, Arabin, et al. uncovered several interesting findings in their 2014 article regarding the effects of obesity during delivery (see Table 4). They noted the increase in rate of Caesarean deliveries in obese women due to obese and overweight women's slower progression through labor (p.646). There is also an increase in the risk of Caesarean deliveries as overweight and obese women require a more complex surgery set-up, as well as a greater incision than that of

their lean counterparts (Arabin, et al., 2014, p. 646). In Cedergen's 2004 analysis, not only did

Table 4. Labor and Delivery Complications Among Singleton Pregnancies

	Controls, *N* = 526,038 [*N* (%)]	BMI 29.1–35, *N* = 69,143 [*N* (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, *N* = 12,402 [*N* (%)]
Cesarean delivery	57,407 (10.9)	11,587 (16.7)	1.76 (1.72, 1.80)	2,661 (21.5)
Instrumental delivery	36,418 (6.9)	4,097 (5.9)	1.16 (1.12, 1.21)	706 (5.7)
Anal sphincter laceration†	13,664 (2.6)	1,372 (2.0)	1.01 (0.95, 1.07)	237 (1.9)
Shoulder dystocia†	753 (0.1)	199 (0.3)	2.14 (1.83, 2.49)	44 (0.4)
Major postpartum hemorrhage†	29,813 (5.7)	4,158 (6.0)	1.19 (1.15, 1.23)	643 (5.2)
Epidural anesthesia†	106,038 (20.2)	13,164 (19.0)	1.20 (1.18, 1.23)	2,370 (19.1)
Induction of labor	40,455 (7.7)	9,035 (13.1)	1.77 (1.73, 1.81)	2,029 (16.4)
Delivery at term (*n*)	464,314	58,214	Reference	10,408
Delivery at 42 weeks of gestation	37,640 (7.2)	6,072 (8.8)	1.37(1.33, 1.41)	1,197 (9.6)
Delivery before 37 weeks of gestation	23,905 (4.5)	3,716 (5.4)	1.22 (1.14, 1.31)	788 (6.4)
Delivery before 32 weeks of gestation	3,062 (0.6)	546 (0.8)	1.45 (1.32, 1.59)	136 (1.1)

BMI = body mass index; OR = odds ratio; CI = confidence interval.
Controls were normal-weight women, BMI 19.8–26. Delivery at term (gestational week 37–41) was the reference concerning gestational weeks at delivery.
* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.
† Only vaginal delivery.

Table 4. Labor and Delivery Complications Among Singleton Pregnancies. Copyright 2014 by Obstetrics and Gynecology. Reprinted with permission.

she find that obesity was associated with both early and late deliveries, but "morbidly obese women were more likely to be induced" (p. 220). It is evident that obesity impacts pregnancy from beginning to end, increasing the risk of complications for both mother and child.

THE IMPACT OF OBESITY ON POSTNATAL WOMEN + INFANTS

In addition to being associated with adverse pregnancy outcomes (e.g. maternal hypertension, preeclampsia, GSD, stillbirths, etc.), obesity also has an effect on the wellbeing of postnatal women. While some women prefer caesarean deliveries (Gholami, et al., 2013, p. 301), they are a major abdominal surgery and, consequently, poses some risks and complications. Indeed, "morbidly obese women are at increased risk of postpartum infectious morbidity" (Machado, 2012, p. 13). Following birth, obesity continues to impact the health of women. Women who were obese prior to pregnancy also "have an increased risk of metabolic syndrome, type 2 diabetes, and cardiovascular disease in later life" (Arabin, et al., 2014, p. 646).

While obesity clearly impacts physical health, some recent studies suggest that it could affect mental health as well. In 2014, Molyneaux, et al. found “obese and overweight women had significantly higher odds of elevated depression symptoms than normal-weigh women” (p. 857). Indeed, they cautioned that “Health care providers should be aware that women who are obese when they become pregnant are more likely to experience elevated antenatal and postpartum depression symptoms than normal-weight women” (p. 857). LaCoursiere, et al. also found that “obesity remained strong associated with screening positive for postpartum depression, compared with women of normal weight” (p. 1011). However, findings by Cline, et al. “revealed that weight gain was inversely associated with PPD for the obese women in [their] sample” (2011, p. 333). While some of this depression could be due to a failure to live up to the western ideal of feminine beauty, more research should be done to examine the possible impact obesity has on neurobiological mechanisms, especially those related to major depressive disorders.

Obesity impacts both the health of the mother and the health of the newborn infant. Cedergren noted in her 2004 article that neonatal outcomes included “merconium aspiration, fetal distress, low Apgar score (less than 7 at 5 minutes), and early neonatal death (less than 7 das after birth” (p. 220; see Table 5). Surprisingly, studies have also found that a mother’s obesity during pregnancy can lead to undesirable outcomes for the child later in life.

Table 5. Neonatal Outcomes Among Singleton Pregnancies

	Controls, *N* = 526,038 [*N* (%)]	BMI 29.1–35, *N* = 69,143 [*N* (%)]	Adjusted OR* (95% CI)	BMI 35.1–40, *N* = 12,402 [*N* (%)]	Adjusted OR* (95% CI)	BMI > 40, *N* = 3,386 [*N* (%)]	Adjusted OR* (95% CI)
Meconium aspiration†	731 (0.1)	85 (0.1)	1.64 (1.30, 2.06)	42 (0.3)	2.87 (2.13, 3.85)	11 (0.3)	2.85 (1.60, 5.07)
Fetal distress	10,470 (2.0)	1,865 (2.7)	1.61 (1.53, 1.69)	429 (3.5)	2.13 (1.93, 2.35)	131 (3.9)	2.52 (2.12, 2.99)
Low Apgar score (< 7 at 5 minutes)	4,956 (0.9)	966 (1.4)	1.58 (1.47, 1.69)	205 (1.7)	1.81 (1.57, 2.08)	86(2.5)	2.91 (2.36, 3.58)
Birthweight > 4500g	17,277 (3.3)	5,080 (7.3)	2.15 (2.08, 2.23)	1,188 (9.6)	3.03 (2.85, 3.21)	384 (11.3)	3.55 (3.20, 3.93)
Early neonatal death‡	750 (0.1)	84 (0.1)	1.59 (1.25, 2.01)	35 (0.3)	2.09 (1.50, 2.91)	14 (0.4)	3.41 (2.07, 5.63)

BMI = body mass index; OR = odds ratio; CI = confidence interval.
Controls were normal-weight women, BMI 19.8–26.
* Adjustments were made for maternal age, parity, smoking in early pregnancy, and year of birth.
† Only vaginal deliveries.
‡ Based on livebirths.

Table 5. Neonatal Outcomes Among Singleton Pregnancies. Copyright 2014 by Obstetrics and Gynecology. Reprinted with permission.

Arabin, et al., shared several jaw-dropping conclusions in a 2014 paper:

> As concluded from 37 709 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. They also suffer from health problems in early life, even after adjusting for age, socioeconomic status, gender, birth weight and gestational age at birth.

In sum, the impact of a mother's obesity not only impacts the developing fetus, but the ongoing growth and development of the child!

CONCLUSION

In conclusion, obesity has serious implications for the health of women. Due to the likelihood of an obese child becoming an obese adult, obesity has the ability to impact a women's fertility and pregnancy from childhood! From metabolic disorders to miscarriages to delivery complications, obesity raises some serious risks for women of childbearing age. Furthermore, maternal obesity places the developing fetus and newborn child at risk. Given the complexity of the relationship between obesity and reproductive functions, I believe there

is opportunity for more research to be done to examine the impact of obesity on the endocrine system. I also believe there is value in trying to find similarities in how both obesity and pregnancy impacts the female body during pregnancy (e.g. adipose tissue levels). By attempting to identifying similarities, perhaps we will learn more about the underlying mechanisms that make it difficult for some women to lose weight and maintain long-term weight loss. I also believe there should be more public policy changes that allow women to prioritize their health and wellbeing (i.e. an increase in sidewalks to encourage walking, more flexible working arrangements to increase activity levels throughout the day, etc). Still, it is vital for both women and health care providers to work together to develop lifestyle choices to prevent maternal obesity prior to conception, during pregnancy, and postpartum.

REFERENCES

Arabin, B., & Stupin, J. H. (2014, July). Overweight and Obesity before, during and after Pregnancy. *Geburtshilfe Frauenheilkd*, *74*(7), 646-655. doi:10.1055/s-0034-1368462

Beigh, S. H., & Jain, S. (2012, July 6). Prevalence of metabolic syndrome and gender differences. *Bioinformation*, *8*(13), 613-616. doi:10.6026/97320630008613

Catalano, P. M., & Kartik, S. (2017, February 8). Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. *BMJ*, *356*(j1). doi:https://doi.org/10.1136/bmj.j1

Cedergren, M. I. (2004, February). Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstetrics and Gynecology*, *103*(2), 219-224. doi:10.1097/01.AOG.0000107291.46159.00

Childhood Overweight. (n.d.). In *Obesity Society*. Retrieved April 30, 2018.

Cline, K. M.C., & Decker, J. (2012, April). Does Weight Gain during Pregnancy Influence Postpartum Depression? *Journal of Health Psychology*, *17*(3), 333-342. doi:10.1177/1359105311414954

Dağ, Z. Ö., & Dilbaz, B. (2015, June 1). Impact of obesity on infertility in women. *Journal of the Turkish-German Gynecological Association*, *16*(2), 111-117. doi:10.5152/jtgga.2015.15232

Denison, F. C., Norrie, G., Graham, B., Lynch, J., Harper, N., & Reynolds, R. M. (2009). Increased maternal BMI is associated with an increased risk of minor complications during pregnancy with consequent cost implications. *BJOG*, 116:1467-1472. doi:10.1111/j.1471-0528.2009.02222.x

Feresu, S. A., Wang, Y., & Dickinson, S. (2015, October 16). Relationship between maternal obesity and prenatal, metabolic syndrome, obstetrical and perinatal complications of pregnancy in Indiana, 2008–2010. *BMC Pregnancy & Childbirth*, *15*(266). doi:10.1186/s12884-015-0696-8

Gholami, A., & Salarilak, S. (2013, April). Why do some pregnant women prefer cesarean delivery in first pregnancy? *Iranian Journal of Reproductive Medicine*, *11*(4), 301-308. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3941424/

Grundy, S. M. (2004, June 1). Article Navigation Obesity, Metabolic Syndrome, and Cardiovascular Disease. *The Journal of Clinical Endocrinology & Metabolism*, *89*(6), 2595-2600. doi:https://doi.org/10.1210/jc.2004-0372

Hu, F. B. (2003, February). Overweight and Obesity in Women: Health Risks and Consequences [Electronic version]. *Journal of Women's Health*, *12*(2). doi:https://doi.org/10.1089/154099903321576565

Keller, K. B., & Lemberg, L. (2003, March). Obesity and the metabolic syndrome. *Am J Crit Care*, *12*(2), 167-170. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/12625176

Lashen, H., Fear, K., & Sturdee, D. W. (2004, July). Obesity is associated with increased risk of first trimester and recurrent miscarriage: matched case–control study. *Human Reproduction*, *19*(7), 1644-1646. doi:https://doi.org/10.1093/humrep/deh277

LaCoursiere, D. Y., Barrett-Connor, E., O'Hara, M. W., Hutton, A., & Varner, M. W. (2010, July). The association between prepregnancy obesity and screening positive for postpartum depression. *BJOG*, *117*(8), 1011-1018. doi:10.1111/j.1471-0528.2010.02569.x.

Machado, L. S.M. (2012, January). Cesarean Section in Morbidly Obese Parturients: Practical Implications and Complications. *North American Journal of Medical Sciences*, *4*(1), 13-18. doi:10.4103/1947-2714.92895

Martinuzzi, K., Ryan, S., Luna, M., & Copperman, A. B. (2008, April 19). Elevated body mass index (BMI) does not adversely affect in vitro fertilization outcome in young women. *Journal of Assisted Reproduction and Genetics*, *25*(5), 169-175. doi:10.1007/s10815-008-9213-6

Molyneaux, E., Poston, L., Ashurst-Williams, S., & Howard, L. M. (2014, April). Obesity and Mental Disorders During Pregnancy and Postpartum: A Systematic Review and Meta-analysis. *Obstetrics & Gynecology*, *123*(4), 857-867. doi:10.1097/AOG.0000000000000170

Obesity Society: http://www.obesity.org/obesity/resources/facts-about-obesity/childhood-overweight

Pasquali, R., & Gambineri, A. (2006). Metabolic effects of obesity on reproduction. *Reproductive BioMedicine Online*, *12*(5), 542-551. doi:10.1016/S1472-6483(10)61179-0

Rates & Trends. (2015, November 12). In *The State of Obesity*. Retrieved February 12, 2018, from https://stateofobesity.org/rates/

Singla, P., Bardoloi, A., & Parkash, A. A. (2010, July 15). Metabolic effects of obesity: A review. *World Journal of Diabetes*, *1*(3), 76-88. doi:10.4239/wjd.v1.i3.76

The Health Effects of Overweight and Obesity. (2012, July 6). In *Centers for Disease Control and Prevention*. Retrieved April 30, 2018, from https://www.cdc.gov/healthyweight/effects/index.html

Tremellen, K., Wilkinson, D., & Savulescu, J. (2017, October). Should obese women's access to assisted fertility treatment be limited? A scientific and ethical analysis. *he Royal Australian and New Zealand College of Obstetricians and Gynaecologists*, *57*(5), 569-574. doi:doi.org/10.1111/ajo.12600

Vahratian, A. (2008, April 16). Prevalence of Overweight and Obesity among Women of Childbearing Age: Results from the 2002 National Survey of Family Growth. *Maternal and Child Health Journa*, *13*(2), 268-273. doi:10.1007/s10995-008-0340-6