CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

Available online at: http://www.iajps.com Research Article

# A SYSTEMATIC REVIEW OF HIGH BMI AND ITS ASSOCIATION WITH FERTILITY IN WOMEN IN THE UNITED KINGDOM

**Abeer Hamed Hawsawi**
Lecturer at King Saud University

**Abstract:**
***Background:*** *Women's fertility has an essential role in preserving the human species. It determines women's ability to successfully conceive, maintain a pregnancy and deliver a healthy infant. Numerous factors, such as genetics, physical conditions and psychosocial lifestyle, influence fertility in women. This study focused on the effect of overweight on gestation because being overweight has been suggested to have numerous effects that may impair fertility, gestation and foetal development.*
***Objective:*** *This systematised literature review was conducted to investigate the association between a high body mass index and fertility in women in the United Kingdom. This investigation included how the body mass index affects pregnancy and foetal health and development.*
***Methods:*** *During the review, a systematic search for relevant study articles was conducted in online databases including Cochrane Library, Science Direct, CINAHL, and MEDLINE. Set inclusion and exclusion criteria were applied to the most relevant studies that were retrieved. After a critical appraisal of the identified studies using the Cochrane Collaboration guidelines, 18 studies were considered germane.*
***Results:*** *The selected studies included six randomised control trials (RCT), six retrospective studies, three prospective studies, two longitudinal studies and one cross-sectional survey. After an extensive analysis, it was discovered that a high body mass index affects fertility in women by influencing pregnancy and foetal development. The definition adopted for a high body mass index for this review was any body mass index above 30 kg/m$^2$. Women in this category experienced increased miscarriages, delayed pregnancy, a higher risk for pregnancy complications, endometrial dysfunction, hormonal imbalance, and irregular menstrual cycles. A high body mass index is also associated with increased chances of foetal abnormalities, such as small-for-gestation babies and low birth weights.**Conclusion and recommendation:** A high body mass index hinders fertility in women by impairing their ability to conceive and maintain a pregnancy and also foetal health and development. This review recommends urgent institutionalisation of weight management programmes to assist women of reproductive age in the United Kingdom to maintain a healthy weight and thereby improve their fertility, particularly those who are attending antenatal clinics or are preparing for assisted conception*

**Corresponding author:**
**Abeer Hamed Hawsawi,**
*Lecturer at King Saud University*
*E-Mail: ahawaswi@ksu.edu.sa*

QR code

*Please cite this article in press Abeer Hamed Hawsawi.,* ***A Systematic Review Of High BMI And Its Association With Fertility In Women In The United Kingdom.,*** *Indo Am. J. P. Sci, 2019; 06(12).*

**Background to the Review**

**Body Mass Index**

BMI refers to an approach used to quantify the amount of body tissues including bones, fat, and muscles (Bouda, Demmouche, & Mai, 2010). It is normally considered the best criterion for classifying the degree or extent of overweight and obesity (World Health Organisation (WHO), 2014). The WHO (2014) outlined a method of classifying weight in terms of BMI to identify overweight and obesity (*See Appendix 1*). According to the WHO (2014) classification, a BMI below 18 kg/m$^2$ is considered underweight, while a BMI between 18.5–24.9 kg/m$^2$ is a normal weight (WHO, 2014). An overweight BMI is from 25.0–24.9 kg/m$^2$. Individuals with a BMI from 30–30.9 kg/m$^2$ are considered to have clinical (class I) obesity, while those whose BMI is between 35–39.9 kg/m$^2$ are categorised as having morbid (class II) obesity (WHO, 2014). A BMI of more than 40 kg/m$^2$ is considered extreme (Class III) obesity (Anderson et al., 2014). This system supports the perspective of this study that women with a BMI above 25 kg/m$^2$ are considered overweight or obese.

The BMI has often been used to determine obesity and overweight. However, its use has faced various criticisms. According to Dag and Dilbaz (2015), the BMI is designed to be used only in population studies and not for individuals. Therefore, it should not be solely used as an absolute diagnostic tool for obesity or overweight. For instance, among patients with acute illness, the BMI classification may not successfully indicate the health risk because the BMI mainly indicates long-term morbidity or mortality from chronic conditions (Anderson et al., 2014). Some critics argue that the body fat percentage (BFP) is more reliable in indicating obesity compared to BMI (Bouda et al., 2010). The BPF refers to the total mass of body fat, both essential and stored (Bouda et al., 2010), and is also an indicator of an individual's fitness because it looks into the quantity of fat irrespective of height or weight, as opposed to the BMI (Dag & Dilbaz, 2015). A lean and muscular individual may be classified as obese or overweight using BMI, while the same individual may have a normal weight according to the BFP scale (Dag & Dilbaz, 2015).

According to Burkhauser and Cawley (2008), almost all social sciences studies define being overweight and obese using the BMI despite widespread agreements within the medical literature that BMI has serious imperfections because the BMI misclassifies substantial fractions of the population as obese or non-obese (Burkhauser & Cawley, 2008). Therefore, some women may be wrongly classified as obese or overweight using this system. One of the barriers in the evaluation and management of obesity among healthcare providers is the reduced awareness of obesity as an independent risk factor for morbidity and mortality. This lack of recognition is often furthered by the use of the BMI, which does not accurately identify a morbidity index among acutely ill patients (Burkhauser & Cawley, 2008). For instance, the BMI may classify individuals who participate in rigorous physical activities, such as athletes, as overweight. When it comes to women's fertility, BMI may not be the most appropriate outcome measure for women who take part in rigorous physical exercises (Parker et al., 2014).

Other measures of obesity include waist circumference and waist-hip ratio. However, they are commonly used to determine abdominal or central obesity, which is marked by the excess deposition of fat tissue around the abdominal area and within the peritoneal cavity (Dag & Dilbaz, 2015). The waist circumference and waist-hip ratio have been considered superior as a classification system particularly because of their effectiveness and reliability in predicting some metabolic risk abnormalities, such as metabolic syndrome, type II diabetes mellitus and cardiovascular diseases (Bouda et al., 2010). A waist circumference of more than 102 cm (men) and 88 cm (women) or a waist-hip ratio of 0.9 (men) and 0.85 (women) are categorised as central obesity (Anderson et al., 2014). However, this systematised review used BMI as the standard measure of overweight because most previous studies have also used BMI to determine overweight in women. Again, most studies are population studies, which depend on the BMI classification rather than the diagnosis of individual patients (Crane, White, Murphy, Burrage, & Hutchens, 2009).

**Women's Fertility**

From a demographic perspective, the term 'fertility' is generally used to denote the number of live offspring that mature individuals are able to produce (Jungheim, 2015). It is an aspect of reproduction that should be optimal in both men and women. In women, fertility denotes the capability of a female individual to conceive, maintain pregnancy, and give birth to a live infant (Gillman & Poston, 2012). The term 'fertility' is related to 'fecundity', which means the probability of a female individual to achieve conception during a particular menstrual cycle (Bates, 2012). Fecundity includes women who are trying to conceive naturally or through scientifically assisted means.

Fertility can be measured in terms of population size, which is also known as summary fertility. The

rate of population growth corresponds to the fertility of people in the population (Bates, 2012). Fertility is also perceived as the number of female individuals who have reached fertile (reproductive) age and are therefore capable of conceiving under normal or assisted circumstances. Fertility in women is important in preserving and ensuring the continuity of the human species because it determines the capability of the woman to produce new offspring for new generations (Bouda et al., 2010). Impairments in women's fertility may result in a consequent decrease in the birth rate, which therefore contributes to a reduced summary fertility (population size) (Bouda et al., 2010). Since overweight and obesity are considered to have effects on women's fertility, they are also capable of reducing the human fertility profile and population size.

**Overweight and Obesity**

Overweight simply refers to having body fat, which exceeds the normal healthy level (WHO, 2014). It is a common occurrence among individuals with plenty of food and sedentary lifestyles (Anderson et al., 2014). On the other hand, obesity refers to a medical condition marked by excess accumulation of fat in the body to an extent that it causes negative health effects (Crane et al., 2009). Generally, people who have a BMI that is above 30kg/m$^2$ are considered obese. Overweight and obesity are both considered major health challenges in developed countries (WHO, 2014). In most cases, the terms 'obesity' and 'overweight' are used synonymously. People with obesity are definitely overweight, but not all those who are overweight are obese. They are mainly caused by increased intake of a high calorie diet more than the body requirements. This is because the body converts the excess calories to fat, which is stored under the skin and around various organs (Crane et al., 2009). This fat storage contributes to the high BMI. Numerous factors, including lifestyle (such as alcoholism), a lack of physical activity (a sedentary lifestyle), eating disorders and poor nutrition, contribute to overweight and obesity (Crane et al., 2009). Other abnormal conditions associated with metabolic disorders and hormonal imbalances (hypothyroidism) are implicated in overweight patients (Crane et al., 2009). According to Anderson et al. (2014), they translate into the development of numerous adverse health conditions including cardiovascular disorders, obstructive sleep apnoea, cancer, and diabetes mellitus type 2.

**High BMI in the UK**

In 2014, more than one billion adults worldwide were considered overweight (WHO, 2014), and about 68% were women of reproductive age 18–35 years. The UK has experienced a high prevalence of overweight and obesity, especially among women in the previous decade (Public Health of England, 2015). For instance, according to the statistics provided by the National Health Service (NHS, 2014), about 30% of women in the UK were overweight with a BMI above 25–30.9 kg/m$^2$ (NHS, 2014). Again, 33% were considered obese (BMI >30.9 kg/m$^2$) (Figure 1).

This increases their chances of becoming infertile. The Office for National Statistics (2014) reported that about 25% of the women in the UK aged between 25 and 32 years experience nulliparity and nulligravidity, which have been associated with obesity and overweight. Again, more than 39% of women in the UK are unable to conceive on their own and maintain the pregnancy until delivery because of complications associated with the effects of obesity and overweight (high BMI). The statistics indicate that there is an urgent need for effective intervention to reduce overweight and obesity to improve women's fertility in the UK.

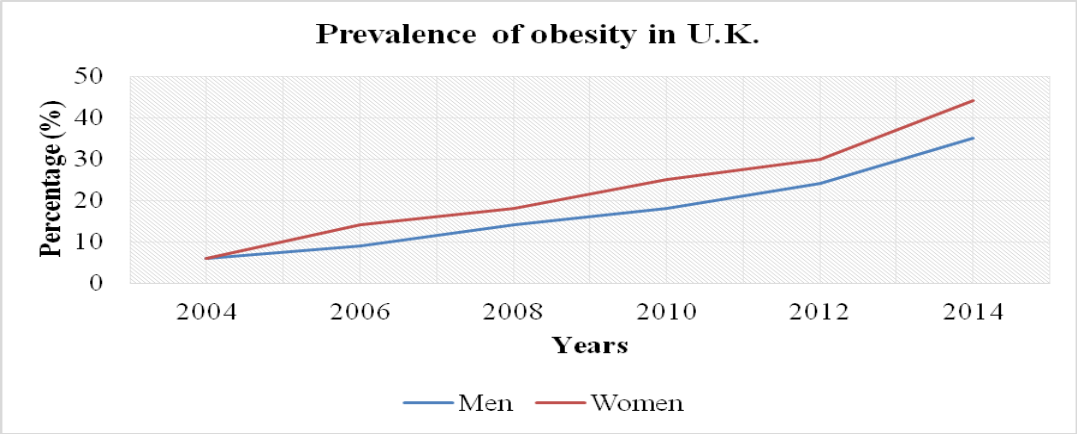


**Figure 1: Prevalence of obesity in the UK (ONS, 2014) Objectives of the Review**

This systematised literature review is performed to achieve the following four important objectives:

i. To identify recently published studies about the relationship between BMI and women's fertility using a schematised search strategy of online databases.

ii. To synthesise the available findings and evidence gathered from the chosen studies in order to identify contentious issues regarding the relationship between a high BMI and women's fertility. This is to be achieved through methodical assessment and appraisal of the existing studies.

iii. To identify how a high BMI affects women's fertility, particularly in terms of pregnancy and foetal health and development.

iv. To recommend some of the evidence-based interventions of managing a high BMI among women in the UK in order to improve their fertility

**Review Questions**

This review is to answer two important questions:

i. What is the effect of a high BMI on women's ability to become pregnant? This question examines the woman's ability to produce viable gametes, conceive, and then maintain a pregnancy.

ii. What is the impact of a high BMI on foetal health and development? This question focuses on the ability of women to deliver a healthy infant.

**Rationale for the Review**

There is extensive pool of diverse findings and evidences on the impacts of BMI and women's fertility, which need to be integrated into a comprehendible format (Jacobsen, Knutsen, Oda, & Fraser, 2013; Makgoba, Savvidou, & Steer, 2011). A large quantity of information is often unmanageable, sometimes contradictory, and may be difficult and time consuming to comprehend (Makgoba et al., 2011). The rationale for conducting this review was to provide integrated, reliable and easy-to-understand evidence collected from the most relevant studies about the association between a high BMI and fertility in women. A systematised literature review relies on more than a single piece of evidence but different confirmations gathered from different studies (Anderson et al., 2014). Hence, it is more reliable than a single high-profile study.

**Focus of the Review**

The focus of this literature review was restricted to looking into the association between a high BMI and the fertility in women in UK A high BMI has been given much attention because it has been widely studies compared to a low BMI (Reynolds et al., 2013). This is because the general indicators of a high BMI, such as obesity and overweight, have been linked to various serious adverse effects on human health more frequently than other factors, such as lifestyle and genetics (Reynolds et al., 2013). The scope is also limited to fertility in women because females have an essential complex contribution to human reproduction compared to males, such as in the maintenance of a viable pregnancy until delivery (Fraser et al., 2011; Van der Steeq et al., 2008).

This review focuses on pregnancy and foetal development. Pregnancy is an essential process and element of fertility. Foetal development influences the production of a viable infant, which is an outcome of a woman's fertility. Lastly, the UK is the centre of focus in this study because it is one of the developing countries burdened with overweight and obesity.

**Definition of Terms**

**Body Mass Index (BMI)**: This refers to the value generated by computing the quotient of body weight (kilograms) and the square of the height (metres) (Dag & Dilbaz, 2015).

**High BMI:** This is defined as any BMI above 30 $kg/m^2$ (WHO, 2014). This review perceives obesity and overweight as indicators of high BMI.

**Woman:** This refers to a female human (Bates, 2012). This study considers a woman to be a female individual between the ages of 15 and 35 years. This is because are expected to be able to conceive, maintain pregnancy, and give birth to live infants in normal or assisted circumstances. It is also the age of prime fertility in women (Schon & Butts, 2015).

**Fertility**: This is the ability of an organism to produce a viable offspring (Schon & Butts, 2015). This literature review considers fertility to include ovulation, fertilisation, implantation, pregnancy, and the birth of live baby. It also includes folliculogenesis, which refers to the process of maturation of ovarian follicles (somatic cells containing immature oocytes), maturation of oocytes and ovum.

**Context of the Review**

Numerous studies have suggested that a high BMI have adverse effects on women's fertility, such as reduced chances of achieving normal conception and maintaining a pregnancy to term, reduced fecundity, increased rate of subfertility, and poor in-vitro fertilisation outcomes (Fraser et al., 2011; Hahn et al., 2014; Van der Steeq et al., 2008; Villavicencio et al., 2010). For example, a study conducted by Van der Steeq et al. (2008) associated being overweight with a reduced occurrence of spontaneous pregnancy and increased secondary infertility. This refers to the inability to the woman to become pregnant or maintain gestation until birth after delivering one or more children (Van der Steeq et al., 2008).

Polotsky et al. (2010) revealed that a high BMI (including obesity and overweight) among women of reproductive age is associated with ovulatory infertility as well as menstrual problems in later life, which may impede conception and pregnancy. Rittenberg et al. (2011) also reported that women who are overweight, as indicated by high a BMI, are predisposed to antenatal and intrapartum complications, such as stillbirth, intrauterine foetal death, congenital malformation, pregnancy-induced hypertension, gestational diabetes mellitus (GDM), pre-eclampsia, and venous thromboembolism.

Some studies have also proposed that there is an association between a high BMI and poor conception and pregnancy outcomes, such as an inability to conceive and an increased likelihood for miscarriage (Metwally et al., 2007; Turner et al., 2010). On the other hand, other studies have presenting contrasting evidence that a high BMI (including moderate obesity) has insignificant effects on women's fertility (Hendriks, Drop, Laven, & Boot, 2012; Jokela, Elovainio, & Kivimaki, 2008). For example, a study conducted by Hendriks et al. (2012) concluded that a high BMI does not impair the quality of the ovum or contribute to subfertility among women. Jokela et al. (2008) reported that obesity is associated with good endometrial health, which improves the chances of conception. Therefore, the presence of controversies in the studies hinders the establishment of an irrefutable conclusion on the relationship between a high BMI on women's fertility.

**Existing Reviews**

The existing systematised reviews have had different focuses, which have made it difficult for an absolute conclusion to be drawn concerning the relationship between BMI and women's fertility (Table 1). Smith and Lavender (2011) conducted a qualitative meta-analysis to investigate the maternity experience of expectant mothers with a BMI above 30 kg/m$^2$. Their study revealed that being overweight has the potential to cause pregnant women to experience adverse effects (Smith & Lavender, 2011). For instance, a high rate of miscarriage and other adverse pregnancy conditions were attributed to an increased BMI and obesity (Smith & Lavender, 2011). One main strength was that the study focused only on overweight women's experiences during pregnancy (Smith & Lavender, 2011). The study did not examine other aspect of fertility, such as conception, which would have resulted in inadequate conclusions regarding the link between high BMI and fertility in women.

Forsum Brantsaeter, Olafsdottir, Olsen, and Thorsdottir (2013) conducted a systematised review to investigate the effects of a reduction in weight among overweight women before pregnancy. The study revealed that weight loss before conception and pregnancy among obese and overweight women increased their fertility rate (Forsum et al., 2013). One strength of the study was the use of an adequate number (15) of studies of various designs, which provided a broader perspective of the relationship between the BMI and women's fertility. However, their study only focused on weight loss among obese and overweight women and therefore did not comprehensively reveal the impact of a high BMI on fertility in these women.

Rittenberg et al. (2010) also conducted a meta-analysis study to explore the effect of BMI on in-vitro fertilisation treatment outcomes among obese women. Their review revealed that an increased BMI was associated with adverse pregnancy results, especially amongst those undergoing IVF (Rittenberg et al., 2010). The inclusion of RCTs strengthened their study by producing strong statistical evidence concerning a raised BMI and women's fertility. However, one of its main weaknesses was that it focused on an artificial means of conception and reproduction (Rittenberg et al., 2010). As a result, the study did not reveal the effect of a high BMI on natural fertility in women. Hence, the results may not be applicable to the general population of obese women who do not undergo assisted reproduction.

Maheshwari, Stofberg, and Bhattacharya (2007) reviewed the literature to investigate whether obesity has any effect on outcomes of the assisted reproduction technique (ART). Their study revealed that there is little evidence that BMI affects live births, ovarian hyper-stimulation syndrome, and recovery of the oocyte (Maheshwari et al. , 2007). One major weakness of their study was the use of an obese BMI with a lower limit (25 kg/m$^2$). According to the WHO (2014), the lower limit of a high BMI should be above 30 kg/m$^2$. Again, Maheshwari et al.'s (2007) study only concentrated on the element of ART and not on the circumstances of natural reproduction. Hence, it was difficult to arrive at an adequate conclusion concerning how a high BMI would affects women's fertility for natural conception.

**Table 1: Summary of Some of the Existing Reviews**

| Study | Objective | Method of systematised review | Type of studies included | Results | Bias |
|---|---|---|---|---|---|
| Smith & Lavender, (2011) | To promote the understanding of the maternity experience for pregnant women with a BMI ≥ 30 kg/m$^2$. | Interpretative approach and the constructivist framework | 6 studies | Healthy weight management increased the health of the mother and the child | Few studies exist, which does not provide robust evidence |
| Forsum et al., (2013) | To investigate the effect of weight loss before conception in overweight or obese women on both the mother and the child | Narrative synthesis | 15 studies | Weight loss (BMI < 30 kg/m$^2$) was associated with a reduced risk for GDM and pregnancy loss | Low statistical strength because a meta-analysis was not used |
| Rittenberg et al., 2010 | To explore the effect of BMI on in-vitro treatment outcomes among obese women | Meta-analysis | 33 studies | A raised BMI was associated with adverse pregnancy results, especially among women undergoing IVF | Limited consideration of other variables that produce pregnancy challenges |
| Maheshwari et al., (2007) | To investigate whether obesity has any effect on assisted reproduction technique (ART) outcomes | 21 studies | Meta-analysis | There is deficient evidence that BMI can affect live births, ovarian hyper-stimulation syndrome, and recovery of the oocyte | The use of a lower limit of the BMI (25 kg/m$^2$). |

**Gaps in the Existing Literature**

The existing reviews have not adequately focused on how a high BMI affects the ability of women to fall pregnant and maintain their pregnancy and foetal health and development. It is clear that it is challenging to draw a decisive conclusion on the effects of a high BMI on women's fertility because there is conflicting evidence on the effect of a high BMI on fertility. For instance, Forsum et al. (2013) and Rittenberg et al. (2011) confirmed that a high BMI affects pregnancy outcomes in overweight women. In contrast, Maheshwari et al., (2007) claimed that a high BMI does not affect the reproduction outcome among overweight women. It is difficult to generalize the evidence revealed by the systematized reviews to the entire population of overweight and obese women because the existing reviews focused only on a portion of the female population, such as those undergoing ART or IVF. Therefore, limited attention was given to natural reproduction and fertility among overweight and obese women. One of the major weaknesses of the available reviews is that they do not highlight the impact of a lifetime of obesity and overweight on women's fertility. Therefore, this review hopes to bridge these gaps by including studies of heterogeneous methodological approaches and sample populations through the inclusion of primary studies that have focused on various populations of women, such as those who experience natural reproduction and fertility. This is important in strengthening the evidence identified by a systematized review.

**Search Strategy**

**Systematized Literature Review**

A systematized literature review is a methodological approach of conducting a literature review that involves the assessment and evaluation of research evidence to answer a vividly pre- stated question (Aveyard, 2014). Moule and Goodman (2014) defined a systematized literature review as a formulated, reproducible and current summary of the evidence generated by previously published studies. It involves the identification of relevant studies based on the particular questions asked, an appraisal of the quality of the studies, and a summary of the findings using scientific procedure.

A systematized literature review has various advantages. It enables the extraction and scrutiny

of relevant information from existing studies. This characteristic assisted us in achieving the aim of this study of inspecting existing evidence regarding the relationship between a high BMI and fertility in women in the UK. A systematized literature review approach enhances the methodological approach of sampling, data collection and data analysis (Moule & Goodman, 2014), which allows for the integration of thematic and methodological issues and cognisant data concerning the connection between BMI and the fertility of women.

Compared to other research methods, such as an experimental approach, conducting a systematised literature review is inexpensive. Aveyard (2014) reported that primary studies are expensive and consume many resources compared to secondary studies, such as systematised reviews. Primary studies of any design (experimental, RCTs and single cohort) also do not have a high level of reliability and dependability compared to a systematised review because a systematised literature review provides consolidated and evaluated evidence (Booth, Papioannou, & Sutton, 2012). Therefore, based on its aforementioned advantages, a systematised literature review approach was considered the most appropriated method.

**Cochrane Collaboration**

This study employed the review guidelines advocated by the Cochrane Collaboration (2008), which refer to the set of instructions that guides study question formulation, search strategies, appraisal of the quality and validity of the selected studies, and data extraction, analysis and interpretation (*Table 2*) (Booth et al., 2012). These guidelines also enhance the selection of the most robust, reliable and valid evidence (Aveyard, 2014). Booth et al., (2012) explained that using the Cochrane Collaboration (2008) guidelines is expedient because it enhances the appraisal of the selected studies to ascertain their sturdiness, dependability and cogency.

**Table 2: Systematized Literature Review Steps (Cochrane Collaboration, 2008)**

| Stages | Activities |
|---|---|
| 1 | Formulation of the study question |
| 2 | Establishing a review procedure |
| 3. | Searching for and selecting relevant studies |
| 4. | Appraisal of the quality of the selected studies |
| 5. | Data extraction using a data collection tool |
| 6. | Synthesis of the result |

Other methods, such as the traditional systematised literature review (TSR), evidence- based practice centre programme guidelines and the National Institute of Health and Clinical Excellence (NICE) approach, were not used because of their typical linearity in congregating information concerning a particular topic. These methods only provide a single perspective of the study question, whereas the Cochrane Collaboration guideline helps in developing various viewpoints because of its interactive and circular nature. For instance, the TSR method was not used because of its various disadvantages. For example, it does not include a peer review protocol for replicating the findings (Booth et al., 2012). The TSR is also always based on the perspective of the review, which may be biased. In addition, it does not include an adequate protocol for selecting and appraising the evidences (Booth et al., 2012). Hence, a traditional method may not produce a robust result compared to a systematised review method.

**Databases**

Research articles used in this systematised literature review were obtained in their electronic form by searching online databases including Science Direct, MEDLINE, CINAHL, Cochrane Library, PubMed Central and SAGE Publications (See Appendix II*)*. These databases were deliberately selected because they are considered the most expedient in providing reliable nursing and other health-related articles. For instance, they contain articles that explore a wide range of disciplines in human health, including nursing and healthcare (Aveyard, 2014). These databases also provide appraised, edited and peer-reviewed studies (Cochrane Collaboration, 2008), which was important in selecting the most valid, trusted and reliable study articles concerning the relationship between BMI and fertility in women.

**Search Terms and Phrases**

The key words and phrases used as pointers during the search process included 'body mass index', 'women fertility', 'BMI and women's fertility'. Others were 'BMI and conception', 'BMI and pregnancy', 'BMI and pregnancy outcomes', 'obesity and fertility', 'high BMI', 'high BMI and fertility', 'high BMI and foetal development', 'high BMI and foetal health', 'high BMI and human fertility', 'overweight and menstrual cycle' and 'overweight and endometrium'. The researcher also used phrases, such as 'reproductive hormonal imbalance', and 'overweight and

women's fertility'. Each term and phrase yielded a different number of outcomes. The researcher used a Boolean operator strategy for developing these search terms (Holly, Salmond, & Saimbert, 2012). This involves mainly the use of "and" developed by George Boole in order to assist in combining

words and phrases (Holly, Salmond, & Saimbert, 2012), which helped in truncating the otherwise long phrases and improved the search outcomes. It also aided in optimising the search results for each keyword and phrase.

**Inclusion and Exclusion Criteria**

Inclusion and exclusion criteria are essential in a literature search since they help in identifying only the most relevant study articles (Table 3) (Cochrane Collaboration, 2008); they were used to reduce bias. To ensure the reliability of the evidence, this review included only primary studies published within the past five years (from 2010–2015). This criterion was used to enhance the collection of only the most recent, updated and current evidence concerning the relationship between BMI and women's fertility (Polit & Beck, 2014). The peer-reviewed studies have undergone rigorous quality assessment, and any serious bias and deviation have been clearly identified (Higgins & Green, 2011). Concerning theme, this review included studies that assessed BMI, overweight or obesity in relation to various aspects of women's fertility, conception, pregnancy, and healthy delivery. Lastly, to concentrate the focus on the UK, the inclusion criteria only allowed studies conducted in the UK to be selected. Studies that did not meet these criteria were excluded from the review.

**Table 3: Inclusion and Exclusion Criteria**

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Primary studies: Cross-sectional surveys, randomised controlled trials (RCT), retrospective, prospective cohorts, and longitudinal studies | Opinions, expert reviews and reports |
| Studies that addressed BMI and fertility in women (including pregnancy, conception, and foetal development) | Studies that looked into themes other than BMI and women's fertility |
| Study articles published within the previous five years (since 2010) | Studies published before 2010 |
| Articles published in English | Articles published in languages other than English |
| Peer-reviewed articles | Non peer-reviewed articles |
| Studies conducted in the UK | Studies conducted in other countries |

**Critical Appraisal Method**

The quality of the selected study articles was critically appraised using the Cochrane Collaboration (2008) appraisal guidelines. For instance, each study was graded using internal validity indicators. The pointers used included the relevancy of the place of study, random selection of sample, clarity, reliability, and reproducibility of the methods, finding accuracy, consideration of ethical issues, and a validity and trustworthiness test (Cochrane Collaboration, 2008). The studies were graded as poor, fair or good in terms of the indicators, and only those with good scores across all the indicators were included in this review.

**Search Outcome**

Approximately 405,264 results were generated during the search of the online databases, including various kinds of study articles, such as primary studies, reviews and opinions. Potentially appropriate articles were first identified by their topics. The researcher read the topics with highlighted keywords and phrases used in the search terms in order to scan the results for possible study articles. Then, the abstracts or the full texts of the research articles were closely read to identify the objectives, aims, methods, population, samples and results of the studies. Theresearcher considered the inclusion and exclusion criteria to identify the most relevant research articles. Lastly, the identified studies were appraised, and the researcher reviewed the identified studies to gather overriding evidence. The process yielded 18 valid and pertinent studies (Figure 2).

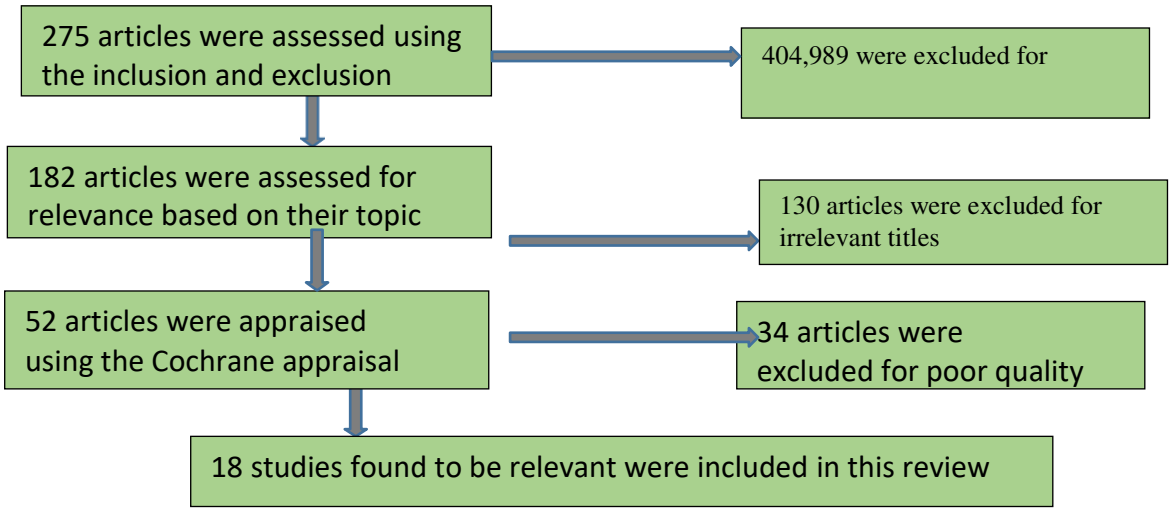


**Figure 2: Search outcome**

**Data Extraction and Management**

The data were extracted by summarising the study's authors, year of publication, study design (type), sample size, findings, and conclusions in a table. The researcher concentrated on the findings and conclusions made by the studies in order to identify the prevailing evidences as well as important themes concerning the relationship between BMI and women's fertility. The tabulation of the summary was essential in keeping track of each selected study during the review period. In data management, the findings concerning how the studies related the BMI and women's fertility were identified and recorded in a descriptive narrative manner to aid in identifying the emerging themes.

**Data Analysis Method**

This study used a systematised literature review method, which aided in the extraction of major descriptive themes identified from the selected studies. This analysis approach was chosen because of the methodological and clinical heterogeneous natures of the chosen studies (Aveyard, 2014); the included studies had different designs and widely dissimilar sample sizes that targeted different populations of women. The limited utilisation of a meta-analysis approach could obscure the actual differences and present unreliable results (Aveyard, 2014).

**Literature review characteristics of the included study:**

The selected studies included six RCTs, six retrospective studies, two longitudinal studies, three prospective studies, and one cross-sectional survey (Table 4). The methodological quality of the selected studies was evaluated using appraisal questions adopted from Cochrane Collaboration (2008) protocols (see Appendix II and IV). The questions were essential in assessing and appraising the relevance, trustworthiness, reliability and effectiveness of the included studies because they evaluated the most important elements of the studies, including the research design, sample, method of data collection and analysis, ethical approval and results (See Appendix IV). The studies had a high methodological quality that promoted the robustness of this systematized review.

**Table 1: Characteristics of the Reviewed Studies**

| Author/Year/Title | Type of study | Objective | Sample | Result | Conclusion | Bias | Significance/ strength to the review |
|---|---|---|---|---|---|---|---|
| Briley (2014). A complex intervention to improve pregnancy outcomes in obese women; the UPBEAT randomized controlled trial. | Randomized control study | To investigate whether the intervention to reduce the BMI increased chances of survival in the offspring | 1546 women | Reduction of BMI increased the survival of the foetus | BMI affects foetal development nt | Applicable to fetal development nt only | A high BMI affects the development of the foetus Large sample size |
| Fraser et al. (2011) Associations of gestational weight gain with maternal BMI, waist circumference and blood pressure measured 16 y after pregnancy: the Avon Longitudinal Study of Parents and | Longitudinal study | To investigate associations of pre-pregnancy weight and GWG with the maternal BMI (in kg/m$^2$), waist circumference (WC), systolic blood pressure (SBP), and diastolic blood pressure (DBP) 16 y after pregnancy | 2356 women | GWG in mid-pregnancy (19–28 weeks) was associated with later and greater SBP, DBP and central adiposity | Optimal GWG must balance divergent associations with different outcomes in both mothers and offspring | A focus on offspring with limited attention to the women's ability to conceive | A high BMI and being overweight are associated with pregnancy risk factors, such as SBP and DBP, which may affect the pregnancy outcome |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Children (ALSPAC). | | | | | | | |
| Hahn et al. (2014)<br><br>Body Size and Risk of Spontaneous Abortion among Danish Pregnancy Planners. | Prospective cohort study | To examine the connection between body size (central adiposity, height and typical weight gain) and increased chances for spontaneous abortion (SAB) | 5132 women | Increased body size is connected with spontaneous abortion | There was a small positive association between obesity and the SAB risk | Non consideration of other variables | A high BMI (obesity) considerably increased the Chances of spontaneous abortion |
| Hayes et al. (2014)<br><br>Association between Physical Activity in Obese Pregnant Women and Pregnancy Outcomes: The UPBEAT Pilot Study | RCT | To investigate the pregnancy outcome among obese women who engaged in physical activity | 183 women | Physical activities improved pregnancy outcomes among obese women | Obesity affected the pregnancy outcome | Inadequate recognition of the control group | Investigated the effect of BMI on pregnancy |
| Jacobsen et al. (2013)<br><br>Obesity at age 20 and the risk of miscarriages, irregular periods, and reported problems of becoming pregnant: the Adventist Health Study-2. | Retrospective | To examine the effect of BMI at age 20 in women with primary and secondary infertility | 33,159 nulliparous women at 20 years | Women with a high BMI have increased chances of nulliparity | Obesity and underweight at age 20 increases the nulliparity chances | Lack of a control group, personal biases | High BMI affects the fertility of women by increasing their nulliparity rate |
| Makgoba, Savvidou, & Steer (2011)<br><br>An analysis of the interrelationship between maternal age, body mass index and racial origin in the development of gestational diabetes mellitus | Retrospective study | To investigate the link between advancing maternal age, BMI and racial origin and GDM | 1688 with GDM and 172,632 without GDM | There was a strong positive association between advancing age, increasing BMI and the development of GDM ($P < 0.01$) | Maternal BMI contributes to GDM development | No focus on fertility elements among the participants | A high BMI affects pregnancy by contributing to adverse conditions, such as GDM |
| Metwally et al. (2010)<br><br>Body mass index and risk of Miscarriage in women with recurrent miscarriage | Retrospective analysis | To investigate the effect of overweight, underweight and obesity on the miscarriage chances in a subsequent pregnancy among women with recurrent miscarriage | 491 patients (844 pregnancies) | Obese and underweight patients had a significantly higher miscarriage chance during the subsequent pregnancy | A high BMI increased the possibility of miscarriage in the subsequen | Use of non-standardized means of measuring BMI (WHO) | A high BMI decreases a women's fertility by contributing to miscarriage in subsequent pregnancies |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | t pregnancy | | |
| Mounce et al. (2015)<br><br>Randomised, controlled pilot trial of natural versus hormone replacement therapy cycles in frozen embryo replacement in | Randomis ed Controlled Study | To determine the effect of BMI on embryo quality | 159 women | Embryos collected fro m obese women had a low quality | A hig h BMI affected the embryo quality | A lack of data from a natural population because<br><br>it only investigated in vitro samples | A high BMI affects the fertility of women<br><br>by influencing the embryo quality |
| Polotsky et al. (2010). Association of adolescent obesity and lifetime nulliparity--the Study of Women's Health Across the Nation (SWAN). | Cross-sectional analysis of baseline data from a longitudin al cohort | To assess whether adolescent obesity contributes t | 527 women | A high BMI while of school age increases the chances<br><br>of lifetime nulliparity | Adolescent obesity was associated with lifetime multigravidit y | Unreliable in terms of the long-term impacts of BMI on women's fertility | A high BMI in women is Associated with difficulties<br><br>in conception |
| Rankin et al (2010)<br><br>Maternal body mass index and congenital anomaly risk: a cohort study | Cohort (longitudi nal) study | To examine the connection between maternal BMI and foetal problems | 41,013 singleton pregnanc ies | The chances of a congenital anomaly were pointedly increased among obese maternal groups | Obesity and overweigh t increased the chances of a congenital abnormality | Concentrated on congenital abnormalities | A high BMI affects foetal development and increases the chances<br><br>of congenital abnormalities |
| Rittenberg et al. (2011)<br><br>Influence of BMI on risk of miscarriage after single blastocyst transfer. | Retrospect ive study | To assess the effect of BMI on the increased rate of miscarriage after SBT | 413 women | Women with a | A high BMI was independe ntly associated with a higher miscarriag e rate after IVF treatment | Depended on artificial fertilization , which cannot be generalized to the entire population | A high BMI affects women's capacity to maintain their pregnancy to term |
| Signe et al. (2012)<br><br>Regular Exercise during Pregnancy to Preven t Gestational Diabetes: A | RCT | To investigate the effect of exercise in preventing gestational diabetes among obese women | 855 women | Exercise among obese wome n reduced gestational diabetes | Obesity increased the chances of gestational diabetes | The study focused more on weight management strategies than the effect of a high BMI on | Obesity influences the maternal ability to carry a pregnancy to term |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | women's fertility | |
| Sim et al. (2014) Weight loss improves reproductive outcomes in obese women undergoing fertility treatment: a randomized controlled trial. | RCT | To assess the impact of weight loss on pregnancy rates among obese women | 27 women (case) and 22 women (control) | The weight loss intervention resulted in a 48% increase in the pregnancy rate | Obesity lowered the pregnancy rate | The study prioritised weight loss exercise rather than the actual BMI of the participants | A high BMI contributes to low pregnancy rates |
| Souter et al. (2011) Women, weight, and fertility: The effect of body mass index on the outcome of superovulation/intrauterine insemination cycles. | Retrospective | Examined the fecundity of overweight women | 1189 | Medication requirements increase with increasing BMIs | Women who are overweight require high doses of medication and produce less follicles | Reliance on findings and not general population | A high BMI causes hormonal imbalances |
| Turner et al. (2010) Body Mass Index and spontaneous miscarriage | Prospective observational study | Investigated spontaneous miscarriage in women with a high BMI | 1200 women | Miscarriage rates increased with a high BMI | A high BMI increased the risk of spontaneous miscarriage | Biasness of the observer (researcher) | No relationship was suggested between obesity and spontaneous abortion |
| Villavicencio et al. (2010) The effect of overweight and obesity on proliferation and activation of AKT and ERK in human endometria | RCT | To investigate whether overweight and obesity could cause endometrial proliferation and activation of AKT and ERK1,2 in cycling premenopausal women | 200 with a high BMI and 320 in the control group | The results showed a correlation between obesity (and overweight) and increased endometrial cell proliferation, and the activation of AKT and ERK1,2 | The activation of AKT and ERK1,2 is type-I endometrial cancer | Focused on premenopausal women only and not general women's fertility | Obesity increases the chances of morbid factors, such as endometrial cancer, that affect women's fertility |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Wallece et al. (2014) Inter-pregnancy weight change impacts placental weight and is associated with the risk of adverse pregnancy outcomes in the second pregnancy | Retrospective cohort study | To investigatethe connection between inter-pregnancy weight alteration and the primary risk of an adverse pregnancy outcome | 12,740 women | Weight loss (>1 BMI unit) was associated with an increased rate of occurrence of pregnancy complications | Alteration in inter-pregnancy increases a number of contrasting pregnancies complications | No direct assessment of the effect of a high BMI on fertility | A high and low BMI during pregnancy is Associated with pregnancy complications |
| Wise et al. (2010) An internet-based prospective study of body size and time-to-pregnancy. | Prospective study | To investigate the association between BMI and time to pregnancy (TTP or fecundity) | 1651 women | There were longer TTPs for overweight women. | Overweight and obesity increases the TTP | Unreliability of remembered data concerning the patient's history, such as BMI | A high BMI contributes to delayed pregnancy and reduces fecundity |

**Synthesis of the Included Studies**

The selected studies were synthesised based on their methodological and thematic qualities. The identified themes were grouped under six major subcategories based on the answer the participants provided for the study questions. This method helped to identify the effect of a high BMI on the ability of a woman to conceive and maintain a pregnancy and also the heath and development of the foetus. The topics included miscarriage, delayed pregnancy, pregnancy complications, endometrial dysfunction, hormonal imbalance, irregular menstrual cycles and foetal abnormalities.

**Question One: What Is the Effect of a High BMI on a Woman's Ability to Fall Pregnant?**

**Miscarriage**

Out of the 18 included studies, four of them associated a high BMI during pregnancy with the increased probability of miscarriage (Hahn et al., 2014; Metwally, Saravelos, Ledger, and Li, 2010; Rittenberg et al., 2010; Turner et al., 2010). This included all women categorised as having obesity of types I, II and III (Hahn et al., 2014; Rittenberg et al., 2011). Miscarriage is defined as a condition where the foetus naturally ceases to live before it completes 20 weeks of gestation (Rittenberg et al., 2011). The term is also used to refer to spontaneous abortion (SAB), which has a similar outcome as miscarriage. Therefore, the reviewed studies used both 'miscarriage' and 'SAB' synonymously. Some of them considered miscarriage to include the loss of the embryo, foetus or pregnancy occurring before 24 weeks (Metwally et al., 2010; Rittenberg et al., 2010).

Rittenberg et al. (2011) carried out a retrospective study and found that women with a BMI greater than 25 kg/m$^2$ were subject to an increased rate of miscarriage, especially those who had undergone assisted reproductive techniques. The statistical analysis of the data gathered from 413 women who had received single blastocyst transfer (SBT) produced an odds ratio (OR) of 2.4 (95%) for miscarriage with a confidence interval (CI) of 1.6–3.8 and a p-value of 0.001 (Rittenberg et al., 2010). For instance, 113 of the 413 women who had a high BMI of more than 25 kg/m$^2$, experienced a miscarriage before 23 weeks following SBT (Rittenberg et al., 2010). The study can be considered as appropriately robust and dependable to the extent that it observed vital confounding variables of women's fertility, including age, infertility aetiology, social behaviours (smoking), a history of SAB and blastocyst quality. The study also employed a standard categorisation criterion for BMI, which was established by the WHO (2014). Moreover, the study provided strong statistical evidence and analysis owing to its suitable sample size. However, one limitation of the study should be noted regarding the limited control measures for SBT that were carried out. The weakness could have produced undesirable effects, such as a lower quality of the blastocyst. Therefore, it is possible to deduce from the study that a high BMI restricts the capacity of a woman to sustain a successful pregnancy to term by increasing the chances of miscarriage (Rittenberg et al., 2010). It is important to note the extent to which this is a negative indicator for women's fertility.

A high BMI was also found to increase the likelihood of miscarriage in subsequent pregnancies. Metwally et al. (2010) performed a retrospective study to discover the impact that varied types of BMI, including obese and overweight values, had on the likelihood of miscarriage in subsequent pregnancies. The outcome measures of the study primarily included the odds of miscarriage in later pregnancies and recurrent SABs. After the data were gathered from 491 patients and 844 subsequent pregnancies was analysed, it was revealed that females categorised as having a high BMI or obesity were at significantly higher odds of miscarriage (OR: 1.71; 95% CI: 1.05–2.8) (Metwally et al., 2010). Again, a high BMI category was marked as a predicting factor for miscarriage (p=0.04). The viability of the findings reported in this study was enhanced by the analysis of data collected in the context of numerous phases, including the examination of the pregnancies during referrals and at miscarriage clinics (Metwally et al., 2010). Another strength of the research design is that it was a longitudinal study, which generated a comprehensive overview of all reproductive performances of the involved participants based on their BMI categories. However, one considerable weakness of the study was the use of a relatively small sample, particularly in the obese category (n=29) (Metwally et al., 2010), which limited the statistical representability of obese women and might have exaggerated the reportedly high chances of infertility. Conversely, the results also had an accepted level of strength due to intricate control of other vital variables, such as age and the fertility status of women.

The reviewed studies also revealed that both overweight and obesity were implicated in the occurrence of spontaneous abortion in the first trimester. Hahn et al. (2014) conducted a prospective cohort study primarily to identify the nature of the relationship between high BMI and greater chances of SAB in a sample size of 523 obese women. Their study revealed that the rate of miscarriage among obese women is high during the earlier stages of gestation. This result

highlighted a considerable correlation between obesity and SAB, especially among women with less than eight weeks of gestation (hazard ratios: 0.81, 95% CI: 0.63–1.05) (Hahn et al., 2014). The strength and reliability of the study was reinforced by the adequate sample size and the use of the Cox proportional hazard regression model in computing the hazard ratios (HRs). This method provided statistically consistent results. The study was also informative insofar as it effectively provided a standard classification of BMI and focused its result measures on the pregnancy assessment of the participants' BMI (Hahn et al., 2014). It is noteworthy that this process served to increase the potential for misclassifications of the participants' BMIs into the right categories. Since the reported BMIs were corroborated against the present BMIs, it was easy to identify the existence of any wide deviation. In this way, the results can be considered reliable to a great degree.

Turner et al. (2010) conducted a single retrospective study that revealed a contradictory result in terms of the relationship between a high BMI and female fertility. The results displayed an inconsequential connection between the SAB incidence and obesity; this was indicated by a BMI greater than 29.9 kg/m$^2$. The study reported a high miscarriage rate of 3.35% among the overweight participants, which was higher than the 2.8% among participants of a normal weight (Turner et al., 2010). The study had a remarkable level of dependability and reliability owing to the abundance of longitudinal follow-up and, in addition, to the monitoring of the participants at various phases, which ensured that the progress of their pregnancies was comprehensively assessed. For example, a series of sonograms was performed on the participants to confirm the progress of singleton pregnancies and bioelectrical impedance analysis (BIA) was conducted at various stages (Turner et al., 2010). This protocol was notable because it resulted in the elimination of other possible causes of SAB, some of which may have influenced the outcome of the pregnancy. However, the study failed to acknowledge the significant difference clearly in the rate of SAB among women based on BMI because of its dependency on their mean body composition and not BMI. However, it is possible to attribute the relatively minor variance in the SAB rates to the small sample size of obese women involved and, in addition, to the inadequate categorisation of BMIs.

**Delayed pregnancy**

Pregnancy describes the period that lasts from the time of the implantation of a fertilised ovum within the endometrium of a woman through the foetal development stages until the time of delivery (Jacobsen et al. 2013). Delayed pregnancy refers to the unintended postponement or failure of planned conception, implantation and gestation (Polotsky et al., 2010), including a delay in conceiving a first child or becoming pregnant after a previous delivery. The reviewed studies used various standards, including nulliparity and nulligravidity, to denote delayed conception and pregnancy.

Four of the reviewed studies confirmed an association between a high BMI and delayed pregnancy among women (Jacobsen et al., 2013; Polotsky et al., 2010; Sim, Dazernaulds, Denyer, Skilton, & Calterson, 2014; Wise et al., 2010). Wise et al. (2010) conducted a prospective cohort study to scrutinise the effect of BMI and TTP; their study utilised a sample size of 1651 women. The TTP was considered as the period between either when the pregnancy was planned or attempted and the time the pregnancy was confirmed, or as the time lapse between pregnancies. The study used Cox regression, a method of examining several variables, to determine the fecundability ratios of women under different categories of BMI. According to Wise et al. (2010), this was a suitable way to define the acute outcome of fecundity among women. The results of their study revealed that there was a significant relationship between the delayed TPP in relation to obesity and high BMI (FR: 0.75, 95% CI: 0.58–0.97) (Wise et al., 2010). The results also indicated that extreme obesity and being significantly overweight would substantially postpone the TPP and also prolong the period between successive pregnancies (Wise et al., 2010). The study provided strong evidence with the potential to be generalisable due to its adequate sample size. The sample only included professionals who help mothers plan their pregnancies, including midwives and residential doctors, amongst others. These individuals have extensive experience with women's fertility. One of the main sources of weakness of the study was that it was internet-based, which limited contact between the researcher and the participants and restricted the means of validating and confirming the information gathered from the participants. Since the participants were professionals, it is expected that the information collected was valid and reliable. Therefore, it can be deduced from the study that a high BMI contributes to sub-infertility among women.

Jacobsen et al. (2013) conducted a retrospective study to investigate the impact of a high BMI at age 20 on the occurrence of future secondary infertility among 33,159 women. Their study revealed that women with a BMI greater than 35 kg/m$^2$ at age 20 were twice as likely to experience nulliparity and nulligravidity. It was observed that a high BMI also contributed to the reduced likelihood of subsequent conception (Jacobsen et al., 2013). The large sample size utilised by the

researchers enhanced the study's reliability and, in addition, improved the dependability and generalisability of its results. It also employed important outcome measures, including nulliparity, nulligravidity and the standard categorisation of BMI (Jacobsen et al., 2013). However, the participants were not screened for other factors that are known to affect spontaneous pregnancy. Nonetheless, it can be inferred that a high BMI value in women significantly contributed to nulliparity and nulligravidity due to the postponement of pregnancy.

Polotsky et al. (2010) carried out a cross-sectional survey to determine the nature of the connection between adolescent obesity and adulthood nulliparity and nulligravidity. These researchers found that the relative prevalence of nulliparity and nulligravidity increased progressively in those instances where the BMI was greater than 29 kg/m$^2$ (p=0.001). For instance, the multivariable logistic regression analysis performed during the study confirmed that women who were obese during adolescence were more likely to be childless in middle age (OR: 2.84, 95% CI: 1.59–5.10) (Polotsky et al., 2010). The multi-ethnic setting and baseline data compiled from a longitudinal cohort contributed to the convenience and reliability of the results (Polotsky et al., 2010). Cross-sectional surveys are generally considered to be the most effective way to provide strong evidence related to a phenomenon. Most importantly, the study adjusted the results for BMI, non-gestational amenorrhea, participants' ethnicity, marital status, and socioeconomic measures (Polotsky et al., 2010). This adjustment was essential in focusing the results on the high BMI. However, it is important to acknowledge the extent to which other variables that contribute to nulliparity and nulligravidity, including genetics, were not adequately considered.

Sim et al. (2014) carried out a randomised controlled study to investigate the association between weight reduction and women's fertility. Their study revealed that weight management and the reduction of BMI increased fertility (Sim et al., 2014). Weight management raises the chances for conception and lowers the incidence of pregnancy risks. Sim et al.'s (2014) study involved 49 obese women who were receiving weight loss therapy during fertility treatment. About 60% of the women who had recorded effective weight loss figures attained good anthropometric measurements and reproductive parameters. For instance, the study demonstrated that women with improved reproductive parameters had a pregnancy rate of 48% (Sim et al., 2014). This improvement clearly indicates that there is relationship between BMI and fertility in women.

One of the strengths of the study was the use of a randomisation method for the sample selection, which essentially increased the generalisation extent of the study's result. The study also used a control group, which helped to confirm the results. Most importantly, the study had well-structured anthropometric and reproductive considerations that allowed it to achieve reliable outcome measures (Sim et al., 2014). It is unfortunate that the study's utilisation of a relatively small sample size reduced the empirical capacity of the collected data to the extent that it could be used to support the identified evidence. However, since the study was an RCT, it is possible to draw the plausible conclusion that a high BMI reduces the pregnancy rate and decreases the number of live births that take place in this population.

**Complications during Pregnancy**

Pregnancy complications refer to health conditions that occur during pregnancy and may impair the pregnancy outcome (Fraser et al., 2011). This study focused on the foetal and maternal pregnancy emergencies that hinder a successful pregnancy outcome.

Three of the included studies revealed that a high BMI contributes to various types of pregnancy complications (Fraser et al., 2011; Makgoba et al., 2011; Wallace, Bhattachrya, Campbell, & Horgan, 2014). The study by Wallace et al. (2014) aimed to investigate the risks posed by inter-pregnancy deviations and adverse pregnancy outcomes. Using a sample size of 12,740 women, the study confirmed that a weight gain of more than 3 kg among women with a BMI > 25 kg/m$^2$ raised the possibility of adverse pregnancy results, particularly in a woman's second pregnancy (Wallace et al. 2014). A few of the identified adverse outcomes included oversized placenta, pre-eclampsia complications, and large for gestational age (LGA) births (Wallace et al., 2014). It should be noted that the study utilised an adequate sample size, and the application of various markers for pregnancy complications aided in the identification of a comprehensive outlook relating to the contribution of a high BMI to women's fertility. However, it was still difficult to locate any specific contribution of a high BMI to instances of pregnancy complications. In addition, the study had remarkable statistical strength, which was used to formulate the conclusion that a high BMI impairs a woman's ability to maintain a healthy pregnancy until delivery. This finding is also attributed to a reduction in the fertility rate among overweight and obese women.

Makgoba et al., (2011) investigated the association between maternal BMI and the development of GDM. Their results indicated a strong and positive relationship between maternal BMI and GDM development (p=0.01) (Makgoba et al., 2011). GDM is considered one of the most common

conditions that may disrupt conception or pregnancy. It can be concluded that a high maternal BMI impairs women's fertility by contributing to GDM, which adversely complicates pregnancy. A binary logistic regression analysis was carried out to achieve statistical control of the study, and a large sample size was utilised. However, the focus on BMI interaction with racial groups limited the attention of the study in relation to several aspects of fertility, including conception and pregnancy outcomes. Nevertheless, it is clear that the most important element of the study was the discovery of the link between a high BMI and GDM.

Signe et al. (2012) carried out a study to assess the importance of exercise during pregnancy among obese women, especially in terms of preventing gestational diabetes and improving insulin resistance. The study included 855 women at a gestational period of about 18– 22 weeks who had been randomly assigned to an exercise program. The results revealed that obese women who participated in active exercise had a 55% lower chance of developing GDM, which reduces the chance of pregnancy complications. Therefore, this finding implies that a high BMI affects women's ability to maintain a pregnancy because of potential complications, such as GDM. The main strength of Signe et al.'s (2012) study was its large sample size, which strengthened the statistical robustness of the results. The study also used women who were in their second trimester, which was important in confirming the implication of a high BMI on foetal health and development. One of the important weaknesses was that the study did not use a standard means of BMI measurement prescribed by the WHO (2014), which would have provided a highly trusted result concerning a high BMI and pregnancy outcomes among obese women.

Briley et al. (2014) conducted a study to examine the impact of weight management on pregnancy outcome and the occurrence of GDM among obese women. The primary maternal outcome was a diagnosis of GDM, while the neonatal outcomes included LGA new-borns. Using a multi-centre RCT involving a sample of 1546 women, Briley et al.'s (2014) study revealed that exercise among obese pregnant women reduced the chances of GDM by 80% and of LGA babies by 25%. This finding implies that a high BMI during pregnancy is associated with increased pregnancy and foetal development risks, which consequently impair women's fertility. The main strength of the study was that it used precise measures for the outcomes. For instance, the maternal diagnosis of GDM was based upon the criteria stipulated by the International Association of Diabetes in Pregnancy Study Group (Briley et al., 2014). It also used customised birth weight centile, which is considered accurate and reliable. The large sample size also included obese pregnant women, which improved the generalisability of the outcome. However, one main weakness was that the study did not consider other variables for the development of GDM and LGA babies. However, there was no indication that procedures to control such variables were required, which may have biased the results.

Fraser et al. (2011) carried out a longitudinal study and reported that women with a high gestational weight gain (GWG), particularly during their mid-pregnancy, experienced increased systolic and diastolic blood pressure. The study found that increased central adiposity, which increases heart function, contributed to the increase in blood pressure. This association implies that a high BMI during pregnancy may contribute to cardiovascular complications, which could affect the outcome of the pregnancy (Fraser et al., 2011). This study was strengthened by the effective adjustment of its result according to age, social class and lifestyle (Fraser et al., 2011), which helped to account for the impact of other factors on cardiovascular health. Fraser et al.'s (2011) study had one weakness; it concentrated on the observation of central adiposity and not on the general classification of BMI.

**Endometrial Dysfunction**

The endometrium is the innermost part of the uterus that is made up of mucus and epithelial membrane (Villavicencio et al., 2010). In this previous study, endometrial dysfunction was considered to be the inability of the endometrium to support conception, including as a result of conditions such as cancer. These authors proposed that a high BMI contributes to the inability of the endometrium to support conception and pregnancy (Villavicencio et al., 2010). Villavicencio et al. (2010) therefore investigated whether a high BMI might contribute to increased endometrial proliferation and irregular AKT and ERK1, 2 activation. Their study identified an increased rate of epithelial cell proliferation among pre-menopausal women who were obese (p=0.05) (Villavicencio et al., 2010). However, the study also included obesity in the same category as overweight. It should be noted that the increased rate the aforementioned resulted in the recruitment of women with a high chances of developing type-1 endometrial cancer, which is indicative of poor fertility.

Because Villavicencio et al.'s (2010) study was experimental in nature, it is widely considered an essential study that is supported by a high level of evidence. The control of the conditions for conception in the study, such as artificial ovary

stimulation, assisted in overriding other factors that may have contributed to reduced ovarian function (Villavicencio et al., 2010) and therefore aided the researchers in improving the viability of their findings. Unfortunately, the study did not use standard measures of endometrial proliferation or all other cancer markers effectively. Additionally, the fact that the study did not adjust its results to consider other cancer- causing factors, including lifestyle, should be acknowledged as a limitation. However, the significance of the statistical evidence provided by the study is enough to infer that a high BMI has an impact on endometrial function.

**Hormonal Imbalance and Irregular Menstrual Cycles**

The menstrual cycle refers to regular alterations in the ovaries and uterus that make pregnancy probable (Souter, Baltagi, Kuleta, Meeker, & Petrozza, 2011). The cycle is necessary to increase the chances of ovum production and uterine preparation for implantation and pregnancy (Polotsky et al., 2010) and is significantly affected by an increasing BMI. Souter et al. (2011) carried out a retrospective study to investigate the fecundity level among infertile, obese and overweight women. The participants were treated with gonadotropin during intrauterine insemination (IUI), and 477 of them underwent 1,189 ovulation induction cycles (Souter et al., 2011). The participants in the study were classified in accordance with their BMI. It was observed that the medication requirements to achieve ovulation increased as the BMI increased (Souter et al., 2011); in addition, the higher the BMI, the lower the level of oestrogen in the blood and the lower the production of pre-ovulatory follicles (Souter et al., 2011). This study effectively focused on reproductive hormones among women with a high BMI and provided valid, reliable results. Similar to other studies that have been discussed, the use of a well- controlled condition of the induction process of ovulation provided a platform on which concise results could be generated. It is unfortunate that the study utilised a small sample size, which means that the results have little statistical significance for generalisation.

Mounce, McVeigh, Turner, and Child, (2015) conducted a study to determine the quality of embryos and the hormonal treatment requirements for women in the UK. Their study included 159 women and identified that those with a high BMI produced poor-quality embryos and required a higher dosage of drug therapy. There was also a 26% reduction in live births among obese women (Mounce et al., 2015), which implies that a high BMI contributed to the poor quality of the embryo and hormonal irregularities, which may impair a woman's fertility. The main strength of the study was that all the interventions were standardised and controlled effectively, which minimised the chances of error and contributed to the generation of reliable results. The main weaknesses of the study were that it was a single centre pilot trial and it used small sample size, which may limit its generalisability to the entire population of the women with a high BMI in the UK.

In a study conducted by Polotsky et al. (2010), obese or overweight women were found to also experience irregular menstrual cycles and considerable non-gestational amenorrhea ($p<0.01$) (Polotsky et al., 2010). Their study also suggested that a reduced chance of getting pregnant is associated with the improper preparation of the uterus due to limited hormone levels in the blood (Polotsky et al., 2010). Despite Polotsky et al.'s (2010) focus on the effect of a high BMI on women's fertility, it remains to be seen whether highlighting the impact of being overweight on the development of amenorrhea was an insightful contribution.

**Question Two: What is the Effect of a High BMI on Foetal Health and Development?**

A high BMI contributes to foetal abnormalities, which result in stillbirths. Conversely, stillbirth is considered an indication of infertility. The reviewed studies looked into numerous factors that contributed to stillbirths, such as babies that were either small or large for their gestational age, placental complications, increased levels of obesity and overweight biomarkers in the blood, and congenital abnormalities (Rankin et al., 2010). Rankin et al. (2010) conducted a cohort prospective study to determine the nature of the relationship between maternal BMI and structural congenital abnormalities. Their study attributed the high rate of congenital anomalies among participants with a high BMI (OR: 1.30, 95% CI: 1.03–1.63, $p=0.03$) (Rankin et al., 2010). A number of the complications contributed to the increased likelihood of stillbirth and intrauterine foetal deaths. The findings of Rankin et al.'s (2010) study can be considered dependable because it adopted a robust and comprehensive approach towards the determination of fatal complications. Additionally, the study's strength was reinforced by its large sample size, which included 41,013 singleton pregnancies of woman with varied BMIs (Rankin et al., 2010). This size enhanced the statistical power of the study and improved the generalisability of its findings. However, the study also depended on the reliability of the recoded information. Furthermore, the researchers failed to utilise an appropriate sample size (Rankin et al., 2010). Again, there was a

limited focus on intrauterine foetal death or stillbirth. The robustness of the quality of the methodology design of the study increased its reproducibility and, in this way, generated important results (Rankin et al., 2010). In light of this, it is possible to deduce that increased BMI has an impact on a woman's ability to support the development of a healthy foetus.

Hayes Bell, Robson, and Poston (2014) set out to identify the association between obesity and pregnancy outcome among obese women in the UK. Their study also looked into the effect of physical activity on the pregnancy outcomes of the same participants (Hayes et al., 2014). The sample size included 183 obese women with a BMI above 30 kg/m$^2$. The study revealed that a high BMI significantly affects pregnancy outcome and physical activity can be used to improve healthy foetal development in obese women. These findings indicate that obesity, which is implies a high BMI, affects the pregnancy and foetal development outcomes. One important strength of the study was that it considered and controlled for other variables that impact the pregnancy outcome, such as nutrition, by thoroughly screening the participants (Hayes et al., 2014). It also followed the participants for a prolonged period of about 30 weeks, which assisted in improving the accuracy of the results. However, one main weakness of this study was its focus on foetal development without highlighting any maternal issues that could affect the pregnancy's outcome.

## DISCUSSION:

This study has revealed that a high BMI has an impact on fertility in women primarily because a high BMI affects various aspects of women's fertility, including pregnancy and foetal health and development. Some of the identified effects were hormonal imbalance and an irregular menstrual cycle, miscarriage and SABs, pregnancy complications, delayed conception and pregnancy, foetal complications, and endometrial dysfunctions. A number of previous studies have confirmed similar results (Tomedi et al., 2013; Valckx et al., 2012). For instance, Tomedi et al., (2013) revealed that obese or overweight women are more likely to experience delayed conception and delayed pregnancy. Slim, Partidge, and Sainsburry (2014) also confirmed that obese women experience reduced chances of conception and increases in spontaneous abortion, and endometrial dysfunction.

This study has successfully revealed that a high BMI contributes to a delay in conception and pregnancy. Since obesity and overweight are indicative of a high BMI, they therefore contribute to reduced fertility among women. It was also found that obesity at any age from puberty onward contributes to increased chances of nulliparity and nulligravidity. A similar result was revealed by the study conducted by Wise et al. (2005), which confirmed that women with a high BMI who experience prolonged obesity and are overweight at any age of their lives from adolescence have twice the chance of never falling pregnant during their lives. Wilkes and Murdoch (2015) also reported that obese women often experience secondary fertility. In other words, it takes a long time for them to establish another pregnancy after a previous one.

However, Vinturache Moledina, McDonald, Slater, and Tough, (2014) revealed an insignificant relationship between obesity during the teenage years and fertility in adulthood among women who have achieved a normal weight. However, the teenage BMI for the included participants was based on memory, which is prone to bias and may result in unreliable results. However, the study agreed that weight gain during pregnancy also contributes to delayed conception for the next pregnancy (Vinturache et al., 2014). Valckx et al. (2012) also confirmed that nulliparity increases with rises in the BMI.

The previous studies that considered a high BMI to be an independent outcome measure without incorporating obesity and overweightness have revealed contradictory answers. For instance, Schon and Butts (2015) reported that a high BMI and significant overweightness are independent determinants for reduced fertility among women. They used a low value for a high BMI of 25.5 kg/m$^2$, which led to the results falling short of meeting the criteria for a high BMI stipulated by the WHO (2014). Parker et al.'s (2014) results indicated that no significant relationship between a high BMI and preterm births exists. The study considered a high BMI to be from 27.0 kg/m$^2$; they did not distinguish between obesity and overweightness (Parker et al., 2014). The WHO (2014) recommended the employment of a standardised BMI categorisation to would ensure that studies produce reliable outcomes that can be directly compared. Mork, Vasseljen, and Nilsen (2010) also revealed an inconsequential interrelation between an increased BMI and poor pregnancy outcomes. However, their study agreed that a high BMI contributes to conditions such as fibromyalgia, which affect pregnancy outcomes (Mork et al., 2010). In this way, it can still clearly be seen that an increased BMI contributed to the low fertility rates in women in either a direct or an indirect or.

The effects of a high BMI on a woman's ability to fall pregnant is associated with various factors, such as increased adiposity and reproductive hormonal imbalance, alterations in the body's metabolism, and productions of adipocytokines

and inflammatory biomarkers. A high BMI causes impairment, alterations and imbalances of reproductive hormones (Brewer & Balen, 2010; Jokela et al., 2008). The physiological basis of the changes is that a high BMI is associated with an increasing number of adipose cells and tissues, which promote the excessive storage of triglycerides in the body (Malik, Schulze, & Hu, 2006; Rittenberg et al., 2010). However, the mechanism of the influence of adipose tissues on reproductive hormones and endocrine organs, including the ovaries and pituitary gland, is not comprehensively understood (Jungheim et al., 2013). It has been suggested that any increase in fat cells, tissues, triglycerides, and low-density lipoproteins affects the hormone trigger mechanism and the gurnard receptivity and utility (Mork et al., 2010; Tomedi et al., 2013), which affects the reproductive system and reduces fertility. Similar results have been generated by other numerous studies (Brewer & Balen, 2010; Jokela et al., 2008). McNeely et al. (2006) also revealed the similar result by explaining that a high BMI that includes obesity and overweight contributes to significant hormonal imbalances, which impair ovulation and the maintenance of pregnancy.

The increased adiposity results to reduced attention of the reproduction drive of the central hypothalamus (Pandey et al., 2014), which results in the decreased utilisation of the luteinizing hormone (LH), pregnanediol glucuronide hormone (PGH) and follicle stimulation hormone (FSH). The low response of the brain to the reproductive hormonal changes impairs the hypothalamic-pituitary-ovarian (HPO) axis (Hendriks et al., 2012) by hindering the endometrial receptivity, impairing menstrual cyclicity, and inhibitingthe process of ovulation. These factors all reduce a woman's probability of getting pregnant. For instance, an irregular LH: FSH ratio among obese women does not favour folliculogenesis (Ovesen & Jensen, 2012). The increased adipose tissues affect the bioavailability of lipid-soluble steroids by hindering their protein transport, which impedes the delivery and distribution of reproductive hormones, such as LH, oestrogen and progesterone hormone, on the targeted organs (Bouda et al., 2010).

Obesity is known to impair the production of progesterone, which is responsible for the maintenance of pregnancy. In obesity, the fat cells lower the expression of the progesterone receptors in the gonads, which minimize its utility (Dağ & Dilbaz, 2015). This explains why this review identified that obese women require high doses of hormones during fertility treatment. This is an indication that they have impaired receptivity to the reproductive hormones. The result is also confirmed by the study conducted by Maheshwari et al., (2007), which found that women who have obesity and are overweight required increased dosages of gonadotropins during ART treatments compared to those with a normal weight. Jokela et al. (2008) also reported that obese women require increased oestrogen hormones to stimulate ovulation compared to those with normal weight.

A high BMI, which manifests as obesity or overweight, is implicated in other conditions, such as cardiovascular disorders, which increase the risk of pregnancy complications as identified in this study (McGovern et al. 2008). For instance, cardiovascular complications occur due to increased deposits of cholesterol (low-density lipoproteins) in the arteries, which are predisposing factors for the development of hypertension, stroke, myocardial infarction, and atherosclerosis, which impairs the woman's ability to maintain pregnancy and give birth to healthy babies (Arendas, Qui, & Gruslin, 2008; Smith & Lavender, 2011). Obesity and overweight are also implicated in the development of cancer of the ovary and the uterine, (Maheshwari et al., 2007), which impair the woman's ability to conceive and maintain a pregnancy.

Fertility depends on the successful implantation of the fertilised ovum in the endometrium and maintenance of pregnancy (Vitonis, Moledina, McDonald, Slater, & Tough,2010) and is influenced by interactions between the embryo and the endometrium (Wilkes & Murdoch, 2015). However, as identified by this study, a high BMI may influence the production of the ovum and also the endometrium integrity, which greatly affect the implantation process. This occurs due to endocrine as well as paracrine alterations, which consequently affects the maturation of the oocyte and the competency of the embryo (Wilkes & Murdoch, 2015). Vinturache et al. (2014) explained that obesity results in hyperandrogenemia, increased insulin resistance, abnormal concentrations of the leptin hormone, and hypersecretion of luteinizing hormone, which affects the maturation of follicles, the maturation of oocytes, ovum production, and implantation. These factors significantly contribute to a reduced level of fertility.

This study established that a high BMI resulted in significant pregnancy complications, spontaneous abortions and miscarriages. This finding has been supported by other numerous studies (Dağ, Z, & Dilbaz, 2015; Gormack et al. 2015; Hendriks et al. 2012; Jacobsen et al., 2014). Jacobsen et al. (2014) revealed that women with a BMI above 30 $kg/m^2$ have 40% increased chances of experiencing spontaneous abortions in the first trimester of their pregnancy. Gormack et al. (2015) reported that the rate of occurrence of miscarriage tripled in cases

with increases in perinatal weight gain among participants are obese and overweight. Crane et al. (2009) also reported that gestational weight gain increases the rate of spontaneous abortion among women with a BMI of above 30k g/$m^2$ by more than 20%. However, the study performed by Anderson et al. (2014) revealed that a high BMI alone does not contribute significantly to spontaneous abortions alone but instead acts dependently on other conditions, related to the mother and the foetus.

The association between a high BMI and the reduced ability of a woman to become pregnant and impairment of foetal development is associated with increased adipocytokines and inflammatory biomarkers. The adipocytokines, which are implicated to impair fertility in women, include insulin-like growth factor (ILGF hormone) and leptin. The ILGF (McNeely et al. 2006) increases the proliferation and differentiation of cells (Jungheim, 2015). In the endometrium, the increased proliferation and differentiation impair conception by limiting the implantation chances, which reduce a woman's chances of getting pregnant (Bates, 2012; Gillman & Poston, 2012). Joham et al. (2015) explained that ILGF also contains a binding protein implicated in the impairment of folliculogenesis and oocyte maturation. However, according to Obermayer-Pietsch, Trummer, Schwetz, Schweighofer, and Thomas (2015), the increased of ILGF also reduced the probability of the healthy development of the embryo before and after implantation.

On the other hand, the increased production of leptin as a result of increased body weight causes overheating due to increase metabolic activities (Trounson, Gosden, & Eichenlaub-Ritter, 2013). This effect results in the an increased production of leptin. Leptin hormone essentially assists in maintaining the development of a normal pregnancy by promoting the endometrial receptivity to implantation (Balen, 2014). However, in large quantities, leptin is known to affect the menstrual cycle and influence the HPO axis and pubertal development and reduce folliculogenesis (Pandey et al. 2014; Rao, 2013). This is because any further increase causes resistance and relative deficiency (Anderson et al., 2014). The increased production of leptin has been hypothesised to increase gonadotropin resistance, which consequently suppresses oestrogen production by human granulosalutein cells and therefore inhibit follicular development and the production of oocytes (Athukorala, Rumbold, Wilson, & Crowther, 2010). Leptin also contributes to the increased occurrence of polycystic ovarian syndrome (PCOS), which further impairs the menstrual cycle and results in chronic oligo anovulation, hyperandrogenism, and insulin overstimulation of the ovarian steroidogenesis (Balen, 2014; Goodwin et al. 2010). These conditions impair women's fertility

A high BMI also contributes to increased inflammatory biomarkers, which are associated with miscarriages noted in women who are overweight and obese (Schon & Butts, 2015). Valckx et al. (2012) concluded that a high BMI increased the intrafollicular concentration of inflammatory biomarkers, such as tumour necrosis factor alpha and interleukin, (IL) 6. These biomarkers have been associated with a reduced quality of oocyte, a hindrance of implantation, and triggering of spontaneous abortion in obese women (Thomsen Humaidan, Bungum, & Bungum, 2014). Consequently, the biomarkers increased the probability of the occurrence of miscarriage. Slim, Partidge, and Sainsburry (2014) also supported the observation by reporting that increased biomarkers hinder both natural and in vivo fertilisation, implantation, and the triggering of spontaneous abortion. Stokes, Anderson, and George (2014) also revealed that other kinds of adipokines, including adiponectin, IL6 plasminogen activator inhibitor (PAI) type 1 and tumour necrosis factor (TNF), increase insulin resistance among overweight women and may cause miscarriage by impairing endometrial development and gonadotropin secretion.

This study effectively identified that a high BMI contributes to foetal complications, which may lead to intrauterine foetal death and stillbirth. It also revealed that a high BMI is associated with increased endometrial dysfunction. Thomsen et al. (2014) identified that being obese and overweight contribute to a considerable rate of stillbirths, foetal malformations, premature births, and endometrial dysfunctions. Smith and Lavender (2011) also reported that women with increased weights have considerable chances of abortions and stillbirth. However, Schon and Butts (2015) revealed an inconclusive effect of obesity on foetal outcomes that was attributed to poor categorisation of BMI of the participants.

Lastly, a high BMI, including obesity and overweight, influence women's social lifestyles, which may affect their psychosocial status and contributes to infertility (Gormack et al., 2015). For instance, Zander-Fox, Henshaw, Hamilton, & Lane, (2012) reported that obese and overweight women have a reduced tendency to engage in active sexual intercourse, which contributes to their significant delay in getting pregnant. The psychological association with being overweight, such as little engagement in social activities and higher levels of stress and depression reduce these women's chances of engaging in sex. This lack contributes to their nulliparity and nulligravidity.

**Assessment and appraisal of the review**

**strengths and limitations of the review:**

This study primarily derives its strength from its utilisation of 18 primary studies that served to enhance the relevancy and the reliability of the discussed evidence. The use of a narrative systematised approach was also essential in the determination of a wide range of evidence that can be easily applied in evidence-based practice. The stratification of the participants based on their BMI among the included studies was effective to the extent that it allowed the researchers to consider the nature of the impact of vital factors associated with fertility.

The study used a well-defined classification of a high BMI (above 30 $kg/m^2$), which is in accordance with the stipulations issued by the WHO (2014) BMI classification scale. This process was essential in assessing the reliability of the included studies based on their outcome measures and BMI categorisation. Therefore, the studies included in this review exclusively used an adequate overweight category, and the generated results of the study can be justifiably considered valid.

A major limitation of this study was that it only included 18 existing studies. As a result, there is a high likelihood that other important and relevant studies were left out. Secondly, another weakness is that is the search was restricted to only study articles published within the past five years. This implies that any important information published previously may have been left out. Lastly, due to the intentional non-use of meta-analysis, this review has limited statistical strengths and may impair the generalisability of the results.

**Conclusion and Recommendations**

## CONCLUSION:

This systematised literature review was specifically concerned with providing evidence to support the notion that a high BMI significantly reduces fertility among women by affecting pregnancy and foetal health and development. The mechanisms associated with women's fertility, including the hormonal balances, are comparatively analogous to all women irrespective of race and socioeconomic status (Wilkes & Murdoch, 2015). In light of this, the factors identified by this study are highly applicable to women in the UK. The value of the study was that it clearly identified the extent to which a high BMI reduces a woman's capacity to achieve conception, to maintain pregnancy, and to deliver a living and healthy child. An increased BMI has been seen to increase the chances of the development of overweightness and obesity, which results in a reproductive hormonal imbalance and an irregular menstrual cycle.

A high BMI increases the frequency of miscarriage and spontaneous abortion and, in addition, contributes to delayed conception and pregnancy. Delayed conception and pregnancy in turn translate into nulliparity and nulligravidity. The study also found that a high BMI serves to increase the chances of complications during pregnancy; such complications include foetal and maternal problems, which reduce the chance that a viable, live, and healthy baby will be delivered. Increased BMI values were also shown to affect ovarian and endometrial functions in a significant way, including predisposition to cancer and other conditions, such as PCOS. Hence, this study has effectively achieved its objective of determining the relationship between a high BMI and the fertility of women in the UK.

**Implications for Practice**

The results generated by this systematised literature review indicate that a high BMI affects women's fertility by influencing their ability to fall pregnant; BMI also impacts foetal health and development. These results are essential in informing evidence-based interventions for weight management among women, particularly before and during pregnancy. For example, by revealing the effects of a high BMI on the ability of women to get pregnant and also on foetal development, this review promotes the acceptability of weight management interventions by both health care practitioners and women. It unveils the need for assessment and monitoring of body weight to prevent overweight or obesity.

The results generated by this review can be used as a guide for evaluating the economic viability of non-pharmacological interventions for weight management. The findings highlight the need for a reduction in gestational weight gain for all women undergoing both natural and assisted reproduction. Our results also provide the basis for health education of mothers concerning the benefits of weight management strategies, which promotes the role of community-based services and identifies the skills required to achieve proper BMI management among women. It should also be noted that this review can be used to identify factors that facilitate or impede weight management interventions in different health-care settings.

**Recommendations**

The evidence generated by this study can be used to formulate four important recommendations. First, the healthcare system in the UK should establish and maintain a weight management programme for all women of reproductive age. This type of programme will assist women in

achieving a healthy weight, which, according to our results, will contribute to an increase in female fertility rates (Bates, 2012). The programme should focus on all women who are of reproductive age, especially from 12 years to those who are transiting into menopause. This is important because the study revealed that an increased BMI at all ages from puberty through adolescence and in to adulthood has an impact on fertility in women. It is possible to combine a weight management programme with the maternal and child health packages currently provided by the primary healthcare system. This will reduce the cost for the introduction of new care bundles and will also assist in reaching as many women as possible from a range of socioeconomic classes.

It is important to note that a weight management programme should target both behaviours and lifestyle modifications. An increased BMI, overweightness, and obesity are the primary results of lifestyle and behavioural choices, such as the consumption of high-energy food, a lack of exercise, and an excessively sedentary life (Jungheim, 2015). This programme will improve fertility among women in the UK and also assist in managing other complications, including cardiovascular disorders. These conditions affect the health of other women across the UK as well.

The second recommendation is that well-established healthcare facilities should be created across the UK with the express purpose of treating women who are affected by overweightness but who want to have children. This would be useful because overweight women are less likely to benefit from fertility treatment interventions, including IVF (Bates, 2012). These services are expensive and fertility treatment services are not entirely covered by healthcare insurance or the National Healthcare System in the UK (NHS, 2014). In the UK, there is a low number of fertility centres and, in most instances, the care and attention given to obese and overweight women at these clinics is not extensive (NHS, 2014). Therefore, fertility treatment centres with specific equipment and technologies to assist women with a high BMI should be established. The government should also provide financial support for overweight women who require fertility treatment. Again, the government should implement financial support systems for overweight and obese females, especially those who require fertility treatment. Jungheim (2015) also supported that both overweight and obesity should be addressed with urgency because of their long-term impacts on fertility.

## REFERENCES:


1. Anderson, N. H., McCowan, L. M., Fyfe, E. M., Chan, E. H., Taylor, R. S., Stewart, A. W., … SCOPE Consortium. (2014). The impact of maternal body mass index on the phenotype of pre-eclampsia: A prospective cohort study. *BJOG: An International Journal of Obstetrics and Gynaecology*, *119*(5), 589–595.
2. Arendas, K., Qui, Q., & Gruslin, A., (2008). Obesity in pregnancy: Pre-conceptional to postpartum consequences. *Journal of Obstetrics and Gynaecology of Canada, 30*(6), 477–488.
3. Athukorala, C., Rumbold, A., Wilson, K., & Crowther, C. (2010). The risk of adverse pregnancy outcomes in women who are overweight or obese. *BMC Pregnancy and Childbirth, 10*, 56–61.
4. Aveyard, H. (2014). *Doing a literature review in health and social care: A practical guide* (3rd ed.). Maidenhead, UK: McGraw-Hill/Open University Press.
5. Balen, A. (2014). *Infertility in practice* (4th ed.). New York: CRC.
6. Bates, W. (2012). *Medical and surgical management of common fertility issues: An issue of obstetrics and gynecology clinics.* New York: Elsevier Health Science.
7. Bellver, J., Melo, M., Bosch, E., Serra, V., Remohi, J., & Pellicer, A., (2007). Obesity and poor reproductive outcome: The potential role of the endometrium. *Fertility and Sterility, 88*(2), 446–451.
8. Booth, A., Papioannou, D., & Sutton, A. (2012). *Systematised literature approaches to a successful literature review*. New York: Sage Publications.
9. Bouda, F., Demmouche, A., & Mai, H. (2010). Impact of female body mass index on infertility.
10. *Journal of Disease and Global Health*, *3*(1), 2454–1842.
11. Brewer, C., & Balen, A. (2010). The adverse effects of obesity on conception and implantation.
12. *Reproduction, 140,* 347–364.
13. Briley, A., Barr, S., Badger, S., Bell, R., Croker, H., Godfrey, K., Poston, L. (2014). A complex intervention to improve pregnancy outcome in obese women: the UPBEAT randomised controlled trial. *BMC Pregnancy and Childbirth, 14*(74), 1–10.
14. Burkhauser, R., & Cawley, J. (2008). Beyond BMI: The value of more accurate measures of fatness and obesity in social science research. *Journal of Health Economics, 27*(2), 519–529.
15. Cochrane Collaboration. (2008). *The Cochrane handbook for systematised literature reviews of interventions.* West Sussex, UK: John Wiley & Sons.

16. Crane, J. M., White, J., Murphy, P., Burrage, L., & Hutchens, D. (2009). The effect of gestational weight gain by body mass index on maternal and neonatal outcomes. *Journal of Obstetrics and Gynaecology Canada*, *31*(1), 28–35.
17. Dağ, Z., & Dilbaz, B. (2015). Impact of obesity on infertility in women. *Journal of Turkish- German Gynaecology Association, 16*(2), 111–117.
18. Fraser, S., Tilling, K., Macdonald-Wallis, C., Hughes, R., Sattar, N., Nelson, S., & Lawlor, D. (2011). Associations of gestational weight gain with maternal body mass index, waist circumference, and blood pressure measured 16 y after pregnancy: The Avon
19. Longitudinal Study of Parents and Children (ALSPAC). *American Journal of Clinical Nutrition*, *93*(6), 1285–1292.Gillman, M., & Poston, L. (2012). *Maternal obesity*. New York: Cambridge University Press.
20. Goodwin. T., Montoro, M., Muderspachi, L., Paulson, R., & Roy, S. (2010). *Management of common problems in obstetrics and gynecology.* New York: John Wiley & Sons.
21. Gormack, A., Peek, J., Derraik, J., Gluckman, P., Young, N., & Cutfield, W. (2015). Many women undergoing fertility treatment make poor lifestyle choices that may affect treatment outcome. *Human Reproduction, 1*(12), 45–59.
22. Hahn, K., Hatch, E., Rothman, K., Mikkelsen, E., Brogly, S., Sorensen, H., … Wise, L., (2014). Body size and risk of spontaneous abortion among Danish pregnancy planners. *Pediatrics and Perinatal Epidemiology, 28*(5), 412–423.
23. Hayes, L., Bell, R., Robson, S., & Poston, L. (2014). Association between physical activity in obese pregnant women and pregnancy outcomes: The UPBEAT Pilot Study. *Annals of Nutrition and Metabolism*, *64*(3), 239–246.
24. Hendriks, A, Drop, S., Laven, J., & Boot, A. (2012). Fertility of tall girls treated with high-dose estrogen: A dose-response relationship. *Journal of Clinical Endocrinology & Metabolism, 97*(9), 12–19.
25. Higgins, J. & Green, S. (2011). *Cochrane handbook for systematised literature reviews of interventions.* New York: John Wiley & Sons.
26. Holly, C., Salmond, S., & Saimbert, M. 2012. *Comprehensive systematised literature review for advanced nursing practice.* New York: Springer Publishing