



**The Impact of Nutritional Deficiencies and Iron
Deficiency Anaemia on Pregnancy Outcome Among
Adult Pregnant South Asian Women in the UK:
Review of Health Risks, Barriers and Policy
Interventions**

By

Rana Hiralben Shaileshbhai (2406250)

A Dissertation submitted in partial fulfilment of the requirements for the degree of
Masters of Science in Public Health and Social Care in Practice

The Institute of Inner-City Learning

University of Wales Trinity Saint David – London Campus

[October 2025]

DECLARATION

I, **Rana Hiralben Shaileshbhai**, hereby declare that I am the sole author of thesis entitled **“The Impact of Nutritional Deficiencies and Iron Deficiency Anaemia on Pregnancy Outcome Among Adult Pregnant South Asian Women in the UK: Review of Health Risks, Barriers and Policy Interventions”** and that no part of this thesis or the whole of this thesis has been submitted for a degree to another university or institution.

I certify that, to the best of my knowledge, my thesis does not infringe upon anyone’s copyright nor violate any proprietary rights and that the ideas, technique, quotations, or other materials obtained from other sources have been appropriately acknowledged in the thesis. Other peoples work included in my thesis, published or unpublished, are all properly credited following standard conventions of referencing. I certify that this is an authentic copy of my thesis, including my final revision, as endorsed by my thesis review committee.

Signed: **Rana Hiralben Shaileshbhai**

Date: 07/10/2025

ACKNOWLEDGEMENT

The final phase of completion of Master's Degree requires us to pursue a dissertation programme that provides me a platform to showcase the knowledge acquired during my course of study. This venture was an outcome of contributions of many people who have been a source of my inspiration, thereby imparting discriminating knowledge and support throughout my work. I consider myself privileged enough to have been associated with the best team at the University of Wales Trinity Saint David, London campus. I take this opportunity to thank all for the help that was extended to me.

First and foremost, I would like to thank and express my sincere gratitude to my Programme Manager **Dr. Diola Bijlhout** for their unwavering support, guidance and motivation throughout the course.

I wholeheartedly like to express my appreciation to my supervisor **Berhe Tesfay** for their valuable insights, constructive feedback and consistent support during each stage of my research. Your supervision has greatly contributed to the quality and depth of my research, and I am truly thankful for your time and dedication.

I would also like to thank and express my gratitude to the whole University of Wales Trinity Saint David faculty for their dedication and efforts towards academic excellence. The knowledge and skillset gained by learning from them have played a pivotal role in offering directions towards fulfilling my understanding in this research.

Finally, I thank all those who have directly or indirectly helped, assistance and supported in this academic journey.

THANK YOU!

ABSTRACT

Background: Nutritional deficiency is an essential factor that impacts pregnancy outcomes. Nutritional deficiency increases the risk of anaemia, and it has different impacts such as gestational diabetes, low birth weight and preterm delivery. The main aim of the study is to examine the effect of maternal nutrition problems and iron-deficiency anaemia on pregnancy outcomes in pregnant South Asian women of reproductive age in the UK and examine related health risks, barriers to get adequate nutrition and existing policy interventions.

Method: A systematic literature review (SLR) is chosen in this review as a research design. We searched PubMed, ProQuest and Google Scholar and the literature search covered the period from 1st January 2017 to 30th September 2025. Searches combined thesaurus and free-text terms for “nutrition deficiencies”, “iron-deficiency anaemia”, “pregnancy outcomes”, “South Asian populations”, “UK setting”, “Health risk”, “Barriers” and “Policy interventions”.

Results: In this review, poor nutrition was associated with increased health risk in terms of increased risk of gestational diabetes. There is a relationship between maternal anaemia and perinatal mortality. It has also been found that maternal anaemia increases the risk of stillbirth. Increasing haemoglobin level among South Asian women is necessary in order to reduce the risk of perinatal mortality. Inadequate knowledge about nutrition and lack of access to nutrition advice are important barriers to nutrition among South Asian pregnant women. It has also been found that guidance on food by the NHS (National Health Services) is an effective intervention that helps in encouraging pregnant women to improve nutrition. The FIGO nutrition checklist is also another important factor that helps in nutritional screening of women during their pregnancy and helps in routine decision-making regarding weight and nutrition in clinical care. Fortification of food items is another essential strategy of improving maternal nutrition.

Conclusion: This study concludes based on the overall findings and discussion that maternal nutrition and iron deficiency anaemia affect pregnancy outcomes and it is evident among South Asian women of reproductive age in the UK.

TABLE OF CONTENTS

ABSTRACT.....	3
List of Figures	7
List of Tables	7
Abbreviation.....	8
CHAPTER 1: INTRODUCTION.....	9
1.1 Research background.....	9
1.2 Research problem	10
1.3 Scope of the research.....	10
1.4 Aim, objectives and research question	11
1.5 Dissertation structure.....	12
CHAPTER 2: LITERATURE REVIEW	13
2.1 Introduction.....	13
2.2 Nutritional deficiency and its impact on pregnant women.....	13
2.2.1 Nutritional issues among pregnant women.....	13
2.2.2 Impact of nutritional deficiency and iron deficiency anaemia among pregnant women	14
2.3 Causes behind iron deficiency anaemia among pregnant women	14
2.3.1 Increased demand of iron.....	14
2.3.2 Insufficient dietary intake	15
2.3.3 Multiple pregnancies	15
2.3.4 Short Interval between pregnancies	16
2.4 Barriers to pregnant women to achieve adequate nutrition and care.....	16
2.4.1 Lack of access to nutritious food	16
2.4.2 Financial constraint	17
2.4.3 Unequal access to maternal care	17
2.4.4 Lack of family support	17
2.4.5 Racial and ethnic disparity	18
2.5 Policies and Strategies to Address Nutrition Issues	19

2.5.1 Improving access to nutritious food	19
2.5.2 Increasing awareness and empowering women	19
2.5.3 Micronutrient supplementation	19
2.5.4 Community-based interventions for improving the food environment.....	20
2.6 Literature gap	21
2.7 Theoretical framework for exploring barriers in maternal nutrition	21
2.7.1 Social cognitive theory	21
2.7.2 Theory of planned behaviour.....	22
2.7.3 Transtheoretical Model (TTM)	22
2.7.4 Health Belief Model	22
CHAPTER 3: METHODOLOGY	23
3.1 Research design.....	23
3.2 Study inclusion/exclusion criteria	24
3.3 Literature search strategy	25
3.4 Literature screening strategy	26
3.5 Quality appraisal.....	27
3.6 Data extraction	27
3.7 Data analysis technique.....	27
3.8 Ethical considerations.....	28
3.9 Limitations	28
CHAPTER 4: RESULTS AND DISCUSSION	28
4.1 Introduction.....	28
4.2 Search result	28
4.3 Summary of selected studies from 2017 to 2025	30
4.4 Quality appraisal results	35
4.5 Social Demographics.....	35
4.6 Thematic analysis.....	35
4.6.1 Health risks related to maternal nutrition issues and iron deficiency anaemia	35
.....	36

4.6.2 Barriers to adequate nutrition and prenatal care.....	37
4.6.3 Interventions to improve maternal nutrition and maternal health outcomes	40
4.7 Interpretation of results	42
4.8 Comparison of results with previous studies	43
4.8.1 Health risks related to maternal nutrition issues and iron deficiency anaemia	43
4.8.2 Barriers to adequate nutrition and prenatal care.....	44
4.8.3 Interventions to improve maternal nutrition and maternal health outcomes	45
4.9 Implications	47
4.10 Strengths and limitations of the study	47
4.11 Future research scope.....	48
Chapter 5: Conclusion and recommendations.....	48
5.1 Conclusion.....	48
5.2 Recommendations.....	50
Appendix.....	69
Quality review of selected study	69
Table 1 : Critical appraisal of cross-sectional studies	69
Table 2: Critical appraisal of qualitative studies	70
Table 3: Critical appraisal of cohort studies.....	70
Table 4: Critical appraisal of RCT study.....	71

List of Figures

Figure 4.1: PRISMA 2020 Flow Diagram. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 flow diagram was used to illustrate the study selection process in this review. The template, obtained from the official PRISMA website (PRISMA, 2024), outlines the number of records identified, screened, excluded, and finally included in the systematic review. This framework enhances the transparency and reproducibility of the review process by providing clear documentation of study identification, screening, eligibility assessment, and inclusion.....	29
Figure 4.2 Graph showing health risks related to maternal nutrition issues and iron deficiency anaemia.....	36
Figure 4.3: Graph showing barriers to adequate nutrition and prenatal care	38
Figure 4.4: Graph showing interventions to improve maternal nutrition and maternal health outcomes	41

List of Tables

Table 1.1: PICO framework.....	12
Table 4.1: Summary of selected studies	30
Table 4.2: Table showing reported health risks related to maternal nutrition issues and iron deficiency anaemia in selected articles	36
Table 4.3: Table showing reported barriers related to maternal nutrition issues and iron deficiency anaemia in selected articles	39
Table 4.4: Table showing interventions to improve problems of maternal nutrition and iron deficiency anaemia in selected articles	41

Abbreviation

CASP – Critical Appraisal Skills Programme

FIGO nutrition checklist– International Federation of Gynaecology and Obstetrics
Nutrition Checklist

IDA – Iron deficiency anaemia

NHS– National Health Service

PICO – Population, Intervention, Comparison, Outcomes

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RCT – Randomized Controlled Trial

SLR – Systematic Literature Review

TTM – Transtheoretical Model

UK– United Kingdom

CHAPTER 1: INTRODUCTION

1.1 Research background

Nutritional deficiency is a condition in which the body do not get enough nutrients as needed such as vitamins, minerals and other nutrients. Gernand *et al.* (2016) elaborated that nutritional deficiency, especially during pregnancy often deteriorates foetal and mother health. Iron deficiency anaemia is considered as a common condition during pregnancy. This is often characterized by lack of red blood cells (Benson *et al.*, 2021). This often causes different symptoms of pregnant women such as fatigue and dizziness (NHS, 2024). There are different causes behind the iron deficiency anaemia among pregnant women. Nutritional deficiency increases the risk of anaemia, and it has different impacts such as gestational diabetes, low birth weight and preterm delivery. Benson *et al.* (2021) stated that poor consumption of iron-rich food items often enhance the risk of anaemia among women. Khaskheli *et al.* (2016) elaborated that iron deficiency anaemia is having high risk of mortality and morbidity. This study found that anaemia among pregnant women due to iron deficiency shows different symptoms such as dizziness, drowsiness. Apart from this, normal colour of skin can get faded along with weakness. This increases the risk of postpartum haemorrhage. 20% of maternal deaths are caused due to iron deficiency anaemia (Khaskheli *et al.*, 2016). This disease can be avoided through consumption of haematopoietic nutrients such as iron, zinc, vitamin B12 and vitamin C (Ifeanyi, 2018). Therefore, nutrition is a key factor behind the occurrence of this disease.

Anaemia during pregnancy has negative impacts on the mother and child. Nivedita and Shanthini (2016) mentioned that anaemia is a common health hazard that is prevalent among women and pregnant women are the most vulnerable group. The issue of anaemia is prevalent among low and middle-income nations. Different factors such as education, occupation and income are responsible for the occurrence of this condition (Nivedita and Shanthini, 2016). Chowdhury *et al.* (2015) mentioned that anaemia is a globally recognised nutritional deficiency disorder that hampered about 2 billion women. This study found that lifestyle and living conditions are essential factors that often cause this issue. Anaemia mainly occurs due to nutritional deficiency, and this result in reducing the level of haemoglobin (Ifeanyi, 2018). Inadequate supply of different nutrients such as iron and vitamin B12 often results in the occurrence of anaemia. A balanced diet is necessary to eliminate the chance of this disease occurring.

Nutritional composition often varies between different ethnic groups residing in the United Kingdom. Cross-Bardell *et al.* (2015) mentioned that the intake of fat is quite high among the South Asian communities in the UK. On the other hand, the intake of fruits and green leafy vegetables is low in this community (Cross-Bardell *et al.*, 2015). This often increases the risk of the occurrence of anaemia among women of this ethnic group. This is because consumption of green leafy vegetables and fruits often enables women to meet their iron deficiency and avoid the occurrence of anaemia, especially at the time of pregnancy. In comparison, other ethnicities such as the African Caribbean community have high energy intake (Goff *et al.*, 2015). Hence, it is essential to conduct in-depth research in the South-Asian community properly in terms of the effect of nutritional deficiency and iron-deficiency anaemia on pregnancy outcomes. This can help to frame strategies to improve the overall health of the women of this community.

1.2 Research problem

Iron deficiency anaemia is a common problem among pregnant women residing in the UK, and its wide occurrence has made this a public health issue. Reportedly, 46% of UK women experiences iron deficiency during their pregnancy (Benson *et al.*, 2021). This issue has an association with poor maternal and neonatal outcomes. The prevalence of anaemia is nearly 24.4% during pregnancy, and about one out of three women experiences this issue after delivering the child (Patient, 2024). Maternal malnutrition is a cause behind this issue in the UK.

The prevalence of anaemia is high among South Asian women who are residing in the UK. Fischbacher *et al.* (2014) mentioned that anaemia is three times more prevalent among South Asian women as compared with European women residing in the UK. The prevalence of anaemia among South Asian women is due to dietary habits. Fischbacher *et al.* (2014) found that 32% of Indian women residing in the UK did not consume meat and among them 23% are anaemic in nature.

South Asian women represent a large and diverse population group in the UK, comprising nearly 7.5% of the whole UK population (Sandhu and Barrett, 2024). However, there is no specific review that investigated. Thus, analysing the impact of nutritional deficiency and iron deficiency anaemia on the pregnancy outcome among South Asian women residing in the UK is essential.

1.3 Scope of the research

This research has the scope of discussing existing interventions to address the issue of malnutrition among South Asian pregnant women of reproductive age in the UK. The

findings of this research can highlight potential risk factors of malnutrition and iron deficiency anaemia during pregnancy in the same population. As a result, the government of the country, the healthcare sector and pregnant women can be aware of these factors and take necessary approaches to manage them effectively. As this research is exploring potential barriers to accessing adequate nutrition and maternal care during pregnancy among the same population, the public health sector will get the opportunity to remove those barriers with effective strategies and planning.

1.4 Aim, objectives and research question

This research aims to evaluate how maternal nutrition and iron-deficiency anaemia affect pregnancy outcomes among reproductive age South Asian pregnant women in the UK and examine related health risks, barriers to receive adequate nutrition and existing effective policy or intervention responses.

Study objectives are,

- To examine the health risks associated with the problem of maternal nutritional and iron-deficiency anaemia in pregnant South Asian women in the UK.
- To identify the key barriers that limit access to adequate nutrition and prenatal care among pregnant South Asian women in UK.
- To discuss current interventions in addressing maternal nutritional issues and provide recommendations on how to improve maternal health outcomes of pregnant South Asian women residing UK.

Research question

What are the health risks, care barriers, and policy intervention results regarding nutritional deficiencies and iron-deficiency anaemia, in adult pregnant South Asian women in the UK?

In the following table, the PICO framework for this research is presented.

Table 1.1: PICO framework

Population	Adult pregnant South Asian women of reproductive age living in the UK
Issue	Nutritional deficiencies, in particular iron-deficiency anaemia
Comparison	No comparison
Outcomes	Understanding of health risks, care barriers, and recommendation to improving policy intervention in pregnant South Asian women of reproductive age living in the UK

1.5 Dissertation structure

Chapter 1: Introduction

This chapter presents the background information about the chosen topic along with an overview of research problems. It is also concerned about setting study aim, objectives and the research question.

Chapter 2: Literature review

This chapter is about presenting a comprehensive overview of literature related to the research topic. It helps to get clear insights of what is already known about the topic and the gaps in existing literature.

Chapter 3: Research Methodology

This chapter presents a clear overview of the research method adopted to answer the research question. This chapter aims to describe the process of data collection, data analysis and ethical considerations.

Chapter 4: Results and Discussion

Findings of the study in relation to research objectives are presented in this chapter. This research findings compares with existing literature and helps to understand the way the findings meet each research objective.

Chapter 5: Conclusion and Recommendation

This chapter draws the conclusion and recommendation based on the overall findings and discussion of the research. It answers the research question effectively.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, a discussion of existing information on the topic has been conducted. A coherent structure has been formed for analysing current literature evidence on the topic. This has helped in building an understanding of the knowledge gap of nutritional deficiency and iron deficiency anaemia among Adult pregnant South Asian women in the UK. Different relevant literatures have been collected and their arguments are logically discussed in this chapter. This has helped to understand the current knowledge base regarding the nutritional deficiency and iron deficiency anaemia among pregnant women. The articles that were included in this literature review section are relevant to the topic and have been published. In the addition, gaps in literature and theoretical framework are also presented.

2.2 Nutritional deficiency and its impact on pregnant women

2.2.1 Nutritional issues among pregnant women

Nutritional deficiency can cause different nutritional issues among pregnant women. Karemoi *et al.* (2020) mentioned in the review study that nutritional issues among pregnant women include anaemia and chronic energy deficit. Poor intake of nutrients can result in chronic energy deficit and this harms both mother and the foetus. Desyibelew and Dadi (2019) argued in the review that many women, especially from low and middle income nations, often face the issue of protein energy malnutrition. This literature review highlighted that the issue of malnutrition among pregnant women is high in South Asian and African nations. Nutritional issues such as poor protein intake have negative neonatal and maternal health outcomes. Marshall *et al.* (2022) further argued in the review study that pregnant women often face nutritional issues due to poor iron intake, and this harms the growth and

development of the foetus. Poor nutritional patterns among pregnant women are associated with dietary patterns and lifestyle difficulties. Marshall *et al.* (2022) also mentioned that consumption of a beneficial diet helps in reducing the nutritional issues faced by women. Nutritional issues such as a lack of iron and protein often occur due to poor consumption of a balanced micronutrient intake. This reduces the chance of a healthy pregnancy among women.

2.2.2 Impact of nutritional deficiency and iron deficiency anaemia among pregnant women

Nutritional deficiency can increase risk among both pregnant women and fetuses. Gernand *et al.* (2016) mentioned in a review study that nutritional deficiency can result in gestational effects. This includes pregnancy loss, which is caused due to essential nutrition components such as iron, vitamins and protein. Avagliano *et al.* (2019) argued that nutritional deficiency during pregnancy also results in brain defects among fetuses and the risk of occurrence of congenital anomalies increases. For example, neural tube defects are an essential congenital anomaly that generally occurs due to the deficiency of iron and folate among pregnant women.

Iron deficiency anaemia can increase the risk of adverse events among pregnant women. Zhao *et al.* (2022) mentioned in a cohort study that the risk of foetal distress, preterm birth and caesarean section often increased among pregnant women who are suffering from iron deficiency anaemia. Besides, this study has also argued that iron deficiency anaemia can cause stress response among pregnant women. Further, Milman *et al.* (2015) argued in another trial that pregnant women with iron deficiency anaemia have a lower ability to carry oxygen to blood. This, in turn, increases the cardiovascular pressure for meeting the need for blood delivery. This increases the risk of hypertension among pregnant women.

2.3 Causes behind iron deficiency anaemia among pregnant women

2.3.1 Increased demand of iron

During pregnancy, the demand of iron often gets increases. Mawani *et al.* (2016) conducted a situational analysis and it was found that iron deficiency anaemia is generally caused among pregnant women due to increased demand for iron. The needs of the body increase due to increasing blood volume and growing fetuses. This increases the risk of anaemia among them. This study elaborated that during the whole gestational period there is an

additional requirement of 700-850 mg of iron, while during the lactation period the requirement of nutritional iron increases due to loss of iron through breast milk (Mawani *et al.*, 2016). In another review study by Fisher and Nemeth (2017) also found that during pregnancy, physiologic iron demands often get increase among pregnant women. This study highlighted that the development of the foetus and placenta requires approximately 360 mg iron. Apart from this, 450 mg of iron is required for the expansion of maternal red blood cells. This can create an issue of iron deficiency among pregnant women, which can deteriorate the overall health condition of women and foetus. Di Renzo *et al.* (2015) stated that iron deficiency due to high demand of iron during pregnancy is common. However, a lack of dietary diversity often complicates the whole process and creates nutritional disorders. Therefore, this is an essential issue among pregnant women.

2.3.2 Insufficient dietary intake

In another narrative review by Obianeli *et al.* (2024) mentioned that insufficient dietary iron intake during pregnancy also increases the risk of iron deficiency anaemia among pregnant women. Due to increased demand for iron, pregnant women must consume more dietary iron, the absence of which results in iron deficiency anaemia among them. Further, Kocytowski *et al.* (2018) argued in a primary study that during pregnancy, many women did not have adequate dietary nutrition and supplementation. Lack of a balanced diet occurs due to poor consumption of different essential food items such as green leafy vegetables and pulses. These food items contain essential micronutrients such as iron, zinc and magnesium. Due to insufficient dietary intake, iron deficiency occurs especially in the third trimester. This study has also found that insufficient dietary intake not only impacts women during pregnancy but also impact them during the first 4-6 months after pregnancy. Hence, this is an important cause behind iron deficiency anaemia among women during pregnancy.

2.3.3 Multiple pregnancies

Iron deficiency anaemia is quite prevalent among women who have multiple pregnancies. Ru *et al.* (2016) mentioned in a research article that multiple gestations such as having a twin, often results in high demand for iron during pregnancy. This increases the risk of complications among these women. However, this study elaborated that no additional supplementation is recommended to them and they are advised to have the same dose of supplementation of iron and folic acid just like women who are carrying one foetus. Besides, Gomes da Costa *et al.* (2016) argued in another primary study that iron deficiency does not differ between single and multiple pregnancies. This study elaborated that iron deficiency mainly occurs due to poor dietary habits and this causes iron depletion and increases the

risk of anaemia. However, this study has included a small number of multiple pregnancies (15) as compared with single pregnancies (186). Thus, this argument requires further research. In another review study by Zgliczynska and Kosinska-Kaczynska (2021), it has been elaborated that the risk of iron deficiency is quite high among women with multiple pregnancies. Apart from this, it has also been elaborated in this review that these women are having high risk of vitamin D deficiency. Thus, this is another essential factor that causes iron deficiency anaemia.

2.3.4 Short Interval between pregnancies

Different studies have also found that a short interval between pregnancies is also an essential factor behind anaemia among pregnant women. Nazir *et al.* (2019) mentioned in a cross-sectional study that 42.6% of the total participants in the research were anaemic in nature. In addition, participants with less than 2 years of inter pregnancy interval showed high rate of anaemia. Specifically, those women who were affected who suffered from anaemia in the past pregnancy. OnwUKa *et al.* (2020) also elaborated that short interval between pregnancies is a risk factor behind different adverse outcomes that including lack of iron. Besides, this study has also highlighted other adverse pregnancy outcomes such as hypertension among pregnant women, postpartum haemorrhage and gestational weight gain. This study has also mentioned to adopt additional precautions, such as timely intake of iron supplementation, to prevent the occurrence of negative outcomes.

2.4 Barriers to pregnant women to achieve adequate nutrition and care

2.4.1 Lack of access to nutritious food

Food security is an essential factor for accomplishing nutritional requirements during pregnancy. Moafi *et al.* (2018) mentioned in a cross-sectional study that pregnant women who faced food insecurity often had a low quality of life. Lack of access to healthy food items often results in different negative gestational outcomes such as stillbirth. In addition, this study has also mentioned that a lack of food security also reduces the food diversity among pregnant women. A cross-sectional study by Nana and Zema (2018) argued that a lack of access to nutritious food items often results in poor dietary practices among pregnant women. In addition, this issue is prevalent in low-and middle-income nations such as south-Asian countries and African nations. Poor access to nutritious food items is generally due to low family income. Thus, the pregnant women and foetuses remain undernourished.

2.4.2 Financial constraint

Low family income often creates barriers for pregnant women to get access to nutritious food items. Serbesa *et al.* (2019) mentioned in a cross-sectional study that a low economic situation is an essential barrier that reduces the ability of pregnant women to consume a healthy diet. Low household income of a family decreases the affordability to purchase healthy food items which directly impacts the health of pregnant women and increases the risk of issues like iron deficiency anaemia. Further, Getaneh *et al.* (2021) argued in their systematic review and meta-analysis that malnutrition among pregnant women increases due to low income along with other factors such as maternal literacy. These factors impact meal planning and taking iron and folic acid supplementation. As discussed above, Desyibelew and Dadi (2019) mentioned in a review that nutritional deficiency issues among pregnant women generally occur in low and middle-income nations. Poverty decreases dietary intake among pregnant women.

2.4.3 Unequal access to maternal care

Poor access to maternal care is an essential barrier that increases the risk of nutritional deficiency and iron deficiency anaemia among pregnant women. Rahman *et al.* (2016) mentioned in a review study that many pregnant women often face issues accessing effective maternal care. This is because affordable care is limited, and this increases the risk of different issues such as malnutrition and anaemia among pregnant women. In another cross-sectional study by Ikeanyi and Ibrahim (2015) it has been argued that provision of quality antenatal care is essential in order to prevent the occurrence of anaemia among pregnant women. This is because antenatal care helps women to gain knowledge about dietary requirements and supplementation is also provided. This study highlighted that the role of antenatal care during pregnancy is increase nutritional awareness. Unequal access to antenatal care is an important barrier that increases the risk of occurring anaemia among pregnant women.

2.4.4 Lack of family support

Family plays an essential role in providing the required amount of nutrition to a pregnant woman. Triharini *et al.* (2018) said that lack of family support is an essential barrier in achieving proper nutrition and care, and this often causes anaemia, such as iron-deficiency anaemia, among pregnant women. Family can provide support through providing information and the required diet. However, poor knowledge regarding the issue among family members can create barriers for women in achieving the required diet. Wiradnyani *et al.* (2016)

contradicted that the lack of family support often creates barriers in accepting iron and folic acid supplements. Adhering to these supplements often helps in reducing the chance of iron deficiency anaemia among pregnant women. Thus, it is necessary to address the identified barriers to increase the overall health of pregnant women and eliminate the risk of iron deficiency anaemia.

2.4.5 Racial and ethnic disparity

Pregnant women also face racial and ethnic disparity, which prevents them from accessing adequate nutrition and antenatal care. A review study by Keygnaert *et al.* (2016) has argued that women who migrate to other countries for living are more likely to face ethnic disparity as native women get access to maternal care earlier and easier compared to women from minor ethnic groups. Maternal morbidity and mortality are more common among women from disadvantaged races and minor ethnicities. On the contrary, Kavle and Landry (2018) have mentioned in a review study that women also face ethnic and racial disparities in home countries in terms of accessing maternal care and appropriate nutrition during pregnancy. For example, racial discrimination and stigma in society cause non-inclusive antenatal care services. As a result, all pregnant women do not get equal access to maternal care, nutritional knowledge and proper nutrition during their pregnancy. Ethnic and racial disparity also causes difficulties in getting employment. Higginbottom *et al.* (2020) have argued that lack of employment leads to poor financial conditions which prevents pregnant women from getting appropriate nutrition and access to antenatal care. It directly impacts their health and pregnancy outcomes. On the other hand, a study by Rainford *et al.* (2024) has explained a completely different scenario related to this matter. It has been mentioned that racial and ethnic disparity often makes women socially isolated. It also impacts their psychological and emotional health and wellbeing. As a result, pregnant women feel less confident and hesitate to ask for any advice on nutrition and access antenatal care. It enhances health issues related to poor nutrition during pregnancy and also affects birth outcomes. Besides, Eslier *et al.* (2023) have argued that racial and ethnic differences are also associated with a language barrier. Non-inclusive antenatal care designs often fail to provide services to people of different languages. On the other hand, pregnant women with different languages fail to make healthcare service providers understand their needs. It prevents them from gaining nutritional knowledge and access to proper food and care from available service authorities.

2.5 Policies and Strategies to Address Nutrition Issues

2.5.1 Improving access to nutritious food

It is necessary to address the issue of food insecurity among pregnant women. McKay *et al.* (2022) explored different interventions for improving access to nutritious food among pregnant women that includes a cash transfer scheme, which can increase affordability of women to purchase food items. In addition, this study has also suggested counselling of pregnant women to increase their knowledge about healthy food items and food insecurity. Urgell-Lahuerta *et al.* (2021) also mentioned in their systematic review that provision of prenatal food supplementation is an essential strategy for improving access of pregnant women to nutritious food. This helps in improving the overall health of both mother and foetus. Siddiqui *et al.* (2017) also elaborated that health policy is necessary to improve access of pregnant women to nutritious food items especially during pregnancy. The public health policies need to aim in reducing issues such as anaemia among pregnant women, which can help to improve birth outcomes and reduce the mortality of mothers and children.

2.5.2 Increasing awareness and empowering women

It is necessary to improve awareness among pregnant women regarding the issue of iron deficiency anaemia in pregnancy. Urgell-Lahuerta *et al.* (2021) mentioned that nutritional education is necessary among pregnant women, which can help to increase their awareness about the necessity of nutrition during pregnancy and outcomes of diseases such as anaemia. Nutritional training can empower women to maintain dietary diversity effectively. On the other hand, Nasir *et al.* (2020) mentioned in a cross-sectional study that supplementation is an essential strategy for empowering women and reducing the impact of conditions such as anaemia during pregnancy. This strategy is effective for those women who have less education level and suffer from issues like iron deficiency anaemia. Supplementation such as iron and folic acid supplementation can help these women to protect themselves from these issues.

2.5.3 Micronutrient supplementation

Different literature pieces have analysed that micronutrient supplementation is another essential strategy that can be adopted in order to manage nutritional deficiency among pregnant women. Santander Ballestín *et al.* (2021) stated in a review study that supplementation is necessary during pregnancy to provide proper nutrition to women and mitigate the issue of nutritional imbalances. Different supplements, such as iron and folic

acid, are provided to pregnant women for managing the issue of nutritional imbalance. This review study further stated that the lack of these supplements increases risk of different improper pregnancy outcomes such as preterm birth. In another article, Milman *et al.* (2016) argued that iron, folic-acid and vitamin D supplementation is much required during pregnancy. These supplements help in managing the deficit of essential micronutrients caused due to poor dietary habits. Lack of micronutrient supplementation can result in different issues, such as miscarriage and preterm delivery. However, this study has highlighted that dietary supplementation is also beneficial for pregnant women.

Safety and efficacy of the supplementation intervention is another crucial factor. Brown and Wright (2020) mentioned in a review that it is necessary for pregnant women to acquire vital information regarding supplementation from dieticians and physicians. For instance, this study highlighted that vitamin-A supplementation is efficient because lack of vitamin-A often increases the risk of poor neonatal immune functioning. This, in turn, increases the chance of occurring different condition like diarrhoea, measles and respiratory illnesses. However, Peña-Rosas *et al.* (2015) contradicted that supplements such as iron supplements have concern regarding safety. This is creating barrier for pregnant women to consume them. For example, consuming iron supplementation can lead to the risk of high haemoglobin level. However, this intervention has been stated as effective for pregnant women with low haemoglobin levels. Therefore, it can be said that this is an effective intervention that can be used to manage nutritional deficiency.

2.5.4 Community-based interventions for improving the food environment

Improving food systems or the environment is vital for enhancing access to affordable and nutritious food items for pregnant women. McKay *et al.* (2022) mentioned in a systematic review study that the intervention of measuring household food insecurity is an effective community intervention. Tools like the household food insecurity access score can be used for measuring the level of food insecurity in a community. This can help to identify the quality of food that is being accessed by pregnant women in a community and strategies can be planned and devised to manage the issue. In another trial study, Harris-Fry *et al.* (2018) argued that cash transfer and nutritional food supply to pregnant women an effective community intervention that can help to improve dietary diversity. This intervention in this study has found that daily energy intake among pregnant women increased. In addition, maternal diet improved as their access to nutritional food items got improved. Harris-Fry *et al.* (2018) also elaborated that cash transfers seem to an effective strategy because it helps

in empowering pregnant women especially those who belong to low and middle-income families. Therefore, it is an essential intervention to improve the nutritional status of pregnant women. Apart from this, Gregory *et al.* (2017) contradicted in another review study that there is different community interventions to reduce nutritional deficiency among pregnant women. This includes food fortification that can be done by adding micronutrient sprinkles such as iron and zinc. In addition, this study has also identified the strategy of biofortification through the help of crop breeding. This can be done through increasing the concentration of zinc and iron in the edible portion of crops by maintaining the yields. These strategies can ultimately help pregnant women to achieve the required dietary diversity and desired pregnancy outcomes can be obtained.

2.6 Literature gap

The review of literature has revealed that there is ample evidence on the identified issue of nutritional deficiency and iron deficiency anaemia among pregnant women. Besides, there are no reviews focusing on the practices, cultures and barriers of nutritional deficiency among the south-Asian women living in the UK. Low iron status of pregnant women often results in different birth outcomes such as low birth weight. Hence, conducting a review on this issue is necessary. In addition, there are fewer studies to overcome the barrier of nutritional issues among pregnant women such as iron-deficiency anaemia, in the UK. In this study, these gaps have been mitigated through focusing on iron-deficiency anaemia among south-Asian pregnant women living in the UK.

2.7 Theoretical framework for exploring barriers in maternal nutrition

2.7.1 Social cognitive theory

This theory highlights the interplay between certain factors including environmental influences, personal factors and behavioural choices. As per this theory, behaviour change takes place with the influence of personal factors such as expectation of outcomes and self-efficacy (Rankin *et al.*, 2017). Besides, this theory also states that access to a certain aspect and social support are environmental factors that influence behaviour change. This theory is relevant in this research as it can help to identify as well as analyse barriers for women to get adequate nutrition during pregnancy. It can help to understand the way the belief of South Asian pregnant women about their self-efficacy to make healthier food choices, social support and their expectations for making healthier food choices affects their decision to get adequate nutrition.

2.7.2 Theory of planned behaviour

This theory postulates that subjective norms, perceived behavioural control and attitude of a person directly affect their intention to adopt a healthy behaviour (Khayeri *et al.*, 2019). This framework is used for promoting healthy behaviour. This theory describes social norms as social pressure and perceived behavioural control as the ability of an individual to change an unhealthy behaviour. This theory is relevant in this research as it can help to recommend effective interventions which can influence women to have healthier diets so that overall maternal nutritional status can be improved. It can also help to identify barriers faced by the chosen population to access nutrition and prenatal care.

2.7.3 Transtheoretical Model (TTM)

This model describes that behaviour change takes place in certain stages which includes pre-contemplation, contemplation, preparation, action, maintenance and termination Gordali *et al.* (2021). In these stages, the intention of individuals changes over time, and they become prepared to adopt healthier behaviour. In the pre-contemplation stage, individuals do not intend to change, in the contemplation stage, individuals consider the possibility of changing (Imeri *et al.*, 2022). Besides, in the preparation stage, individuals intend to take action. After that action is taken and maintained for a long time. The termination stage ensures no relapse. This model is relevant in this study as it can help to recommend interventions which can support these changes in pregnant women to adopt healthier eating behaviour, which can improve their nutritional status. Using this model, self-efficacy and the level of confidence of pregnant women can be improved in a way that they can put more effort into accessing nutrition and maternal care.

2.7.4 Health Belief Model

This model postulates that someone may adopt a healthier behaviour if they think that they are at risk of developing serious health conditions. As per this model, belief of individuals about the benefits associated with a healthier behaviour and barriers to taking action towards this also affects their decision of adopting the concerned behaviour (Beressa *et al.*, 2024). Prevention of disease through advocating healthier behaviour is the main focus of this model (Alyafei and Easton-Carr, 2024). Therefore, it is widely used in promoting health and wellness (Azadi *et al.*, 2021). This model is relevant in this study as it can help to understand the way pregnant women can be influenced to improve their nutritional status to avoid complications such as iron deficiencies which may impact pregnancy outcome. This model helps to understand that pregnant women can put effort into accessing nutrition if they

believe that poor nutrition can impact their pregnancy outcome. This model also helps to understand that barriers to access nutrition and maternal care affect decisions of South Asian pregnant women in the UK regarding healthy eating in pregnancy.

In this study, though each of the research objective is better addressed by the above different models, the health belief model will be used mainly as it addresses most of the objectives.

CHAPTER 3: METHODOLOGY

3.1 Research design

A systematic literature review (SLR) is chosen in this study as a research design. This method is rigorous and helps researchers to conduct evidence-based research (Boland *et al.*, 2017). The research method of SLR is effective because it helps in following a strict protocol. The topic of the impact of nutritional deficiencies and iron deficiency anaemia on pregnancy outcome among adult pregnant South Asian women in the UK can be analysed in an in-depth way, following the methodology. Cooper *et al.* (2018) said that the SLR method is transparent and helps in uncovering new insights. Thus, this method is appropriate for this study. Moreover, adopting this method helps in identifying and analysing available research articles on a specific topic of interest (Munn *et al.*, 2018). This method initiates through framing a well-defined research question and searching relevant articles with the help of pre-determined search terms. The study selection process is done following inclusion and exclusion criteria. Xiao and Watson (2019) mentioned that this is an effective method that helps in conducting comprehensive and transparent research. Hence, high-quality evidence can be retrieved about the impact of nutritional deficiencies and iron deficiency anaemia on pregnancy outcomes among adult pregnant South Asian women in the UK. This method has been chosen because it helps in minimising bias through following a particular protocol, and it is cost-effective and time-efficient.

3.2 Study inclusion/exclusion criteria

During conducting the study, eligibility criteria were set (Table 3.1)

Table 3.1: Inclusion and exclusion criteria

Factors	Inclusion criteria	Exclusion criteria
Population	The studies that considered adult pregnant South Asian women of reproductive age residing in the UK is considered in this study	The research articles that did not consider South Asian women residing in the UK are rejected
Issue	The journal articles that focused on the issue of nutritional deficiencies, in particular iron-deficiency anaemia are considered for the review process.	The articles that focused on other issues other than nutritional deficiency among pregnant women were rejected.
Outcomes	The articles that aimed in achieving the outcome of understanding of health risks, care barriers and intervention strategies and policies of South Asian pregnant women in the UK considered for the systematic review.	The articles that aimed in achieving any other outcomes apart from health risks, care barriers and intervention strategies and policies faced by South Asian pregnant women residing in the UK. Articles which are not primary studies.
Study design	Studies that adopted primary research design are selected that include cohort, cross-sectional, randomized controlled trials and qualitative study design.	Studies with secondary research design are excluded from the synthesis but could be cited to provide contextual background.
Language of publication	Articles published in English are included	Articles published in any other languages not considered
Time period	Studies published between 2017-2025 are selected	Studies published before 2017 are rejected

3.3 Literature search strategy

Search strategy is an important part of a systematic review research as it helps to search and select authentic articles which can help to meet the research aim and objectives. This research has used an effective search strategy to conduct the literature search and obtain the most relevant articles. Ho *et al.* (2016) have stated that a search strategy helps in identifying credible data sources and the selection of keywords which can be used as effective search terms. Authentic databases are selected first and then an initial search is conducted using search terms and appropriate use of Boolean operators. Studies irrelevant to the topic, were identified and excluded from the search system, and researchers select studies that are most relevant to the study topic. The different components of the search strategy are used that described below.

Databases used

This research has identified credible databases on the basis of the benefits associated with those databases. Search has been performed on PubMed, ProQuest and Google scholar. According to Bramer *et al.* (2018), ProQuest includes millions of articles on a diverse range of topics. Getting primary articles on a specific topic is easier on this database due to its advanced search option. It also helps with the proper citation of collected articles. This database is connected with different publishers to ensure the inclusion of recent articles. This aspect has helped this research to get recent studies to analyse their findings for answering the research question. On the other hand, PubMed is widely accepted as a public health database (Gusenbauer and Haddaway, 2020). It is updated regularly, which enables researchers to get recent articles in a desired public health topic. This database also helps to get the correct citations of articles. Both basic and advanced search options are available in PubMed, and it has helped to get articles with primary methods and topics related to the research subject. In all of these databases, filters for date and full-text have been applied, and this approach has helped to access full-text newly published articles on the research topic. Moreover, Google scholar was also utilised to broaden the search approach. It is largest free academic search system since it attempts to index nearly all electronically available scholarly literature. Its user friendly interface and ability to track citation make it easier for researchers to identify related research (Gusenbauer and Haddaway, 2020). This search engine helps to access literature on diverse range of disciplines. Using search terms, basic search has been conducted on Google Scholar and required articles have been retrieved.

Search terms and Boolean operators used

Search term selection is an important part of a search strategy and this research has chosen keywords that are linked with the study topic so that sufficient number of articles can be retrieved. This research has considered the PICO framework to identify keywords which have been used further as search terms. These terms and alternative terms have been combined using AND and OR Boolean operators AND Boolean operators have been used to combine search terms mentioned below, and OR has helped to include synonyms of search terms, which are considered as alternative search terms. Main search terms used to conduct the article search are “Nutritional deficiencies”, “Iron deficiency anaemia”, “Pregnancy outcome”, “Adult women” “South Asia”, “The UK”, “Health risk”, “Barriers” and “Policy interventions”. Besides, synonyms of these search terms have been used to formulate meaningful search strings.

The search string with the search terms and Boolean operators are mentioned below,

- ((Nutritional deficiencies OR Dietary deficiencies OR Malnutrition OR Undernutrition OR Nutrient deficiencies) AND (Iron deficiency anaemia OR anaemia) AND (Pregnancy outcome OR Birth outcomes OR Perinatal outcomes OR Maternity outcomes) AND (Adult women OR Adult females) AND (South Asia) AND (The UK)) (on PubMed)

- ((Nutritional deficiencies OR Dietary deficiencies OR Malnutrition OR Undernutrition OR Nutrient deficiencies) AND (Health risk OR Health outcomes) AND (Barriers OR Challenges OR Obstacles) AND (Policy interventions) AND (South Asia) AND (The UK)) (on ProQuest and Google Scholar)

After the rigorous literature search all the relevant articles were transferred to Refwork for database management and deduplication.

3.4 Literature screening strategy

The study selection process of this research has been conducted considering the inclusion/exclusion criteria. An effective screening strategy has helped to exclude irrelevant articles and select the most relevant ones for the review. At first, the initial search was performed on the chosen databases and search engines with the help of search terms and Boolean operators. Then, duplicate articles have been identified and removed shortly. After the removal of deduplicate articles this study has also used an effective screening strategy to identify the most relevant articles on the topic. Waffenschmidt *et al.* (2018) has mentioned that screening involves title and abstract screening and full-text screening. During the title

and abstract screening of articles, used methodologies and brief findings mentioned in the abstract have been read carefully so that irrelevant ones can be identified easily. This process has helped this study to exclude irrelevant articles with different study topics and secondary methodology. After that, full-text screening has been done which has helped to get the most relevant primary studies which are eligible to help this research in meeting study objectives and answer the research question. The process of study selection with the help of the screening strategy has been demonstrated in the PRISMA diagram, which is attached in the results chapter.

3.5 Quality appraisal

Assessing quality of selected studies is an essential process in systematic review that aims to identify potential bias and limitations (Zeng *et al.*, 2015). In this study, CASP quality appraisal tool has been selected for analysing overall quality of the chosen articles. This tool has been selected because it is widely used for evaluating the quality and validity of similar studies (CASP, 2025). Appropriate checklists are chosen that match the study design of the chosen articles. The checklist for cross-sectional, cohort, RCT and qualitative checklists were applied. High scores denote a good quality of the selected studies.

3.6 Data extraction

Extracting essential information from the chosen articles is necessary in order to conduct an analysis effectively. Jonnalagadda *et al.* (2015) stated that data extraction in a systematic review is a process of identifying and organising information from the selected studies. In this study, a data extraction form has been used in this study. This tool has been used because it helps in performing data extraction following different criteria in a systematic way (Taylor *et al.*, 2021). In this study, data extraction has been performed by the reviewer and monitored by the supervisor that helped in ensuring the reduction of bias.

3.7 Data analysis technique

In this study, thematic analysis has been chosen for analysis of the patterns of the findings (Terry *et al.*, 2017). This analysis method has been chosen because it helps in conducting in-depth analysis in a flexible way. Initially the articles were read properly and after these codes were identified. Later, the codes were grouped properly to form themes. After this process, findings were reported under those themes.

3.8 Ethical considerations

This research has maintained an ethical approach while handling the data collected from the chosen articles. Authors of those articles have been acknowledged using referencing and in-text citations. The references are put in the reference list at the end of the study. Besides, no data has been directly copied from the articles to adhere to the plagiarism norms. No informed consent has been collected in this research as no human participants are involved. In addition, other ethical considerations such as maintaining the privacy of data and confidentiality, are not necessary here as this study adopted a secondary approach.

3.9 Limitations

The method of SLR is appropriate in answering the research question. However, there are different limitations, such as limiting study selection to only English language articles and articles published after 2017. This can result in the exclusion of different relevant studies. Including only high-quality articles in a review is an essential obstacle, which is mitigated in this study through conducting a quality appraisal of chosen articles.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the review and discusses the results in comparison with other literature and the health belief model. It includes the PRISMA chart which demonstrates the process of study screening and selection as well as the findings from the included articles. It is also going to discuss the implications of the study findings and key strengths and limitations of the study. This chapter is set to provide a clear insight of the way the findings can answer the research question and meet study objectives.

4.2 Search result

The initial search was conducted on PubMed, ProQuest and Google Scholar. The literature search covered the period from 1st January 2017 to 30th September 2025. A total of 295 articles were found as the initial search result. However, there were 134 duplicated articles which were excluded at the beginning. At first, the title and abstract of the 161 articles after deduplication were screened against the inclusion and exclusion criteria. 125 articles have been found irrelevant due to different topic contexts and secondary methodology. After that, full text of the remaining 36 articles has been screened through reading the whole article.

After reading the whole articles, 26 of them were irrelevant because they don't meet the research objectives, and the final number of articles included in this review as 10. Data was searched on PubMed, ProQuest and Google Scholar on 7th July 2025 to 2nd of August 2025.

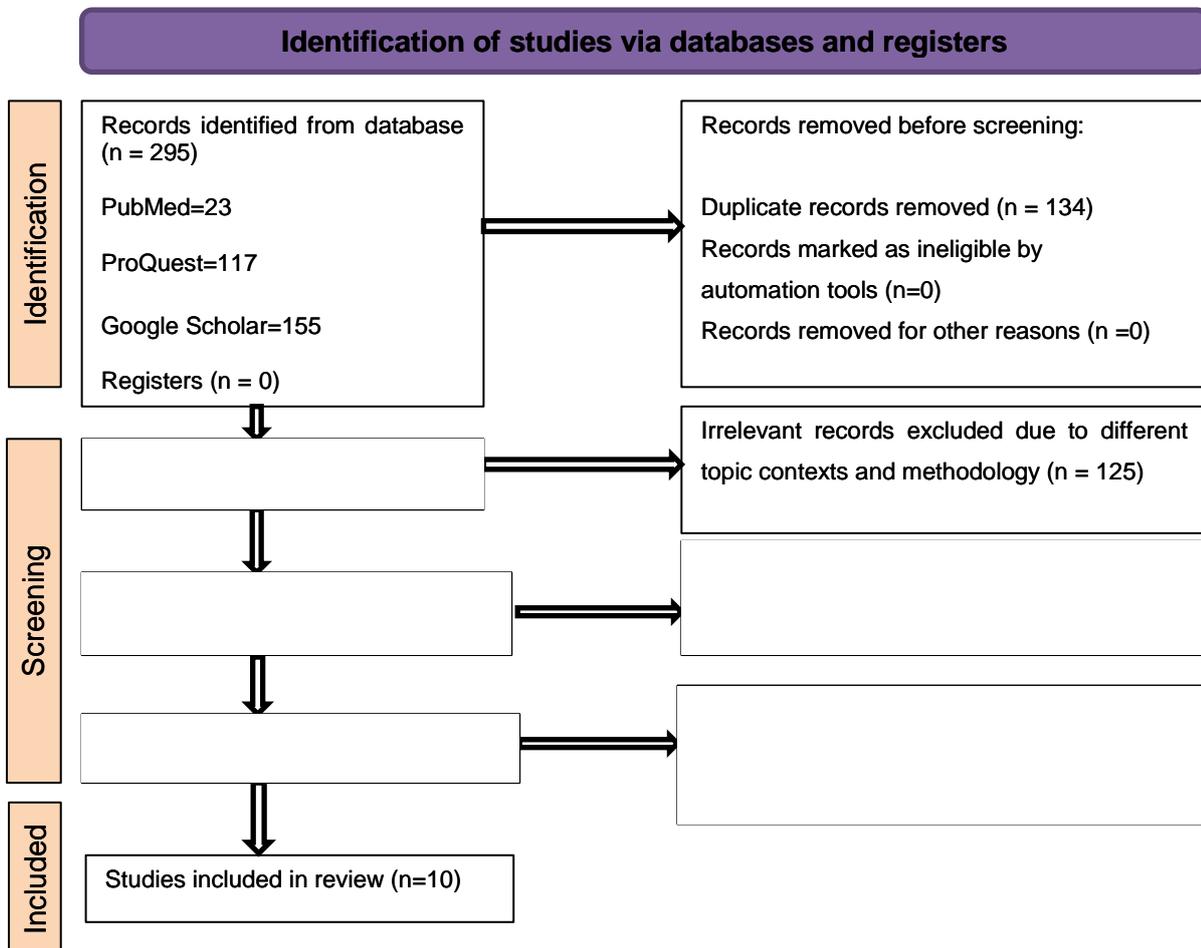


Figure 4.1: PRISMA 2020 Flow Diagram. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 flow diagram was used to illustrate the study selection process in this review. The template, obtained from the official PRISMA website (PRISMA, 2024), outlines the number of records identified, screened, excluded, and finally included in the systematic review. This framework enhances the transparency and reproducibility of the review process by providing clear documentation of study identification, screening, eligibility assessment, and inclusion.

4.3 Summary of selected studies from 2017 to 2025

A total of 10 articles that were published between 2017-2025 were included in this study (Table 4.1) The table contains summary of the chosen articles that include purpose of the research, study design, data collection process and sample size and key findings.

Table 4.1: Summary of selected studies

Citation (Author and year of publication)	Purpose of the study	Study design	Data collection and sample size	Key findings
Soltani <i>et al.</i> (2017)	To assess dietary habits and practices of using supplements among young women during pregnancy	Cross-sectional study	Survey, n=351	This study has found that lack of intake of healthy food options such as meat, eggs, soft cheese and oily fish negatively impacts pregnancy and birth outcomes. Eating well and taking supplements as prescribed during pregnancy have been found helpful in gaining weight and ensuring baby's health after birth. Unhealthy diet and lifestyle can lead to increased risk of stillbirths. Clear association between adverse pregnancy outcomes and poor nutritional status is well-documented in this study.
Burden <i>et al.</i> (2023)	To analyse maternal haemoglobin level and pregnancy outcomes due to nutrition among UK women	Cohort study	Measuring haemoglobin, n=13619	It has been found in the study that poor nutritional habits often result in health risks such as gestational diabetes among South Asian Pregnant women in the UK. It has been found that during late pregnancy 40.4% of participants are having low haemoglobin

				<p>rate. This is associated with different pregnancy outcomes such as low birth weight and preterm birth. This study highlighted that poor consumption of nutritional micronutrients such as iron and zinc often results in different health risks. Low birth weight and preterm birth are common among all ethnic groups in the UK including South Asian women.</p>
Nair <i>et al.</i> (2017)	To evaluate the relationship between maternal haemoglobin and incidents of stillbirth	Cohort study	Measuring maternal haemoglobin and assessing birth outcomes, n=14001	<p>This study has found that maternal anaemia is associated with risks of perinatal mortality and stillbirth. Both of these risks were found three to five times higher among women with maternal anaemia compared to women with haemoglobin level greater than 110g/l. Anaemia has been found to be a common issue caused by iron deficiency among pregnant women. Perinatal deaths have been found decreased by 29% with per unit haemoglobin level increase.</p>
O'Toole <i>et al.</i> (2024)	To analyse the experience of anaemia among South Asian pregnant women in the UK and role of iron oral supplementation	Qualitative study	Semi-structured interview, n=14	<p>It has been elaborated by an Indian participant in the study that the health risk of anaemia due to iron deficiency is quite common in this ethnicity. Different health risks such as fatigue have been faced by the women due to lack of iron and other nutritional micronutrients. However, in this study, the participant from the South-Asian community elaborated that</p>

				consumption of oral supplementation has suited and there are no side effects apart from constipation.
McCarthy <i>et al.</i> (2024)	To examine the association between access to nutrition knowledge and advice and practices and attitude among pregnant women	Cross-sectional study	Self-administered survey, n=334	Inadequate nutrition knowledge and lack of access to nutrition advice have been found barriers to nutrition among South Asian pregnant women. Only half of the participants admitted that they consider healthy eating extremely important during pregnancy. 25.7% participants consumed folic acid supplements during pregnancy. Due to lack of knowledge, consumption of healthy food including vegetables, fruits, meat, fish and dairy products has been found to be the same pre and during pregnancy.
Goodwin <i>et al.</i> (2018)	To explore the experience of midwives and migrant women from Pakistan during their pregnancy in the UK	Qualitative study	Semi-structured interview, n=20	Inappropriate advices from family members, specifically mothers-in-law, have been found a barrier for pregnant women to access care and build positive relationships with midwives. Male dominated culture creates barriers for healthcare professionals to interact with pregnant ladies and provide accurate care as per their needs. Male partners interact with midwives in place of their pregnant wives. Stereotype about religious belief among healthcare professionals also becomes a barrier for Pakistani women to access maternal care.

Garcia <i>et al.</i> (2018)	To understand the intake of folic acid during preconception among South Asian women in Luton, UK	Qualitative study	Focus group discussion and semi-structured interviews, n=25	Limited knowledge about risk factors associated with adverse pregnancy outcomes have been found a barrier to intake of folic acid pre conception. This study has also found poor memory, unplanned pregnancy and lack of awareness among mothers about the importance of consuming folic acid are also potential barriers. Besides, language barriers and lower levels of health literacy are other barriers to folic acid prior to conception and during pregnancy among South Asian women in the UK.
Beasant <i>et al.</i> (2023)	To analyse practices of providing necessary information to pregnant women by midwives in the UK	Cross-sectional	Online questionnaire, n=122	This study has found that the guidance on food by the NHS is effective in encouraging pregnant women to improve nutrition. Women get advice on eating fish, specifically tinned tuna from NHS guidance and midwives. However, lack of confidence and lack of training about providing the guidance have been reported by midwives which are affecting effectiveness of this guidance. Improving knowledge of midwives regarding food and drink that should be limited or avoided can improve effectiveness of this guidance.
Jacob <i>et al.</i> (2022)	To examine the acceptability of the FIGO Nutrition Checklist before and	Cross-sectional study	Survey, n=298	The FIGO Nutrition Checklist has been found to be a valuable resource which ensures benefit for both babies and mothers. It helps in nutritional

	during pregnancy for accessing nutritional status and prevent excessive weight gain during pregnancy			screening of women during their pregnancy and helps in routine decision-making regarding weight and nutrition in clinical care. This checklist is acceptable during clinical visits by pregnant women. However, there are certain barriers to implementing this checklist which include need for non-stigmatised communication and lack of training to healthcare professionals and time.
Tripkovic <i>et al.</i> (2017)	To examine the effectiveness of food fortification intervention in improving nutritional deficiency among South Asian pregnant women living in the UK	Randomised controlled trial	Measuring vitamin D2 and vitamin D3 level, n=335	It has been found in the study that vitamin D2 and D3 fortified juice and biscuits have helped to produce an incremental change among nutrition levels of pregnant women. Significant increase in vitamin D2 and D3 due to fortification proves that dietary intake of nutrition is essential to achieve desired pregnancy outcomes. In this study it has been seen that 71% of South Asian women comply with the fortification of food products. However, the compliance rate of white European women is high as compared with South Asian women (93%). In addition, however, this study elaborated that a low dose of fortification is better as compared with high dose.

4.4 Quality appraisal results

CASP (Critical Appraisal Skills Programme) a critical appraisal checklists are used for conducting the quality appraisal process. During appraisal, the chosen studies have got high quality score. In this study, 8 among 10 studies have got full score. The *appendix* portion of the study includes different checklists and results tables used in this study, which include cohort (two studies), cross-sectional (four studies), qualitative (three studies) and RCT (one study) (Appendix). The included studies are of high quality as they have achieved high scores. Answers were taken through simple 'Yes' (Yes=1) or 'no' (No or Cannot tell=0). The number of 'Yes' are calculated to give individual scores to included studies. However, some studies are having limitations, Goodwin *et al.* (2018) did not locate the researcher culturally.

4.5 Social Demographics

The chosen studies have focused on women who belong to South Asian ethnicity and are currently living in the UK. A total of n=29119 women were analysed in this review. This includes women from India, Pakistan and Bangladesh. These women are having low to middle income and face issues such as a lack of proper diet during pregnancy. Across the studies, women from the South Asian community face issues like poor nutritional habits due to lack of proper income. They also have less education level which restricts awareness regarding supplementation and proper antenatal care during pregnancy.

4.6 Thematic analysis

4.6.1 Health risks related to maternal nutrition issues and iron deficiency anaemia (Theme 1)

Findings from this review indicate that nine studies have reported that unhealthy food intake results in increasing risk of still birth and preterm birth (Soltani *et al.*, 2017, Burden *et al.*, 2023, Nair *et al.*, 2017, O'Toole *et al.*, 2024, McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022). (table 4.2 and figure 4.2). It can also cause iron deficiency anaemia. Moreover, one study highlighted that poor intake of healthy food is related with gestational diabetes (Burden *et al.*, 2023) (table 4.2). Besides, three studies elaborated that low haemoglobin is an impact of unhealthy food intake (Burden *et al.*, 2023, Nair *et al.*, 2017, O'Toole *et al.*, 2024) (table 4.2).

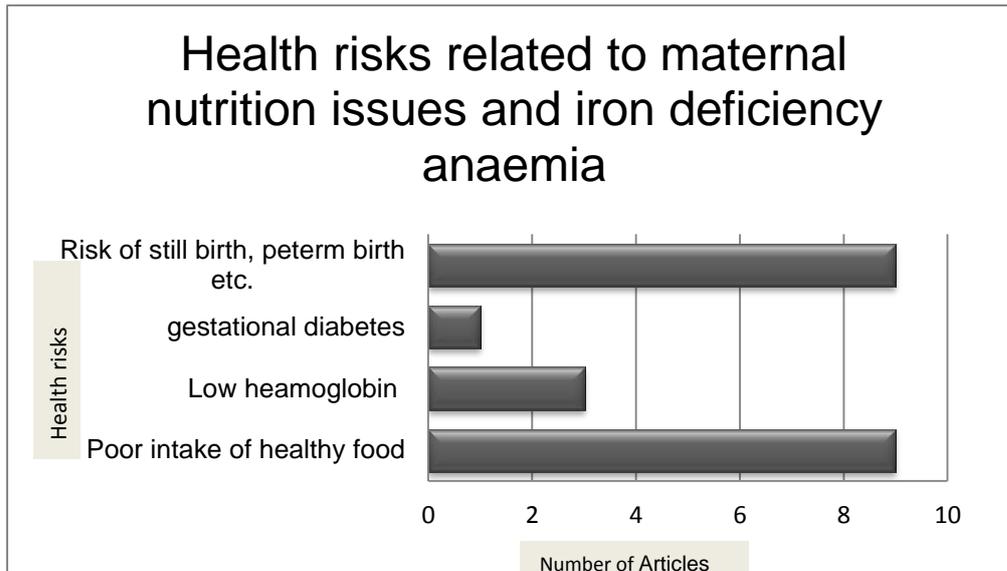


Figure 4.2: Graph showing health risks related to maternal nutrition issues and iron deficiency anaemia

Table 4.2: Table showing reported health risks related to maternal nutrition issues and iron deficiency anaemia in selected articles

Article	Health risks			
	Poor intake of healthy food	Low haemoglobin	gestational diabetes	Risk of still birth, preterm birth etc.
<u>Soltani et al., 2017</u>	✓	<u>N/R</u>	<u>N/R</u>	✓
<u>Burden et al., 2023</u>	✓	✓	✓	✓
<u>Nair et al., 2017</u>	✓	✓	<u>N/R</u>	✓
<u>O'Toole et al., 2024</u>	✓	✓	<u>N/R</u>	✓
<u>McCarthy et al., 2024</u>	✓	<u>N/R</u>	<u>N/R</u>	✓
<u>Garcia et al., 2018</u>	✓	<u>N/R</u>	<u>N/R</u>	✓
<u>Goodwin et al., 2018</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>	✓
<u>Beasant et al., 2023</u>	✓	<u>N/R</u>	<u>N/R</u>	✓
<u>Jacob et al., 2022</u>	✓	<u>N/R</u>	<u>N/R</u>	✓
<u>Tripkovic et al., 2017</u>	✓	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>

The findings revealed that unhealthy food intake during pregnancy affects birth outcomes. Inadequate intake of healthier food, including soft cheese, eggs, meat and oily fish has a negative impact on pregnancy outcome (Soltani *et al.*, 2017). Unhealthy eating and inappropriate lifestyle have been found to be associated with a higher risk of stillbirth. Supplement intake and healthy eating help pregnant women gain weight and give birth to healthy babies. Poor nutritional status of pregnant women has been found a key reason for adverse pregnancy outcomes. On the other hand, poor nutrition is also associated with increased health risk in terms of increased risk of gestational diabetes (Burden *et al.*, 2023). Lower levels of haemoglobin are more likely to be present in late pregnancies among South Asian pregnant women in the UK. The risk of low birth weight rises as maternal haemoglobin levels are lower. It has been found that inadequate consumption of micronutrients including zinc and iron, is the cause behind low haemoglobin, which is also known as maternal anaemia. This review has also found evidence about the association between maternal anaemia and perinatal mortality (Nair *et al.*, 2017). Moreover, maternal anaemia also increases the risk of stillbirth. Women with anaemia are three to five times more likely to experience these negative pregnancy outcomes compared to women who have haemoglobin levels more than 110g/l. Anaemia is considered as a common issue caused due to iron deficiency among pregnant women. This is because the demand for iron increases during the time of pregnancy. In addition, it has been found that perinatal death risk often decreases by 29% with the increase of haemoglobin level. Thus, it can be said that increasing haemoglobin level is necessary in order to avoid the risk of iron deficiency anaemia. Besides, O'Toole *et al.* (2024) described that among South-Asian ethnicities such as Indian women the health risk of anaemia is quite common due to iron deficiency. It has been found in the study that different health risks such as fatigue have been faced by the women due to poor consumption of iron rich food items. Lack of iron and nutritional micronutrients often results in poor pregnancy outcomes. In this study, it has also been found that South Asian participants elaborated that consumption of iron supplementation has suited and there are no side effects apart from constipation.

4.6.2 Barriers to adequate nutrition and prenatal care (Theme 2)

During the review, it has been found that six studies claimed lack of knowledge is an essential barrier to adequate nutrition (McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017). On the other hand, language and literacy are another barrier, which has been identified by six studies (McCarthy

et al., 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017). In addition, six studies identified awareness of supplements is another barrier (McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017) (figure 4.3 and table 4.3). Moreover, six articles also identified awareness of supplements is another barrier (McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017). The review has also found that five studies highlighted that cultural norm is another barrier to adequate nutrition (McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022). As per the review, two studies found that poor family support is an essential barrier to adequate nutrition (Garcia *et al.*, 2018, Goodwin *et al.*, 2018) (figure 4.3 and table 4.3).

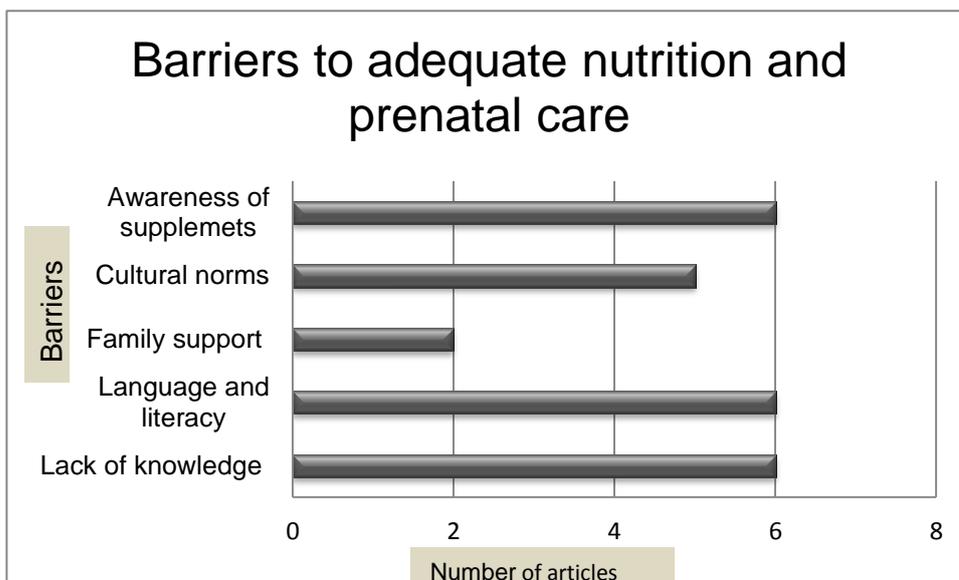


Figure 4.3: Graph showing barriers to adequate nutrition and prenatal care

Table 4.3: Table showing reported barriers related to maternal nutrition issues and iron deficiency anaemia in selected articles

Article	Barriers to adequate nutrition and prenatal care				
	Lack of knowledge	Language and literacy	Family support	Cultural norms	awareness of supplements
<u>Soltani et al., 2017</u>	N/R	N/R	N/R	N/R	N/R
<u>Burden et al., 2023</u>	N/R	N/R	N/R	N/R	N/R
<u>Nair et al., 2017</u>	N/R	N/R	N/R	N/R	N/R
<u>O'Toole et al., 2024</u>	N/R	N/R	N/R	N/R	N/R
<u>McCarthy et al., 2024</u>	✓	✓	N/R	✓	✓
<u>Garcia et al., 2018</u>	✓	✓	✓	✓	✓
<u>Goodwin et al., 2018</u>	✓	✓	✓	✓	✓
<u>Beasant et al., 2023</u>	✓	✓	N/R	✓	✓
<u>Jacob et al., 2022</u>	✓	✓	N/R	✓	✓
<u>Tripkovic et al., 2017</u>	✓	✓	N/R	N/R	✓

During the review, the chosen studies identified different barriers to adequate nutrition and prenatal care among South Asian pregnant women residing in the UK. It has been mentioned that inadequate knowledge regarding nutrition and poor access to nutritional advice are crucial barriers among South Asian pregnant women (McCarthy *et al.*, 2024). During the literature review section, it has been analysed that many pregnant women often face issues to access effective maternal care due to poor awareness (Rahman *et al.*, 2016). In another study by Nagesh *et al.* (2024) also argued that lack of available knowledge regarding available services regarding child and maternal care is a major barrier. On the other hand, Fatema and Lariscy (2020) argued that women with less mass media exposure are having poor knowledge regarding nutrition and maternal care services. Due to this barrier, consumption of healthy food items did not increase during pregnancy.

The six studies have reported on the barriers to adequate nutrition (McCarthy *et al.*, 2024, Garcia *et al.*, 2018, Goodwin *et al.*, 2018, Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017). McCarthy *et al.* (2024) mentioned that inadequate knowledge about nutrition and a lack of access to nutrition advice are important barriers to nutrition among South Asian pregnant women. As a result, this study found that only half of the participants admitted that they consider healthy eating as extremely important during pregnancy. In addition, only 25.7% participants consumed folic acid supplements during pregnancy. Apart from this, due

to lack of knowledge, consumption of healthy food items such as vegetables, fruits, meat and eggs is the same during pre and during pregnancy.

Goodwin *et al.* (2018) mentioned in study that inappropriate advice from family members such as mother-in-law is an essential barrier for south-Asian pregnant women to access care and build effective relationships with midwives. In addition, this study has also found that male-dominated culture is another barrier for South-Asian women residing in the UK to interact with the healthcare professionals.

Garcia *et al.* (2018) stated that limited knowledge about risk factors associated with adverse pregnancy outcomes has been found a barrier to the intake of folic acid pre-conception. In addition, other memories, such as poor memory and unplanned pregnancy, also create barriers to achieving adequate nutrition. Besides, lack of awareness among mothers about the importance of consuming folic acid is another potential barrier. Due to language barrier and low level of health literacy, women have reported no or low consumption of folic acid before and after conception.

4.6.3 Interventions to improve maternal nutrition and maternal health outcomes (Theme 3)

Different strategies have been found effective to improve maternal nutrition status and related health outcomes. The findings show that NHS nutrition guidance is an essential intervention to improve maternal nutrition (Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017) (figure 4.4 and table 4.4). Besides, FIGO nutrition checklist is also identified as an important intervention that can help women make quality nutritional choices (Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017) (figure 4.4 and table 4.4). Food fortification is an essential intervention that can be used to improve maternal nutrition (Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017) (figure 4.4 and table 4.4).

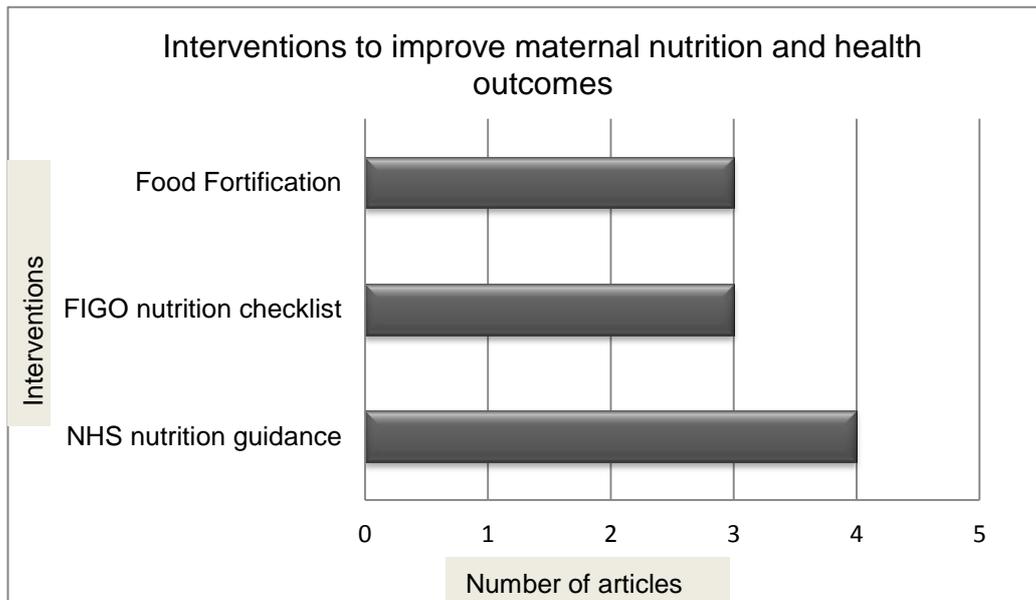


Figure 1.4: Graph showing interventions to improve maternal nutrition and maternal health outcomes

Table 4.4: Table showing interventions to improve problems of maternal nutrition and iron deficiency anaemia in selected articles

Article	Policy Interventions		
	NHS nutrition guidance	FIGO nutrition checklist	Food Fortification
<u>Soltani et al., 2017</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>Burden et al., 2023</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>Nair et al., 2017</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>O'Toole et al., 2024</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>McCarthy et al., 2024</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>Garcia et al., 2018</u>	<u>✓</u>	<u>N/R</u>	<u>N/R</u>
<u>Goodwin et al., 2018</u>	<u>N/R</u>	<u>N/R</u>	<u>N/R</u>
<u>Beasant et al., 2023</u>	<u>✓</u>	<u>✓</u>	<u>✓</u>
<u>Jacob et al., 2022</u>	<u>✓</u>	<u>✓</u>	<u>✓</u>
<u>Tripkovic et al., 2017</u>	<u>✓</u>	<u>✓</u>	<u>✓</u>

Three of the studies (Beasant *et al.*, 2023, Jacob *et al.*, 2022, Tripkovic *et al.*, 2017) has identified interventions and to improve the maternal nutrition and then the health outcomes.

Beasant *et al.* (2023) elaborated in a cross-sectional study that guidance on food by the NHS (National Health Service) is an effective intervention that helps in encouraging pregnant women to improve nutrition. This intervention can help South Asian women to obtain adequate knowledge about nutrition especially during pregnancy. For example, this guideline advised pregnant women to eat fish such as tuna.

In another cross-sectional study by Jacob *et al.* (2022) elaborated that the FIGO nutrition checklist is another essential resource that helps in achieving benefit for both mothers and babies. It helps in nutritional screening of women during their pregnancy and helps in routine decision-making regarding weight and nutrition in clinical care. This checklist can be applied at the time of clinical visits by pregnant women. This study has also highlighted that there are different barriers to implementing this checklist that includes need for non-stigmatised communication and lack of training to healthcare professionals and time.

Tripkovic *et al.* (2017) discussed in the study that fortification of food items such as juices, biscuits with vitamin D2 and D3 is an important interventions. This study has elaborated that fortification of juice and biscuits have resulted in incremental change among nutrition levels of pregnant South Asian women. Significant increase in vitamin D2 and D3 due to fortification proves that dietary intake of nutrition is essential to achieve desired pregnancy outcomes.

4.7 Interpretation of results

The result has answered the research question effectively by shedding light on the health risks, care barriers and interventions related to nutritional deficiencies, specifically iron deficiency, among women of reproductive age from South Asian background in the UK. Health risks associated with poor nutrition are the risk of still birth (Soltani *et al.*, 2017). Women who consume healthy food such as eggs, meat, soft cheese and oily fish during their pregnancies are capable of maintaining healthy weight gain and delivering healthy babies. Besides, poor nutrition also enhances the chance of gestational diabetes. This study has also found that iron deficiency anaemia increases health risks among the chosen population. Pregnant women with lower haemoglobin levels are more likely to experience adverse pregnancy outcomes, including stillbirth.

Anaemia also increases risk of fatigue. South Asian women face certain barriers to access maternal care and appropriate nutrition, which affects pregnancy outcomes. For example, lack of access to nutrition advice and lack of nutrition knowledge are key barriers to improving nutritional status during pregnancy (McCarthy *et al.*, 2024). Many of the target

population do not have the knowledge to improve dietary consumption after conceiving. They also do not increase consumption of eggs, vegetables, fruits and meats due to lack of knowledge about their positive impact on pregnancy outcomes. Culture has also been found influencing the eating behaviour of pregnant women from South Asian backgrounds. For example, male dominated culture prevents women from interacting with midwives and listening to the advice of their mothers-in-law during pregnancy in terms of choosing food. As their husbands interact with midwives, it is difficult to enhance their knowledge about nutrition (Goodwin *et al.*, 2018). Lack of awareness and limited knowledge about risk factors associated with pregnancy outcomes are also preventing women from accessing nutrition and maternal care. The chosen population have been found facing a language barrier to access maternal care and nutrition advice. It often leads to lower consumption of folic acid which plays an important role in ensuring positive pregnancy outcomes. This study also found NHS guidance, FIGO nutrition checklist and inclusion of D2 and D3 in regular diet as effective interventions of improving nutrition status and maternal health outcomes.

4.8 Comparison of results with previous studies

4.8.1 Health risks related to maternal nutrition issues and iron deficiency anaemia

During the review study, it was found that food intake during pregnancy impacts birth outcomes as inadequate intake of healthier food creates the issue of nutritional deficiency and risk of stillbirth increases (Soltani *et al.*, 2017). The findings have been supported through Mosha *et al.* (2017), as it has been stated that sufficient consumption of dietary iron and calcium often decreases the risk of poor pregnancy outcomes such as stillbirth. On the other hand, Qu *et al.* (2019) argued that consumption of adequate vegetables is necessary to reduce nutritional deficiency during pregnancy and this decreases the incidence of stillbirth within pregnant women. In another study, Roseingrave *et al.* (2022) discussed that stillbirth is a crucial impact that often occurs due to inadequate diet intake during pregnancy. It has been elaborated in the study that women who has risk of stillbirth need to take additional antenatal support and follow different dietary guidelines during pregnancy. This is because stillbirth has a devastating impact on the women and their family.

The current study has also highlighted the fact that poor nutrition among South Asian pregnant women residing in the UK is also associated with a higher risk of gestational diabetes (Burden *et al.*, 2023). This is supported by Silva-Zolezzi *et al.* (2017) in which it has

been discussed that different nutritional factor such as Vitamin D and iron, are necessary in order to decrease the risk of gestational diabetes. This study found that low vitamin D increased risk of this condition among most of the participants. On the other hand, Duarte-Gardea *et al.* (2018) argued that having proper nutrition is necessary to mitigate the risk of gestational diabetes. This study identified the necessity of medical nutritional therapy to increase knowledge among women about consumption of adequate nutrition to reduce the chance of occurring perinatal outcomes. The present review study has found that different other complications such as low birth weight and preterm delivery increase due to low levels of maternal haemoglobin (Burden *et al.*, 2023). On the other hand, Triunfo and Lanzone (2015) elaborated in another study that underweight of newborn is another essential issue that often occurs due to inappropriate diet intake. Weight management of newborns are necessary for effective growth and development. This study found that it is essential to intake appropriate diet and nutrition in order to eliminate the risk of underweight of newborns.

The review has also highlighted the issue of the association between maternal anaemia and perinatal mortality (Nair *et al.*, 2017). The findings have been supported by other studies. For example, Smith *et al.* (2019) described that anaemic women often face serious consequences throughout pregnancy such as longer hospitalization, caesarean delivery and preeclampsia. This increases the risk of fatality among pregnant women. On the other hand, Parks *et al.* (2019) argued that maternal mortality is not associated with maternal anaemia but neonatal mortality is linked with anaemia among mothers. This study also elaborated that low birth weight, preterm birth and postpartum haemorrhage are some other consequences that can occur due to the issue of anaemia among mothers. During conducting the review, O'Toole *et al.* (2024) described that among South-Asian ethnicities such as Indian women the health risk of anaemia is quite common due to iron deficiency. Similarly, Singal *et al.* (2018) also elaborated that maternal mortality and anaemia is common among Indian pregnant women. This study highlighted that different reason, such as belonging to poor socio-economic backgrounds and nutritional inadequacies, often increases the risk of anaemia among pregnant women in South Asian nations like India. In addition, Parks *et al.* (2019) also discussed that maternal mortality and anaemia is common among women from South Asian nations like India and Pakistan. In these regions, severe maternal anaemia is common among pregnant women of these areas.

4.8.2 Barriers to adequate nutrition and prenatal care

Different studies highlighted that various barriers exist to adequate nutrition and prenatal care (figure 4.3 and table 4.3). The current review has also found that inappropriate advice

from family members such as mother-in-law is a barrier for South Asian pregnant women that limits access to care services and builds proper relationships with caregivers (Goodwin *et al.*, 2018). The finding can be linked with previous literature review as it has been elaborated that lack of family support is a barrier in achieving proper nutrition and care that causes iron-deficiency anaemia (Triharini *et al.*, 2018). Martin *et al.* (2021) mentioned that engagement of family members is an essential factor in ensuring proper nutrition of pregnant women and newborn children. This study highlighted that poor awareness among family members regarding the issue of malnutrition among pregnant women are a crucial factor. In another primary study by Nguyen *et al.* (2017) has also found that pregnant women who received proper support from family members often took supplements of iron and zinc regularly that helped in improving pregnancy outcomes. Adequate family support is important to increase self-efficacy of women to avoid the issue of nutritional deficiency.

The present review also identified that limited knowledge about risk factors associated with adverse pregnancy outcomes have been found a barrier to intake of folic acid pre-conception (Garcia *et al.*, 2018). The findings have been supported by Kamau *et al.* (2019) as it is discussed that lack of knowledge about iron and folic acid supplementation among women is prevalent and it is related with different factors such as socio-economic status, marital status, maternal age and employment. Kamau *et al.* (2018) stated that knowledge is an essential factor that increases compliance of pregnant women to iron and folic acid supplements. This reduces the prevalence of anaemia among them. This study found that knowledge among pregnant women can be increased through counselling, which can help to increase their compliance to supplementation and reduce nutritional imbalance. In this review, it has also been found that language barrier and low level of literacy are some other barriers that are faced by South Asian pregnant women residing in the UK (Garcia *et al.*, 2018). Therefore, these barriers need to be avoided to improve healthcare access.

4.8.3 Interventions to improve maternal nutrition and maternal health outcomes

The current study found that NHS guidance regarding marketing nutrition is an effective intervention that can encourage pregnant women to improve nutrition (Beasant *et al.*, 2023). This intervention can guide South-Asian women residing in the UK to obtain adequate knowledge about nutrition during pregnancy. Sanders *et al.* (2016) stated in their study that the NHS in England aims to improve nutritional knowledge among pregnant women. This study has also stated that the NHS has also stated that maternal diet needs to be improved to increase health of mothers and babies. On the other hand, Glenister *et al.* (2020) NHS is

an essential governing body in the UK that sets guidance and strategies for improving maternal care.

The review also found that the FIGO nutrition checklist is an important resource that helps in obtaining benefits for both mothers and babies (Jacob *et al.*, 2022). Killeen *et al.* (2023) also argued in their study that the FIGO nutrition checklist supports healthcare providers as they can achieve clear knowledge about the nutrition level of pregnant women. This checklist also helps in identifying nutritional deficiencies among pregnant women. Killeen *et al.* (2020) also mentioned that the FIGO checklist is comprehensive and easy to use. This is a convenient way of understanding the present nutritional status of women.

The review has also found that fortification of essential food items with vitamins such as D2 and D3 can help in bringing nutritional change among pregnant women from South Asian ethnicity living in the UK (Tripkovic *et al.*, 2017). During the literature review section of the study, Gregory *et al.* (2017) have also highlighted the intervention of food fortification, such as iron and zinc, that helps pregnant women to obtain the required dietary diversity. It has been elaborated that dietary intake diet is necessary to achieve desired pregnancy outcomes. In another research study by Athe *et al.* (2020) identified that micronutrient deficiency, especially among pregnant women, can be managed through the help of fortification of food items. Certification is an essential intervention that helps in mitigating issues like iron deficiency. Besides, Liu *et al.* (2016) argued in their primary study that fortification of food items with folic acid helps in reducing congenital anomalies among newborns. This is an essential micronutrient without which poor pregnancy outcomes, such as the occurrence of congenital heart diseases, can occur. Hence, it can be said that fortification is an essential intervention that can help to mitigate nutritional deficiency and help women to avoid issues like anaemia. It also helps to improve the overall health of the foetus, and different issues like congenital anomalies can be avoided. There are different policy interventions for South-Asian women in the UK. The NHS communication toolkit is an essential policy that helps to eliminate the issue of inequality in the healthcare system. The local maternity system receives a letter from the chief midwifery officer to provide support for pregnant women from the South Asian community living in the UK (NHS, 2024). The NICE or National Institute for Health and Care Excellence has provided a guideline for increasing supplement use among South-Asian pregnant women (NICE, 2025). This helps in improving vitamin D supplements.

4.9 Implications

The results have been found consistent with the previous studies. It supports existing theories, including the health belief model, theory of planned behaviour, transtheoretical model and social cognitive theory. For example, the findings that social support affects the behaviour of pregnant women aligns with the social cognitive theory. Lack of support from in-laws and husbands is creating barriers to access nutrition advice and adoption of healthy eating behaviour among South Asian pregnant women. Besides, the findings also support the theory of planned behaviour by postulating the way existing interventions are used to influence healthy eating behaviour among South Asian women during their pregnancy. Similarly, the findings also support the health belief model.

This result matters as it can help the government of the UK to develop a uniform policy under which women from any ethnic background can get nutrition advice during their pregnancy at of cost. It can improve eating practice during pregnancy and women can give birth to healthy babies. The result can also be practically implemented by the researcher disseminating the result in a way that it can increase awareness among the chosen population regarding the importance of having a healthy diet to avoid iron deficiency anaemia and adverse pregnancy outcomes.

4.10 Strengths and limitations of the study

The study has different strengths and limitations. Choosing a systematic literature review is an essential strength because it helps in conducting a comprehensive review by following an effective protocol. Choosing this method has also helped in improving the transparency of the research. Conducting thematic analysis is another strength of the study. Adopting this method helped in gathering an in-depth understanding of the topic. Despite having useful information, the evidence considered had several limitations. Focusing on South Asian women living in the UK is a limitation of the study. This is because women from different ethnicities live in this area and including more population groups could have helped in improving the generalisability of findings. There were few UK based primary studies that disaggregated outcomes by some of the South Asian sub-group (Indian, Pakistani, and Bangladeshi). There was also limited intervention trial work specifically considering cultural or language need over and above vitamin D fortification. Moreover, evaluations of service level tools, such as the FIGO nutrition checklist, on outcomes such as stillbirth and low birth weight in UK South Asian women are sparse.

4.11 Future research scope

In the future, nutritional deficiency and iron deficiency anaemia among pregnant women of other ethnicities living in the UK need to be analysed. This can help to draw comparisons between different ethnicities in terms of nutritional deficiency. In addition, a primary study needs to be conducted to measure the effectiveness of the interventions identified in this review to improve maternal nutrition and maternal health outcomes. For example, randomised controlled trials can be conducted to measure the effectiveness of food fortification interventions among pregnant women residing in the UK. Besides, more in-depth research is required on the issue of iron-deficiency anaemia to reduce its impact and improve pregnancy outcomes.

Chapter 5: Conclusion and recommendations

5.1 Conclusion

Synthesised evidence indicates that suboptimal maternal nutrition especially iron deficiency anaemia is associated with increased risks of stillbirth, preterm birth, low birth weight, and gestational diabetes among South Asian pregnant women of reproductive age in the UK. Food intake directly affects birth outcomes. As per this study, lower intake of healthy food causes negative pregnancy outcomes which are a serious matter of concern. Pregnant women who consume unhealthy food and lead an unhealthy life are more likely to experience the incidents of stillbirth. It means that food intake during pregnancy not only affects the body of mothers, but also affects the health and growth of children in the womb. Increased risk of gestational diabetes can also be found among pregnant women with poor nutrition status. This study also concludes that supplement intake as per the advice of physicians has a significant role in maintaining the body weight of mothers and ensuring healthy pregnancy outcomes. Lower haemoglobin level leads to iron deficiency anaemia and this condition have been found as one of the main reasons behind poor pregnancy outcome. This condition is present among South Asian women in the UK as per the evidence synthesis. While conducting the study, the findings showed that South Asian women residing in the UK often lack iron supplementation and this results in poor pregnancy outcomes.

It can also be concluded that different barriers can be faced to achieve adequate nutrition and prenatal care. Inadequate knowledge regarding nutrition and poor access to nutrition advice are some essential barriers to nutrition. This is because South Asian women in the

UK are migrants and they have less knowledge regarding accessing nutritional knowledge in the UK. The supplementation rate is also low among this population group. Lack of knowledge often results in low consumption of fruits and vegetables, which are natural sources of different micro and macronutrients. During the review, it was seen that half of the South Asian pregnant women consider that healthy eating is essential during the time of pregnancy. Many close family members often give wrong guidance to South Asian women residing in the UK. Different family members like mother-in-law often give wrong advice such as preventing interaction with healthcare professionals. South Asian women live in a male dominated culture that also creates barriers in achieving effective knowledge regarding nutrition. Another potential barrier behind poor nutrition is poor memory and unplanned pregnancy.

It can also be concluded that different interventions need to be implemented for improving maternal nutrition and health outcomes. The government of this region can focus on improving guidance on food. The regulatory agency of National health services is to improve this guidance, which can be used to encourage pregnant women for improved nutrition. A proper national guidance on nutrition of pregnant women is important as it can improve access of people irrespective of ethnicity to knowledge about nutrition, especially during pregnancy. Lack of guidance and knowledge has been identified as an important factor that reduces the uptake of proper nutrition during pregnancy. This study also concludes that the FIGO nutrition checklist is beneficial for both babies and mothers as it involves in nutrition screening of women during their pregnancy. This study supports use of this checklist to make correct decisions regarding nutrition requirements in pregnancy and strategies to manage weight. It means that considering this tool, the nutrition status of mothers can be managed positively and a positive pregnancy outcome can be ensured. However, lack of training among healthcare staff and stigmatised communication can prevent its implementation and reduce its effectiveness eventually. Moreover, food fortification is also an effective intervention to improve maternal nutrition. This study has established the fact that fortification of food juice and biscuits with vitamin D2 and vitamin D3 is also an effective intervention to improve nutrition level among pregnant women. It can help to achieve positive pregnancy outcomes.

In conclusion, this study postulates that women must get healthy food throughout the pregnancy period to achieve a positive pregnancy outcome. Language and literacy plays an important role in the eating behaviour and accessing prenatal care among pregnant women which can be considered a new insight. It means that these issues must be addressed at the community level so that maternal nutrition level can be improved and South Asian women

can be empowered to access prenatal care to deal with iron deficiency anaemia effectively. This study can ensure wider public health impact by highlighting the effectiveness of the identified interventions to reduce health risks associated with maternal nutrition among South Asian women in the UK. Besides, this study is indicating the importance of developing a policy for ensuring access to healthy food for women from any socio-economic background in the UK. It can reduce the rate of iron deficiency anaemia and increase the rate of healthy birth outcomes.

5.2 Recommendations

The findings of this study inform specific recommendations which are mentioned in the following paragraph,

Breaking language barriers in antenatal nutrition counselling to improve pregnancy outcomes among South Asian women in the UK:

This study recommends that health promotion campaigns must be designed and run by the public health sector of the UK government regarding nutritional requirements during pregnancy and available nutrition advice and services across the nation. This will require funds for including healthcare professionals to deliver the campaign to South Asian communities living in the UK. These campaigns can influence women from this population to understand the importance of healthy eating during pregnancy to avoid iron deficiency anaemia and poor birth outcomes. It can also help to gain knowledge about food items which are healthy and must be consumed during pregnancy for better health of both mother and babies. This campaign should also share knowledge about replacing unhealthy food options with healthier food options so that pregnant women can achieve positive pregnancy outcomes. It can improve the overall health literacy level among women from the South Asian Community and improve their decision-making skills and eating behaviour during pregnancy.

Language barrier is preventing pregnant women from understanding the significance of folic acid consumption throughout pregnancy as per the findings of this study (Garcia *et al.*, 2018). Therefore, this research recommends the government of the UK to reform available prenatal care services and enhance inclusiveness. Pregnant women from any cultural background must get assistance in their native language so that they can share their concerns related to nutritional requirements during pregnancy and their impact on pregnancy outcomes. It will require the government to recruit healthcare professionals from different cultural backgrounds in the public health field and arrange language training programs for existing healthcare staff who deliver maternal care services. It can encourage more women

from non-UK backgrounds to come forward and ask for assistance in making decisions regarding eating during pregnancy. It can help to reduce the rate of iron deficiency anaemia and related healthcare costs across the UK. Rate of neonatal mortality due to poor maternal nutrition can also be reduced with the help of inclusive prenatal care services. Besides, it can encourage more women to focus on their diet during pregnancy with the help of advice from experts regarding the same.

Telephonic reminder service to improve Iron, folate and vitamin D supplementation among pregnancy outcomes among South Asian women in the UK:

This research has also found that poor memory is a potential barrier to nutritional intake and folic acid supplement intake among South Asian pregnant women (Garcia *et al.*, 2018). This study recommends the healthcare department of the UK to mitigate this barrier by introducing a telephonic reminder service across the UK. Healthcare professionals who are engaged in providing maternal care can be asked to remind mothers about consuming healthy food and supplements at least twice a week so that they get assistance in developing this healthy behaviour. Contact numbers can be collected during GP or clinical visits for accessing maternal care. It will require a minimum fund for the telephone charge and remuneration of the healthcare staff for this additional duty. It can help to increase intake of supplements and healthy food which plays an important role in ensuring positive birth outcomes. It can also make mothers, along with South Asian females of reproductive age, feel valued and supported throughout the pregnancy terms and encourage them to practice healthy eating to avoid complications related to poor nutrition during their pregnancy.

Midwife training module on use of FIGO checklist and non-stigmatising communication skills to improve nutrition screening during pregnancy:

This study has also found that lack of training and time of healthcare professionals are creating barriers to use FIGO nutrition checklist (Jacob *et al.*, 2022). This study recommends the healthcare department to arrange a training program for healthcare professionals regarding time management and develop non-stigmatised communication skills so that use of FIGO nutrition checklist can be optimised. Senior healthcare expats with prior experience of delivering maternal services to women from different cultural backgrounds are required to be recruited to run the training program. It can be scheduled for two hours biweekly as healthcare professionals get limited time after performing their daily duties. It can enhance the engagement of healthcare professionals in using the FIGO checklist for nutritional

screening of pregnant women. As a result, nutrition gaps can be identified and addressed during pregnancy and incidents of iron deficiency anaemia can also be reduced.

Reference list

1. Alyafei, A. and Easton-Carr, R. (2024) 'The health belief model of behavior change', *StatPearls*. Available at: <https://www.statpearls.com/point-of-care/161679> (Accessed 2 September 2025)
2. Athe, R., Dwivedi, R., Pati, S., Mazumder, A. and Banset, U. (2020) 'Meta-analysis approach on iron fortification and its effect on pregnancy and its outcome through randomized, controlled trials', *Journal of family medicine and primary care*, 9(2), pp.513-519. Available at: <https://journals.lww.com/jfmpc/layouts/15/oaks.journals/download.pdf.aspx?an=01697686-202009020-00013> (Accessed 21 August 2025)
3. Avagliano, L., Massa, V., George, T.M., Qureshy, S., Bulfamante, G.P. and Finnell, R.H. (2019) 'Overview on neural tube defects: From development to physical characteristics', *Birth defects research*, 111(19), pp.1455-1467. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC6511489/pdf/nihms-986149.pdf> (Accessed 16 July 2025)
4. Azadi, N.A., Ziapour, A., Lebni, J.Y., Irandoost, S.F., Abbas, J. and Chaboksavar, F. (2021) 'The effect of education based on health belief model on promoting preventive behaviors of hypertensive disease in staff of the Iran University of Medical Sciences', *Archives of Public Health*, 79(1), p.69. Available at: <https://link.springer.com/content/pdf/10.1186/s13690-021-00594-4.pdf> (Accessed 2 September 2025)
5. Beasant, L., Ingram, J., Tonks, R. and Taylor, C.M. (2023) 'Provision of information by midwives for pregnant women in England on guidance on foods/drinks to avoid or limit', *BMC Pregnancy and Childbirth*, 23(1), p.152. Available at: <https://link.springer.com/content/pdf/10.1186/s12884-023-05441-8.pdf> (Accessed 19 August 2025)
6. Benson, C.S., Shah, A., Frise, M.C. and Frise, C.J. (2021) 'Iron deficiency anaemia in pregnancy: a contemporary review', *Obstetric medicine*, 14(2), pp.67-76. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC8358243/pdf/10.1177_1753495X20932426.pdf (Accessed 27 June 2025)
7. Beressa, G., Whiting, S.J. and Belachew, T. (2024) 'Effect of nutrition education integrating the health belief model and theory of planned behavior on dietary diversity of pregnant women in Southeast Ethiopia: a cluster randomized controlled trial',

- Nutrition Journal*, 23(1), p.3. Available at: <https://link.springer.com/content/pdf/10.1186/s12884-025-07284-x.pdf> (Accessed 2 August 2025)
8. Boland, A., Cherry, G. and Dickson, R. eds. (2017) 'Doing a Systematic Review: A student's guide', Available at: <https://siopsa.developmentserver.co.za/wp-content/uploads/2020/09/CAT-2321.pdf> (Accessed 26 August 2025)
 9. Bramer, W.M., De Jonge, G.B., Rethlefsen, M.L., Mast, F. and Kleijnen, J. (2018) 'A systematic approach to searching: an efficient and complete method to develop literature searches', *Journal of the Medical Library Association: JMLA*, 106(4), p.531. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC6148622/pdf/jmla-106-531.pdf> (Accessed 26 August 2025)
 10. Brown, B. and Wright, C. (2020) 'Safety and efficacy of supplements in pregnancy', *Nutrition Reviews*, 78(10), pp.813-826. Available at: <https://academic.oup.com/nutritionreviews/article-pdf/78/10/813/33891744/nuz101.pdf> (Accessed 16 July 2025)
 11. Burden, C.A., Smith, G.C., Sovio, U., Clayton, G.L. and Fraser, A. (2023) 'Maternal hemoglobin levels and adverse pregnancy outcomes: individual patient data analysis from 2 prospective UK pregnancy cohorts', *The American journal of clinical nutrition*, 117(3), pp.616-624. Available at: <https://www.sciencedirect.com/science/article/pii/S0002916522105198> (Accessed 19 August 2025)
 12. CASP (2025) *Checklist* Available at: <https://casp-UK.net/casp-tools-checklists/> (Accessed 26 August 2025)
 13. Chowdhury, H.A., Ahmed, K.R., Jebunessa, F., Akter, J., Hossain, S. and Shahjahan, M. (2015) 'Factors associated with maternal anaemia among pregnant women in Dhaka city', *BMC women's health*, 15, pp.1-6. Available at: <https://link.springer.com/content/pdf/10.1186/s12905-015-0234-x.pdf> (Accessed 27 June 2025)
 14. Cooper, C., Booth, A., Varley-Campbell, J., Britten, N. and Garside, R. (2018) 'Defining the process to literature searching in systematic reviews: a literature review of guidance and supporting studies', *BMC medical research methodology*, 18(1), p.85. Available at: <https://link.springer.com/content/pdf/10.1186/s12874-018-0545-3.pdf> (Accessed 26 August 2025)
 15. Cross-Bardell, L., George, T., Bhoday, M., Tuomainen, H., Qureshi, N. and Kai, J. (2015) 'Perspectives on enhancing physical activity and diet for health promotion among at-risk urban UK South Asian communities: a qualitative study', *BMJ open*, 5(2), p.e007317. Available at:

- <https://bmjopen.bmj.com/content/bmjopen/5/2/e007317.full.pdf> (Accessed 27 June 2025)
16. Desyibelew, H.D. and Dadi, A.F. (2019) 'Burden and determinants of malnutrition among pregnant women in Africa: A systematic review and meta-analysis', *PloS one*, 14(9), p.e0221712. Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0221712&type=printable> (Accessed 16 July 2025)
 17. Di Renzo, G.C., Spano, F., Giardina, I., Brillo, E., Clerici, G. and Roura, L.C. (2015) 'Iron deficiency anemia in pregnancy', *Women's Health*, 11(6), pp.891-900. Available at: <https://journals.sagepub.com/doi/pdf/10.2217/whe.15.35> (Accessed 16 July 2025)
 18. Duarte-Gardea, M.O., Gonzales-Pacheco, D.M., Reader, D.M., Thomas, A.M., Wang, S.R., Gregory, R.P., Piemonte, T.A., Thompson, K.L. and Moloney, L. (2018) 'Academy of nutrition and dietetics gestational diabetes evidence-based nutrition practice guideline', *Journal of the Academy of Nutrition and Dietetics*, 118(9), pp.1719-1742. Available at: <http://medi-guide.meditool.cn/ympdf/14B18D63-6404-EB24-91C7-B0A6C1007790.pdf> (Accessed 21 August 2025)
 19. Eslier, M., Deneux-Tharoux, C., Schmitz, T., Luton, D., Mandelbrot, L., Estellat, C., Radjack, R. and Azria, E. (2023) 'Association between language barrier and inadequate prenatal care utilization among migrant women in the PreCARE prospective cohort study', *European Journal of Public Health*, 33(3), pp.403-410. Available at: <https://academic.oup.com/eurpub/article-pdf/33/3/403/50503968/ckad078.pdf> (Accessed 2 August 2025)
 20. Fatema, K. and Lariscy, J.T. (2020) 'Mass media exposure and maternal healthcare utilization in South Asia', *SSM-population Health*, 11, p.100614. Available at: <https://www.sciencedirect.com/science/article/pii/S2352827320302512> (Accessed 21 August 2025)
 21. Fischbacher, C., Bhopal, R., Patel, S., White, M., Unwin, N. and Alberti, K.G.M.M. (2014) 'Anaemia in Chinese, South Asian, and European populations in Newcastle upon Tyne: cross sectional study', *bmj*, 322(7292), pp.958-959. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC31036/pdf/958.pdf> (Accessed 28 June 2025)
 22. Fisher, A.L. and Nemeth, E. (2017) 'Iron homeostasis during pregnancy', *The American journal of clinical nutrition*, 106, pp.1567S-1574S. Available at: <https://www.sciencedirect.com/science/article/pii/S0002916522027253> (Accessed 16 July 2025)

23. Garcia, R., Ali, N., Griffiths, M. and Randhawa, G. (2018) 'Understanding the consumption of folic acid during preconception, among Pakistani, Bangladeshi and white British mothers in Luton, UK: a qualitative study', *BMC pregnancy and childbirth*, 18, pp.1-9. Available at: <https://link.springer.com/content/pdf/10.1186/s12884-018-1884-0.pdf> (Accessed 19 August 2025)
24. Gernand, A.D., Schulze, K.J., Stewart, C.P., West Jr, K.P. and Christian, P. (2016) 'Micronutrient deficiencies in pregnancy worldwide: health effects and prevention', *Nature Reviews Endocrinology*, 12(5), pp.274-289. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC4927329/pdf/nihms-791980.pdf> (Accessed 16 July 2025)
25. Getaneh, T., Negesse, A., Dessie, G., Desta, M., Assemie, M.A. and Tigabu, A. (2021) 'Predictors of malnutrition among pregnant women in Ethiopia: a systematic review and meta-analysis', *Human Nutrition & Metabolism*, 26, p.200131. Available at: <https://www.sciencedirect.com/science/article/pii/S266614972100013X> (Accessed 16 July 2025)
26. Glenister, C., Burns, E. and Rowe, R. (2020) 'Local guidelines for admission to UK midwifery units compared with national guidance: a national survey using the UK midwifery study system (UKMidSS)', *PloS one*, 15(10), p.e0239311. Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0239311&type=printable> (Accessed 21 August 2025)
27. Goff, L.M., Timbers, L., Style, H. and Knight, A. (2015) 'Dietary intake in Black British adults; an observational assessment of nutritional composition and the role of traditional foods in UK Caribbean and West African diets', *Public Health Nutrition*, 18(12), pp.2191-2201. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC10271628/pdf/S1368980014002584a.pdf> (Accessed 27 June 2025)
28. Gomes da Costa, A., Vargas, S., Clode, N. and Graça, L.M. (2016) 'Prevalence and risk factors for iron deficiency anemia and iron depletion during pregnancy: A prospective study', *Acta medica portuguesa*, 29(9), pp.514-518. Available at: https://repositorio.ulisboa.pt/bitstream/10451/45183/1/Prevalence_risk_factors.pdf (Accessed 16 July 2025)
29. Goodwin, L., Hunter, B. and Jones, A. (2018) 'The midwife–woman relationship in a South Wales community: Experiences of midwives and migrant Pakistani women in early pregnancy', *Health Expectations*, 21(1), pp.347-357. Available at: <https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/hex.12629> (Accessed 19 August 2025)

30. Gordali, M., Bazhan, M., Ghaffari, M., Omidvar, N. and Rashidkhani, B. (2021) 'The effect of TTM-based nutrition education on decisional balance, self-efficacy and processes of change for fat intake', *Health Education*, 121(3), pp.229-245. Available at: https://perpustakaan.poltekkes-malang.ac.id/assets/file/jurnal/2021_Vol.122_3_gabung.pdf (Accessed 2 August 2025)
31. Gregory, P.J., Wahbi, A., Adu-Gyamfi, J., Heiling, M., Gruber, R., Joy, E.J. and Broadley, M.R. (2017) 'Approaches to reduce zinc and iron deficits in food systems', *Global Food Security*, 15, pp.1-10. Available at: <https://researchonline.lshrm.ac.uk/id/eprint/4363549/1/Approaches%20to%20reduce%20zinc%20GREEN%20AAM.pdf> (Accessed 16 July 2025)
32. Gusenbauer, M. and Haddaway, N.R. (2020) 'Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources', *Research synthesis methods*, 11(2), pp.181-217. Available at: <https://onlinelibrary.wiley.com/doi/pdf/10.1002%2Fjrsm.1378> (Accessed 26 August 2025)
33. Harris-Fry, H.A., Paudel, P., Harrison, T., Shrestha, N., Jha, S., Beard, B.J., Copas, A., Shrestha, B.P., Manandhar, D.S., de L Costello, A.M. and Cortina-Borja, M. (2018) 'Participatory women's groups with cash transfers can increase dietary diversity and micronutrient adequacy during pregnancy, whereas women's groups with food transfers can increase equity in intrahousehold energy allocation', *The Journal of nutrition*, 148(9), pp.1472-1483. Available at: <https://www.sciencedirect.com/science/article/pii/S0022316622163947> (Accessed 16 July 2025)
34. Higginbottom, G.M., Higginbottom, G., Evans, C., Morgan, M., Bharj, K.K., Bharj, K., Eldridge, J., Hussain, B. and Salt, K. (2020) 'Access to and interventions to improve maternity care services for immigrant women: a narrative synthesis systematic review', *Health and Social Care Delivery Research*, 8(14), pp.1-122. Available at: <https://www.journalslibrary.nihr.ac.uk/hsdr/HSDR08140> (Accessed 2 August 2025)
35. Ho, G.J., Liew, S.M., Ng, C.J., Hisham Shunmugam, R. and Glasziou, P. (2016) 'Development of a search strategy for an evidence based retrieval service', *PloS one*, 11(12), p.e0167170. Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0167170&type=printable> (Accessed 26 August 2025)
36. Ifeanyi, O.E. (2018) 'A review on nutritional anaemia', *International Journal of Advanced Multidisciplinary Research*, 5(4), pp.11-15. Available at:

- https://www.academia.edu/download/56538562/A_Review_on_Nutritional_Anaemia.pdf (Accessed 27 June 2025)
37. Ikeanyi, E.M. and Ibrahim, A.I. (2015) 'Does antenatal care attendance prevent anemia in pregnancy at term?', *Nigerian journal of clinical practice*, 18(3), pp.323-327. Available at: <https://www.ajol.info/index.php/njcp/article/download/114864/104500> (Accessed 16 July 2025)
 38. Imeri, H., Toth, J., Arnold, A. and Barnard, M. (2022) 'Use of the transtheoretical model in medication adherence: a systematic review', *Research in Social and Administrative Pharmacy*, 18(5), pp.2778-2785. Available at: https://www.researchgate.net/profile/Austin-Arnold-5/publication/353262618_Use_of_the_transtheoretical_model_in_medication_adherence_A_systematic_review/links/63eaa1864dcb750da757173f/Use-of-the-transtheoretical-model-in-medication-adherence-A-systematic-review.pdf (Accessed 2 September 2025)
 39. Jacob, C.M., Inskip, H.M., Lawrence, W., McGrath, C., McAuliffe, F.M., Killeen, S.L., Divakar, H. and Hanson, M. (2022) 'Acceptability of the FIGO nutrition checklist in preconception and early pregnancy to assess nutritional status and prevent excess gestational weight gain: a study of women and healthcare practitioners in the UK', *Nutrients*, 14(17), p.3623. Available at: <https://www.mdpi.com/2072-6643/14/17/3623> (Accessed 19 August 2025)
 40. Jonnalagadda, S.R., Goyal, P. and Huffman, M.D. (2015) 'Automating data extraction in systematic reviews: a systematic review', *Systematic reviews*, 4(1), p.78. Available at: <https://link.springer.com/content/pdf/10.1186/s13643-015-0066-7.pdf> (Accessed 26 August 2025)
 41. Kamau, M.W., Mirie, W. and Kimani, S. (2018) 'Compliance with Iron and folic acid supplementation (IFAS) and associated factors among pregnant women: results from a cross-sectional study in Kiambu County, Kenya', *BMC public health*, 18(1), p.580. Available at: <https://link.springer.com/content/pdf/10.1186/s12889-018-5437-2.pdf> (Accessed 21 August 2025)
 42. Kamau, M.W., Mirie, W. and Kimani, S.T. (2019) 'Maternal knowledge on iron and folic acid supplementation and associated factors among pregnant women in a rural county in Kenya', *International journal of Africa nursing sciences*, 10, pp.74-80. Available at: <https://www.sciencedirect.com/science/article/pii/S2214139118301124> (Accessed 21 August 2025)
 43. Karemoj, T.M., Mardiah, W. and Adistie, F. (2020) 'Factors affecting nutritional status of pregnant women', *Asian Community Health Nursing Research*, pp.39-39. Available at:

https://www.researchgate.net/publication/367867546_Factors_Affecting_Nutritional_Status_of_Pregnant_Women (Accessed 16 July 2025)

44. Kavle, J.A. and Landry, M. (2018) 'Addressing barriers to maternal nutrition in low-and middle-income countries: A review of the evidence and programme implications', *Maternal & child nutrition*, 14(1), p.e12508. Available at: <https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/mcn.12508> (Accessed 2 August 2025)
45. Keygnaert, I., Ivanova, O., Guieu, A., Van Parys, A.S., Leye, E. and Roelens, K. (2016) 'What is the evidence on the reduction of inequalities in accessibility and quality of maternal health care delivery for migrants? A review of the existing evidence in the WHO European Region', Available at: https://srhr.dspace-express.com/bitstream/20.500.14041/1004/1/Bookshelf_NBK390809.pdf (Accessed 2 August 2025)
46. Khaskheli, M.N., Baloch, S., Sheeba, A., Baloch, S. and Khaskheli, F.K. (2016) 'Iron deficiency anaemia is still a major killer of pregnant women', *Pakistan journal of medical sciences*, 32(3), p.630. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC4928413/pdf/PJMS-32-630.pdf> (Accessed 24 June 2025)
47. Khayeri, A., Mahmoodi, Z., Rahimzadeh, M., Salehi, L., Moghadam, Z.B. and Saeieh, S.E. (2019) 'Effect of the theory of planned behavior education on nutritional behaviors of overweight and obese women before pregnancy', *International Journal of Women's Health and Reproduction Sciences*, 7(4), pp.471-477. Available at: https://ijwhr.net/pdf/pdf_IJWHR_360.pdf (Accessed 16 July 2025)
48. Killeen, S.L., Callaghan, S.L., Jacob, C.M., Hanson, M.A. and McAuliffe, F.M. (2020) "It only takes two minutes to ask"—a qualitative study with women on using the FIGO Nutrition Checklist in pregnancy', *International Journal of Gynecology & Obstetrics*, 151, pp.45-50. Available at: <https://obgyn.onlinelibrary.wiley.com/doi/pdfdirect/10.1002/ijgo.13322> (Accessed 21 August 2025)
49. Killeen, S.L., Donnellan, N., O'Reilly, S.L., Hanson, M.A., Rosser, M.L., Medina, V.P., Jacob, C.M., Divakar, H., Hod, M., Poon, L.C. and Bergman, L. (2023) 'Using FIGO Nutrition Checklist counselling in pregnancy: A review to support healthcare professionals', *International Journal of Gynecology & Obstetrics*, 160, pp.10-21. Available at: <https://obgyn.onlinelibrary.wiley.com/doi/pdfdirect/10.1002/ijgo.14539> (Accessed 21 August 2025)
50. Kocyłowski, R., Lewicka, I., Grzesiak, M., Gaj, Z., Sobańska, A., Poznaniak, J., von Kaisenberg, C. and Suliburska, J. (2018) 'Assessment of dietary intake and mineral

- status in pregnant women', *Archives of gynecology and obstetrics*, 297(6), pp.1433-1440. Available at: <https://link.springer.com/content/pdf/10.1007/s00404-018-4744-2.pdf> (Accessed 16 July 2025)
51. Liu, S., Joseph, K.S., Luo, W., León, J.A., Lisonkova, S., Van den Hof, M., Evans, J., Lim, K., Little, J., Sauve, R. and Kramer, M.S. (2016) 'Effect of folic acid food fortification in Canada on congenital heart disease subtypes', *Circulation*, 134(9), pp.647-655. Available at: <https://www.ahajournals.org/doi/pdf/10.1161/circulationaha.116.022126> (Accessed 21 August 2025)
52. Marshall, N.E., Abrams, B., Barbour, L.A., Catalano, P., Christian, P., Friedman, J.E., Hay Jr, W.W., Hernandez, T.L., Krebs, N.F., Oken, E. and Purnell, J.Q. (2022) 'The importance of nutrition in pregnancy and lactation: lifelong consequences', *American journal of obstetrics and gynecology*, 226(5), pp.607-632. Available at: <https://www.sciencedirect.com/science/article/pii/S0002937821027289> (Accessed 16 July 2025)
53. Martin, S.L., McCann, J.K., Gascoigne, E., Allotey, D., Fundira, D. and Dickin, K.L. (2021) 'Engaging family members in maternal, infant and young child nutrition activities in low-and middle-income countries: A systematic scoping review', *Maternal & child nutrition*, 17, p.e13158. Available at: <https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/mcn.13158> (Accessed 21 August 2025)
54. Mawani, M., Ali, S.A., Bano, G. and Ali, S.A. (2016) 'Iron deficiency anemia among women of reproductive age, an important public health problem: situation analysis', *Reproductive System & Sexual Disorders: Current Research.*, 5(3), p.1. Available at: https://ecommons.aku.edu/cgi/viewcontent.cgi?article=1031&context=pakistan_fhs_mc_med_intern_med (Accessed 16 July 2025)
55. McCarthy, E.K., Ní Riada, C., O'Brien, R., Minogue, H., McCarthy, F.P. and Kiely, M.E. (2024) 'Access to nutrition advice and knowledge, attitudes and practices of pregnant women in Ireland: A cross-sectional study', *Journal of Human Nutrition and Dietetics*, 37(5), pp.1159-1169. Available at: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jhn.13342> (Accessed 19 August 2025)
56. McKay, F.H., Spiteri, S., Zinga, J., Sulemani, K., Jacobs, S.E., Ranjan, N., Ralph, L., Raeburn, E., Threlfall, S., Bergmeier, M.L. and van der Pligt, P. (2022) 'Systematic review of interventions addressing food insecurity in pregnant women and new mothers', *Current nutrition reports*, 11(3), pp.486-499. Available at:

- <https://link.springer.com/content/pdf/10.1007/s13668-022-00418-z.pdf> (Accessed 16 July 2025)
57. Milman, N., Jønsson, L., Dyre, P., Pedersen, P.L. and Larsen, L.G. (2015) 'Ferrous bisglycinate 25 mg iron is as effective as ferrous sulfate 50 mg iron in the prophylaxis of iron deficiency and anemia during pregnancy in a randomized trial', *Journal of perinatal medicine*, 42(2), pp.197-206. Available at: <http://www.healthprevent.net/img/cms/Bibliographie/Biblio%20Lactoferrine/Abstracts%20Isofer.pdf> (Accessed 16 July 2025)
58. Milman, N., Paszkowski, T., Cetin, I. and Castelo-Branco, C. (2016) 'Supplementation during pregnancy: beliefs and science', *Gynecological Endocrinology*, 32(7), pp.509-516. Available at: <https://air.unimi.it/bitstream/2434/560354/4/Supplementation%20during%20pregnancy%20beliefs%20and%20science.pdf> (Accessed 16 July 2025)
59. Moafi, F., Kazemi, F., Samiei Siboni, F. and Alimoradi, Z. (2018) 'The relationship between food security and quality of life among pregnant women', *BMC pregnancy and childbirth*, 18(1), p.319. Available at: <https://link.springer.com/content/pdf/10.1186/s12884-018-1947-2.pdf> (Accessed 16 July 2025)
60. Mosha, D., Liu, E., Hertzmark, E., Chan, G., Sudfeld, C., Masanja, H. and Fawzi, W., (2017) 'Dietary iron and calcium intakes during pregnancy are associated with lower risk of prematurity, stillbirth and neonatal mortality among women in Tanzania', *Public health nutrition*, 20(4), pp.678-686. Available at: <https://www.cambridge.org/core/services/aop-cambridge-core/content/view/C3041D9FA3FD3EFD2C4B4E820AA1F00B/S1368980016002809a.pdf/div-class-title-dietary-iron-and-calcium-intakes-during-pregnancy-are-associated-with-lower-risk-of-prematurity-stillbirth-and-neonatal-mortality-among-women-in-tanzania-div.pdf> (Accessed 21 August 2025)
61. Munn, Z., Peters, M.D., Stern, C., Tufanaru, C., McArthur, A. and Aromataris, E. (2018) 'Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach', *BMC medical research methodology*, 18(1), p.143. Available at: <https://link.springer.com/content/pdf/10.1186/s12874-018-0611-x.pdf> (Accessed 26 August 2025)
62. Nagesh, N., Ip, C.H.L., Li, J., Fan, H.S.L., Chai, H.S., Fan, Y., Wong, J.Y., Fong, D.Y. and Lok, K.Y.W. (2024) 'Exploring South Asian women's perspectives and experiences of maternity care services: A qualitative evidence synthesis', *Women and Birth*, 37(2), pp.259-277. Available

- at: <https://www.sciencedirect.com/science/article/pii/S187151922300313X>
(Accessed 21 August 2025)
63. Nair, M., Churchill, D., Robinson, S., Nelson-Piercy, C., Stanworth, S.J. and Knight, M. (2017) 'Association between maternal haemoglobin and stillbirth: a cohort study among a multi-ethnic population in England', *British Journal of Haematology*, 179(5), pp.829-837. Available at: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/bjh.14961>
(Accessed 19 August 2025)
64. Nana, A. and Zema, T. (2018) 'Dietary practices and associated factors during pregnancy in northwestern Ethiopia', *BMC pregnancy and childbirth*, 18(1), p.183. Available at: <https://link.springer.com/content/pdf/10.1186/s12884-018-1822-1.pdf>
(Accessed 16 July 2025)
65. Nasir, B.B., Fentie, A.M. and Adisu, M.K. (2020) 'Adherence to iron and folic acid supplementation and prevalence of anemia among pregnant women attending antenatal care clinic at Tikur Anbessa Specialized Hospital, Ethiopia', *Plos one*, 15(5), p.e0232625. Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0232625&type=printable> (Accessed 16 July 2025)
66. Nazir, I.I., Alharthi, B.A., Althomali, H.A., Alsini, R.A., Alzaedi, H.Z. and Althagafi, M.A. (2019) 'Short Inter-Pregnancy Interval as a Risk Factor for Anaemia in Pregnancy', *EC Microbiology*, 15, pp.148-157. Available at: <https://ecronicon.net/assets/ecmi/pdf/ECMI-15-00768.pdf> (Accessed 16 July 2025)
67. Nguyen, P.H., Sanghvi, T., Kim, S.S., Tran, L.M., Afsana, K., Mahmud, Z., Aktar, B. and Menon, P. (2017) 'Factors influencing maternal nutrition practices in a large scale maternal, newborn and child health program in Bangladesh', *PloS one*, 12(7), p.e0179873. Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0179873&type=printable> (Accessed 21 August 2025)
68. NHS (2024) *Anaemia* Available at: <https://www.nhs.uk/conditions/iron-deficiency-anaemia/> (Accessed 27 June 2025)
69. NHS (2024) *Communication toolkit* Available at: https://skh4u7dfcv2.s3.amazonaws.com/2025/09/D2530210/Clarifi_Work/fdb2a673-2deb-4bd2-b45c-5e655a8f8c72/C0702_Communications-toolkit-for-local-maternity-teams-to-improve-communications-with-Black-Asian-and-minority.pdf [Accessed 16 September 2025]

70. NICE (2025) *Vitamin D: supplement use in specific population groups*. Available at: <https://www.nice.org.UK/guidance/ph56/chapter/What-is-this-guideline-about> [Accessed 16 September 2025]
71. Nivedita, K. and Shanthini, F. (2016) 'Knowledge, attitude and practices of pregnant women regarding anemia, iron rich diet and iron supplements and its impact on their hemoglobin levels', *Int J Reprod Contracept Obstet Gynecol*, 5(2), pp.425-431. Available at: <https://www.academia.edu/download/86369150/2320-1770.ijrcoq2016038320220523-1-1ehhkv1.pdf> (Accessed 27 June 2025)
72. Obianeli, C., Afifi, K., Stanworth, S. and Churchill, D. (2024) 'Iron Deficiency Anaemia in Pregnancy: A Narrative Review from a Clinical Perspective', *Diagnostics*, 14(20), p.2306. Available at: <https://www.mdpi.com/2075-4418/14/20/2306> (Accessed 16 July 2025)
73. OnwUKa, C.C., Ugwu, E.O., Obi, S.N., OnwUKa, C.I., Dim, C.C., Eleje, G.U., Ezugwu, E.C., Agu, P.U., Nwagha, U.I. and Ozumba, B.C. (2020) 'Effects of short inter-pregnancy interval on maternal and perinatal outcomes: A cohort study of pregnant women in a low-income country', *Nigerian journal of clinical practice*, 23(7), pp.928-933. Available at: <https://www.ajol.info/index.php/njcp/article/view/197712/186480> (Accessed 16 July 2025)
74. O'Toole, F.E., Hokey, E., McAuliffe, F.M. and Walsh, J.M. (2024) 'The experience of anaemia and ingesting oral iron supplementation in pregnancy: A qualitative study', *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 297, pp.111-119. Available at: <https://www.sciencedirect.com/science/article/pii/S0301211524001192> (Accessed 19 August 2025)
75. Parks, S., Hoffman, M.K., Goudar, S.S., Patel, A., Saleem, S., Ali, S.A., Goldenberg, R.L., Hibberd, P.L., Moore, J., Wallace, D. and McClure, E.M. (2019) 'Maternal anaemia and maternal, fetal, and neonatal outcomes in a prospective cohort study in India and Pakistan', *BJOG: An International Journal of Obstetrics & Gynaecology*, 126(6), pp.737-743. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC6459713/> (Accessed 21 August 2025)
76. Patient (2024) *Anaemia in pregnancy*. Available at: <https://patient.info/doctor/anaemia-in-pregnancy> (Accessed 27 June 2025)
77. Peña-Rosas, J.P., De-Regil, L.M., Malave, H.G., Flores-Urrutia, M.C. and Dowswell, T. (2015) 'Intermittent oral iron supplementation during pregnancy', *Cochrane database of systematic reviews*, (10). Available

- at: <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD009997.pub2/pdf/full> (Accessed 16 July 2025)
78. PRISMA (2024) *Prisma template* Available at: <https://www.prisma-statement.org/prisma-2020-flow-diagram> (Accessed 29 September 2025)
79. Qu, Y., Chen, S., Pan, H., Zhu, H., Yan, C., Zhang, S. and Jiang, Y. (2019) 'Risk factors of stillbirth in rural China: a national cohort study', *Scientific reports*, 9(1), p.365. Available at: <https://www.nature.com/articles/s41598-018-35931-1.pdf> (Accessed 21 August 2025)
80. Rahman, M.M., Abe, S.K., Rahman, M.S., Kanda, M., Narita, S., Bilano, V., Ota, E., Gilmour, S. and Shibuya, K. (2016) 'Maternal anemia and risk of adverse birth and health outcomes in low-and middle-income countries: systematic review and meta-analysis', *The American journal of clinical nutrition*, 103(2), pp.495-504. Available at: <https://www.sciencedirect.com/science/article/pii/S0002916523121538> (Accessed 16 July 2025)
81. Rainford, M., Barbour, L.A., Birch, D., Catalano, P., Daniels, E., Gremont, C., Marshall, N.E., Wharton, K. and Thornburg, K. (2024) 'Barriers to implementing good nutrition in pregnancy and early childhood: Creating equitable national solutions', *Annals of the New York Academy of Sciences*, 1534(1), pp.94-105. Available at: https://www.ohsu.edu/sites/default/files/2024-04/Barriers%20to%20implementing%20good%20nutrition%20NYAS_FINAL.pdf (Accessed 2 August 2025)
82. Rankin, A., Kuznesof, S., Frewer, L.J., Orr, K., Davison, J., de Almeida, M.D. and Stewart-Knox, B. (2017) 'Public perceptions of personalised nutrition through the lens of Social Cognitive Theory', *Journal of health psychology*, 22(10), pp.1233-1242. Available at: <https://bradscholars.brad.ac.UK/server/api/core/bitstreams/8ef66fac-59df-498c-b080-46596132b966/content> (Accessed 13 August 2025)
83. Roseingrave, R., Murphy, M. and O'Donoghue, K. (2022) 'Pregnancy after stillbirth: maternal and neonatal outcomes and health service utilization', *American Journal of Obstetrics & Gynecology MFM*, 4(1), p.100486. Available at [https://www.ajogmfm.org/article/S2589-9333\(21\)00181-6/pdf](https://www.ajogmfm.org/article/S2589-9333(21)00181-6/pdf) (Accessed 23 September 2025)
84. Ru, Y., Pressman, E.K., Cooper, E.M., Guillet, R., Katzman, P.J., Kent, T.R., Bacak, S.J. and O'Brien, K.O. (2016) 'Iron deficiency and anemia are prevalent in women with multiple gestations', *The American journal of clinical nutrition*, 104(4), pp.1052-1060. Available

- at: <https://www.sciencedirect.com/science/article/pii/S0002916522046305> (Accessed 16 July 2025)
85. Sanders, J., Hunter, B. and Warren, L. (2016) 'A wall of information? Exploring the public health component of maternity care in England', *Midwifery*, 34, pp.253-260. Available at: <https://www.sciencedirect.com/science/article/pii/S026661381500282X> (Accessed 21 August 2025)
 86. Sandhu, K.K. and Barrett, H. (2024) 'Girls just wanna have fun! South Asian women in the UK diaspora: Gradations of choice, agency, consent and coercion', In *Women's Studies International Forum* (Vol. 102, p. 102859). Pergamon. Available at: <https://www.sciencedirect.com/science/article/pii/S0277539523001863> (Accessed 26 June 2025)
 87. Santander Ballestín, S., Giménez Campos, M.I., Ballestín Ballestín, J. and Luesma Bartolomé, M.J. (2021) 'Is supplementation with micronutrients still necessary during pregnancy? A review', *Nutrients*, 13(9), p.3134. Available at: <https://www.mdpi.com/2072-6643/13/9/3134> (Accessed 16 July 2025)
 88. Serbesa, M.L., Iffa, M.T. and Geleto, M. (2019) 'Factors associated with malnutrition among pregnant women and lactating mothers in Mieso Health Center, Ethiopia', *European journal of midwifery*, 3, p.13. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC7839159/pdf/EJM-3-13.pdf> (Accessed 16 July 2025)
 89. Siddiqui, M.Z., Goli, S., Reja, T., Doshi, R., Chakravorty, S., Tiwari, C., Kumar, N.P. and Singh, D. (2017) 'Prevalence of anemia and its determinants among pregnant, lactating, and nonpregnant nonlactating women in India', *Sage Open*, 7(3), p.2158244017725555. Available at: <https://journals.sagepub.com/doi/pdf/10.1177/2158244017725555> (Accessed 16 July 2025)
 90. Silva-Zolezzi, I., Samuel, T.M. and Spieldenner, J. (2017) 'Maternal nutrition: opportunities in the prevention of gestational diabetes', *Nutrition reviews*, 75(suppl_1), pp.32-50. Available at: https://academic.oup.com/nutritionreviews/article-pdf/75/suppl_1/32/16731113/nuw033.pdf (Accessed 21 August 2025)
 91. Singal, N., Setia, G., Taneja, B.K. and Singal, K.K. (2018) 'Factors associated with maternal anaemia among pregnant women in rural India', *Bangladesh Journal of Medical Science*, 17(4), pp.583-592. Available at: <https://banglajol.info/index.php/BJMS/article/view/38320/26091> (Accessed 21 August 2025)
 92. Smith, C., Teng, F., Branch, E., Chu, S. and Joseph, K.S. (2019) 'Maternal and perinatal morbidity and mortality associated with anemia in pregnancy', *Obstetrics &*

- Gynecology*, 134(6), pp.1234-1244. Available at: <https://journals.lww.com/greenjournal/layouts/15/oaks.journals/downloadpdf.aspx?an=00006250-201912000-00015> (Accessed 21 August 2025)
93. Soltani, H., Duxbury, A., Rundle, R. and Marvin-Dowle, K. (2017) 'Dietary habits and supplementation practices of young women during pregnancy: an online cross-sectional survey of young mothers and health care professionals', *BMC nutrition*, 3, pp.1-15. Available at: <https://link.springer.com/content/pdf/10.1186/s40795-017-0137-3.pdf> (Accessed 19 August 2025)
94. Taylor, K.S., Mahtani, K.R. and Aronson, J.K. (2021) 'Summarising good practice guidelines for data extraction for systematic reviews and meta-analysis', *BMJ Evidence-Based Medicine*, 26(3), pp.88-90. Available at: <https://ora.ox.ac.uk/objects/uuid:57afbdd7-9d8b-4a5a-984f-5427a7b68efa/files/rr207tp62r> (Accessed 26 August 2025)
95. Terry, G., Hayfield, N., Clarke, V. and Braun, V. (2017) 'Thematic analysis', *The SAGE handbook of qualitative research in psychology*, 2(17-37), p.25. Available at: <https://uwe-repository.worktribe.com/index.php/OutputFile/888534> (Accessed 26 August 2025)
96. Triharini, M., Armini, N.K.A. and Nastiti, A.A. (2018) 'Effect of educational intervention on family support for pregnant women in preventing anemia', *Belitung Nursing Journal*, 4(3), pp.304-311. Available at: <https://www.belitungraya.org/BRP/index.php/bnj/article/download/332/211> (Accessed 16 July 2025)
97. Tripkovic, L., Wilson, L.R., Hart, K., Johnsen, S., De Lusignan, S., Smith, C.P., Bucca, G., Penson, S., Chope, G., Elliott, R. and Hyppönen, E. (2017) 'Daily supplementation with 15 µg vitamin D2 compared with vitamin D3 to increase wintertime 25-hydroxyvitamin D status in healthy South Asian and white European women: a 12-wk randomized, placebo-controlled food-fortification trial', *The American journal of clinical nutrition*, 106(2), pp.481-490. Available at: <https://www.sciencedirect.com/science/article/pii/S0002916522025461> (Accessed 19 August 2025)
98. Triunfo, S. and Lanzone, A. (2015) 'Impact of maternal under nutrition on obstetric outcomes', *Journal of endocrinological investigation*, 38(1), pp.31-38. Available at: https://www.academia.edu/download/50793591/Impact_of_maternal_under_nutrition_on_ob20161208-17873-15ho56g.pdf (Accessed 23 september 2025)
99. Urgell-Lahuerta, C., Carrillo-Álvarez, E. and Salinas-Roca, B. (2021) 'Interventions on food security and water uses for improving nutritional status of pregnant women and children younger than five years in low-middle income countries: a systematic review',

- International journal of environmental research and public health*, 18(9), p.4799. Available at: <https://www.mdpi.com/1660-4601/18/9/4799> (Accessed 16 July 2025)
100. Waffenschmidt, S., Knelangen, M., Sieben, W., Bühn, S. and Pieper, D. (2019) 'Single screening versus conventional double screening for study selection in systematic reviews: a methodological systematic review', *BMC medical research methodology*, 19(1), p.132. Available at: <https://link.springer.com/content/pdf/10.1186/s12874-019-0782-0.pdf> (Accessed 26 August 2025)
101. Wiradnyani, L.A.A., Khusun, H., Achadi, E.L., Ocviyanti, D. and Shankar, A.H. (2016) 'Role of family support and women's knowledge on pregnancy-related risks in adherence to maternal iron-folic acid supplementation in Indonesia', *Public health nutrition*, 19(15), pp.2818-2828. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC10270846/pdf/S1368980016001002a.pdf> (Accessed 16 July 2025)
102. Xiao, Y. and Watson, M. (2019) 'Guidance on conducting a systematic literature review', *Journal of planning education and research*, 39(1), pp.93-112. Available at: <https://library.help.edu.my/wp-content/uploads/2023/06/4.-Xiao-Y-Watson-M.-2019.-Guidance-on-Conducting-a-Systematic-Literature-Review.pdf> (Accessed 26 August 2025)
103. Zeng, X., Zhang, Y., Kwong, J.S., Zhang, C., Li, S., Sun, F., Niu, Y. and Du, L. (2015) 'The methodological quality assessment tools for preclinical and clinical studies, systematic review and meta-analysis, and clinical practice guideline: a systematic review', *Journal of evidence-based medicine*, 8(1), pp.2-10. Available at: https://www.researchgate.net/profile/Xian-Tao-Zeng/publication/270907782_The_methodological_quality_assessment_tools_for_pre_clinical_and_clinical_studies_systematic_review_and_meta-analysis_and_clinical_practice_guideline_A_systematic_review/links/5e2ff3dc4585152d156f7ae0/The-methodological-quality-assessment-tools-for-preclinical-and-clinical-studies-systematic-review-and-meta-analysis-and-clinical-practice-guideline-A-systematic-review.pdf (Accessed 26 August 2025)
104. Zgliczynska, M. and Kosinska-Kaczynska, K. (2021) 'Micronutrients in multiple pregnancies—the knowns and unknowns: A systematic review', *Nutrients*, 13(2), p.386. Available at: <https://www.mdpi.com/2072-6643/13/2/386> (Accessed 16 July 2025)
105. Zhao, D., Zhang, C., Ma, J., Li, J., Li, Z. and Huo, C. (2022) 'Risk factors for iron deficiency and iron deficiency anemia in pregnant women from plateau region and their impact on pregnancy outcome', *American journal of translational research*, 14(6),

p.4146. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC9274566/pdf/ajtr0014-4146.pdf> (Accessed 16 July 2025)

Appendix

Quality review of selected study

The selected studies were assessed for quality using CASP as it is predetermined appraisal criteria. The table below summarizes the methodological strengths and weaknesses identified.

Table 1 : Critical appraisal of cross-sectional studies

Articles	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Score
Soltani <i>et al.</i> (2017)	Yes	11/11										
McCarthy <i>et al.</i> (2024)	Yes	11/11										
Beasant <i>et al.</i> (2023)	Yes	11/11										
Jacob <i>et al.</i> (2022)	Yes	11/11										

Q1. Did the study address a clearly focused issue?

Q2. Did the authors use an appropriate method to answer their question?

Q3. Were the subjects recruited in an acceptable way?

Q4. Were the measures accurately measured to reduce bias?

Q5. Were the data collected in a way that addressed the research issue?

Q6. Did the study have enough participants to minimise the play of chance?

Q7. how are the results presented and what is the main results?

Q8. was the data analysis sufficiently rigorous?

Q9. Is there a clear statement of findings?

Q10. Can the results be applied to the local population?

Q11. How valuable is the research?

Table 2: Critical appraisal of qualitative studies

Articles	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
O'Toole et al. (2024)	Yes	10/10									
Goodwin et al. (2018)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	9/10
Garcia et al. (2018)	Yes	10/10									

Q1. Was there a clear statement of the aims of the research?

Q2. Is a qualitative methodology appropriate?

Q3. Was the research design appropriate to address the aims of the research?

Q4. Was the recruitment strategy appropriate to the aims of the research?

Q5. Was the data collected in a way that addressed the research issue?

Q6. Has the relationship between researcher and participants been adequately considered?

Q7. Have ethical issues been taken into consideration?

Q8. Was the data analysis sufficiently rigorous?

Q9. Is there a clear statement of findings?

Q10. How valuable is the research?

Table 3: Critical appraisal of cohort studies

Articles	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Score
Nair et al. (2017)	Yes	12/12											
Burden et al. (2023)	Yes	Yes	Yes	No	No	Yes	10/12						

Q1. Did the study address a clearly focused issue?

- Q2. Was the cohort recruited in an acceptable way?
- Q3. Was the exposure accurately measured to minimise bias?
- Q4. Was the outcome accurately measured to minimise bias?
- Q5. Have the authors identified all important confounding factors? Have they taken account of the confounding factors in the design and/or analysis?
- Q6. Was the follow up of subjects complete enough? Was the follow up of subjects long enough?
- Q7. What are the results of this study?
- Q8. How precise are the results?
- Q9. Do you believe the results?
- Q10. Can the results be applied to the local population?
- Q11. Do the results of this study fit with other available evidence?
- Q12. What are the implications of this study for practice?

Table 4: Critical appraisal of RCT study

Article	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Score
Tripkovic et al. (2017)	Yes	11/11										

- Q1. Did the study address a clearly formulated research question?
- Q2. Was the assignment of participants to interventions randomised?
- Q3. Were all participants who entered the study accounted for at its conclusion?
- Q4. Were the participants 'blind' to intervention they were given? And Were the investigators 'blind' to the intervention they were giving to participants?
- Q5. Were the study groups similar at the start of the randomised controlled trial?
- Q6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?
- Q7. Were the effects of intervention reported comprehensively?
- Q8. Was the precision of the estimate of the intervention or treatment effect reported?
- Q9. Do the benefits of the experimental intervention outweigh the harms and costs?
- Q10. Can the results be applied to your local population/in your context?

Q11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?