

Common Infections Associated with Food Consumption during Pregnancy: Socioeconomic and Cultural Factors Contribute to the Global Burden of Foodborne Illnesses Related to Poor Outcomes among Pregnant Women and Fetus: Health Care Providers can Play a Vital Role to Increase Food Safety Knowledge among Pregnant Women

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Abstract

Food and nutrition-related counselling during pregnancy are conventional. However, a large portion of prenatal counselling does not include adequate information to increase food safety knowledge among pregnant women. In this paper, a literature review has been conducted to address food borne illnesses that cause poor maternal and fetal outcomes. Food poisoning during pregnancy can result from poor food handling and poor selection of food. Pregnant women are often encouraged by health care providers to consume many healthy food items such as fresh fruits and vegetables, dairy products such as milk, soft cheese, poultry, cured meat, fish, and seafood. Although these are nutritious food for both the mother and the fetus, inadequate food preparation can lead to various food borne illnesses from this group of healthy and nutritious meals. Accessibility and affordability of food and socio-behavioural and cultural factors often influence the food consumption by pregnant women. Physician or healthcare providers act as a trustworthy source of health-related knowledge sharing among pregnant women; intervention to increase food safety knowledge among women of reproductive age or pregnant women through their healthcare providers can decrease the rate of food borne illnesses during pregnancy. The table 1 highlighted review findings on the maternal and fetal poor health outcomes caused by some well known food borne pathogens. Table 2 highlighted the Centers for Disease Control's (CDC) food safety recommendations for pregnancy. The socioeconomic and cultural factors are discussed to identify barriers associated with safe food consumption during pregnancy to avoid food borne illnesses. The final suggestion is to ensure prenatal counselling by health care providers includes these critical food safety-related information.

Keywords: Foodborne Illness; Food Poisoning; Foodborne Pathogens; *Listeria monocytogenes*; *Toxoplasma gondii*; *Clostridium botulinum*; Hepatitis A and Hepatitis E; Fetal Health Outcome; Stillbirth; Safe Food Handling; High-Risk Food; Intervention; Prenatal Counselling

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Introduction

Food and nutrition-related counselling is an essential component of prenatal care. It is necessary to address that food and nutrition counselling for pregnant women is a widely accepted practice among health care providers, but food safety-related information is often missing from such practice [1-5]. As a result, common food borne illnesses during pregnancy, causing harm to mother and unborn fetus [6-13]. Food safety recommendation for pregnant women includes avoidance of high-risk foods that cause detrimental effects on mother and fetus. Although in many developed nations, implementation of food avoidance guidelines (For example avoidance of soft cheese, deli meat during pregnancy as recommended by the Centers for Disease Control (CDC)) [27] is easy to implement, however these food avoidance guidelines are less popular among many developing and underdeveloped nations due to socioeconomic and cultural factors. Several factors act as barriers to prevent food borne infections or illnesses among pregnant women worldwide. In this paper, some of these significant socio-behavioral and cultural factors [14-17] will be briefly discussed to ensure understanding of some root causes of poor adherence with food safety practices among pregnant women. These are 1) Poverty and food insecurity. 2) Accessibility of recommended food during pregnancy. 3) Inadequate prenatal care 4) Inadequate food safety knowledge among healthcare providers. 5) Culture based concepts on the healthy and unhealthy foods during pregnancy among pregnant women and their family members. 6) Culture, tradition, and food taboos. 7) Malnutrition and decrease immunity results from poor spacing and too frequent birth 8) Unsanitary living condition. 9) Travel to endemic countries. 10) Lack of culturally sensitive food safety information, resource or guidelines to follow during pregnancy [14-16].

Food poisoning during pregnancy

Women become more susceptible to infection due to various physiological changes during pregnancy. The most important one is pregnancy-related changes in the immune system and hormonal levels. During pregnancy, the immune system changes to protect the baby, so that the mother's immune system does not reject the fetus as a foreign body. As a result, part of the immune system gets suppressed. So standard defence mechanism against many harmful bacteria may be affected too [18].

The hormonal level also changes as a result of pregnancy. For example, increase progesterone level causes relaxation of the smooth muscle of gastrointestinal and urinary system. So, there is a more stasis of fluid in these systems and more susceptibility to infection. The uterus expands and puts pressure on GIT and Urinary tract. Any invading bacteria can survive and multiply quickly to causes severe illness [19].

According to Foodborne Diseases Active Surveillance Network (Food Net) surveillance data, incidence rates of Listeriosis varies by age, ethnicity, and pregnancy status from 2008 to 2016. The invasive Listeriosis annual incidence rate among the general population is 0.28 (excluding pregnant women), and the incidence rate is 3.73 cases among pregnant women [20].

Objectives of the Study:

- 1) To introduce food borne illnesses that have poor maternal and fetal health outcomes during pregnancy.
- 2) To add the recommended food safety guidelines (CDC's) during pregnancy.
- 3) To address socio-behavioral and cultural factors that contribute to poor adherence to food safety practices during pregnancy by pregnant women.

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- 4) To ensure prenatal counseling provided by health care workers includes adequate food safety information to prevent food borne illnesses during pregnancy.
- 5) To suggest further research to ensure the availability of food safety information or educational resources in a culturally sensitive manner (for example, based on local language and regional food consumption habits).

Methods

A literature search conducted from Pubmed, Google scholar, SAGA, WHO, and CDC websites to gather evidence-based information on poor effects of food associated with infectious diseases/food borne illnesses on pregnant women and their unborn fetus. The author also reviewed articles published on socioeconomic factors that influence food consumption habits during pregnancy. These factors directly or indirectly act as a barrier to prevent food borne illnesses during pregnancy. Finally, the Centers for Disease Control and World Health Organization websites are searched to find out a current recommendation on food safety tips for pregnant women.

Scope

This article addresses only commonly occurring food-borne illnesses that cause detrimental effects on both mother and fetus. This article only highlighted on the interventions targeting health care providers. As food safety intervention is a must broader area includes discussion around international and regional food safety policies, collaborative actions of multiple industries and agencies which is beyond the scope of this article;

Limitation

In this article author intended to discuss only infectious diseases that are related to food and water consumption. This review excludes any pieces of literature or reports on food poisoning results from various toxins and chemicals such as pesticides, lead, mercury, arsenic. Malnutrition and health problems results from inadequate food consumption before and during pregnancy are not within the scope of this article.

Strength

The review suggested that there are inconsistencies exist among health care providers knowledge and attitude towards the practice of food safety related counseling to their pregnant patient. There is a knowledge gap among pregnant women regarding food safety and how to prevent foodborne illnesses. The article also recommended that it is essential to distinguish between healthy eating guideline during pregnancy from the instruction on how to avoid high-risk foods or alternative methods of food preparation to decrease the risk of foodborne illnesses from high-risk food consumption during pregnancy.

Review Result

Although food poisoning caused by various microorganisms, toxins, and chemicals, this article addressed only some common infectious agents such as Hepatitis A, Hepatitis E, *Listeria monocytogenes*, *Toxoplasma gondii*, *Clostridium botulinum* associated with high-risk food intake. These microorganisms were found to cause serious pregnancy complication by interrupting fetal growth and development during the literature review. The overall findings on these microorganisms are summarized in the table 1. The summary of the CDC's food safety recommendations for pregnant women is provided in table 2. To increase food safety knowledge among pregnant women by

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improving prenatal counselling by health care providers. The socioeconomic and cultural factors are discussed to identify the barriers associated with safe food consumption during pregnancy to avoid food borne illnesses. A final suggestion is to enhance further research in finding a way of educating pregnant women by providing information on food safety. The review findings indicated that above mentioned pathogenic microorganisms cause serious pregnancy related complications such as interruption of fetal growth and development.

Author's name, Year of publication/Type of study/Geographical area	Foodborne illness/cCausative agent of foodborne illness/ Mode of Transmission	Incidence among pregnant women / Risk Factors / Pregnancy outcomes: Mother, Fetus and neonates.
<p>#1 Author's name, Year of publication Chaudhry and Koren, 2015 [6]</p> <p>Type of study and geographical area. Not specify.</p>	<p>Causative agent: Hepatitis A. Incubation period: 15 to 50 days. -Vaccine- preventable disease. -Vaccine is prepared from an inactivated virus and it is safe during pregnancy. -70% of individual develop protection two weeks after administering the first dose of hepatitis A vaccine.</p> <p>Mode of Transmission Fecal-oral route. a) Direct contact with an infected person. b) Consumption of contaminated food or water.</p>	<p>Incidence among pregnant women -Although hepatitis A is a common cause of acute hepatitis, underreporting of infection among pregnant women. -Data on the incidence and pregnancy outcome results from the hepatitis A infection is inadequate [6].</p> <p>Implicated food /risk factors: Unvaccinated individual traveled to an endemic country. Poor hygiene, for example, poor hand hygiene. Food handlings practice is inappropriate (inadequate cooking). Lack of water sanitation. Contamination of food and drinks.</p> <p>Pregnancy outcome: Pregnant women: Hepatitis A infection during second or third trimester of pregnancy may lead to premature uterine contractions, placental abruption, premature rupture of the membranes and preterm labor.</p> <p>Fetus and infant: In most cases infant born to mother with hepatitis A infection during pregnancy does not get hepatitis A infection. n rare cases, vertical transmission is associated with fetal ascites, meconium peritonitis, neonatal hepatitis A infection and distal ileum perforation. Breastfeeding: There is no evidence that Breast milk is a source of hepatitis A virus transmission. The administration of inactivated HAV to protect the infant. Vaccine or immunoglobulin [6].</p>

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<p>#2 Author's name, Year of publication Moran., <i>et al.</i> 2018 [7]</p> <p>Type of study and geographical area. A Systematic Review. Studies conducted in USA, Canada, Denmark, France, Australia,Iran.</p>	<p>Causative agent: Listeria monocytogenes. --Incubation period: 3 to 60 days Listeriosis is a systemic illness. -Symptoms Range from gastroenteritis, meningitis and severe sepsis. -In the USA and France, approximately 19% and 17% of a known cause of foodborne diseases related to death caused by Listeria infection. Mode of Transmission: Listeria can survive in refrigerated ready to eat foods, and this bacteria is resistant to diverse food processing environment, so people can easily get infected from contaminated ready to eat food. Listeriosis can frequently affect the fetus and newborn by transplacental transmission [7]</p>	<p>Incidence among pregnant women -Pregnant women are 10-20 times more likely to get infected with listeriosis. - Pregnancy-related cases account for 20.7% of listeriosis globally. - Overall case fatality that includes neonatal death is 14.9%. Implicated food /risk factors: Consumption of high-risk foods during pregnancy (CDC, Food Standards Australia, New Zealand). -These high-risk foods include delicatessen-style meat, cold cut meats, dairy products made from unpasteurized milk, soft, semisoft and surface-ripen cheeses, ready to eat foods. -The Odd Ratio for listeriosis during pregnancy after consumption of these foods range from 4.12 to 17.8 [7]. Pregnancy outcome: Maternal, fetal and neonatal Outcomes: Acute febrile illness, diarrhea, abdominal cramps, stiff neck, vomiting, photophobia, headache, spontaneous abortion, still-birth, premature birth, live birth of a seriously ill premature or term Neonate. In utero, death, meningitis, and septicemia [7]. Mother with listeriosis during pregnancy may remain asymptomatic or present with mild or influenza-like illnesses such as fever, malaise, myalgia, headache. But serious consequences in the fetus or neonates [7].</p>
<p>#3 Author's name, Year of publication Park., <i>et al.</i> 2018 [8].</p> <p>Type of study and geographical area. Case report. Korea.</p>	<p>Causative agent: Listeria monocytogenes. Mode of Transmission: Consumption of high-risk foods during pregnancy.</p>	<p>Incidence among pregnant women -Pregnancy associated listeriosis is estimated 12-20 times more prevalent than general population, account for 35% of all cases. -Neonatal mortality rate 20-30%. Implicated food /risk factors: Two cases presented in this article. 1st Case: blood culture is positive for listeria and diagnosed with chorioamnionitis. Both mother and fetus received an oral antibiotic. Follow-up of the baby continues until six months. Source of infected or suspected food history not provided. 2nd case: Mother developed gastroenteritis after having a sandwich one week ago. She developed severe diarrhea and fever. She did not receive antibiotic treatment. Later on, a Listeria monocytogenes was confirmed in maternal blood and placental tissue and also in the swab of neonate's skin. The fetal outcome was stillborn at 29-weeks gestation. Mother received treatment later on. This article emphasis on early identification and treatment of listeriosis. Infection among pregnant women. Pregnancy outcome: Pathological findings of placenta affected by listeriosis is microabscesses or microabscesses with focal necrosis and haemorrhages. Maternal: nonspecific maternal symptoms, including flu-like illness, enteric illness [8]. The fetal outcome includes preterm labor, reduced fetal movement, stillbirth, neonatal infection [8].</p>

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<p>#4 Author's name, Year of publication Badell., <i>et al.</i> 2018 [9].</p> <p>Type of study and geographical area. A systematic review.16 cases of botulism among pregnant women (11 cases in the third trimester; 1 case during the postpartum period). Cases occur in USA, Spain, Russia, Germany, Armenia</p>	<p>Causative agent: Clostridium botulinum, a spore-forming anaerobic, gram-positive bacillus.</p> <p>Mode of Transmission: a) Consumption of contaminated Foodborne. b) infected wound, c) infant botulism, d) Iatrogenic and e) Adult intestinal colonization. In this systematic review total of 10 cases were associated with foodborne exposure among pregnant women, 2 cases were from a wound Contamination and in 4 cases, the cause was unknown.</p>	<p>Incidence of botulism may vary geographically. In the USA, annually 100-150 cases of botulism occur.</p> <p>Implicated food /risk factors: In this study, out of a total of 16 cases, among 5 cases epidemiological link existed between home canned green beans, canned fish. -5 cases resulted from exposure to foods with laboratory-confirmed botulinum toxin, -Two resulted from wound contamination, Four cases cause is unknown. -One postpartum case was related to wound contamination.</p> <p>Pregnancy outcome: Signs and symptoms described in these cases included nonspecific gastrointestinal symptoms, cranial nerve paralysis, muscle weakness, and compromised respiratory function. The common symptoms were diplopia or blurry vision (86% cases), peripheral muscle weakness in (80% of cases), respiratory failure in (80% of cases), nausea and vomiting (>50% of cases), difficulty swallowing (47% of cases). About one-third of cases reported dry mouth or sore throat, dysphonia, change in hearing, nasal speech, and hoarseness [9].</p> <p>Maternal outcome: 11 of cases developed progressive neurological deficits and respiratory failure that required ICU admission. 2 cases die from respiratory failure, and one was in a persistent vegetative state.</p> <p>Fetal outcome: Out of a total of 12 cases, 6 were Preterm delivery, one fetal death due to unexpected maternal mortality and unable to do a timely cesarean section. Four of the preterm births were due to medically induced delivery to decompensate maternal symptoms. One preterm delivery was associated with the placental abruption. No report of neonatal death. There is no report of congenital botulism or botulism related neurological symptoms among neonate or infant born to these mothers.</p> <p>There is no adverse event associated with botulinum antitoxin therapy identified among mother who received it or among neonate born to these mothers. This article emphasis on the early detection and treatment of botulism in pregnancy. It also addresses that women who received antitoxin within the first 72 hours of symptom onset had better outcomes than those who received antitoxin later.</p>
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<p>#5 Author's name, Year of publication. Hussain., <i>et al.</i> 2017 [10]. Type of study and geographical area. Descriptive article.</p>	<p>Causative agent: The protozoan parasite Toxoplasma gondii. There are three main genotypes (type 1, type 2, and type 3). All three types can cause human illness. Type 2 is associated with most cases of congenital toxoplasmosis in Europe and USA. Mode of Transmission: Contaminated Food and environment, directly and indirectly, cause infection in human, -Consumption of contaminated food or drink. (for example, raw contaminated meat, unpasteurized dairy or untreated water) Vertical transmission from mother to fetus. (Trans placental route).</p>	<p>Incidence among pregnant women: In USA, 23% of adolescents and adults are infected with T. gondii, which accounts for 24% of deaths due to foodborne illness in the USA [10]. Implicated food /risk factors:3 major routes are as follows. a) consumption of raw or inadequately cooked infected meat (T gondii infection in the meat of the animal) or eat uncooked foods that have come in contact with contaminated meat. b) human can inadvertently ingest oocysts that cat have passed in their feces, either in the litter box or outdoors in soil (e.g. soil from gardening or unwashed fruits or vegetables). c) A woman can transmit the infection to her unborn fetus. In this study, high-risk foods mentioned are as follows: meat(pork, sheep, cattle, chicken), Unpasteurized goat's milk, fresh plant products(unwashed, contaminated with soil or washed with contaminated water), raw seafood, unpasteurized milk, milk products, and contaminated or unfiltered water [10]. Pregnancy outcome: Maternal outcomes: T. gondii infection may remain asymptomatic or may cause mild self-limiting symptoms (fever, malaise, and lymphadenopathy), Acute illness can cause visual impairment to anyone, especially immune-compromised individual. Fetal outcomes: Infection among pregnant women can cause detrimental fetal outcomes. Infant can be born with mental retardation and impaired eyesight or blindness [10].</p>
<p>#6 Author's name, Year of publication Labrique., <i>et al.</i> 2012 [11]. Type of study and geographical area. Descriptive article. Bangladesh.</p>	<p>Causative agent: Hepatitis E virus Mode of Transmission: Fecal-oral route.</p>	<p>Incidence among pregnant women -HEV genotype 1, predominant among people in the greater floodplains of Southern Asia. -In 2001 -2007 >110,000 pregnancies in a population of 650,000 women in rural Bangladesh, acute hepatitis, most likely hepatitis E attributed to 9.8% of pregnancy-associated deaths Implicated food /risk factors. Consumption of contaminated food and water. - Direct and indirect contact with an infected person. Pregnancy outcome: Maternal outcome: Acute hepatitis 7% to 40% case fatality rates among pregnant women [11].</p>

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<p>#7 Author's name, Year of publication Chaudhry, <i>et al.</i> 2015 [12].</p> <p>Type of study and geographical area. Descriptive article.</p>	<p>Causative agent: Hepatitis E virus. Genotype 1,2,3 &4. -Single-stranded RNA virus. -Genotype 1 and 2 infect only human and this two genotype common in countries with poor sanitary conditions such as South Asia. Serotype 3 and 4 can infect humans, pigs, and other animals, can results in sporadic infection in both developed and developing countries.</p> <p>Mode of Transmission: Fecal-oral route.</p>	<p>Incidence among pregnant women In developing countries annually 2400 to 3000 stillbirths results from hepatitis E infection during pregnancy. HEV infection during 3rd trimester may lead to maternal mortality rate between 15% to 25%.</p> <p>Implicated food /risk factors: Consumption or utilization of fecally contaminated water for food preparation.</p> <p>Pregnancy outcome: Maternal outcomes: Evidence shows HEV is an important contributor to maternal morbidity and mortality in South Asia, especially if infection occurs in the third trimester with genotype 1. The virus has a 50% rate of vertical hepatitis E infection during pregnancy and in the 3rd trimester. Especially with genotype 1, associated with more severe disease and might lead to fulminant hepatic failure and maternal death [12].</p> <p>Fetal outcomes: vertical transmission is common. Hepatitis E is associated with miscarriage, stillbirth, neonatal death in 56% of infants. Two separate studies indicated that 15% to 5% of live-born infants of mothers with hepatitis E infection died within one week of birth [12]. Breastfeeding is safe if the mother is asymptomatic, even if breast milk contains HEV RNA and anti-HEV antibodies. Breastfeeding is unsafe if the mother has acute hepatitis or an increased viral load [12].</p>
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Table 1: List of some food borne pathogens during pregnancy that can cause poor maternal and fetal health outcomes.

	Foods to avoid during pregnancy	Reason not to consume particular food items	Safer alternative
1	Any raw fish or seafood. Any raw fish items such as sushi, sashimi, raw oysters, clams, Scallops, Caviche must be avoided.	Raw fish and seafood contain pathogenic bacteria and parasites.	Any raw fish or seafood must cook at 145 degrees F.
2	Smoked seafood such as salmon, whitefish, cod, tuna, or mackerel.		Smoked fish and seafood must reheated 165 degrees F before eating. Canned smoked fish or smoked fish must thoroughly cooked before consumption.
3	Avoid consumption of unpasteurized juice such as freshly squeezed juice.	Possibility of cross-contamination of pathogenic bacteria from outer surface or skin to the inner part.	Unpasteurized juice or cider must bring to a rolling boil or boiled for at least 1 minute before consuming to kill any pathogenic bacteria

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4	Avoid unpasteurized milk and any dairy products made from unpasteurized milk.		Drink only pasteurized milk. Unpasteurized milk must bring to a rolling boil or boiled for at least 1 minute before consuming to kill any pathogenic bacteria. Boiled milk to kill pathogenic bacteria when pasteurized milk is not available.
5	Avoid Soft cheese made from unpasteurized milk. For example Brie, Feta, Camembert.		Pregnant women should eat hard cheese such as cheddar and Swiss cheese.
6	Avoid eating raw, or undercooked egg. Food items that contain raw eggs such as eggnog, raw batter, Caesar salad dressings, or homemade ice creams.		Fully cooked egg, eggs must cook until the egg yolks are firm. Food items that contain raw egg must be cook until temperature reaches to 160 degrees F.
7	Premade salad such as chicken salad, ham salad, or seafood salad. These foods are usually found from delis.	Premade salad may contain food pathogens such as Listeria.	Prepared salad at home. Cook or reheat ingredients appropriately. Food safety recommendations must follow to preparing salad at home.
8	Avoid raw sprouts such as alfalfa, clover, mung bean, radish.	These may contain E. coli or salmonella.	Cook sprouts thoroughly to kill bacteria before eating sprouts.
9	Avoid eating hotdog, cold cut meat, deli style meat, poultry and fermented and dry sausage without reheating.	These food items may contain Listeria which grows in refrigerated temperature.	Reheat these meats to steaming hot or 165 °F before eating. These food items may contain Listeria which grows in refrigerated temperature.
10	Avoid eating refrigerated meat spreads or pate:	Unpasteurized meat spreads or pate can contain Listeria.	It is safe to eat canned pate or meat spread.
11	Undercooked meat and poultry	According to CDC 50% of toxoplasmosis cases are associated with consumption of meat that is contaminated	1) Through cooking of meat and poultry, use a food thermometer to ensure internal temperature has reached 165 degrees F or recommended temperature for a particular type of meat or poultry. 2) Freeze several days at subzero temperature to reduce bacterial load before cook.3) Avoid cross-contamination with raw meat and ready to eat meal in the kitchen by separating cutting board, knife, utensil and wash and disinfect utensil that come in contact with raw meat.4) wash hand thoroughly after touching raw meat or poultry.
12	Avoid consumption of raw fruits and vegetables without properly wash them. They should avoid ready to eat food like a salad from vendors.		Wash fruit and vegetables thoroughly before peeling them or eat them.

Table 2: CDC recommendation of food safety during pregnancy to avoid food borne pathogens [27].

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The Socio-behavioral and cultural factors that act as barriers to prevent foodborne illnesses during pregnancy: These are

- 1) **Poverty and food insecurity:** Poverty is one of the significant barriers to access nutritious foods during pregnancy. One of the studies conducted in Bangladesh among impoverished women (who depends on grant-based livelihood program) indicated that one of the reasons for limited food choice or decreased food intake during pregnancy is inability to buy certain foods due to poverty. Some study participants reported they consume what they can afford, such as rice, potato, and small fish. Women participants show a fair amount of knowledge on the benefit of nutritious diet during pregnancy [14,21].
- 2) **Accessibility of recommended food during pregnancy:** Geographical and environmental factors often play a significant factor to determine the kinds of food women can eat during pregnancy. One cross-sectional study in rural Ethiopia found that women would only eat food grown or sold in the area. Cereals and legumes would be prepared out of these products are commonly eaten by all family members, including pregnant women. Small amounts of fresh produce would be grown in the area, and certain cultural stigmas would result in the foods not being consumed by the pregnant women. It is not mentioned if these food taboos were created because of the scarcity of certain fruits and vegetables in those areas [16,17]. Pregnancy itself can produce accessible barriers for women, for example, pregnant women who do not have close family members to ensure the availability of enough food for the expectant family member.
- 3) **Inadequate prenatal care:** Multiple factors act as barriers to receive prenatal care by pregnant women. Some of these critical factors are low socioeconomic status, lack of education, awareness, or difficulty accessing medical facilities due to travel cost associated with long distance between home to a health care center or inadequate social support. Other crucial factors that can affect prenatal visit are maternal age, pregnant women not living with partner, drug and alcohol abuse during pregnancy, multiparity, nonacceptance of pregnancy, adverse social context [17,22].
- 4) **Inadequate food safety knowledge among healthcare providers:** Previous studies showed that healthcare workers knowledge of safe food handling is inadequate, which can affect prenatal counselling for pregnant women [1,2]. The prenatal counselling guidelines must distinguish the food and nutrition guidelines from the food avoidance guidelines. Food avoidance guideline should include a list of foods [11] that required to avoid during pregnancy, such as uncooked meat, uncooked fish, unpasteurized milk and milk products, deli meat, and soft cheese. As these foods are nutritious foods, therefore this food avoidance guideline may confuse pregnant women unless it includes alterations or proper explanation why these foods can cause an increased risk of infection during pregnancy and what measures can be taken to reduce foodborne illnesses. Counseling during prenatal and antenatal visits must include discussion on the safe food preparation methods [4,13,23-26]. Pregnant women trust and rely on the dietary advice they receive from their physician or health care providers [4,24]. They also receive nutritional counseling from close relatives [15].
- 5) **Culture-based concepts on healthy and unhealthy foods during pregnancy among pregnant women and their family members:** The definition of unsafe food during pregnancy may vary across cultures. To many people, the hazardous foods mean unhealthy foods such as junk foods or less nutrition dense foods [15]. To many women, the nutritious food includes poultry, meat, fish, milk, dairy products, green leafy vegetables, fruits. Well, nutritious meals can be hazardous during pregnancy [18,27] due to lack of safe food handling knowledge among pregnant women and inadequate guidance they receive from health care providers on that issue. Therefore, it is essential to teach pregnant women how to avoid being ill from unsafe food preparation.

- 6) Culture, tradition, and food taboos: Food choices during pregnancy by women in many nation and geographical region depends on cultural beliefs, customs and food habits. Although pregnant women's educational level, knowledge, and awareness of the benefits of nutritious foods, antenatal visits can influence food choices [4,17,21,24,25,28]. There are various cultural believe and food taboos exist in some geographical region, especially among people with little or no educational background [14-16,28]. These food taboos can act as a barrier to provide antenatal counseling to mother regarding food and nutrition as well as food safety to prevent infections. Pregnant women who are still struggling economically to ensure proper nutrition and healthy diet choice, educate them with food avoidance guideline such as safe food handling seem challenging. One of the cross-sectional study conducted in rural areas in Ethiopia indicated, pregnant women in that region avoid eating certain foods during 3rd trimester because they believe whatever food mother eats after eight months of pregnancy, it passes mother's womb to feed the baby directly. Mother avoid leafy green vegetables such as cabbages after eight months of pregnancy as they believe it will harm the fetus. Consumption of dairy products such as milk, cheese, yogurt during pregnancy considered harmful for the fetus [16,21]. Different food-related beliefs and taboos exist in different geographical regions. For example, in some states of the USA, selling raw milk and milk products are legal. According to the Centers for Disease Control and Prevention, 82% of foodborne illnesses resulted from raw milk or raw milk products in the USA between 1973 to 2009. Consumption of raw milk and milk products is associated with a higher number of *Listeria monocytogenes*, toxoplasmosis, and *E. coli* O157 among pregnant women (the American Academy of Pediatrics, 2014). One of the reasons to support the policy of selling raw milk is some individuals believe that pasteurization destroys many healthy components of liquid such as carbohydrates, protein, vitamins, enzymes, calcium, although evidence shows there is no difference in nutritional value between pasteurized and unpasteurized milk [29].
- 7) Malnutrition and decrease immunity results from poor spacing and too frequent birth: Multiparity and poor spacing are two factors to poor adherence of prenatal care. On the other hand, inadequate prenatal care and birth control related counseling can lead to too frequent childbirth. Mather with a poor socioeconomic condition may suffer from malnutrition and other complex health conditions due to inadequate nutrition and health care. These women may suffer a weak immune system to fight against foodborne illnesses or other infections and suffer from prolonged and severe symptoms and complications.
- 8) Unsanitary living condition: Unsanitary living conditions prevent safe food preparation and cause contamination of food products. For example, washing utensils with untreated water can contaminate cooked or ready to eat foods. The unsanitary living condition can prevent maintaining personal hygiene such as hand hygiene. Poor living conditions can cause secondary transmission of infections [30].
- 9) Travel to endemic countries: A large number of people travel from developed countries to developing countries every year. Travelers are at increased risk of becoming ill with food borne pathogens. In many developing countries, there is lack of sanitary water supply, inadequate food safety regulations to ensure safe food handlings at restaurants, fluctuation of electricity supply to equipment (for example refrigerator) hamper maintenance of proper storage temperature of food. No exclusion policy of ill food handlers or early return of ill food handlers at work can lead to the spread of foodborne infection to customers. According to the World Health Organization, 15 -20 million travelers to developing countries experience diarrhoeal disease annually [30-33].

Lesson Learned

- A higher level of hormone such as progesterone is essential to the maintenance of pregnancy by down regulating of cellular immunity [18]. Therefore, pregnant women are often more susceptible to infection due to a change in the immune system. Contaminated

foods lead to a vicious cycle of poor nutrition among pregnant women and make them more susceptible to food borne illnesses and associated complications.

- Socioeconomic, culture, and environmental factors may influence food consumption habit and food selection. For example, cultural food taboos, poverty, and food scarcity may play vital role to set a limit on the food options.
- Prenatal counselling done by health care practitioners is more focus on food and nutritional counselling to prevent malnutrition and healthy pregnancy and healthy fetal growth and development. On the other hand, health care providers less likely discuss food safety recommendations such as information on how to avoid high-risk foods (Table 2) to prevent food borne illnesses during pregnancy.
- Food safety recommendation for pregnant women is a bit different than the general population. Some food borne pathogens (As discussed in table 1) are not only harmful to pregnant women but also affect the unborn fetus. The fetus may develop severe illnesses as well as fetal loss is common due to stillbirth, abortion, premature delivery.
- Some food products increase the risk of exposure to food borne pathogens to pregnant women (Table 1). Some foods items those are healthier options and usually prevalent in some culture, however not safe for pregnant women [5,28]. So, women should get proper guidance from their primary care providers. It is also essential to counselled pregnant women regarding proper food selection, alternative options of high-risk foods, and safe food handling and preparation to mitigate some of these risks.
- The review result suggested there is a significant gap in the area of food safety counselling practice by the health care providers to their pregnant patient (not women) and there is inconsistency on the level of safe food handling knowledge among practitioners. Although their knowledge and expertise on food borne pathogens and the effects of food borne pathogens on pregnant women are clear.
- Health care providers are a reliable source of health-related information for pregnant women. Further research needs to be conducted to find out ways of knowledge translation from HCPs to women of reproductive age.

Intervention: Prenatal counselling

The review result suggested there is a significant gap in the area of food safety counselling practice by the health care providers to their pregnant women and there is inconsistency on the level of safe food handling knowledge among practitioners. Although their knowledge and expertise on food borne pathogens and the effects of food borne pathogens on pregnant women are clear [1-3,13,17,24,25,26,28].

A study conducted on focus groups of new mothers to determine the knowledge and attitudes of pregnant women regarding food safety yields interesting results. It had the settings of seven family doctors offices and three focus groups of new mothers who recently delivered in British Columbia in Canada. Pregnant women completed a questionnaire at their health care provider's office. Participants of this study identify barriers to receiving food safety-related information from their health care providers. Participants mentioned their knowledge of high-risk foods, food safety practices, and listeriosis were limits [1]. A similar study in British Columbia showed that 88% of study participants (health care practitioners) were aware of listeriosis, only 35% of them counseled their patients on the risk of listeriosis during pregnancy [2]. Another Study showed that out of 23 health care providers, only eight had provided food safety information to their pregnant patients [3]. Limited Knowledge on the food safety issue and limited time spend with patients are common barriers to

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provide food safety-related information to their patient [3]. An online survey was conducted to assess the knowledge and attitude of U.S. physicians regarding pros and cons of seafood consumption by their patient yielded the deficiency of the food safety-related knowledge (such as mercury and other contaminations of seafood) among health care providers [34].

Example of suggested intervention

The review found current Maternal and Child Health Handbook program compelling intervention for both health care practitioners and pregnant women to convey a health-related message [35-40]. The Maternal and Child Handbook (a booklet that outlines a safe pregnancy, delivery, and child health recommended by WHO) has been introduced in 30 nations to improve mother's and child's health outcomes. The booklet details various aspects to a healthy pregnancy adapted, such as the use of nutritious foods, iron, and folic acid. Some sections of this book also discussed safe food handling practices and food-borne pathogens such as listeriosis [40]. This paper would like to recommend that the Maternal and Child Health Handbook update the food safety section according to current recommendations. Although this booklet contains standard information regarding mother and child health, it is an example of a culturally sensitive health resource for pregnant women and child up to 6 years of age [35]. This book is also a tool for a healthcare worker to keep records and monitor child's health from birth until the age of 6. This paper also suggests including less text but more diagrams and easily understandable depictions, which would be more useful to an individual with low literacy rates. Finally, this paper recommends that there needs to be more research and focus on determining effective ways to better communicate food safety recommendations to pregnant women by the health care providers [35].

Conclusion

Food safety is a global public health priority as unsafe food leads to morbidity and mortality associated with food-borne illnesses. Every year worldwide 600 million (1 in 10 people) become ill with food poisoning, and 420,000 people die as a result of contaminated food consumption which leads to a loss of 33 million healthy life years or DALYs (Disability Adjusted Life Years) [41]. Pregnant women, infants, and young children are vulnerable groups who can have severe complications from food-borne illnesses. Contaminated foods lead to a vicious cycle of poor nutrition among vulnerable people and make them more susceptible to food-borne illnesses and associated complications. Evidence shows that health care workers' knowledge on safe food handling is inadequate, which can affect prenatal counseling for pregnant women. The prenatal counseling guideline must distinguish the food and nutrition guideline from the food avoidance guideline. This guideline may confuse pregnant women unless safe food preparation methods are described to rectify unsafe methods. Finally, this paper recommends that there needs to be more research and focus on determining effective ways to better communicate food safety recommendations to pregnant women by the health care providers.

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