Social Determinant Effects on Gestational Diabetes Mellitus and Hypertensive Disorders of Pregnancy and Their Effects on Both Mother and Fetus

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Gestational diabetes mellitus (GDM) and hypertensive disorders of pregnancy (HDP) are two different types of maternal cardiometabolic disorders. GDM can be developed even in women without a previous history of diabetes. It affects around 14% of pregnancies and there is no current treatment for the disease other than diet and exercise1. HDP comprises three different diseases called chronic hypertension, gestational hypertension, and pre-eclampsia-eclampsia. What unifies the three is that they all affect the mother's blood pressure. The purpose of this literature review is to explore how the five social determinants of health influence a woman's susceptibility to GDM and HDP, while highlighting the short and long-term effects on both the mother and fetus. While some short term effects of GDM and HDP such as high blood pressure or insulin resistance and long-term effects such as cardiovascular disease or maternal/fetal obesity are known, the wide range of adverse outcomes are yet to be elucidated. In addition, the lack of a concrete diagnostic criteria for these pathologies results in a wide variety of disease severity and difficulty in establishing a universal therapeutic strategy. For example, glucose levels have been used as an indicator for GDM. However, glucose levels even lower than the normal range still results in adverse outcomes for the fetus. Therefore, a comprehensive review that elucidates how the social determinants of health contributes to the pathogenesis of GDP and HDM is invaluable so that possible intervention strategies to reduce its incidence.

Introduction

Cardiometabolic specifically refers to conditions such as diabetes and insulin resistance. Maternal cardiometabolic disorders refer to these conditions that occur to a woman when pregnant. Gestational diabetes mellitus (GDM) and hypertensive disorders of pregnancy (HDP) are the two most common types of maternal cardiometabolic disorders (CMDs)[1]. Gestational diabetes mellitus (GDM) is a common pregnancy complication and happens when a woman develops high blood sugar during pregnancy. There are a variety of risk factors such as obesity and family history, but there is still much more research to be done on the disease such as in risk-assessment, diagnosis, and more. GDM can have negative effects on both the mother and fetus in the short and long term.

Hypertensive disorders of pregnancy (HDP) include complications such as pre-eclampsia, gestational hypertension, and chronic hypertension. Pre-eclampsia, for example, occurs when the mother is diagnosed with high blood pressure and proteinuria after the 20 week mark in pregnancy. This diagnosis criteria has evolved in the past 10 years and now women can be diagnosed with preeclampsia without proteinuria[1]. Common risk factors for HDP include higher body mass index, higher maternal age, preeclampsia in previous pregnancies, multiple gestation, and antiphospholipid antibody syndrome[2]. Many of these factors connect to the different social determinants of health. Higher body mass index can be connected to a poor diet from a lack of economic stability. Preeclampsia from previous pregnancies can be the result of poor access to healthcare that caused the pathology to not be properly dealt with. The distribution of these two diseases among areas with varying social determinants of health is key in elucidating concrete approaches to reduce the incidence of HDP and GDM. The social determinants of health (SDOH) are categorized as the conditions that people live in. SDOH is split into five branches which are economic stability, education access and quality, health care access and quality, neighborhood and environment, and social and community context. This review will examine the effects of a lack of the five SDOHs on the pathogenesis of GDM and HDP. Studies have shown that HDP and GDM are unevenly distributed amongst areas with a lower income compared to higher income areas[1], which is something that this paper will address along with the effects that social determinants other than economic stability have on the two diseases.

Gestational Diabetes Mellitus (GDM)

. Gestational diabetes mellitus (GDM) was found to affect approximately 14% of pregnancies around the world, which is around 18 million births per year in 2017[3]. During pregnancy, a woman's body changes in order to house the fetus through a variety of adaptations. One change that occurs is the body's sensitivity to insulin. This sensitivity is what allows the body to store energy for the fetus in the future. However, the release of certain local and placental hormones such as estrogen, progesterone, cortisol, and placental growth hormone result in insulin resistance in the mother[3]. This change causes the blood glucose levels to increase so that the glucose can be used to support the fetus, which is something that most pregnant women will go through[3]. The normal metabolic adaptations to pregnancy include the breakdown of stored fat, resulting in free fatty acid concentrations and glucose-stimulated insulin secretion (GSIS)[3]. However, when such normal metabolic adaptations to pregnancy do not happen, GDM is the result. Gestational diabetes is usually diagnosed in the second or third trimester[3]. However, the diagnosis criteria for the disease is something that health professionals are still debating. As of now, the ADA, the World Health Organization (WHO), the International Federation of Gynaecology and Obstetrics, and the Endocrine Society advocate that the International Association of Diabetes and Pregnancy Study Group's (IADPSG) criteria is most accurate in the diagnosis of GDM[3]. This criteria was established based on a large study of 23,000 pregnant women known as the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) Study[3]. The results found that glucose levels even below the normal diagnostic range for GDM can be dangerous for both the mother and fetus, so the threshold must be lowered. Women should undergo glucose testing at their very first prenatal visit1. This change has caused more women to be diagnosed with GDM, which can be helpful in the long run. However, this also means higher healthcare costs, which this paper will later connect using the social determinants of health. The risk factors for gestational diabetes include obesity as a result of unhealthy lifestyle, ethnicity, an unhealthy (often westernized) diet, older maternal age, and prior familial diagnosis of the pathology[3]. This paper further analyzes the potential risk factors of HDP.

Hypertensive Disorders of Pregnancy (HDP)

Hypertensive disorders of pregnancy (HDP) is the leading cause of maternal death globally2. Chronic hypertension, gestational hypertension and preeclampsia-eclampsia are the three principal parts of HDP. Chronic hypertension is when the mother develops high blood pressure before pregnancy or prior to the 20 week time point of pregnancy3. High blood pressure occurs when the force of the blood against the walls of the arteries becomes too high. While normal blood pressure is 120/80, anything above or below this range requires attention. There are two major categories of chronic hypertension, which are mild and severe. Mild is up to 179 mm Hg systolic and 109 mm Hg and severe is categorized as greater than 180 systolic or 110 diastolic[2]. This high blood pressure can lead to future problems such as preeclampsia-eclampsia later on in pregnancy, prematurity, intrauterine death, and placental abruption[2]. Gestational hypertension is when high blood pressure occurs during the pregnancy, often after the 20 week mark of pregnancy. As gestational hypertension specifically refers to high blood pressure while pregnant, it does not persist post-partum. However, it is possible for gestational diabetes to complicate into chronic hypertension post pregnancy. Lastly, preeclampsia-eclampsia is when the mother develops high blood pressure with proteinuria after the 20 week mark of pregnancy. Women with preeclampsia-eclampsia often show signs of end-organ or uteroplacental dysfunction, which means that their organs are not functioning properly or the placenta is not fully developing[2]. Preeclampsia-eclampsia can lead to symptoms such as chronic headaches, nausea, or trouble breathing, and in some severe cases, it can lead to seizures, which are known as eclampsia[2]. Subcapsular hemorrhages and hepatic ruptures can also occur as a result and have a staggering 60% morbidity rate associated with this pathology[2]. While the three pathologies are relatively diverse in their causes and onset of diagnosis, all of them are connected to high blood pressure at the core.

Early intervention is crucial for better health outcomes for both the mother and child since pre-eclampsia is a maternal disease, so the management is centered around reducing the risk for the mother and fetus. Common risk factors for HDP include higher body mass index, higher maternal age, preeclampsia in previous pregnancies, multiple gestation, antiphospholipid antibody syndrome, and a genetic predisposition to the pathology[2]. Many of these factors connect to the different social determinants of health. Higher body mass index can be connected to a poor diet from a lack of economic stability. Preeclampsia from previous pregnancies can be the result of poor access to healthcare that caused the pathology to not be properly dealt with. Tests such as antenatal testing are used to assess the fetal well-being[2]. It is also of important note that preeclampsia-eclampsia can still occur even when pregnancy is over, a state known as postpartum preeclampsia. This paper aims to contextualize all five social determinants of health (SDOH) in the incidence of gestational diabetes mellitus (GDM) and hypertensive disorders of pregnancy (HDP).

Economic Stability and GDM

Economic stability is characterized by a person's access to different essential resources[4]. It often depends on a person's livelihood or source of income that they need to support them-

selves. Money plays a key part in society and is what gives people access to things such as quality healthcare, nutritious food, housing, and other necessities. There is a large gap between the burden that GDM causes in low income countries versus high income areas2. As the diagnostic criteria for gestational diabetes mellitus continues to evolve with new research, more and more women are being diagnosed. As of now, approximately 9-25% of pregnant women have been formally diagnosed with GDM[3]. While this does mean that more women are now aware of their disease and how to handle it, it comes at a cost. Health-care costs may potentially increase along with the psychological burden that the new expenses can have on a mother. Women who are also not able to afford certain lifestyles, such as one that is filled with a nutritious diet, can have a higher risk of developing gestational diabetes. One risk factor of GDM is obesity or a lack of nutrient-dense foods. Many women who follow a westernized diet, which lacks green leafy vegetables, fruits, protein, and other critical, healthier components, are known to have a higher intake of processed foods, sugars, and fats. Places such as McDonald's, which are known to provide food for a cheaper price, serve a lot of processed items without the necessary nutrients that a pregnant woman needs to stay healthy. According to the official McDonald's website, a Big Mac, which is one of their most popular burgers, contains 590 calories, 34 grams of fat, 9 grams of sugar, and 3 grams of dietary fiber[5]. The only vegetables in the burger are the shredded lettuce and pickles, which do not amount to enough greens. The low dietary fiber content is alarming. The average adult should be consuming around 25 to 30 grams of dietary fiber per day, which is ten times the amount found in a Big Mac.

One's diet can also affect the microbiome within the body that plays a key part in regulating health and disease. Collinsella is a genus which can affect metabolism by affecting the absorption of nutrients and is connected to the circulation of insulin[5] also important in the development of the gut microbiota. Changes in this microbiota, which can be caused by a higher body mass index, can lead to increased insulin resistance. Gut microbiota dysbiosis, which is an imbalance in the gut microbiota of the host, is also a symptom of type 2 diabetes. Specific food types such as a westernized diet tend to lack basic nutrients such as dietary fiber[5]. A high dietary fiber content in one's diet can reduce the amount of Collinsella in the body, which has been shown to improve the metabolic rate in patients with diabetes[5]. A higher metabolic rate means that the body will be able to burn more calories quicker. Gut microbiota profiles were analyzed by the SPRING cohort for a study done on 53 overweight and 73 obese women who were all pregnant in order to find a correlation between Collinsela and insulin resistance. The study tested the fasting blood of each of the women when they were on their normal diets and was analyzed for insulin, blood glucose, total cholesterol, and more. According to the results of the study, the group of overweight women with higher Collinsella levels had high insulin levels, and the group of obese women with lower Collinsella abundance had lower insulin levels[5]. One's economic standing should not be able to affect their healthy living, specifically their diet. Health providers should prioritize providing families with the necessary nutritional produce in order to mitigate the effects of an unhealthy diet regardless of the patient's economic status. This can be done through focused outreach programs to low income families sponsored by hospital funding to also spread awareness on the pathology and how it can be controlled.

Economic Stability and HDP

Economic stability also has a multitude of effects on hypertensive disorders of pregnancy. Because the risk factors of HDP and GDM are quite similar, they share many of the same effects. For example, a less nutritious and balanced meal, which is often cheaper, increases a person's risk of HDP just like it does GDM. The distribution of HDP in high income countries (HICs) versus low and middle income countries (LMICs) is the primary focus of this section. A 2019 survey sought to chart the prevalence of HDP according to the six different regions categorized by the World Health Organization (WHO). This survey found that Africa had the highest average prevalence of the disease as compared to areas such as North America and the Western Pacific in general[1]. Without going into the social aspect of this section, the data presents interesting facts because of its connection to HICs and LMICs. Africa has struggled throughout history to escape the clutches of poverty throughout the continent. The slave trade, effects of imperialism, mass genocides, famine, and vast geography are only some of the factors that have contributed to the low-income situation. A lack of economic stability in Africa means less knowledge on HDP and how to help women prevent or treat it. More research needs to be sponsored and supported in lower income areas in order to educate more people on the dangers of the disease and how to treat it responsibly. Volunteers and hospitals with enough money can also bring supplies to low income areas in order to treat the people affected by the pathology. Without doing so, the disparity amongst women being diagnosed with HDP according to their economic status will only continue to grow.

Education Access and Quality for GDM and HDP

Educational access and quality is a social determinant of health that encompasses an individual's overall education as a result of their access, while simultaneously linking it to their prospective jobs and income. This paragraph will specifically

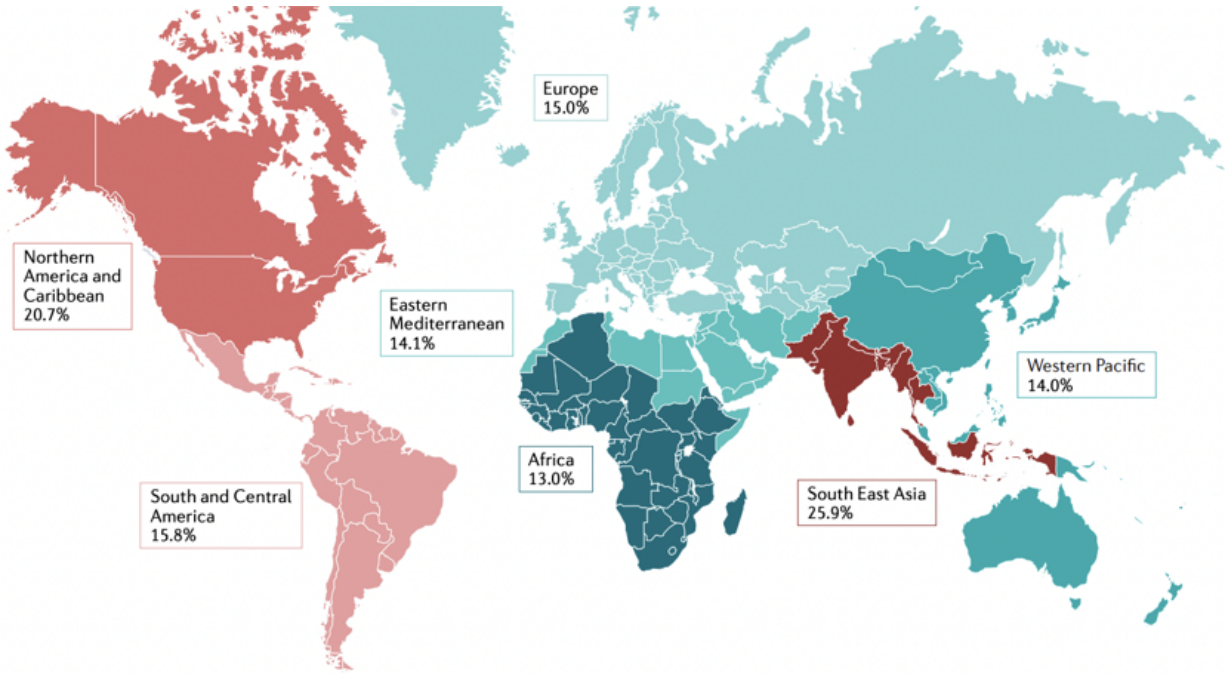

Fig. 1 The map above displays data taken from 2019 on the prevalence of HDP in different areas of the world. Red in an area indicates a high prevalence of HDP (from example in Africa), while little teal shows a lower prevalence of the disease [1]. The map shows how the areas with lower economic stability are more widely affected by HDP than when compared to areas with higher economic stability such as North America.

focus on how being uneducated on both GDM and HDP as pathologies can lead to more problems in the future. The diagnosis criteria for both GDM and HDP continues to evolve as more and more studies are being done. Signs of GDM can be nonexistent and often need a blood test to indicate high blood sugar. Online training modules have been tested to determine their ability to sufficiently educate women on the disease, promote self-efficacy in providing information on GDM, and recommend different forms of diabetes prevention. The results of this testing found that out of the 82 individuals who completed the testing and 20 who completed the training and assessments, there were overall improvements in knowledge such as approximately a 20% improvement in GDM knowledge [6]. According to the research, training modules can be a highly effective way of educating people on GDM and HDP since it can be paced and revisited based on one's own understanding. However, one downside of this form of education is that not all women may have access to such modules on the internet and operating these sites can be a difficult task on its own. Simpler and more accessible ways of educating women on GDM need to be created and spread amongst the general public. Women who are not knowledgeable about such information during pregnancy can eventually lead to devastating long-term effects on the mother and child. Health care providers should spread information on such online training modules in order to further educate women and families on the risks, prevention, and treatment of GDM so the cases of the disease can be mitigated. This spread of knowledge could occur during hospital appointments or even doctor visits to certain neighborhoods where less people have access to healthcare.

Health Care Access and GDM

Health care access and quality is a social determinant of health that refers to a person's ability to obtain equitable and quality healthcare services to maintain a better quality of life. This paragraph will focus on how a lack of healthcare access and healthcare professionals can affect possible treatment opportunities for patients. When dealing with this pathology, timing and proper treatment is highly important in mitigating the risks and effects that it can have on the mother and fetus. In order for patients to be provided timely and appropriate care, proper health care must be provided. Many doctors have turned to telemedicine intervention, which is a form of remote diagnosis and treatment for people who do not have direct access to in-person health care [7]. People of color tend to fall into this group of people with less direct access to healthcare such as in the state of Virginia where in certain areas with a higher black

population, there are less hospitals in the area than when compared to the distribution of hospitals in primarily white populated areas. While telemedicine is a good option for people who can not physically be at a hospital, it is still not accessible for people who do not have access to the internet or have the funds to pay for such a visit. While GDM is a chronic condition, existing research has also detailed methods to curtail its incidence. Routine glucose monitoring is a key method implemented that allows patients to better control their disease and adapt the treatment plans to their needs. Studies have shown that pregnant women with GDM who use different continuous glucose monitoring devices can have improvements in their HbA1C and less neonatal complications, such as a decreased risk of neonatal hypoglycemia by 55%[8]. However, steps like these often require access to healthcare professionals. Close monitoring allows for healthcare professionals to implement lifestyle changes by analyzing data. The continuous glucose machine (CGM) is worn by the patient and the data gathered is then analyzed by a clinician or the patient themselves. CGM devices work by testing the interstitial fluid in the subcutaneous layer, which contains nutrients from capillaries and waste byproducts from cells. It also is responsible for providing cells with glucose. A sensor is inserted into the patient, often by a clinician, and the data is transmitted wirelessly[8]. This sensor measures the glucose concentration. The data from the device, which can sometimes be overwhelming and difficult to interpret by an inexperienced person, can be crucial in the controlling of GDM. Professional use or practice-based CGMs can only be found in a professional healthcare setting. This specific type of CGM device only requires the patient to wear it for 6-14 days so that the data can be actively used to assess the effects of certain foods and exercise on the health of the mother and even fetus[8]. Without the help of a healthcare professional, there is the risk of a less successful use of CGMs and people or clinics that can not afford the CGM devices have limited options. Health care providers and clinics with the supplies should provide different areas with less resources continuous glucose monitoring tests in order to help more mothers figure out the best course of treatment with their respective doctors and successfully live with the disease.

Health Care Access and HDP

The distribution of hospitals across any given geographical area serves as an indicator of one's access to healthcare, which is necessary in preventing and controlling hypertensive disorders of pregnancy. In certain places with a higher population of Caucasian people than people of color, there is a clear disparity amongst the distribution and amount of hospitals available to the public. The state of Virginia in the United States is known for its higher Caucasian population compared to its African American population. Petersburg, a city located on the east side of Virginia, has approximately 33,000 people and a higher African American population when compared to the Caucasian population. Fredericksburg, another city in Virginia and north of Petersburg, has a population of approximately 28,000[9]. In contrast, Fredericksburg has a higher Caucasian population than that of people of color. The city of Petersburg has ten total hospitals for varying purposes for the population of over 30,000 people to utilize. Some of these hospitals also do not have the proper resources to provide pregnant women with the necessary maternal care in order to diagnose and tackle HDP. Seven out of ten of these hospitals are located in the southern portion of the city and the three are further north. Around 20% of families in Petersburg live in poverty[9]. The central and western parts of Petersburg have no close access to hospitals within city limits. Fredericksburg, with its higher Caucasian population, has seventeen total hospitals. This number is regardless of the fact that Fredericksburg has a population around five thousand less than Petersburg and the city itself is smaller in size. While the hospitals in Fredericksburg are located more in the northern region, the high volume of hospitals makes it more accessible to the public and the women who are in need of help. Around 10% of families in Fredericksburg live in poverty[9]. When HDP goes undiagnosed, it can cause short-term effects such as hospitalization and long-term effects such as cardiovascular disease (which this paper will go more into depth about later into the essay). The lack of convenient hospital locations in different areas can help explain the clear division amongst people of different races diagnosed with HDP. Rather than placing multiple hospitals within the same close radius of one another, more hospitals need to be built in areas with less access to hospitals in order to provide the proper care to a larger number of people.

Neighborhood and Environment and GDM

Neighborhood and environment as an SDOH is categorized as where a person lives and the situation in that area. This includes the amenities or the type of people that a person is surrounded by in their home environment. Being in a high stress relationship, without a clean source of water, and no food with high nutritional value close by (see previous paragraph of effects of economic stability on GDM) can all affect a woman's susceptibility to GDM. This paragraph will specifically focus on how different levels of air pollution in an environment can make a woman more susceptible to GDM. This includes factors such as being around smokers, organic pollutants, and more. Air pollution is known to be connected to maternal CMDs as it can cause DNA damage and placental oxidative stress[1]. A review including 11 different studies shows that fine particles of nitrogen oxides and SO2 increases a woman's risk of GDM[1]. While there is still much

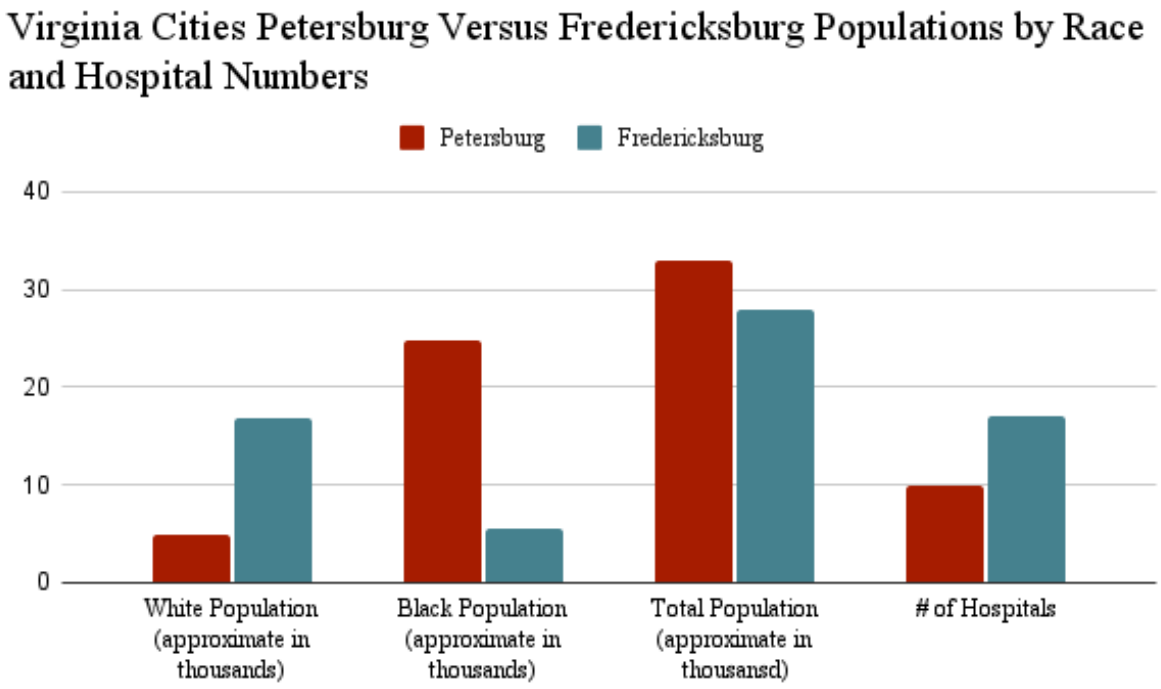

Fig. 2 This table displays the population (in thousands) and number of hospitals in two different cities in Virginia. Petersburg is known for its higher black population compared to its white population and Fredericksburg is the opposite. The data shows that a higher black population correlates with a fewer number of hospitals in the immediate area, which can give evidence as to why there is a higher number of people of color who are predisposed to HDP because of their lack of access to proper healthcare.

research to be done in this particular field, it is important to note that isolating the sole effects of air pollution on GDM proves to be difficult. A clinical study aiming to assess the connection between GDM and exposure to air pollutants utilized the electronic records of 395,927 pregnancies from the Kaiser Permanente Southern California health records [10].The average concentration of certain air pollutants such as nitrogen oxide, ozone, sulfate, and ammonium were measured based on the locations of the mothers. The data was also altered according to pre-pregnancy BMI, race, education, smoking during pregnancy, and more. Linear models utilizing g-computation were then used to approximate the effects of air pollution on GDM. There were models for the effects of single pollutants versus multiple pollutants done as well. The study proved that there was the highest risk of developing GDM when exposed to PM2.5, PM10, NO2 and PM2.5 constituents [10]. These constituents are separated based on their size, but are essentially all fine particles. The data showed a 10.9% increased risk of GDM when mothers were exposed to single pollutants. The highest odds occurred when the exposed pollutant was nitrogen oxide (NO2) [10]. The data associated with multiple pollutants also showed an increased risk of GDM when exposed to different pollutants such as black carbon PM2.5. While the data from this study is concrete and can apply worldwide since such pollutants are found everywhere at varying concentrations, it can be expanded upon more in order to find the impact of other air pollutants on GDM. Air pollution is a problem that has been affecting the world since even before the Industrial Revolution in the 1760s and if the government and people invest more money or time into things such as sustainable living and clean energy, one possible effect could be lower incidences of GDM in women who live in areas with high air pollution. Such forms of sustainable living include less plastic waste by going to the farmer's market and clean energy includes solar power.

Neighborhood and Environment and HDP

Similarly, to how environmental pollutants can have adverse effects on a woman's susceptibility to GDM, it can also have similar negative effects on HDP. Per- and polyfluoroalkyl substances (PFAS) are certain chemicals that are known for their abilities to resist heat, oil, water, grease, and stains [11]. They are often found in consumer products, water sources, the envi-

ronment, and more. PFAS have already been associated with increasing a person's risk of developing certain cancers, kidney disease, liver disease, immunotoxicity, and the list continues to grow[12]. PFAS are highly resilient due to their makeup and properties, which allows them to seep into the ground, contaminating groundwater, drinking water, and the environment. Many people in certain areas drink water contaminated with PFAS on a daily basis. Around nine epidemiological studies have been done on the connection between PFAS and HDP pathogenesis[12]. One of these studies from 2019 by Wikström and colleagues investigated the connection between eight different PFAS and preeclampsia. The study was done on women in the Swedish Environmental Longitudinal, Mother and child, Asthma and allergy (SELMA) cohort. The data showed a ratio of 1.53 as the PFO concentration and exposure increased[12]. Another study in China from 2020 that also used data from a previous 2019 study showed a correlation between PFHpA, a subset of PFA, and increased risk of hypertension during pregnancy[12]. The study from 2019 examined the concentration of six PFAs in the umbilical cord blood of 674 women in China. There was no information found on the controlled variables such as maternal age of the women. One out of the six PFAs (perfluorobutanesulfonic acid) was shown to have a strong connection to HDP diagnosis[12]. The 2020 study determined the amounts of ten different PFAs through the blood tests of 3220 women. One hundred and thirty-five of these women would eventually develop HDP and the study found the connection between PFHpA and HDP[12]. Studies are also being done on the effects of traffic-related air and noise pollution on susceptibility to HDP, but there is not yet much concrete evidence on it[13]. Increasingly careful precautionary measures must be taken in order to assure the protection of different neighborhoods from dangerous PFAS that are being unknowingly ingested. The testing of water for PFAS in different neighborhoods can lead to less cases of HDP related to this cause.

Social and Community Context and GDM

Social and community context as an SDOH is very broad. It includes huge branches of social life such as race, discrimination, community impact, upbringing, more. This essay will interpret social and community context as having to do more with race, since the other parts intersect more distinctly with the other SDOH. Worldwide estimates of GDM numbers are difficult to rely on because of the inconsistencies and room for error. The International Diabetes Federation was able to estimate that in 2017, around 14% of the 1 million live births are affected by GDM[3]. South-East Asia had the highest number of GDM cases (24.2%) and the lowest was seen in Africa[1]. In the United States, Native Americans, Hispanics, Asians, and African-Americans women have the highest chances of developing GDM. This data is difficult to interpret in order to connect it to race because there are a variety of factors (that tie into the other SDOH) for why the data may be the way it is. For example, many people of color face discrimination because of their race, directly influencing their access to healthcare, education, and economic stability. (More information on the effects of education and healthcare access can be found in previous paragraphs with those titles). For example, in regards to access to healthcare, the International Diabetes Federation estimated that approximately 90% of worldwide reported cases of hyperglycemia happened in low and middle-income countries such as Africa where access to healthcare is limited[3]. Higher income is often correlated with better opportunities to enlist the services of specialized health professionals. Thus, those who have lower-income are often not able to afford necessary and elective services that correspond to better health outcomes. Certain races do, however, tend to have a family history of GDM that affects their susceptibility to the pathology, which is not attributed to the other SDOHs. GDM is connected to lower number and decreased function of the mitochondria in skeletal muscle cells, which studies have shown to have a possible connection to genetics[3]. On the other hand, race can be considered more of a social construct rather than a separation based on true genetic differences, so a person's predisposition to pathologies can be entirely separate from genetics[1]. The data on the distribution of GDM is also entirely based on the reported number of cases of the pathology, not taking into consideration that certain demographics may not have the resources of education to report their disease. More research has to be done in this area in order to get concrete evidence on the effect of race or where someone comes from, regardless of their economic standing or discrimination, in order to better understand how to deal with the disease and take better care of patients. Such new studies could effectively be conducted for this purpose by grouping together pregnant women with highly similar economic and educational backgrounds, but varying racial backgrounds in order to test the susceptibility of each person to GDM.

Social and Community Context and HDP

HDP is one of the most common causes of maternal deaths worldwide, which attests to its distribution everywhere. In contrast to the distribution of GDM, HDP is most prevalent in Africa[1]. Approximately 334.9 out of every 100,000 women there have HDP[1]. Southeast Asia and the Middle East are the next to follow with the highest numbers. The distribution of HDP seems to be more reliant on the income distribution in different areas. This makes it difficult to assess how specifically race contributes to the disease. However, studies have shown that African American women and Filipino women have the highest chance of developing HDP as well as

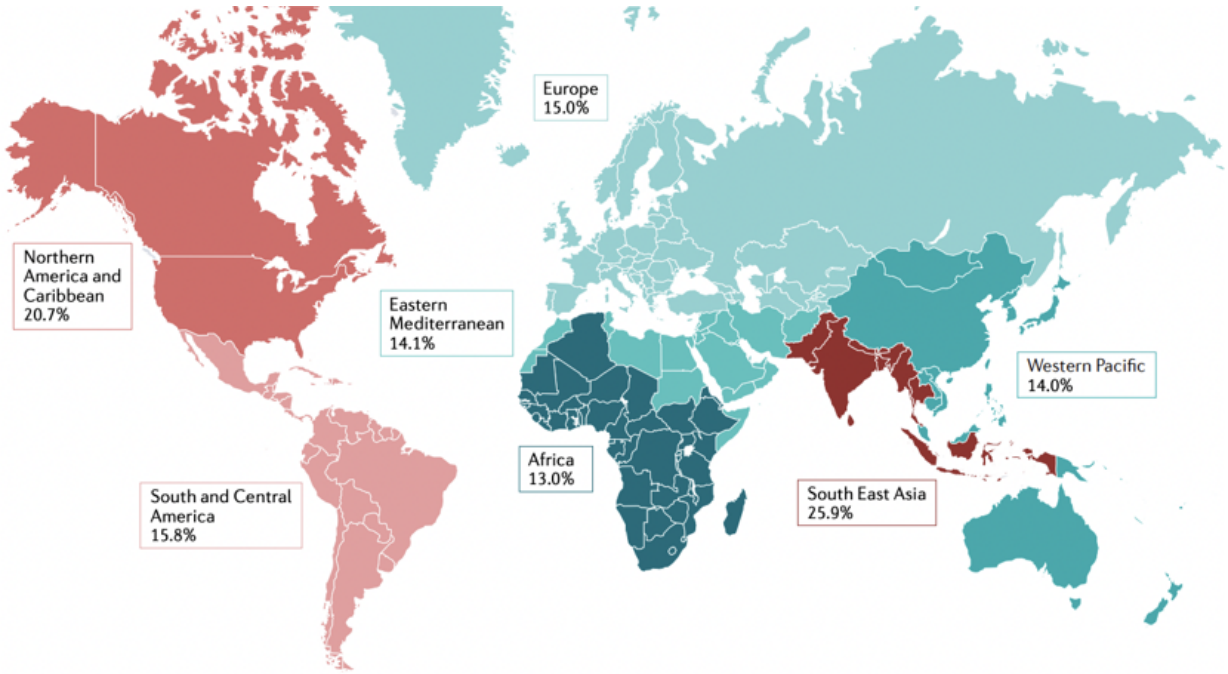

Fig. 3 The map above displays the prevalence of GDM in 2021. The percentage displays the amount of pregnant women with GDM in that area and clearly displays the distribution of the disease depending on the region [1]. According to the graph, the highest percent of GDM according to population is in South East Asia. Northern America and Caribbean and South and Central America are also following closely with high percentages of GDM.

other populations of color. A study done on people of African Caribbean origin proved that white people still have a lower chance of developing HDP when compared to them [1]. The stress of racial discrimination can have a worsening impact on the health of women and increase their chances of developing HDP. It is crucial to consider and continue researching the effects that these specific SDOHs have on the incidence of these pathologies as they have debilitating effects on the mother and fetus. Similarly to the structure of study for the previous paragraph on Social and Community Context and its connection to GDM, the studies isolate the variable being tested, which is race, by grouping together pregnant women with similar backgrounds, but varying racial identities in order to test the susceptibility of each person to HDP. The next section seeks to assess the long and short term effects of these diseases on the mother and fetus in order to highlight the importance of reducing the incidence of HDP and GDM.

Short-Term Effects of GDM on Fetus

GDM can lead to a variety of short-term and long-term effects for the fetus. The severity can change depending on how well the disease was controlled by the mother. For the fetus, the short-term effects are associated with when they have not yet been born to when they are still newborns. GDM and also pregestational diabetes mellitus (PGDM) puts the fetus at risk of excessive birth weight, otherwise known as macrosomia [7]. This is a result of the mother's hyperglycemia and children with this are born higher than the 90th percentile. Newborn bodies tend to be less proportionate and have more body fat. Macrosomia can lead to the child dying in the womb, neonatal morbidity, and Erb's palsy [7]. In addition, macrosomia can cause injuries to the fetus due to the traumatic nature of the delivery. Shoulder dystocia occurs when the child's shoulders get stuck in the pelvis due to their large size and occurs more often with women lacking pregnancy care. Neonatal hypoglycemia can also occur, which is when the baby is born with dangerously low blood sugar levels. While this may not be categorized as a short-term effect, GDM in mothers can also lead to morbidities in the offspring. The rate of having a stillbirth is also 4.0-51 times higher in women with diabetes compared to those without [7]. Perinatal death can also occur, which is when the fetus dies after 24 weeks' gestation or dies in its first week postpartum. Perinatal death is more likely to occur because of a lack of glycemic control. While there are many more short-term effects that GDM has on the fetus, these are only a few with concrete evidence from scientific studies backing them up.

Long-Term Effects of GDM on Fetus

There are numerous studies being done on the long-term effects that GDM can have on the offspring. It is associated with having neurobehavioral and psychiatric disorders. A study was done that examined the motor abilities of 32 children, ranging from six to twelve years old. All of their mothers had GDM and the children had similar levels of schooling. The trial also included 57 children with mothers who had PGDM and 57 control children[7]. The findings found that there was a higher number of children with a lower IQ when their mothers had GDM when pregnant. Some studies have shown that the decrease in IQ of the offspring is connected to the mother's improper control of her GDM[7]. This improper control can be the result of no access to healthcare, not enough money to deal with the disease, a lack of knowledge on the gravity of it, and all of the social determinants of health. Bloch-Petersen found that children born with diabetic mothers can have lower language, speech, and motor development compared to other children[7]. However, this only occurs in cases where the GDM affected the fetal growth in a negative way. GDM can also predispose children to attention deficit disorder (ADHD). One study found the children of mother's who were treated for severe GDM had a significant increase in the rate of ADHD[7]. GDM in the mother can also cause the offspring to have different neuropsychiatric problems such as Autism Spectrum Disorder (ASD). People with ASD often have trouble communicating properly with others. Obesity caused by maternal PGDM is also connected to an increased risk of ASD. Gestational diabetes mellitus can also increase the chances of malformations in the fetus such as neural tube defects, renal anomalies, and other musculoskeletal system malformations. All of these long-term effects on the fetus have not been shown to have a correlation with why the mother has GDM, but just the mother having the disease. The long-term effects of GDM are still being investigated and there is much work to be done since it is technically more difficult to get accurate data on grown people compared to isolated newborns.

Short-Term Effects of GDM on Mother

The previous paragraph about GDM as disease at the beginning of the paper discusses the process of gestational diabetes mellitus. It explains how the mother develops hyperglycemia, which is high blood sugar. This is a result of insulin resistance, which is often the body's overreactive response to pregnancy. Insulin controls the amount of sugar in the blood, so when glucose can not properly enter the cells, it tends to build up in the blood-stream[3]. There are customarily no physical symptoms experienced by the mother, such as headaches of nausea. In most cases, GDM resolves itself post-pregnancy, so many of its symptoms are short-term.

Long-Term Effects of GDM on Mother

Similarly to in fetuses, mothers with GDM have a higher chance of developing chronic diseases such as diabetes, metabolic syndrome, and cardiovascular disease. Type-2 diabetes is a common disease for mothers to develop after GDM. A study showed that approximately 40-50% of mothers who had GDM eventually developed Type-2 diabetes around 5-10 years after their pregnancy ended[7]. Type-2 diabetes is when the body does not produce enough insulin on its own, or is resistant to insulin. Similarly to with GDM, the glucose is not able to be absorbed by the cells, so it builds up in the blood-stream, resulting in higher blood sugar. The treatment for type-2 diabetes includes medicine, diet, exercise, and lifestyle intervention, in general.

Short-Term Effects of HDP on Fetus

While there are a variety of different short-term effects of HDP on fetuses, a highly researched one is intrauterine growth restriction (IUGR). IUGR is defined as impaired growth as well as development of the fetus[14]. Infants are categorized as having IUGR when they are below the 10th percentile in birth weight. The mortality rate for newborns with IUGR is much higher compared to babies without it. It is also associated with hypoxia, which is the lack of oxygen at birth, hypoglycemia, which is low blood sugar at birth, and premature birth[14]. Placental abruption can also occur in some cases[12]. This is when the placenta separated from the walls of the uterus prior to delivery. It can be life-threatening for both the fetus and mother due to the heavy-bleeding that it can cause.

Long-Term Effects of HDP on Fetus

The offspring of a mother who had HDP has a higher likelihood of developing certain diseases later in their life. These include hypertension, cardiovascular diseases, and strokes[15]. While the genetics of preeclampsia do impact the long-term effects on the fetus, other factors such as lifestyle also play a role and must be factored in. Children born from a preeclamptic pregnancy can have impaired vascular function. The vascular system is what circulates blood throughout the body and also a part of other systems such as the respiratory. Some of these children are also found to have hormonal changes different from other children not born from a preeclamptic pregnancy. In their adolescence, male and female offspring may have unusually high levels of testosterone[15]. These hormonal differences can lead to differences in the process of puberty for these children and can affect their development of hypertension and cardiovascular disease in the future.

Short-Term Effects of HDP on Mother

Pre-eclampsia is the specific HDP that this part of the essay will focus on. Maternal morbidity is one of the drastic effects of HDP. Cerebrovascular bleeding is the next short-term effect. This is when cerebral aneurysms rupture, which can lead to serious bleeding in the brain[15]. In some cases, the blood can destroy some of the brain cells. Retinal detachment is when the tissues in the back of the eye start to pull away from the tissues supporting it. This can lead to flashing or darkened vision, eye floaters, and more. Treatment for this is possible, which is why it is in the short-term category[15]. HELLP syndrome is the next effect. It is a life-threatening condition that causes red cells to break down. It can lead to intense nausea, headaches, swelling, and more. Treatment is also available for this. The last effect for this paragraph is eclampsia, which was discussed earlier in the essay (under the HDP information paragraph), but is essentially seizures that can lead to comas if not treated properly.

Long-Term Effects of HDP on Mother

Pre-eclampsia can lead to consequences that may only appear up to 15 years postpartum. For example some effects include chronic hypertension, ischemic heart disease, stroke, and death. Data from a study showed that women with pre-eclampsia in the past were around 60% more likely to have an ischemic stroke[15]. In general, stroke related morbidity chances increase. End-stage kidney disease (ESKD) is also associated with a past history of pre-eclampsia. The severity is often controlled by how the pre-eclampsia was controlled during pregnancy. Some researchers believe that ESKD in women with a history of pre-eclampsia is caused by preterm birth, which is common with the disease[15]. Genetic predisposition is also related to the severity of the long-term effects since genetics do play a role in developing the pathology in the first place and how extreme it is. The severity of the pathology for each person will impact the long-term effects. More research has to be done on follow-up care for women with pre-eclampsia, which is why there is not a lot of information with concrete evidence to back it up on the long-term effects for women.

Conclusion

GDM and HDP are both very serious types of maternal CMDs. A woman's susceptibility to these pathologies is affected by her economic stability, education access, healthcare access, neighborhood and environment, and social and community context. All five SDOHs are interconnected, so if a woman unfortunately is on the wrong side of the majority of them, she will have a higher chance of getting the disease. Both GDM and HDP can have short and long-term effects on the mother and fetus depending on how well the mother is able to control the disease during pregnancy. More research has to be done on the effects of certain SDOHs such as social and community context in order to better understand how to prevent and treat different women, especially as the basic ideas about the diseases such as diagnosis criteria are continuing to shift. Key questions such as whether solely race without other factors such as money or resources affects the pathogenesis of GDM and HDP have to be further tested in order to better understand the pathologies through controlled and thoughtful experiments. While there is information on the short and long-term effects of the GDM and HDP, more research would be beneficial in understanding especially the long-term effects in order to obtain a better quality of life for patients and the offsprings of women diagnosed with the diseases during pregnancy.

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