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Insights from obstetric providers and emergency medical technicians on determinants of maternal morbidity and mortality among underserved, rural patients in the United States

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1. Introduction

Over the past two decades, individuals in the United States (US) have faced a steadily increasing risk of experiencing severe morbidities attributable to pregnancy and dying from pregnancy-related causes. The prevalence of severe maternal morbidity (SMM), defined as the occurrence of end-organ damage in the mother encompassing unexpected outcomes of labor and delivery, has nearly tripled since the turn of the 21st century (Creanga et al., 2014; Neggers, 2016). The prevalence of pregnancy related mortality (PRM), defined as the death of a woman during or within one year of pregnancy due to pregnancy-related complications or aggravated preexisting conditions, has nearly doubled (Creanga et al., 2014; Neggers, 2016).

Such patterns are associated with numerous factors broadly corresponding to health status and social determinants of health frameworks (Creanga et al., 2014). Traditionally underserved pregnant patients, including those living in rural settings, are more likely to have diagnosed co-morbidities and impeded access to healthcare, elevating their risk for SMM and PRM (Hansen et al., 2021; Neggers, 2016; Petersen et al., 2019). To better understand the factors and circumstances that elevate risk of vulnerable rural residents, we examined the perspectives of patients and healthcare providers who care for patients with histories of SMM and/or PRM. This manuscript reports the perspectives of providers, including physicians trained in obstetrics and emergency medical technicians who have managed obstetric emergencies. These providers make pivotal decisions concerning patient management in complex clinical situations, and have in-depth, tacit knowledge of their regional healthcare landscape.

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Declaration of competing interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmqr.2023.100320.

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1.1. Context and study setting

This study examines SMM and PRM in the context of rural Appalachia, a region known for its extensive health and social inequalities, many of which contribute to adverse pregnancy outcomes (Hansen & Moloney, 2020). With nearly 25 million residents across 13 states that defy simple characterization (Short et al., 2012), the Appalachian region is known for its rural geography and widespread economic distress (Short et al., 2012). Central Appalachia, which includes eastern Kentucky, represents an extreme version of inequities, with especially severe rates of unemployment and poverty (Pollard & Jacobsen, 2017).

Related to conditions of resource scarcity, Appalachian residents face a distinct and elevated risk profile for SMM and PRM (Hansen & Moloney, 2020). Appalachian females of childbearing age are in poorer health prior to the conception of pregnancy and report poorer health and higher rates of smoking, obesity, and poor nutrition compared to their non-Appalachian counterparts (Short et al., 2012). However, high disease burden does not entirely account for disparate outcomes; Appalachian individuals face increased odds of SMM even when controlling for known patient-level risk factors, including chronic disease prevalence (Hansen et al., 2021).

Residents of Appalachian communities also have limited access to obstetric specialists, resulting in sparse resources with respect to risk detection and crisis management when complications arise. Access to obstetric care in Appalachia is worsening (Efird et al., 2021), mirroring trends throughout rural US communities; >80% of rural counties lack a hospital with obstetric services (Hung et al., 2016; Kozhimannil et al., 2018). Closures of rural hospitals shift obstetric management from the hospital setting to local clinic staff and emergency medical technicians (EMTs), who may not be sufficiently equipped to provide obstetric care (Kozhimannil et al., 2018). Despite limitations in EMTs' ability to deliver obstetric care, EMTs increasingly play a critical role in providing medical care to pregnant patients experiencing adverse labor and delivery.

To better understand the challenges surrounding patient management, determinants of healthcare utilization (Hatcher et al., 2011), and causal mechanisms underlying health inequities in Appalachian communities (Hansen et al., 2020), we undertook in-depth interviews with obstetric care providers and EMTs. We aimed to characterize participants' experiences treating patients with SMM and/or PRM, highlight perceived contributing factors to SMM and PRM, and identify points of intervention.

1.2. Theoretical framework

The conceptual framework for action adopted by the World Health Organization Commission on the Social Determinants of Health (i.e., the CSDH framework) was used to examine distinct levels and mechanisms of causation resulting in disparities in SMM and PRM in an at-risk population (Organization, 2010). We used the CDSH framework to inform qualitative interview questions and data analysis.

Creators of the CSDH framework posit the social gradient of health is caused by the unequal distribution of power, income, and services, leading to downstream inequities in individuals' immediate living conditions. The CSDH framework comprises two broad categories of

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determinants: *intermediate* and *structural*. Intermediate determinants encompass individuals' places within social hierarchies based on their social status, relative exposure to health-compromising conditions, and ability to utilize health-promoting tools. Intermediate determinants include material resources available to an individual, biologic and psychosocial risk factors, and factors related to local healthcare systems. Structural determinants generate social stratification and determine individuals' position within a social hierarchy. Structural determinants comprise socioeconomic position with respect to class, education, race, and gender. Additionally, structural determinants include the key social, economic, and political contexts that define socioeconomic position and that generate and maintain social hierarchies. By identifying social contexts, differential vulnerability, and differential consequences experienced by patients, the CSDH framework highlights distinct levels and mechanisms of causation resulting in health inequity (Barton & Anderson, 2021).

The CSDH framework has been used to synthesize current literature on the social determinants of maternal mortality globally, and identify potential areas of clinical and public health intervention (Hamal et al., 2020; Malqvist et al., 2017; Mmusi-Phetoe, 2016; Wang et al., 2020). Few studies have explored causal pathways between social determinants and maternal health disparities, and how structural and intermediate determinants influence one another to impact disparate health outcomes (Wang et al., 2020). Additionally, minimal attention has been paid to regional differences in maternal health outcomes within the US. (Wang et al., 2020) This study seeks to address these gaps in the context of an underserved, rural Central Appalachian population from the perspective of healthcare providers serving pregnant Appalachian patients.

2. Methods

2.1. Research design

As part of a National Institutes of Health grant [OMITTED], semi-structured in-depth qualitative interviews informed by the CSDH framework were conducted with obstetric care providers and EMTs. Interview questions pertained to intermediary and structural determinants of SMM and potential points of intervention. Interview guides were created by the three authors in collaboration (see Appendix A).

2.2. Participants and recruitment

Obstetric care providers and EMTs were recruited for in-depth qualitative interviews and were eligible if they were age 18 and older, practiced professionally in an Appalachian county as defined by the Appalachian Regional Commission (Pollard & Jacobsen, 2017) and provided care for a woman with SMM. Snowball sampling involved sending email messages through physician and EMT professional contacts known to the PI (AH) to recruit seeds and posting fliers in obstetric care clinics.

A total of twenty Appalachian individuals participated; ten EMTs who had provided emergency care for patients with severe pregnancy complications, and ten obstetric care providers practicing in Appalachia.

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2.3. Data collection

All interviews were conducted by the study PI (AH). In light of the COVID-19 pandemic, all interviews were conducted remotely. Participants decided on a medium of communication (i.e., phone or Zoom) and time for the interview. Interviews lasted approximately 1 h. Participants were asked about their experiences providing care for patients who experienced SMM or died from pregnancy-related causes. Additionally, they were questioned about their perceptions of factors contributing to SMM and PRM, including both intermediate determinants (e.g., healthcare system factors) and structural determinants (e.g., education). Lastly, participants were asked about potential strategies for future interventions to decrease SMM and PRM among rural residents. EMTs were provided with a fifty-dollar check for their participation. Obstetric care providers were entered into a raffle to win an item from a regional sports team.

2.4. Data analysis

Interviews were recorded with participants' consent and transcribed verbatim by the PI. To facilitate the analysis, we used NVivo software. Transcripts were analyzed using inductive coding, a strategy which identifies patterned responses directly from the data (Thomas, 2003). To enhance rigor, two coders independently reviewed interview transcripts, developed an initial codebook, and established an initial coding protocol. Memos within NVivo software documented the identification of new themes and enhanced data interpretation. The coders established an inter-rater reliability of K 0.8. Analysis continued until team members reached thematic saturation (i.e. incoming data produced little new information to address the research question) (Guest et al., 2006). Following content analysis, the authors organized themes according to the CSDH framework (i.e. intermediary and structural determinants).

2.5. Ethics and permission

Verbal consent was obtained from each participant before the initiation of the interview. The consent process involved an emailed cover letter explaining the aims of the study, descriptions of the interview process, possible risks of participation, and information concerning the study's funding. Prior to the interview, the PI reviewed the cover letter with the participant, addressed questions, and obtained consent (with participants affirming their approval). Ethical approval was granted by the [OMITTED] institutional review board (#58634). Participants were protected by a Certificate of Confidentiality.

3. Findings

Participants described several levels of factors that influence health and wellbeing during pregnancy, including material circumstances (including basic needs, patient transportation, and food deserts), maternal substance use disorder (SUD), emergency transport, and pre-pregnancy health. Structural determinants involved socioeconomic position (including class and education), as well as socioeconomic and political contexts (including social and economic environments, and discrimination) (Organization, 2010).

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3.1. Demographics

Of the ten healthcare providers, nine were physicians and one was an advanced practice registered nurse. Of the physicians, eight had completed residencies in obstetrics and gynecology, and one had completed a residency in family medicine with an additional obstetric fellowship. Seven participants were female and three were male, with an average age of 41 years (SD =10). Providers reported a mean of 11 years in practice (SD = 12), with a range from 2 years to 40 years. Nine identified as non-Hispanic white, and one identified as "Asian American." Of the ten EMTs, two were female and eight were male. The mean age was 38 years (SD = 7). EMTs reported a mean of 14 years in practice (SD = 7). All identified as non-Hispanic white. In the quotes below, all participants are referred to as "providers" or "EMTs" to maintain confidentiality.

3.2. Intermediary determinants

3.2.1. Material circumstances—Basic Needs. Providers and EMTs explained how patients' limited resources constrained their abilities to adopt health-promoting behaviors and access timely obstetric care, ultimately increasing the risk of severe morbidity. Providers and EMTs commented on struggles surrounding the attainment of basic needs among many of their rural patients. Provider 8 described:

> We have several patients that we're concerned [about], either about their financial means to take care of the infant upon discharge, or their social situation, transportation. Do they have food? Do they have clothing? I mean, I paid a lady's water bill this week in my office because I just started asking questions, because I could tell that there was something …

Participants identified multiple points of intervention to better ensure patients' basic needs were met. Namely, they endorsed the need to expand affordable phone and internet services in rural Appalachian communities (Table 1).

Transportation. Participants noted long travel times to clinic appointments as a barrier to care utilization. Provider 8 explained,

> It complicates it, as far as our patient population, from a lack of transportation standpoint. Yeah, in being able to, let's say, go up there for their preoperative visit, then go up there for prenatal visit, then go there for delivery. Having the resources to be able to stay that far away from home is also very difficult for them.

EMT 2 similarly noted severe challenges surrounding transportation; "Some of them didn't have rides. The really impoverished people didn't have means to go, or a way to get there. So, they just didn't do it." EMT 1 echoed, "And it's not like she can just drive across town. She's having to drive 50 miles. So, it's a lot. And usually they have other kids, and it's just hard for them to keep that up."

Suboptimal nutritional intake and Food Deserts. When asked why Appalachian and rural patients specifically experience excessive rates of blood transfusion, the most common indicator of SMM in the US (How Does CDC Identify Severe, 2021), providers often cited nutritional anemias. "I feel like iron deficiency anemia is rampant in this area," Provider 10

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noted. Provider 1 explained, "I find that a lot of women are anemic to begin with, and I think that's because their diets are not good. They don't eat a lot of food rich in iron and proteins – things that would help them to make blood to begin with." Another explained her patients' nutritional status as malnourished; "It's fast food, but it's still malnutrition if you think about it. It's not actually getting correct iron and vitamins."

Providers frequently described poor nutritional intake associated with a limited food landscape. One participant who grew up in the rural community in which she now practiced explained:

> And then being from Appalachia, rural area, obviously growing up here – the resources to be able to eat the diet that we're telling them that they need to eat is often unobtainable. So, we hear that a lot. Even though that's their desire, to do better, they financially cannot afford those foods that we're telling them to eat instead.

Concerning future interventions, participants stressed the need for greater availability and affordability of nutritious foods to manage and prevent maternal disease states. Specifically, participants discussed the role of nutritious diets in preventing diabetes, hypertension, and nutritional anemias.

3.2.2. Substance use disorder in pregnancy—When discussing factors that contribute to SMM and PRM, EMTs frequently mentioned substance use disorders (SUDs). EMT 6 sighed before explaining:

> I can't emphasize enough - I guess because I get so sick of seeing it - is the effect that drugs are having on our young people, especially these young mothers … You know, especially in rural areas, the effect is just so, so, so great. You just don't know how many people I have been to that … we was just too late to get to them. It's just over and over and over again. It's just totally unacceptable what's going on right now.

EMT 8 noted associations between SUD and interpersonal violence, a leading cause of pregnancy-related mortality (Wallace et al., 2020):

> I would say, especially on our end, because it seems like a lot of the ones that we will end up dealing with, and especially the ones that have the horrible, tragic outcomes, are drug related. And then, at least in our area, and then working through law enforcement, that kind of stuff, we've had a lot kind of circle around the human trafficking aspect, and the drugs is the tool to basically control a person … Then you add in the increased domestic violence … some of which can be very tragic outcomes, that kind of stuff, if there's an assault involved.

Providers similarly acknowledged the burden of SUD, primarily opioid use disorder (OUD), among their patients, particularly during the postpartum period. "Once the baby is delivered, [there's] not necessarily great continuity, not great continuation of care," Provider 2 explained. "So unfortunately, a lot of them run into issues with custody battles, and basic social service battles, and all of the stress of those situations end up letting them just relapse

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and kind of go back to their old lifestyles." Participants identified expanded follow-up and treatment options for postpartum patients as a potential point of intervention (Table 1).

Providers often distinguished between those patients who do and those do not receive medication for addiction treatment (MAT). When speaking of widespread problems with opioids within the community, Provider 6 explained:

> … You have these women who, you know, have marginal compliance, they have terrible veins, they have very poor social circumstance. You know, the ones [who] are not in the [MAT] programs … everything that goes along with that truly complicates prenatal care to a whole new level. And I think that's the unique thing about being in this part of the state.

Some providers noted that the stigma around SUD during pregnancy may deter patients from presenting for prenatal care. "… We have a lot of patients who are scared, mistrustful and simply afraid to talk, or even to show for care," Provider 10 explained. However, providers frequently noted the benefit of MAT on maternal outcomes, especially through facilitating prenatal care adherence. Provider 2 explained:

> So, we do have a lot of patients who have, for example, opiate dependence. That's one, which oddly enough, leads to better prenatal care because they come more frequently to get their medication assisted treatment. So, I would say that's kind of one advantage to their prenatal care. Because they do need their Suboxone, something just to help keep them through the pregnancy, and generally they're more compliant just because their maternal instinct is much stronger than their addictions.

Some providers noted that prescribing policies hinder access to some types of MAT. Specifically, at the time that this data was collected, practitioners were required to take an additional training ranging from 8 to 24 h in order to administer, dispense, and prescribe buprenorphine (brand name is Suboxone). Becoming a buprenorphine waiver practitioner is an "extra hoop to jump through." This requirement was eliminated in December 2022. As Provider 3 described, "I do think some of the policies, when it comes to prescribing opioid maintenance therapy, makes it challenging for providers, which then trickled down to the patients and their ability to get it readily." Many providers identified expanded access of MAT for pregnant patients as a critical point of intervention (Table 1).

Overall, providers strongly endorsed programs which integrated prenatal care alongside MAT; "We try to make everything coincide. Their Suboxone visit, the prenatal visit, etc." Provider 8 explained. Greater incorporation of treatment services with prenatal visits were seen as an additional point of intervention (Table 1). Other participants noted the benefit of residential programs for individuals in MAT during pregnancy. Only one provider questioned the efficacy of MAT in her practice:

> So, I've been here long enough to see different programs roll through to try to help with opiate addiction … As far as the outcomes, in my personal opinion, data I've seen for mother and baby, I'm not sure that I have seen a huge improvement or a decrease in the mortality and morbidity with my patients that are currently

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> substance abusers by these programs. I know other providers are probably going to feel different, but they continue to not only use their medical assisted treatment they're provided, but they're still having their relapses and they're still using other illegal substances with this medication as well.

3.2.3. Challenges surrounding emergency transport—

Providers frequently mentioned challenges with transportation complicated healthcare delivery in emergency contexts. Provider 5 noted transporting patients to facilities with appropriate care has been complicated by closures of rural obstetric units. "It's not that unusual for me to get transfers from a couple of the other regional hospitals that are 30–45 min away in some cases, but just don't practice obstetrics anymore. At this point, we're down to one per county, sometimes less in this area," he explained.

Providers and EMTs strongly described the critical role of Emergency Medical Services (EMS) in the management of pregnant and post-partum patients in need of urgent medical intervention in rural Appalachia. Both providers and EMTs acknowledged difficulties surrounding the transport of patients to the "appropriate level of care" in settings with few obstetricians and no high-risk maternal-fetal medicine specialists readily available. Some providers voiced frustration that pregnant patients were transported to facilities without the capacity to provide sufficient care, as Provider 1 explained:

> Oh, there's nothing, it's terrible. Like EMS will pick up women from their house, and they'll be like, 'I think I'm in labor.' And they take them to the nearest hospital … And I'm like, 'Dude, those people don't have an obstetrician … I know it's a little bit farther ride, but you got to bring them to a hospital that actually has OB care.' I feel like they should at least triage it the way they do a stroke. Like if EMS has a patient who seems to be having a stroke, you're not supposed to take them to a hospital without a working CT scanner, because that's step one in stroke protocol, to do a CT scan of the head … And I feel like that should be there, should be some sort of guidelines like that for obstetrics. If they come with [an] obstetrical complaint, and the next nearest hospital does not have an OB/GYN, you bypass it and go to the next hospital.

Despite the known lack of obstetric care resources at certain facilities, EMTs acknowledged additional constraints which often made transporting patients to the nearest hospital the only viable option, regardless of obstetric care availability. EMTs expressed that local EMS resources were largely limited to a very few ambulances and EMS personnel. Moreover, transporting a patient long distances for high-risk obstetric care may come at the expense of depleting resources for the rest of the population. "It's like it looks now, because you can't take an ambulance away from 10,000 people," EMT 2 explained.

> If we took everybody to Lexington [nearest city with tertiary medical care], that's three-and-a-half hours round-trip. If the county's just got one ambulance, then yeah, that's not gonna work. If we can take them to the hospital and they get 'em stabilized, we can call somebody in to make that trip, and it doesn't deplete resources.

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EMTs noted specific policies, including medical administration, within EMS that further complicated patient management in rural settings. For example, administering magnesium, a medication used to prevent convulsions in patients with eclampsia, requires two providers (i.e., two paramedics) certified in advanced life support; our participants explained rural emergency medical services rarely have the trained personnel to employ two paramedics per ambulance. One EMT explained, "There's not an ambulance service I know of that runs a double paramedic right now. So, you couldn't even give that, and that's a state law. So, we're kind of hamstrung, really." Another voiced, "But we don't have the resources, and rural Kentucky sure doesn't have the resources. And it's just kind of the way it is."

Participants identified multiple strategies to increase emergency transportation options (Table 1), mainly focusing on preparing EMTs for critical yet rare obstetric emergencies. Participants advocated for collaborations between EMT leadership and obstetric care providers to develop more extensive protocols for EMTs responding to obstetric emergencies and posited a roundtable discussion with obstetric care stakeholders to identify standards of care for high-risk patients. Participants identified additional opportunities for continued clinical training in obstetric emergencies, such as annual simulation training. Participants also reported the need for state EMS policies to be critically reevaluated to better serve rural EMS. EMTs noted some policies, such as limitations surrounding medication administration, were created with metropolitan communities in mind.

3.2.4. Poor pre-pregnancy health—

When questioned about factors underlying their patients' risk for SMM and PRM, providers frequently noted the high burden of chronic disease within their patient population and poor health during the prenatal period. "I think that patients often have complicated deliveries because they have complicated pregnancies," Provider 3 noted. She went on to explain, "The risk factors for postpartum hemorrhage are things like gestational diabetes or macrosomic infant. Or abruption, which can be drug-related or hypertension-related. So, I think, again, those chronic health issues come into play at time of delivery."

Another provider noted chronic diseases often precede pregnancy, but are first detected and diagnosed during prenatal care:

> So, there is a lot of diabetes. It's probably pre-existing, it's getting diagnosed at the time of their first prenatal visit. Or hypertension getting diagnosed at the time of their first prenatal visit, and sometimes even some heart problems that are getting diagnosed … There are a lot of health issues in this part of the state.

Providers rarely noted the prevalence of chronic disease without also noting the social conditions contributing to the epidemiologic landscape. Specifically, providers frequently noted the role of material circumstances (i.e., limited optimal food intake) and inadequate patient education as contributing to high rates of diabetes and hypertension.

3.3. Structural determinants: socioeconomic position

3.3.1. Social setting—

Both EMTs and providers discussed how patients' social and economic position influenced their interactions with the healthcare system. Some EMTs

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attributed patients' utilization of healthcare to their social upbringings and level of support; for example, EMT 4 explained:

I think it varies on the mother herself. Whether or not, if she's interested in taking care of herself, and she's interested in taking care of her of her unborn child. That's going to be the determining factor. What kind of home that she grew up in. If it was a loving, nurturing environment, or has she been on her own since she was basically 14?

Providers also noted how patients' socioeconomic position may influence their clinical decision-making when they lack support at home. Although providers noted the importance of following clinical guidelines (i.e., transfusing a patient according to trimester-specific hemoglobin levels), they also noted social factors may influence their decision to administer more aggressive care including longer hospital stays. Specifically, some providers reported accounting for patients' level of social support at home, their likelihood to present to follow-up care, and their distance from the hospital if a severe complication were to arise. Provider 5 explained:

> We're keeping the patient just typically one to two days [after delivery], and so sending somebody out with a hemoglobin of seven might be fine for somebody who has access to healthcare in the city. But I am more likely to transfuse somebody with that kind of hemoglobin, because my concern is not only about the mother's wellbeing, but also baby's wellbeing. If mom can't get up and take care of the family and the children, she is really hobbled. A lot of times these are single women and may, and probably don't, have much support. It really is about 'Do you want to risk somebody passing out at home with a baby in their arms?'

3.3.2. Class—Providers often noted the role of class in patients' interactions with healthcare beyond barriers to material circumstances. Participants discussed class with respect to patients' financial realities. Some providers noted stigma towards patients living in severe poverty and viewed this stigma as a barrier to care utilization. Provider 10 expressed:

> I think any of our patients who are in a tough situation, who are really struggling with financial crisis, really struggling with being on that edge of a stable home versus not, I think they really are afraid of what people are going to think when they walked through the door. I definitely had patients who … I mean, having a reliable shower can be a question at a time. And I know they are afraid that people would think they're just dirty or they don't try, when it's really, they don't have the opportunity to even do so.

EMTs provided a variety of perspectives when discussing class within their communities. Some EMTs noted the receipt of government benefits as a critical social stratifier, rather than as a means to alleviate inequities. EMT 1 explained,

> I feel like I am from a different class, I guess you would say, in this area. Because a lot of times, you have a couple of different classes. You have your working class and, you know, your people who work every day. They don't receive government benefits, and they don't have things like that. And then you have your people who

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> have never worked a day in their life, they're, you know, dependent on food stamps and Medicaid and things like that.

EMT 1, and other participants who noted government assistance programs as a means of social stratification, harbored a negative connotation toward the recipients of government safety net programs. "It's almost like everything has been given to them their entire lives, so they expect that … Like their expectations are unbelievable," EMT 1 explained. Although such views were not universal among participants, EMTs who held this perspective on government assistance often described patients as passive players in their own obstetric care.

3.3.3. Education—Providers and EMTs both noted the role of education in patients' healthcare utilization. Participants pointed to insufficient prenatal education as well as pre-conception education (e.g., the public-school curriculum) as contributing to poor health literacy. Provider 3 explained,

When you're starting out with somebody who literally doesn't know their own anatomy, you're starting from absolute scratch with all of those encounters. And so people, providers tend to not want to do that, and they don't have time to do it because there are so many patients. And so, they leave, and they still don't understand. Even after they've been in your office, they still don't understand what's going on. I think that that's a huge issue. And providers not knowing how, not realizing that patients are starting from that level.

> Providers directly attributed poor prenatal education as a risk factor for delayed healthcare utilization. "A lot of times I think they don't understand – even when we do education – I don't know that that these women always necessarily understand those risk signs to look for," Provider 7 explained. "Sometimes we see patients … in the postpartum period, they've been given education before they leave the hospital, and then sometimes we see them, and complications have kind of been brewing, and they haven't necessarily sought care in a timely fashion."

Many participants identified strategies for intervention related to education (Table 1). Participants suggested collaborations with local school systems and county health departments to introduce comprehensive health curriculum for teens and young adults. Additionally, participants suggested integrated prenatal education during prenatal appointments (i.e., opportunities to meet with a prenatal educator during a prenatal appointment while waiting to be seen by the obstetric provider), as well as integrated consultations with dieticians during prenatal appointments.

3.4. Structural determinants: socioeconomic and political context

3.4.1. Economic and social policies—Participants expressed a connection between dramatic changes in the socioeconomic landscapes of their communities and more proximal determinants of maternal health. The Appalachian providers spoke extensively of regional job loss due to the decline of the coal industry and viability of farming. Participants elaborated on the widespread ramifications these economic shifts had on community wellbeing, intergenerational health, and pregnancy outcomes. EMT 5 explained:

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> … We've also lost a generation now that did work in the fields through pregnancy. So, there's no one to turn to that they can look up to and say, 'well, they did it.' So, I think, almost the death of the old rural culture and the incipience of this new technical age is just … the job opportunities that are available just don't meet the needs of someone who is pregnant and a young woman.

In particular, participants connected maternal SUD to a decline in economic opportunity. EMT 6 expressed, "Something else you've got going on in Eastern Kentucky counties and stuff like that is the further you go east, towards [X] County, you start going up in [Y] County and those places like that, the drug use is just so … people don't realize, it's so astronomically high." After discussing a specific case of maternal morbidity and fetal demise complicated by substance use, EMT 6 went on to explain:

> People in these counties – and I'm not using this as an excuse – but a lot of people in these counties, there's nothing there. I mean [in our] County, Kentucky – [X]ville, [X] County Kentucky – last year, year before last, was voted the second poorest county in all the United States. You have people there that's basically, it's sad to say, that don't have anything to look forward to. They don't have anything …. They don't have any hopes for the future.

Additionally, many participants spoke of government assistance programs when describing diminished economic opportunity within the region. Participants viewed government safety net programs complexly. Some viewed assistance programs as symptoms of a fraught economic landscape with diminished job opportunities. Other viewed safety net programs as part of an intergenerational "cycle" that perpetuated limited prospects for mothers and their children. EMT 5 explained:

> So, in turn, they either have to go to work or get government benefits. And a lot of times it's easier to get the government benefits than it is to find a job, because they didn't finish high school. And it's … it's a never-ending cycle. And it only seems to be getting worse in this area.

Provider 1 articulated:

> But right now, they're just in such a vicious circle of just getting a check, and you don't finish your education, so therefore you don't get a good job. And therefore, you start getting a government check again, and it just keeps [going] in a vicious cycle. And so, you're seeing a lot of these women, that's all they know. They're like, 'Yeah, I make it to high school, then I get pregnant, and then I raise my kids by myself, without a really significant partner. My mom helps me and then, when my kids get to be teenagers, they'll have their own babies, and that's that. And that seems to just be the norm. So that's where you get the negative connotations about Appalachian culture, you know, about them being lazy or uneducated and obese. But I think it has a lot of deeper roots, you know. And I don't know how to break that cycle, but we have to do something …

Participants identified several points of intervention to alleviate challenges surrounding the social and economic contexts of their communities (Table 1). Although participants had diverse views on public assistance programs, providers discussed the need to expand public

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insurance for low-income individuals (i.e., Medicaid) to include coverage throughout 1-year postpartum. Several participants strongly endorsed expansion of Community Paramedics programs, which fund regular home visitation for at-risk patients. In order to successfully implement and expand such programs, participants spoke about the need to reevaluate EMS payment systems to allow compensation for home visits.

3.4.2. Discrimination—

When asked what "discrimination" means to them, and how discrimination may impact healthcare, participants largely spoke of potential discrimination against low-income patients, patients with SUD, teen mothers, and "frequent fliers" who repeatedly utilize EMS and the emergency department. Provider 7 explained:

> I think a lot of these women definitely have experienced discrimination in healthcare. I think in general less educated women or women that come from kind of disadvantaged socioeconomic backgrounds, I think a lot of times they're dismissed, you know. Or even they may not be able to get across something that may be important for them to convey to their provider … And so, I do, especially, you know, a lot of these women utilize the ER system a lot and I do think a lot of times they get dismissed there. And so, I think sometimes there can be a little bit of, may have this preconceived notion that, you know, their care isn't going to be as good because they've experienced this in the past.

Provider 4 alluded to the historical distrust of medicine. They described discrimination in healthcare as "an ingrained, multigenerational way of life."

Despite the stark inequities in SMM and PRM surrounding minoritized racial groups in the US, participants rarely noted the influence of race on poor pregnancy outcomes. Some participants immediately associated race with discrimination, but none noted racial disparities in their patient populations. These findings may be due to the lack of racial diversity in these predominantly white Central Appalachian counties (Pollard & Jacobsen, 2017).

4. Discussion

The interviewed providers viewed patients' SMM not as isolated events, but rather as symptomatic of underlying social and economic challenges facing their communities. Consistent with the CSDH framework, participants often described a multidirectional relationship between determinants of SMM and PRM. For instance, participants discussed how socioeconomic contexts (e.g. limited employment opportunities) influenced socioeconomic position (e.g. class, education) and intermediary determinants (e.g. prevalence of SUD, material circumstances). Intermediary determinants subsequently impact structural determinants (e.g. cultural values). Intermediary and structural determinants combine and culminate in poor maternal pregnancy outcomes.

The CSDH framework provides a platform to understand the consequences of regional economic hardship. Providers and EMTs spoke extensively of dramatically diminished opportunities for community development, and ramifications these economic and social shifts had on community health. The health effects of regional economic distress are not

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unique to pregnancy; counties in Appalachia with high rates poverty maintain some of the nation's highest rates of all-cause mortality (Borak et al., 2012). Through the lens of maternal health, participants articulated how widespread poverty and limited economic opportunities adversely affect patients' health, and how detrimental health outcomes are perpetuated intergenerationally. By discussing a "never-ending" and "vicious" cycle of poverty, participants expressed how patients' pregnancy outcomes are influenced by their social and economic environments. These environments may also ultimately affect their patients' infants and the next generation of Appalachian adults.

Participants discussed mechanisms through which patients' social and economic environments limit opportunities to adopt health-promoting behaviors, including diet, comprehensive health education, and access to appropriate care. Many rural areas lack a population base large enough to support a grocery store with a variety of affordable and nutritious foods (Sharkey, 2009). Rural families who rely on convenience stores are faced with high prices and limited selection of high quality foods (Sharkey, 2009), resulting in a greater burden of nutrition-related disease (Sharkey & Horel, 2008). Additionally, participants noted comprehensive health education for girls and women is difficult to access, further impacting patients' abilities to navigate optimal health behaviors in pregnancy.

Participants also shared how regional social and economic environments present further challenges surrounding the utilization of specialty care, as patients may struggle with expensive and time-consuming travel distances, inadequate postpartum insurance coverage, and possible class-based discrimination within healthcare. Such constraints also directly translate to increased risk of poor outcomes, as high-quality prenatal care and access to specialized obstetric care alleviate risk of SMM and PRM (Kozhimannil et al., 2018).

Also consistent with the CSDH framework, some participants placed maternal health and outcomes in the broader historical, socioecological and cultural context of the region. Some participants championed the resilient work ethic of their region, describing past generations as "really tough people" who "work their body down," and described pregnant individuals as performing physically demanding field work. In contrast, they described current generations as having "almost a lazy culture." Participants directly related this shift to the elimination of tobacco subsidies and decline in farming, and coal jobs leaving the area. Embedded within these discussions of poverty and resiliency is a valorization of work, even when historical working environments were not necessarily conducive to optimal pregnancy health.

The value placed on "work ethic" also had implications for perceptions of social stratification, and the relationship between class and maternal health. Some participants viewed social welfare programs as contributing to social stratification, rather than a mechanism to alleviate social disparities, and differentiated between low-and middle-income individuals who received government assistance and individuals who did not. For these participants, the receipt of government assistance was a more significant differentiator of class than financial wealth. Although both EMTs and physicians endorsed meritocratic ideals, some EMTs spoke to how their own class identities differed from the patients whom they served by their employed status, describing themselves as belonging to a "different class" of working people. Importantly, both EMTs and physicians identified

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widespread unemployment and reliance on government assistance as consequences of a shifting economic landscape and structural shortcomings.

Although physicians had significantly greater incomes than many of their patients and EMTs, some passionately identified as Appalachian and described a shared regional history with their patients. Some physician participants referenced longstanding family histories in the region, and believed their families underwent similar hardships as the ancestors of their patients. Although this perspective varied among participants and was not universally held, it may serve to diminish othering phenomena among providers towards their patients.

In identifying determinants of SMM and PRM and directly positing strategies for future intervention, participants identified practical opportunities to alleviate SMM and PRM within their patient populations. In contrast to efforts to reduce PRM aimed at obstetric care providers (e. g., the development of "bundles" to standardize care for postpartum hemorrhage) (Ananth & D'Alton, 2016), the points of intervention identified by participants extend beyond the healthcare sphere. Results inform a diverse range of intervention strategies that may be further investigated by a range of stakeholders.

Participants identified tangible points of intervention to alleviate maternal health disparities and promote community health. Although some participants practiced in relatively populous Appalachian counties (i.e., with populations of 25,000 individuals), participants overwhelmingly identified rurality as a key characteristic of their patient population, and interventions reflected the challenges of providing obstetric care to rural patients. Strategies outlined by EMT participants represent focused and finite goals for enhancing EMTs' ability to provide effective care. Some EMT participants challenged the effectiveness and feasibility of current EMS guidelines in their rural counties, suggesting that policies that work well in densely populated areas will not translate well to rural communities and should instead be tailored to rural Appalachian communities. For example, limitations in pre-hospital medication administration created unforeseen challenges for rural EMS given severe shortages in rural communities (Bailey, 2009; Cash et al., 2022). Longer travel times provides an additional challenge to limited pre-hospital treatment. The further distances to hospitals mean patients spend a greater length of time under the direct care of EMTs, potentially making pre-hospital care more critical.

The potential for expanded collaborations between obstetric care providers and EMS is apparent in the interventions suggested by participants. Participants identified the need to grow partnerships between EMS leadership and obstetric providers, facilitating the development of EMS protocols and continued clinical training for rare obstetric emergencies. Many community members – from physicians to EMTs to SMM survivors – remain invested in reducing adverse maternal outcomes. A roundtable discussion between diverse stakeholders may serve as a necessary first step, as suggested by participants (Table 1).

Notably, several participants additionally championed the role of Community Paramedics (CP) programs in rural communities as a response to other systematic shortcomings. They suggested CP programs allow providers to establish trusting relationships with patients,

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provide patient education, and care for patients who may be limited by transportation, childcare, and financial constraints. CP programs are associated with clinically meaningful differences in patients' health, decreased need for intensive care, and decreased health costs (Bennett et al., 2018). In the participants' counties of practice, CP programs have not been enacted for the care of high-risk obstetric patients. The potential of CP programs to alleviate peripartum health disparities warrants further study and reevaluation of current EMS reimbursement models.

Participants frequently referenced high rates of substance use in their communities, reflecting Central Kentucky as an "epicenter" of the opioid epidemic (Brant, 2021). Many identified opportunities for intervention involved optimizing care for patients with substance use disorders. Providers spoke of the need for further integration of treatment services during prenatal visits and expanded access for MAT for pregnant patients. Morever, they identified ample opportunity for expanded services and follow-up in the post-partum period. Some providers referenced that the resources available to patients with substance use disorder are often limited to the prenatal period, and patients are under-treated following the birth of their child.

EMTs largely commented on the immediate burden of substance use in their communities and the preventable morbidity and death among young adults. Some participants explained how working in a rural county at times required them to respond to calls for individuals and families personally known to them. The burden of the opioid epidemic was refenced with respect to their personal communities, as the differentiation between their patient population and their own communities was often indistinct.

Participants also spoke to the importance of extending Medicaid coverage to include a full post-partum year. Federal law currently requires pregnancy-related Medicaid coverage to extend to sixty days postpartum (ACOG, 2022). While some individuals may qualify for Medicaid through other pathways or receive Medicaid coverage for a full year through state-expanded Medicaid, others do not receive this support (ACOG, 2022). Patients may remain at risk for morbidity and mortality triggered by pregnancy throughout the first post-partum year (Sliwa et al., 2018), with particular risk for maternal death secondary to self-harm (Mangla et al., 2019). Postpartum Medicaid expansion is associated with greater outpatient care utilization by patients with significant morbidity events at delivery (Gordon et al., 2020), indicating the importance of insurance expansion for individuals with histories of SMM.

Participants identified a diverse range of other critical interventions outside the strict scope of obstetric healthcare delivery (Table 1). Expanding the affordability and availability of nutritious foods and reliable phone and internet services were championed by participants. Such expanded social services are amenable to policy level approaches; for example, enhancing the extent and duration of the WIC program or SNAP benefits or subsiding internet services may offer indirect but effective support services and intervention. Clinical commentary on maternal mortality has reasoned "a rising tide would lift all boats" (Carroll, 2017) – efforts to broadly improve women's health and alleviate longstanding social

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inequities among minoritized and underserved populations would diminish rates of PRM and SMM.

Limitations

In-depth interviews limit the generalizability of this study's findings to other patient populations, including other individuals from other rural regions of the U.S. Although the predominantly white participants of this study spoke to distinct aspects of Appalachian identity, the identified points of intervention may other underserved and minoritized rural residents. For instance, expanding Medicaid coverage throughout the late post-partum period may have a particular positive impact on rural Black and Indigenous individuals in the US, who utilize Medicaid coverage for pregnancy care at a greater rate than white patients (MACPAC, 2022).

Finally, despite the greater vulnerability of minoritized populations to adverse pregnancy outcomes, participants predominantly identified as non-Hispanic White. Although this is reflective of regional demographics, Appalachia is by no means a homogenous area and inclusion of a diverse array of participants would have strengthened this study. Inclusion of participants with diverse racial identities would have further strengthened the study.

The perspectives of other key stakeholders – including patients and healthcare professionals besides physicians, EMTs, and advanced practice providers-are missing from this manuscript. Nurses, resident physicians, and doulas were not eligible for study participation owing to a traditional lack of autonomy in healthcare decision-making among these professions. Inclusion of perspectives from these fields would have provided rich insight into diverse aspects of patient care and should be pursued in future research.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Intervention ideas proposed by research participants, organized by CSDH construct.

	Construct	Select Quotes	Points of Intervention
Intermediary Determinants	Material Circumstances	"Sometimes we have to wait until the beginning of the month to try to get all the patients again when their phones are reset. So that definitely is a barrier. And you know, even internet. A lot of these women may, don't, they may not even have access to internet where they live if they're in a rural area."	• Expansion of affordable phone and internet services in rural Appalachian communities • Greater availability and affordability of nutritious foods to manage maternal disease states
	Substance Use Disorders in Pregnancy	"As far as addiction care, we're growing in the number of centers in the area for sure. It's still few and far between as they take pregnant patients." "…We also have worked really closely with a Hep-C coordinator and substance use MAT through [a local clinic]. So that's really great …We can at least get them in with ou clinic so they're getting prenatal care and getting that substance use piece of it too."	• Integration of treatment services during prenatal visit • Expanded access of MAT for pregnant patients • Extended follow-up for patients with SUD in the post-partum period
Intermediary Determinants	Healthcare System	"Well, for one, if they could have more providers in the area that had, you know, a little more expertise on the subject … If you had a provider that came in here, even if they were just here one day a week and saw the people in this area, it would make a tremendous difference in the care that is provided." "… Most of our medical directors are emergency physicians, so they're not trained in obstetrics … I think it would be a really good idea if you can get some obstetric providers on board with our medical directors for the ambulance services, and say, 'Hey, how about paramedics be able to … do this procedure to help prevent these pregnancy complications.' … We really need to get some labor and delivery people on board to help expand our protocols with stuff like that." "The only thing I could think of that would be an easy first step would be … a roundtable discussion. You know, a liaison from every agency, department, clinic, and someone to lead the discussion. So, the care can be better facilitated for these patients. And for us to say, 'If we show up on the scene with someone who doesn't have prenatal care, who do we direct those patients to and who's going to receive them?' and further that discussion." "I'd say there's some … a fair amount of benefit to simulation training. Even bringing OB docs out, or nurse midwives, that kind of stuff, and run scenarios … We can simulate it to the best of our ability. Doing that more annually would be very, very beneficial." "And just, you know … have a, keep them a plan specific to [a patient's] area. Like understand that you can't just show up at this hospital and expect to get quality OB care …"	• Collaborations between EMS leadership and obstetric care providers • Development of more extensive protocols for EMTs responding to obstetric emergencies • Continued clinical training in obstetric emergencies for EMTs (i. e., annual simulation training) • Evaluation of state EMS policies that limit the care EMTs can administer to pregnant patients in rural settings • Expanded access to obstetric providers via regional telehealth or in-person outreach • Roundtable discussion with obstetric care stakeholders to identify standards of care for high-risk patients in rural settings • Development of individualized plans for patients during the prenatal period concerning when/where to present to care in case of emergency
Structural Determinants	Education	"I think it should be an education if they go to the health department or they try to seek care, there oughta be a "This is how it's gonna work. You need to follow up with this." Whatever. "If you have a problem, this is a problem" - tell them what the problems are - "then you need to go to the hospital." "I wish we had people who could be dietitian consultants through their pregnancy, which we do for our gestational diabetics … But I mean, that could be applicable for anybody with a BMI over 30 or 40. We could have a dietary consult, but we just don't have those kind of resources. That's number one. But number two is just basic education. So maybe this could be something within a public school system providing more education on healthy lifestyle. Contraception is not even discussed in [our county's] public schools, from what I understand … So I think that could be one step, just better education from the get-go."	• Collaborations with local school systems and county health departments to introduce comprehensive health curriculum for teens and young adults • Integrated prenatal education during prenatal appointments (i. e., opportunities to meet with a prenatal educator during a prenatal appointment while waiting to be seen by the obstetric provider) • Integrated consults with dieticians
	Economic and Social Policies	"If we're going to stay with the Medicaid model for most of our patients in this area, really extending that coverage out 6–12 months would allow them to not only to get contraception, but also if we did diagnose the chronic disease during their pregnancy, having them be able to get that taken care of in those first six to 12 months postpartum would be huge." "[Community Paramedics Programs] would help for women who have transportation issues, women who just don't feel like they can go to a hospital. It would definitely fulfill a need. The issue would be that the state of	• Expanded Medicaid coverage to 1-year post-partum • Economic investments in pregnant women and new mothers • Expansion of pilot Community Paramedic Programs for high- risk obstetric patients

Construct	Select Quotes	Points of Intervention
	Kentucky would have to buy into it, and then you would have to have insurance companies buy in for there to be a reimbursement program for that. Because right now, the only way you get money is if you go to the hospital.”	• Reevaluation EMS compensation system to allow for home visits

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