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Review

Mpox in pregnancy: Unraveling the maternal-fetal risks of a re-emerging disease, a narrative review

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ABSTRACT

Mpox has re-emerged, particularly with the spread of Clade Ib in 2024 and recent outbreaks have raised concerns about its impact on pregnant women. Limited data suggest increased risks of adverse outcomes such as stillbirths and miscarriages, but understanding of mpox in pregnancy remains incomplete. A narrative review of literature was conducted, focusing on maternal-fetal transmission and the implications of different MPXV clades. The spread of Clade Ib, first identified in 2023, has heightened concerns about vertical transmission, particularly in rural African regions where access to diagnostic tools and treatments is limited. The risk of vertical transmission has become a pressing concern, considering the high transmission rates of Clade Ib. Despite limited data, maternal-fetal transmission has been documented, with serious fetal outcomes such as stillbirths and hydrops fetalis. Continued research and surveillance are critical to developing effective clinical guidelines and public health interventions, especially for managing mpox in pregnancy.

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Introduction

Formerly known as monkeypox, mpox is a re-emerging zoonotic disease caused by Monkeypox virus (MPXV), a species belonging to the genus Orthopoxvirus within the family *Poxviridae* [1,2]. Following over three years of the SARS-CoV-2 pandemic [3], the World Health Organization (WHO) declaration of a new mpox outbreak as a Public Health Emergency of International Concern (PHEIC) underscores the potential for heightened concern in response to reports of a novel virus spreading globally [4]. The true burden and geographical distribution of endemic mpox remain unclear due to diagnostic challenges and limitations in surveillance [5]. However, mpox has historically impacted children and adolescents in rural, low-income areas of West and Central Africa, with data from the Democratic Republic of the Congo showing the highest incidence rate of 18.1 per 100,000 among 5–9-year-olds [6].

Throughout the years, limited epidemiological data on the impact of mpox during pregnancy have been collected. A 2024 systematic review of seven studies identified 32 pregnant women infected with clade IIb MPXV between 6 and 31 weeks of gestation. Among the 12 pregnancies with reported outcomes, half resulted in intrauterine fetal demise [5]. However, it remains unclear whether pregnant women are more susceptible to MPXV due to immunomodulatory changes in pregnancy, whether the infection is more severe during pregnancy, what the fetal and newborns outcomes are and whether there are differences in the maternal and fetal health depend on the MPXV clade [7].

Given this gap in knowledge, we undertook a narrative review of the most recent literature on mpox in the context of pregnancy, with particular focus on the newly emerging mpox variant.

Epidemiology

MPXV is now recognized to have two genetically distinct clades that originated in different geographical regions of Africa: Clade I (including sub-clades Ia and more recently Ib) is endemic in Central Africa, while Clade II (subdivided into IIa and IIb) is endemic in West Africa [8–10].

Since its isolation in monkeys in 1958 and the first human case in 1970 [11], several mpox outbreaks have occurred, primarily in rural rainforests areas of Central and West Africa, as a result of zoonotic spillover events and, as a result, did not garner broad attention [12,13]. Historically almost all mpox cases reported outside Africa were linked to international travel or the importation of exotic pets [14].

In 2017, an mpox outbreak in Nigeria, became one of the largest recorded in Africa at that time, mainly caused by west African clade of the virus, with more than 120 confirmed cases and several deaths [15]. This outbreak raised concern due to a possible human-to-human transmission in urban areas, but the sexual transmission route of this outbreak may have been underreported [16].

Clade I MPXV predominated until 2022, with most documented cases occurring in Central Africa [17]. However, the unprecedent global outbreak of 2022 was primarily associated with a new lineage, B1 of Clade IIb MPXV [18,19] with more than 87,000 mpox cases reported by 121 Countries across all 6 World Health Organization (WHO) regions [20].

The multi-country outbreak of mpox rapidly spread through human-to-human close contact and sexual transmission, affecting several countries where the virus had not previously been observed. On 23 July 2022, WHO Director-General, Dr. Tedros Adhanom Ghebreyesus, declared mpox a Public Health Emergency of International Concern (PHEIC) [21].

With a sustained global decline of cases, this PHEIC was lifted in May 2023. However, seven African Union Member States (AU MS) (Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Ghana, Liberia, Nigeria) continued to report cases in 2023, totaling 14,957 cases with 739 deaths, resulting in a case fatality rate (CFR) of 4.9 % [22]. Phylogenetic studies have indicated that by the mid-September 2023, a new Clade Ib MPXV emerged in Kamituga, a densely populated mining town in Democratic Republic of the Congo (DRC) [9].

DRC has since become the epicenter of this new epidemic, with the high transmission rate of Clade Ib facilitating the rapid spread of the virus, particularly due to the commercial nature of the mining town. By 2024, the DRC, which had reported approximately 88 % of mpox cases in Africa in that year, had recorded 19,513 cases before the emergency declaration. To date, 59 467 suspected cases and 1300 deaths linked to mpox since 2024 have been reported within DRC [23].

The epidemic also spread to neighboring countries including Rwanda, Burundi, Kenya, and Uganda, which had not previously reported mpox [24]. On 13 August 2024 Africa CDC declare the ongoing MPOX Clade I outbreak a public health emergency of continental security (PHECS) [25], while the following day, the WHO declared it a PHEIC [26].

All documented transmission routes of MPOX, both zoonotic and human-to-human (whether sexual or not) have been observed in the ongoing outbreak, although the relative contribution of each mode of transmission remains unclear. A particular concern is the high incidence among children, who are disproportionately affected, likely due to household transmission and contact with small mammals [27,28].

Although the true number of cases may be underestimated, the global number of confirmed mpox cases has risen steadily since 2022, reaching 124,753. As of 14 February 2025, more than 15 AU MS across all five regions of Africa have reported a cumulative total of 21,113 confirmed cases since the beginning of 2024 [29].

Starting from August, Sweden, Thailand and India reported the firsts imported cases of mpox due to MPXV Clade Ib outside Africa [30–32]. As of 14 February, other several imported travel-related cases have also been detected in Germany (seven cases), United Kingdom (nine cases), the United States of America (four cases), Canada (one case), Pakistan (one case), Belgium (two cases), China (seven cases), France (one case), India (one case), Oman (one case), the United Arab Emirates (one case), and Ireland (one case) [29]. Secondary transmission among close contacts of imported cases within the EU/EEA have been reported in the UK, Germany, Belgium, China and France [33].

Pregnant women represent a neglected population in this context, due to the scarce resources and limited technical capacity for virus detection in deep rural regions of Africa, where much of the natural history of the infection has unfolded [34]. Following the 2022 global outbreak and the ongoing epidemic in Africa, the risk of vertical transmission of mpox has garnered increasing attention.

Virology

MPXV is a large, enveloped, double-stranded, linear DNA (dsDNA) virus of ~190 kb with a diameter of approximately 200–250 nm that uniquely replicates within the cytoplasm of the infected cells, independently of the host cell's cellular machinery [2]. The virus is extremely complex and contains more than 100 viral proteins, whose functions are not yet completely known [2].

As previously described, two clades have been identified: Clade I (formerly known as Congo Basin clade) and Clade II (formerly known as West African clade), with further classification into subclades Ia, Ib, IIa and IIb [35]. These clades exhibit different epidemiological characteristics and clinical outcomes. Clade Ia is endemic in animal reservoirs, primarily rodents and non-human primates, and it has historically caused small outbreaks in humans, predominantly affecting children, who are at greater risk for severe disease. Clade Ib

was first identified in 2023 during an outbreak in eastern Democratic Republic of the Congo, where cases were primarily observed in adolescents and adults, with sexual transmission being a key mode of spread, and subsequently expanded to other African countries and travellers [30]. Recent studies revealed that a novel Clade Ib has a deletion of the D14L (OPG032) gene [36]. The D14L gene encodes valosin-containing protein (VCP)-MPOX, which contributes to virulence, together with inhibiting the complement cascade [37]. Comparative studies between Clade I and II, with the D14L gene either deleted or inserted, showed no differences in virulence. So, other factors besides VCP-MPOX are necessary to explain this aspect [38].

Subclade IIa is also a zoonosis with occasional spillover from animal reservoirs to humans. In contrast, subclade IIb transmission is primarily sustained through human-to-human contact, predominantly affecting men who have sex with men and their sexual networks. This subclade triggered the global mpox epidemic in 2022 [20].

A recent systematic review reported that Clade I is associated with a significantly higher mortality rate than Clade II (OR 10.6 %, 95 % CI 8.4–13.3 Vs OR 3.6 %, 95 % CI 1.7–6.8) [39]. However, this comparison involved populations with different characteristics in terms of age and did not account for potential disparities in reporting practices, publication bias, access to medical care, or HIV status. Moreover, data from Clade I did not include the recently detected Clade Ib. The mortality rate of MPXV Clade Ib appears lower than that of Clade Ia, estimated at approximately 4.9 %, although it remains unclear whether this difference is attributable to the virulence of the variant or the fact that most infected individuals are adults, who are intrinsically at lower risk of severe disease [40].

Like smallpox, MPXV can be transmitted vertically, although the exact mechanisms of intrauterine transmission remain unknown [41]. Four pathways of transmission have been theorized: 1) genital ascension: the virus could ascend from infected vagina and cervix, infecting the chorionic membranes; 2) hematogenous route: high viral loads (up to 10^6 copies per millilitre in one case) can enter the fetal circulation from the maternal bloodstream through the maternal-fetal interface at the chorionic villi; 3) direct infection of placenta: MPXV may directly infect the placental syncytiotrophoblast, through mechanisms like transcytosis or membrane fusion; 4) inflammatory mediation: inflammation triggered by the virus could disrupt maternal immune responses, allowing viral invasion of fetal blood [42].

Maternal-fetal transmission of Clade Ia mpox has been demonstrated through the detection of the virus in fetal tissue biopsies and autopsies, amniotic fluid, and cord blood [43,44]. Additionally, in a meta-analysis and systematic review conducted by Clemente et at, mpox-specific IgM has been identified in serum or cerebrospinal fluid (CSF) in children within a few days of birth[5]. While there are limited reports of fetal infection or intrauterine transmission involving Clades IIa and IIb, a recent nonhuman primates model research by Krabbe et al. suggests that Clade IIb can also be transmitted from mother to fetus, with a similar pattern of infected tissues as previously observed in human cases involving Clade Ia [45].

Transmission of mpox from breastfeeding mothers to their infants can also occur, likely through close contact. However, it remains unknown whether MPXV is present in breast milk [46].

Clinical manifestations

To date, most of the available literature on mpox (MPX) in pregnancy is limited to case reports. To provide a comprehensive analysis of the clinical manifestations of MPX during pregnancy, we conducted a literature review using MEDLINE, focusing exclusively on original research articles published in peer-reviewed medical journals. Relevant studies were identified using a combination of the following search terms: "monkeypox" OR "mpox" AND "pregnancy" OR "fetus" OR "stillbirth" OR "miscarriage." A total of 65 articles were initially screened for eligibility; however, the majority (51/65, 78.5 %) were excluded as they did not report original cases of MPX infection during pregnancy. The data extracted from the 10 (10/65, 15.4 %) selected articles are summarized in Table 1.

A total of 37 cases of MPX in pregnancy have been documented in the literature, with the majority described in North America (28/37, 75.7 %) and Africa (8/37, 21.6 %). Clade assignment was infrequently determined (5/37, 13.5 %), with clade II infections confirmed in 4 out of 5 cases (80 %) and Clade I infection identified in 1 out of 5 cases (20 %). The median maternal age was 22 years (range: 19–29), and, based on the available data, most cases were reported during the second trimester of pregnancy (11/22, 50 %). Most cases reported the characteristic MPX rash (26/30, 86.7 %). Additionally, a smaller proportion presented with or without typical genital ulcers (3/30, 10 %) and lymphadenopathy (3/30, 10 %). In terms of fetal outcomes, there were three cases of stillbirth (3/37, 8.1 %) and two cases of miscarriage reported (2/37, 5.4 %). Moreover, one case of fatal hydrops fetalis associated with hepatomegaly and peritoneal effusion was described.

These findings align with the Centers for Disease Control and Prevention (CDC) recommendations, which emphasize that the signs and symptoms of MPXV infection in pregnant women may resemble those observed in the general population, including fever, headache, lymphadenopathy, malaise, sore throat, and cough [55]. Distinguishing MPXV infection during pregnancy can be challenging, as its symptoms may overlap with other conditions, including dermatoses of pregnancy, such as polymorphic eruption of pregnancy, or more common infections like varicella zoster. Additionally, sexually transmitted infections (STIs) together with MPX have been reported and an inclusive diagnostic approach is recommended when testing for potential infections[55].

It is important to acknowledge that, beyond the 37 cases described here, additional instances of MPX in pregnancy have been mentioned in the literature [56]. Moreover, the prevalence of the disease may be underestimated, particularly in light of the emergence of the new Clade 1b, which is primarily spreading in Africa. Currently, there is no available data regarding the impact of MPX Clade 1b on pregnancy or fetal outcomes.

Considering the physiological changes in the immune system during pregnancy, pregnant women are among the groups at higher risk of exposure to mpox [57]. However, due to the limited number of studies on mpox in pregnancy, data on disease severity in this population remain scarce. Data from a recent systematic review conducted by Clemente et al., reported that maternal primary outcomes were preterm delivery, pregnancy loss, requirement for hospitalization or intensive care, and maternal death [5]. Moreover, existing knowledge of other *orthopoxviruses* confirm that smallpox poses a greater risk of severe illness in pregnant women than in nonpregnant individuals, with a higher case fatality rate, mostly in the third trimester of gestation [58,59].

The primary congenital outcomes included mother-to-child mpox transmission, preterm birth, small-for-gestational-age status, low birth weight, microcephaly, and hepatosplenomegaly. When comparing fetal outcomes with other *orthopoxviruses*, preterm birth, miscarriage and stillbirth are more frequently observed in pregnant women infected with smallpox [58].

Diagnosis

Rapid diagnosis is crucial for managing mpox, including isolation to prevent transmission, minimizing outbreaks, and guiding treatment strategies [60]. Since mpox symptoms closely resemble those of other, mainly viral, infections [61], diagnosis must be supported

Table 1
Clinical characteristics of the included articles.

First Author	Journal	Year	Article	Country	Sample	Age (mother)	Gestational Trimester	Year of infection	Symptoms (mother)	Complications (delivery)	Diagnosis (mother)	Fetal symptoms and outcome
García-Hernández L [47]	Rev Clin Esp (Barc)	2024	Case Report	Spain	1	24	First	2022	Rash, Lymphadenopathy, Genital Lesions	Chorioamniositis	NA	No
Sampson MM [48]	Obstet Gynecol	2023	Case Report	USA	1 (§)	20	Third	2022	Vaginitis, Genital lesions, Lymphadenopathy, subsequent rash	No	qRT-PCR on vaginal/ lesions swab	No
Contag CA [49]	J Clin Virol	2023	Case Report	USA	2 (*)	19 (1), 23 (1)	Second (1), Third (1)	2022 (2)	Vaginitis (1), No (1)	Chorioamniositis (2)	qRT-PCR on vaginal/ lesions swab (2)	No
Schwartz DA [50]	Emerg Infect Dis	2023	Retrospective	Democratic Republic of the Congo	1 (**)	22	Second	2008	Rash, Lymphadenopathy	No	qRT-PCR on blood)	Intrauterine fetal death
Oakley LP [51]	MMWR Morb Mortal Wkly Rep	2023	Review	USA	23 (§§)	NA (23)	First (3), Second (4), Third (3), NA (13)	NA (23)	Rash (23), Genital Lesions (4)	NA (23)	NA	No (2), Abortion (1), NA (20)
Renfro ZT [52]	IDCases	2023	Case report	USA	2 (*)	19 (1), 22 (1)	Second (2)	2022 (2)	Vaginitis (1), Oligohydramnios (1)	Intrahepatic cholestasis (1), Chorioamnionitis (1)	qRT-PCR on vaginal/ lesions swab (2)	Arrhythmias (NICHD category II) (2)
Yinka-Ogunleye A [15]	Lancet Infect Dis	2019	Retrospective	Nigeria	1	NA	Second	NA	NA	NA	NA	Abortion
Doshi RH [53]	Emerg Infect Dis	2019	Retrospective	Democratic Republic of the Congo	1	33	NA	2017	NA	NA	Serology	Died at 2 years-old
Mbala PK [44]	J Infect Dis	2017	Case reports	Democratic Republic of the Congo	4	20 (1), 25 (1), 29 (1), 22 (1)	First (2), Second (2)	NA (4)	NA (4)	NA (4)	qRT-PCR on blood/ maternal fluids (4)	No (1), Miscarriage (2), Rash, Hydrops fetalis, and death (1)
Jezek Z [54]	J Hyg Epidemiol Microbiol Immunol	1983	Case Report	Democratic Republic of the Congo	1	NA	NA	NA	NA	NA	NA	Rash, Death at 5–6 weeks due to malnutrition

Legend: (*) Clade 2; (**) Clade 1; (§) pregnant woman treated with oral tecovirimat at a dosage of 600 mg twice daily for 14 days; (§§) both eleven pregnant women and their newborns were treated with oral tecovirimat. In one case, the newborn additionally received Vaccinia Immune Globulin Intravenous (VIGIV).

by both epidemiological factors and laboratory findings. The WHO classifies mpox cases as suspected, probable, or confirmed, based on these criteria [62].

Diagnosis of mpox infection in obstetric and pediatric populations is challenging, since the current diagnostic criteria do not specifically address testing among pregnant women and children [56].

The gold standard for confirming mpox is real-time polymerase chain reaction (RT-PCR) or conventional PCR targeting MPXV, which can be used alone or in combination with sequencing to determine the viral clade [63]. Depending on clinical presentation, RT-PCR can be performed on various biological samples [64–66].

As reported in several case reports, PCR has also proven effective in cases of vertical transmission, detecting MPXV in amniotic fluid, peritoneal fluid, placental tissue from mpox infected mothers and in fetal tissue, and umbilical cord blood [44,67]. Whether MPXV is present in breast milk is still unknown, because PCR performed on breast milk from one MPXV-infected woman tested negative for MPOX DNA [51].

Serological tests, such as enzyme-linked immunosorbent assay (ELISA), lateral flow assays (LFAs), immunofluorescence assay (IFA), and immunohistochemistry, are important in seroprevalence and vaccine efficacy studies [68], but have limited value in diagnosing acute mpox due to cross-reactivity with other *orthopoxviruses* (OPV) [69].

Dashraath et al. suggested that an ELISA may guide appropriate delivery decisions for women with recent mpox infection [43]. Detecting seroconversion of specific IgM and IgG antibodies in unvaccinated pregnant women, approximately 4 days after the onset of rash, may allow for the deferral of delivery [68]. This could enable the transplacental transfer of maternal IgG antibodies against MPXV to the fetus, in analogy to the management approach for varicella [70].

Moreover, as described in a recent systematic review of maternal and congenital mpox infection, serology was used in two cases to confirm a mpox congenital diagnosis [41].

Histopathology and immunohistochemistry analyses using antibody to vaccinia virus on placental tissue have proved to be useful for determining mpox infection. Basal hemorrhages, visible on both the maternal and fetal side, can be observed, along with a pattern of extensive and diffuse positive staining in chorionic villous stromal cells [71].

Real-time PCR remains the fastest, cheapest and most sensitive assay to detect, distinguish and monitor MPXV outbreaks. Schuele et al. developed, validated and implemented a new RT-PCR assay (dD14–16) to detect the novel MPXV Clade Ib [72]. Until now, identification of the MPXV genetic clade has been primarily based on genome sequences of the detected virus. Additionally, the PCR assays recommended by the CDC for distinguishing MPXV from other *orthopoxviruses*, but also between Clade I and Clade II MPXV strains, may result in false negatives [73], because of the large ~ 1 kbp deletion in MPXV genome, specifically in the OPG032 gene [9,36].

Treatment

The majority of patients do not require antiviral treatment, as mpox is typically a self-limiting illness. For immunocompetent patients with mild disease, pain control and supportive care are usually sufficient. However, antiviral treatment should be considered for specific groups, including vulnerable populations and individuals with active skin diseases at high risk of dissemination or those with life-threatening mpox. Vulnerable groups include severely immunocompromised patients, as well as pregnant, recently pregnant or breastfeeding women [74].

The only treatment approved by the European Medicines Agency (EMA) for mpox diseases is tecovirimat [75], although other options have been used in the last years, as outlined in Table 2.

Due to the altered immune status, pregnancy and breastfeeding are considered indications for prioritized treatment in patients with mpox. Given the limited data on efficacy, medical management should be tailored based on the stage and severity of the illness [94]. If treatment is indicated, tecovirimat is recommended as the first-line antiviral by the US Centers for Disease Control and Prevention (CDC) to prevent vertical transmission, despite not being authorized for use during pregnancy and the absence of clear guidelines [80]. Animal studies to date have shown no embryotoxic or teratogenic effects, and pregnant and breastfeeding women are eligible for enrollment in the open-label Study of Tecovirimat for Human Monkeypox Virus (STOMP) [43,81]. Additionally, a CDC report on pregnant persons noted that 11 pregnant women who received tecovirimat experienced no adverse effects [51].

The use of cidofovir and brincidofovir in treating mpox during pregnancy is controversial, as animal reproduction studies have demonstrated teratogenic effects. Thus, these medications must be avoided, particularly in the first trimester of pregnancy [83]. Limited data also exist regarding vaccinia immune globulin intravenous (VIGIV), and its effects on fetal health and on fertility remain unclear. However, since immune globulins have been widely used during pregnancy without any specific negative effect on reproductive health, VIGIV may be considered for selected cases [95]. Medical management should be integrated with obstetric guidance to ensure appropriate fetal surveillance and determine optimal delivery timing [43].

Prevention

Early detection of cases, combined with vaccination, are critical pillars for the prevention and control of global mpox outbreaks.

Timely identification of confirmed cases is essential to implement primary prevention measures aimed at disruption transmission chain. Control interventions, applicable in both hospital and domestic settings, include patient isolation, strict adherence to hand hygiene practices, and the use of appropriate personal protective equipment [96,97].

Vaccination serves as another important tool to reduce viral transmission and can be used as pre-exposure prophylaxis (PrEP) or post-exposure prophylaxis (PEP) [98,99].

To date, two vaccines licensed for smallpox have demonstrated cross-protection against the MPXV: the ACAM2000 vaccine, a live, replication-competent vaccinia virus, and JYNNEOS (MVA-BN), a non-replicating modified vaccinia Ankara virus vaccine.

Their use in pregnancy has been debated for years, as most clinical trials do not include pregnant women [100]. If indicated, and following a thorough assessment of the benefits and potential adverse effects of vaccination, a PEP should be offered to reduce the risk of vertical transmission and protect the fetus.

Like other live vaccines, ACAM 2000 is contraindicated during pregnancy due to the risk of transplacental transmission, which can negatively affect pregnancy outcomes [43,101]. In contrast, MVA-BN, a highly attenuated, non-replicating vaccine, has not shown vaccine-related fetal malformations in animal studies [102].

Alongside infection control and preventive measures, pregnant and breastfeeding women who have been exposed to mpox and are at risk may be vaccinated with the MVA-BN, which has proven efficacy in preventing infection. However, the MVA-BN vaccine is generally not recommended during pregnancy unless the benefits of preventing mpox outweigh any potential unknown risks [103].

Table 2
Treatment options available for mpox infections including pregnancy.

	Mechanism of action	Uses	Indication for mpox			Approval
			Immunocompromised	Severe mpox	Pregnancy	
Tecovirimat	Inhibition of the viral envelope protein VP37, blocking the viral maturation and release from the infected cells [76]	Smallpox, non-variola *orthopoxvirus* infections, including mpox	Yes [77–80].	Yes	Yes	Approved by EMA for mpox for adults and children with body weight at least 13 kg, not approved by Food and Drug Administration (FDA) even if clinical trials are exploring its safety and efficacy against MPXV [81,82]. Approved by FDA for human smallpox disease [83].
Brincidofovir	Selective inhibition of viral DNA polymerase (pro-drug of the acyclic nucleotide analogue) [76]	Adenovirus, smallpox, non-variola *orthopoxvirus* infections, including mpox	No	Yes (in combination with tecovirimat) [84,85]	No	Approved by FDA for human smallpox disease, not approved for mpox. Approved for adults and children, dosage adjusted on weight [83].
Cidofovir	Selective inhibition of viral DNA polymerase [86]	Adenovirus, BK virus, cytomegalovirus, herpes simplex virus, non-variola *orthopoxvirus* infection, including mpox [86,87]	Yes (in combination with other drugs, except brincidofovir) [88]	Yes (in combination with other drugs, except brincidofovir) [88]	No	Approved by FDA for CMV retinitis in AIDS patients, not approved for mpox [89]. Approved for adult ≥ 18 years, not recommended for use in children (≤17 years) because safety and efficacy have not been established. Used in high-risk populations to treat adenovirus infections [90].
Trifluridine	Inhibition of viral replication incorporating into viral DNA in place of thymidine [91]	Herpes simplex virus, mpox infection	No	Yes (in combination with tecovirimat for ocular mpox) [92]	No	Approved for adults, avoid breastfeeding. Safety and efficacy have not been established for use in children.
Vaccinia Immune Globulin Intravenous (VIGIV)	Cocktail of purified antibodies from individuals immunized with the smallpox vaccine, providing cross-protection across the OPXV genus, including for MPXV [93]	Complication due to Vaccinia vaccination, mpox infections during outbreak [82]	Yes [82,93]	Yes	No	Licensed by FDA for treatment of complications due to vaccinia vaccination for adults. Safety and effectiveness in paediatric population has not been established.

Conclusions

This narrative review highlights the knowledge gaps regarding mpox infection during pregnancy, particularly with the emergence of new MPXV clades such as Clade Ib. While existing data suggest that mpox poses significant risks to both maternal and fetal health, including miscarriage, stillbirth, and neonatal complications, the limited number of reported cases hinders a comprehensive understanding of these outcomes. The scarcity of clade-specific information, especially concerning Clade Ib, further complicates efforts to assess the relative virulence and transmission dynamics in pregnant women. Pregnant women appear equally susceptibly to MPXV infection compared to non-pregnant individuals although whether it is more severe in pregnancy remains unclear.

Recommendations and future directions

Diagnostic challenges persist, with current methodologies not fully adapted to the needs of obstetric populations. While tecovirimat appears promising for managing mpox in pregnancy, its safety and efficacy remain underexplored in this context. Decisions about treatment, mode of delivery or other obstetrics interventions in pregnancy should be individualized based on available resources, gestational age of fetus and clinical severity. Ongoing research and surveillance are essential to better inform clinical and public health strategies, particularly for vulnerable populations such as pregnant women.

Search strategy and selection criteria

We searched PubMed and Google Scholar for peer-reviewed, English-language, quantitative studies published up to 25th August, 2024, that examined the involvement of climate change on human health. References for this review were identified from MEDLINE and PubMed with the following search term combination: "monkeypox" OR "mpox" AND "pregnancy" OR "fetus" OR "stillbirth" OR "miscarriage". Inclusion was assessed by screening titles and abstracts, followed by full text review of screened-in studies; screening and coding of all studies were independently conducted by two authors, with disagreements resolved through discussion. The final reference list was generated based on the timeline, originality, accessibility and relevance to the scope of this narrative review. Non peer reviewed articles were not included in this review.

Ethical approval

Not Applicable.

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CRediT authorship contribution statement

Conceptualization: E.Q.R.; data curation: B.R., G.T., and E.Q.R.; investigation: B.R., G.T., and E.Q.R.; methodology: B.R., G.T., and E.Q.R.; resources: B.R., G.T., and E.Q.R.; supervision: E.Q.R.; validation: B.R., G.T., J.L., R.G., F.B., L.R.T., F.C., and E.Q.R.; visualization: B.R., G.T., J.L., R.G., F.B., L.R.T., F.C., and E.Q.R.; writing – original draft preparation: B.R., G.T., and E.Q.R.; writing – review and editing: B.R., G.T., J.L., R.G., F.B., L.R.T., F.C., and E.Q.R.

Data Availability Statement

Not applicable.

Declaration of Competing Interest

None to declare.

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of the manuscript, the authors used ChatGPT, provided by OpenAI, to improve grammar and readability of the paper. After using this service, the authors reviewed and edited the content as needed. The authors take full responsibility for the content of the publication.

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