



The use and role of telemedicine in maternal fetal medicine around the world: an up-to-date

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Abstract

Purpose The aim of this narrative review is to summarize data about the use and role of telemedicine in maternal fetal medicine (MFM).

Methods We searched pubmed and scopus to find articles about telemedicine in MFM by using the terms telmedicine or telehealth and maternal fetal medicine.

Results Telehealth has been widely used for several medical specialties. During the coronavirus disease 2019 (COVID-19) pandemic, telehealth has gained investment and further research. Even though telemedicine in MFM has not been frequently applied, from 2020 onwards it has increased in both implementation and acceptance worldwide. The need to screen the patients in overloaded centers in a pandemic scenario required telemedicine in MFM, which has exhibited consistently good results concerning health and budget. The aim of this study was to review the telehealth programs and research focused on MFM around the world. Few studies have been applied to MFM and even fewer in developing and undeveloped countries. The majority of studies were concentrated in the USA and in Europe.

Conclusion Further research is needed, especially in non-developed countries, to comprehend the potential role of telemedicine in MFM for improving the life quality of the patients, health professionals, and to be cost-efficient.

Keywords Telehealth · Maternal fetal medicine · Telemedicine · COVID-19

1 Introduction

Telehealth is, by definition, the set of health actions carried out remotely, including consultation, diagnosis, therapeutic guidance, monitoring, and referral of patients [1, 2]. The use

of the internet facilitates the storage and sharing of data, the visualization of essential information for consultation, and the recording of conversations by videoconference. Telemedicine has advantages for consultations in several specialties and in varying degrees of complexity, especially in rural areas [3]. Telemedicine increases the efficiency of assistance in these locations by reducing travel costs and minimizing waiting times for presential appointments [4]. Although virtual assistance is able to promote the expansion of access to health care, some disadvantages must be considered in its development, including technological obstacles, failure to use tools, difficulty in building doctor-patient trust, and the possibility of invasion of confidential data.

In Brazil, telehealth follows the guidelines stated by the legal resolution 2.314 from April 20th, 2022 of the Brazilian Medical Council, which sets the ethical principles that professionals must abide especially by the principle of non-harming [5]. It shall be highlighted that the resolution was enacted soon after the worst months of the pandemic, and it

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is no surprise that most of the debate around the modality had the COVID-19 pandemic as a background. The rule delegates to the health professional the decision around whether or not non-face-to-face medical appointments should be set, stating that the gold standard remains the in-person consultations [5]. The non-disclosure clauses remain the same, establishing that the patient has the right to secrecy and the doctor must provide means of conducting the consultation that guarantees that right [5]. The patient must also agree, out of free will, to teleconsultation [5].

The last enacted norm from the CFM concerning telemedicine was set in 2002, which shows how the pandemic made the debate around this modality resurface [6]. Between 2002 and 2022, internet access undoubtedly improved, which shows a mismatch between technological and social progress and their applicability to the health system. Today, electronic devices are much more accessible and available, and it is possible to issue prescriptions and medical certificates following standards set by norm 2.314/2022 [5]. The norm is very clear about the autonomy of the professional, delegating to them and to the patient the decision of whether or not the need for an in-person consultation to fulfill the medical evaluation [5]. The resolution does not stipulate specific conditions or diseases that should necessarily be treated and followed face-to-face, although it states that chronic conditions and long-term monitoring both demand at least one in-person appointment every 180 days, requiring the same professional for the online and in-person follow-up [5]. The modalities of telehealth recognized by the norm are regular appointments, referral appointments, consultancy, diagnosis, monitoring and vigilance, triage, and surgery.

The COVID-19 pandemic hit the world population in an unprecedented way [7]. The high transmissibility of SARS-CoV-2, associated with the elevated degree of pathogenicity led the World Health Organization (WHO) to recommend collective social isolation [8]. Although essential activities, such as face-to-face medical care, were allowed in this scenario, the risk of infection by exposure during the process led to the postponement of procedures and elective consultations in several health institutions [9]. This fact, associated with the sudden increase in hospital demands during the pandemic, facilitated the implementation of telemedicine in visits to people at risk groups for the development of Severe Acute Respiratory Syndrome (SARS), such as obstetric patients [10].

Fetal medicine is essentially important to prevent the worsening of diseases that affect the fetus still during pregnancy [11]. Prenatal care allows the identification of gestational changes and initiates procedures for maternal-fetal treatment by reducing perinatal, childbirth, and postpartum complications, increasing the rates of positive outcomes [12]. The effectiveness of these processes is directly related

to the availability and distribution of these resources in Healthcare Systems. In Brazil, the Ministry of Health currently recommends at least six prenatal consultations during pregnancy - one in the first trimester, two in the second and three in the third - but this number should be increased if there are possible gestational complications [13].

Telemedicine emerges as an alternative to consultation in fetal medicine, considering that it may be able to reduce the demand for care and inequality in access. The expansion of this tool can be advantageous due to the possibility of matrix support – shared construction of clinical knowledge between the reference team and the support team, complementing the information to increase the resoluteness of care – in cases that do not require complex technical intervention. In addition, this modality of health can facilitate the patient's contact with professionals specialized in high-risk prenatal care and fetal medicine and reduce the bureaucratic obstacles associated with the scheduling and referral of patients. This study aimed to review the application and potential role of telemedicine in fetal medicine worldwide.

2 Methods

Data was obtained independently by the authors, who carried out a comprehensive and non-systematic search in BVS (Virtual Health Library; integrated with LILACS (Latin-American and Caribbean Literature in Healthcare)), MEDLINE (PubMed interface), Scopus, and SciELO databases. Search strategies included Medical Subject Heading (MESH) terms as: “telemedicine”, “telehealth”, “obstetrics”, “gynecology”, “fetal medicine”, “prenatal care” and “prenatal attention”. The search emphasized recent articles, published case series, consensus statements, guidelines, meta-analyses, systematic reviews, and prospective cohort studies, critically reviewed and selected by the authors.

3 Overview of the evolution of telemedicine worldwide

Some studies showed that telehealth provides similar health outcomes when compared with traditional methods of health care. Telehealth enhances patients satisfaction and engagement without interfering with the patient-physician relationship [1]. The synchronous modalities of telehealth, with bidirectional or real-time synchronous audio and video provide immediate, clear, and accurate information in real-time. Indeed, video conferencing allows the exchange of verbal and non-verbal cues, and images, which are important for consultation, allowing the patient and the professional to access information previously unknown [2].

There has been an increase in the number of countries with strategies related to telehealth. According to data from the third global health survey from WHO in 2015, approximately a quarter of respondent countries described that there was an explicit national telehealth policy or strategy in their countries. Three quarters of the respondent countries had a teleradiology program. Half reported a telepathology program, remote patient monitoring, and a teledermatology program, while one third exhibited a telepsychiatry program [14]. Neurosurgery also used telemedicine as a tool, specially during COVID-19 pandemic, in order to assess patients data and prioritize their clinical condition, as well as to define operable cases. The strategy was presented as an important service to enlarge medical access and educational resources, although the lack of legislation in the field still limited their use [15].

Regarding successfully implemented models, the Antenatal and Neonatal Guidelines, Education and Learning System (ANGELS) is a program based on the prestigious model provided by the University of Arkansas for Medical Sciences [16, 17]. Another great model to evaluate the efficacy of telemedicine platforms for acute and inpatient care is the program of telestroke known as program of remote evaluation for acute ischemic stroke, which was implemented in Georgia since 2003. Studies have shown similar or even improved patient outcomes in Telestroke care [18–21]. Neurologists of these programs provided remote stroke consultations and determined the eligibility for thrombolytic administration. Consequently, the early indication of this therapy decreased complications and in-hospital mortality [22].

Other successful examples are the studies of *Ladyzynski et al.* and *Perez-Ferre et al.* [23, 24]. The authors showed that providers were allowed to titrate treatment regimens regularly without excessive in-person clinic visits, facilitating potentially improved compliance as well as diabetes-related pregnancy outcomes [23, 24]. Prior studies have shown at worst noninferiority and at best reduced rates of macrosomia and cesarean delivery in patients managed with telemedicine compared with controls, which were seen more frequently in clinics for diabetes care [23, 24]. As rates of diabetes continue to rise in the setting of the obesity epidemic, thereby limiting traditional health care resources for these patients, tediabetes management technologies have been considered even more crucial [22].

There was also an evolution regarding the management of asthma in pregnancy through telemedicine. Poorly controlled asthma in this period can interfere with the health of the mother and the fetus. In this regard, telehealth applications can optimize asthma management and outcomes in pregnant women. *Zairina et al.* [25], through a randomized clinical trial, investigated the effectiveness of a telehealth

program linked to the cell phone, connecting a portable Bluetooth enabled spirometer to improve asthma control during pregnancy [22, 25].

There is ample potential for additional telemedicine platforms for the management of other conditions, including osteoarthritis, substance abuse, depression, and attention-deficit / hyperactivity disorder. Patients under specific treatment protocols - who need to be monitored for potential adverse effects of treatment, adherence, progress or deviations from expected courses - can safely benefit from telemedicine. Currently, these support technologies are proliferating, and the use of wearable devices, smartphones, and equipped (smart) homes has become more common. New methods of capturing and analyzing people's health data are being developed [22, 26, 27].

In Brazil, *Silva et al.* [28] described the support to maternal needs for contact and guidance through the telephone network. The use of the phone call proved to be an opportunity to clarify doubts and deal with the discontinuity in monitoring and the vulnerability of the population in focus. This initiative favored the apprehension of health needs, aided with doubts regarding basic care and problem-solving, as ways to prevent damage and promote child health. This support showed good acceptance by the families with children in vulnerable situations and enabled promptness in solving doubts. Finally, it is also necessary to consider that, in emerging and underdeveloped countries, the use of technology, such as mobile phones, is more accessible to the population and services [28].

Lowery et al. [29] reported an example of a successful implementation of telehealth for delivery of obstetrical care in rural areas of the United States. Patient satisfaction and experience were among the most important indicators for ensuring the quality of health services. Thus, surveys were conducted for telehealth evaluation. The participants were obstetric patients who received telehealth services in 2016 and providers in Arkansas from July to August 2017. The feedback was positive [30, 31]. Due to the social context imposed by COVID-19 pandemic, this method was applied effectively and the providers in an urban setting have described telehealth as a potential means to provide basic support for obstetrical care [32]. It is also noteworthy that data reveal an increased interest for remote monitoring and telehealth medicine as an option for a more individualized plan of care [33].

A possible drawback is that telemedicine can be costly in terms of operational expenses, since some of the gadgets needed for this approach are not accessible to everyone, especially in countries that struggle with poverty, such as Brazil. Even so, the cost of acquiring the equipment is rapidly overcome by the economy that telemedicine allows. As highlighted by *Leighton et al.* [34], telemedicine resulted

in an estimate of over 90 dollars in economy per consultation in Pennsylvania [35, 36]. In a national public health system setting, or even in a private one, this cost should not be viewed as a burden, but as an investment [36]. Additionally, studies conducted in Zimbabwe proved that with only cellphone messages and WhatsApp access, telemedicine is still beneficial [37]. Other problems that could be faced in the implementation of telemedicine in Brazil involve the lack of a secure and stable internet connection, as well as the prevalence of illiteracy that is still high in Brazil [38].

Telepsychiatry had a positive impact on helping with crises and preventing suicide as discussed by *Kilova et al.* [39]. In the case of distant locations, it is an excellent way to provide access to mental care more cheaply and dynamically. *Li et al.* [40] defended that this approach does not replace face-to-face meetings, but it works very well in a complementary way, being a novel modality of engaging with patients. When internet access is not a central issue, an essential aspect of Crisis Text Line organization was to incorporate text conversations into crisis therapy, which is especially important for teen audiences [41].

Most of the studies were conducted in developed countries, considerably marked by high indexes of education and good internet quality for their citizens. Notably, one of the studies was conducted in London, in 1996, when the internet connection was still incipient [42]. *Fisk et al.* [42] described that most of the aforementioned benefits were achieved using an internet connection of 2 Mbit/s, which is considered slow nowadays [43]. A study conducted in Zimbabwe included only urban patients with internet access [37]. Therefore, there is a lack of research conducted in underdeveloped countries and in areas where access to the internet is limited and illiteracy indexes are high. Furthermore, it must be clear that telemedicine cannot fix a health system, as mentioned by *Britt et al.* [16] “telemedicine is not a panacea for resolving health disparities”. A consequence of this fact is the higher frequency of less satisfactory results of telemedicine in black families and poorer municipalities [16].

A successful telemedicine program can be beneficial to the professionals, the patients, and the health system itself. Further research on the application and possible implementation of telemedicine in multiple specialties is necessary. Telemedicine needs an adequate technical capacity to accomplish clinical efficacy, reduce costs, and provide assistance to the patient.

4 Telemedicine in fetal medicine

Several authors exposed the advantages of the adoption of telehealth services in obstetric and gynecological health. Although it is noteworthy that the majority of the articles had the COVID-19 pandemic as a background. Since one of the most important prophylactic measures is social distancing, there is a lot of pressure on health providers to continuously monitor patients of different complexities, and telemedicine has been recognized as a valuable tool [10, 37, 44]. Socioeconomic differences between countries, regions, and cities should be taken into account to analyze the application and the role of telemedicine.

Regarding remote initiatives in fetal medicine, studies that described telemedicine implementation usually included mobile phone applications and web services as basic technologies for remote prenatal care [35, 45–48]. Additionally, devices that allow home monitoring were used in some programs, although the cost of these resources was not reported [36, 48]. The information collected is saved on a web server, allowing the physician to analyze and intervene when necessary.

The majority of the studies described an improvement in information access to pregnant women [35, 45]. Some benefits observed also included the possibility to interact online with physicians and to create conferences among health professionals [35, 36, 45, 47]. Moreover, the reduction in patient trips to access specialized care, and high satisfaction with the remote prenatal service were reported by the patients [17, 34, 47–51], as well among the care providers. However, the healthcare providers mentioned that they would rather do in-person consultations than the patients did [33]. Additionally, patients reported a feeling of empowerment credited to self-evaluation in cases in which the pregnant woman was given gadgets to monitor parameters such as maternal blood pressure [51]. At last, *Lowery et al.* [17] reported early diagnosis of conditions related to pregnancy and its potential impact on the reduction of newborn complications.

It should be noted that neither mothers nor staff were assigned to telemedicine without proper training, which included group sessions that taught them how to use the gadgets and the most effective way to perform a teleconsultation. Notably, the study of *Novoa et al.* found that all of the care providers taken into account “were above 40 years of age and reported that they were not completely familiar with computer technology and had no previous experience with telemonitoring”. The same study showed that more than 90% of the doctors interviewed responded positively to the possibility of continuing telemonitoring after the pandemic, supporting how effective and accepted the modality can be. [52] The prenatal care schedule was also frequently

reviewed allowing pregnant women to be more comfortable and less anxious during the follow-up [53]. In face of the pandemic, the adherence to appointments decreased and telemedicine substantially avoided or, at least, reduced the probability of absenteeism [33].

Fetal tele-echo exhibited a specificity and a sensitivity of 100% when applied for complex congenital heart disease, and a sensitivity of 100% and a specificity of 79% for the screening of less serious congenital heart diseases [54]. Parameters including preterm labor, the baby's weight, and the mother's blood pressure showed minimal differences when accompanied in-person or remotely. Moreover, macrosomia was even less present in newborns who were accompanied by telemedicine [34]. In-person appointments were not suspended and the health care workers in the aforementioned studies promptly provided the transition to a completely in-person follow-up when necessary.

Especially in the studies conducted in the USA, some evaluated areas were predominantly rural, which is a reality in large portions of the Brazilian territory, mainly in the North and Northeast regions, the least urban areas of the country according to Brazil's institute of epidemiology (*IBGE-Instituto Brasileiro de Geografia e Estatística*) [38]. Indeed, there was a significant raise in patient attendance and reduced different patients' needs and impairments to attend the appointments. This scenario results in a considerable economy of resources for both sides - the health system and the patient - as telemedicine is widely known to be economically viable when compared to other modalities [34, 55]. The advantages of telemedicine were more noticeable in rural areas, but Schramm et al. [43] also reported beneficial effects of telehealth in urban areas of developed countries, as occurred in Leipzig, Germany [43, 51].

Table 1 summarizes the finding of the main studies about telemedicine in maternal fetal medicine (MFM). Telemedicine aimed to facilitate high-risk pregnancies referrals or decrease prenatal visits, optimizing the care [46, 48]. *Zhu et al.* [35] described a program in which high-risk pregnancies were monitored until 42 days after childbirth by a cell phone applicative (app), aiming to provide medical information and improve high-risk pregnancy care [35].

The New York University (NYU) Health system implemented a rapid systemwide expansion of video-enabled telemedicine visits using already established infrastructure, in response to the COVID-19 pandemic. The MFM telemedicine area showed that the 3 most common visits were for maternal comorbidities, poor obstetrical history, genetics, and preconception counseling. The conclusion was that there were no significant technological barriers identified [56]. Although, *Escobar et al.* showed that women with public insurance in a single NYC academic obstetric practice were significantly less likely to utilize telehealth

for prenatal care than patients with private insurance. The reasons that patients did not use telehealth may be related to barriers including limited access to technology, low digital literacy, and unreliable internet coverage [57].

A project that has been recently highlighted is called Antenatal and Neonatal Guidelines, Education and Learning System (ANGELS) and one of its actions is detailed in Table 1 [47]. It was implemented in 2003, by Medicaid in Arkansas, a state that has 48% of the population living in the rural area [16]. ANGELS' purposes were to enhance health access to high-risk pregnancies, providing contact with MFM specialists and without interrupting local management of these patients. ANGELS has a call center full time available to guide pregnant women and health professionals inside the program [36, 49]. Another strategy found to organize a correct flow of referral patients was the promotion of remote education through scheduled conferences with local physicians [36]. Other services offered by the project include a structured telemedicine network with technological equipment, case management, clinical research, and guidelines development. According to population needs, portable ultrasound and specialists were available to analyze the images [36]. The call center and the conferences also aimed to promote better communication between primary care professionals and MFM specialists [49].

As a consequence of this program, an increase in ultrasound consultations for high-risk pregnancies was reported [49]. Although it was not observed any increase in the number of patients receiving MFM specialist contact, a decrease in contacts and in the referrals that did not match with guidelines recommendations was also reported by the project [49]. In addition, remote modalities reduced the probability of unnecessary traveling by low-risk pregnant women [49].

5 Conclusion

Telemedicine has been widespread in the world and provides benefits comparable to face-to-face consultations. With the start of the COVID-19 pandemic, this method was applied effectively. Even though most reviewed articles mainly evaluated the USA, researches conducted in developing countries such as China, or third world countries, such as Zimbabwe, also highlighted the decrease of expenses associated with positive outcomes when evaluating different indicators [35, 37]. Both rural and urban municipalities were evaluated, and in both of them the results were also positive.

A limitation of the reviewed articles was that essential topics, including cost reduction, provided by telehealth

Table 1 Main projects related to Telehealth in Maternal Fetal Medicine around the world

PROJECT NAME/YEAR	LOCATION	DEVICE USED	THE AIM	PARTICIPANTS	ADVANTAGES	LIMITATIONS
Reduced prenatal visit model (OB Nest), 2019, [48]	Midwest, US	Web server and telephone	Optimize outcomes related to pregnancy	Pregnant women, <13 gestational week. Half of them were recruit to a usual care and the other half to reduced prenatal visit model (OB Nest)	Higher satisfaction with the OB Nest; Reduction of pregnancy related stress at 14 weeks and at 36 weeks gestation; Reduction of prenatal visits in OBN;	Although the number of clinic appointments decreased, the time spent on virtual care was higher
Antenatal and Neonatal Guidelines, Education and Learning System (ANGELS), 2007 [47]	Arkansas, US	Web server	Provide access to perinatal care in the state, overcoming geographic barriers	Pregnancies with urologic anomalies that require specialist consultation	Saves time and money; is convenient	lack of a control group to compare the results
ILITIA, 2017 [46]	Brazil	Web server	Facilitate diagnose and the referral of high-risk pregnancies; Avoid unnecessary referrals and patient's transportation	1380 referral forms sent to the Clinic of High Risk Prenatal (PNAR)	Well accepted by the health professionals; accurate and fast system; is easy to access; allows remote discussions among professionals	Did not have a mobile version; had few problems with connection
Maternal and child health handbook APP (MCH-APP), 2019, [35]	Hangzhou, China	Web server and APP mobile	Provide health education and improve high risk pregnancy care	134,884 high-risk pregnant women in the telemedicine group and 93,465 recruited to an usual care.	Reduction of Maternal mortality; provided an easier and faster interaction with physicians;	Did not reduce prenatal visits;
Home monitoring program, at Aarhus University Hospital, 2021 [58]	Denmark	Digital platform (Open-Tele system), accessed by mobile device.	Evaluate outcomes of home-monitoring of high and moderate-risk pregnancies.	400 high and intermediate-risk pregnancies, observed in Aarhus University Hospital, during 2011 to 2019.	less family anxiety, more flexibility, couple involvement, family support, cost reduction, less hospitalization, no severe fetal or maternal complications associated.	Socioeconomic and demographic information were not included in this analysis.

facilities, and the real impact of these programs on pregnancy related outcomes, were not deeply detailed in the studies.

In conclusion, telehealth is an important tool for MFM, especially in areas with poor access to high-risk prenatal care. The described programs showed benefits regarding referral time saving, cost reduction, acceptance and decreased prenatal visits [46–48]. In Brazil's context, the length of the country and socioeconomic disparities can indicate difficulties in accessing specialists during pregnancy. Therefore, a telemedicine program could decrease MFM centers overload and enhance Brazilian public health system coverage.

Author Contribution BAF, BA, ACM, BC, RFD and UGH made the literature revision and selection of main articles. BAF, BA, ACM, BC and UGH defined the topics of this review and wrote the first draft. FMB, JD and ACSS conceptualized the study, made general supervision and revised the manuscript. ACSS submitted the final version of the manuscript, which is approved by all authors.

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