Original Article

Developing a computerized and integrated maternal health surveillance system (CIMHSS): a lesson learned from Iran

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ABSTRACT

Introduction: Identifying the risk factors of maternal mortality and morbidity requires the use of standard data, the integration of various information systems and state of the art technology to analysis maternal care data. This study was conducted for developing standard data elements and the designing of a Computerized and Integrated Maternal Health Surveillance System (CIMHSS) to investigate adverse maternal outcomes. Materials and Methods: The study was conducted in two stages: 1) Determining the Minimum Data Set (MDS) using the Delphi technique among 70 experts throughout the country; 2) Designing an information system for the integration of the various maternal care data sources. Then approved MDS developed in terms of CIMHSS data base to investigate maternal health and adverse maternal outcomes. Data in both stages were analyzed through the descriptive statistics. Results: The maximum mean of score of experts opinions (20±0) for MDS were attributed to the domains of pregnancy and postpartum common assessment, and maternal history & physical assessment. The minimum mean score (16.05±6.74) was in the domains of "initial laboratory before pregnancy". The CIMHSS adverse maternal outcomes reports revealed that highest frequent adverse outcome pertain to "preterm labor in women with preeclampsia" 86 (85.15%); "cesarean complications in women with gestational diabetes" 65 (64.36%). Conclusion: Experts believed that for proper maternal health, data relating to maternal health assessment and physical examination has more priority in comparisons to laboratory examination. The CIMHSS reports indicate that blood pressure disorders, diabetes and high Body mass index (BMI) were the most contributing factors in adverse maternal outcomes. Given the causal relationship between the risk factors and maternal health, collecting and integrating a wide range of data regarding to maternal health assessment and physical examination is required for enabling proper interventions.

Keywords: Infant, newborn, pregnancy, diabetes, gestational, pre-eclampsia, diabetes gestational, maternal mortality, body mass Index, blood pressure, information systems, surveillance, risk factor

Introduction

The main objective of maternal healthcare is to identify and manage women at risk of complicated pregnancies. According to studies, approximately 830 of pregnant women die due to pregnancy and childbirth complications each year. Maternal health care plays an integral role in reproductive health [1]. Regardless of this importance, previous literature indicated that maternal mortality and morbidity account for the main challenges faced by health systems [2]; Developing countries are more seriously faced with these pregnancy-related complications and 99% of maternal mortalities occur in these countries. Although most cases of mortality can be prevented through early and targeted interventions [3, 4] . Realizing this aim requires the collection of high-quality data on the various risk factors at the point of care to assist managers and healthcare providers identify the factors affecting maternal health care services [1, 3, 5] . However, according to evidence one of the reasons for the poor management of obstetric complications in a Maternal Care Surveillance System (MCSS) is the inadequate

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and unqualified information [2, 6, 7] . Another factor affecting the promotion of the MCSS is the development of standard data elements for the comparison and analysis of maternity care. The standardization of data facilitates the interoperability of different information systems and data sharing through information technology systems [3]. Moreover, MCSS data should be properly analyzed to facilitate intervention and decision-making by maternal care managers and policy-makers. The analysis of large volumes of data requires computerized methods. Data mining is the process of exploring and modeling large amounts of data to discover patterns or relationships between the variables [8]. Discovering trends and hidden patterns using data mining significantly improves our understanding of the progress and management of diseases and also improves patient care. Identifying the risk factors of maternal mortality and morbidity requires the standard data elements, integrated data sources and automated methods for data analysis in the MCSS. Employing data mining technique to promote maternal health should be conducted evolutionary in developing countries due to shortcomings in data quality, and isolation and fragmentation of information systems. This study was conducted for developing standard data elements and the designing of a Computerized and Integrated Maternal Health Surveillance System [CIMHSS) to investigate adverse maternal outcomes [9].

Iran's Health care system: An overview

In Iran, health care services are rendered through the Primary Health Care (PHC) network, which consists of more than 17,325 health houses, 2407 rural health centers, 307 rural maternity centers, 2186 urban health centers, 1666 health posts and 614 hospitals with maternity units (in both the public and private sector). The Iranian health system is governed at three levels of practice, including district, provincial and national levels. Maternal health is provided under reproductive health services and reproductive health is part of primary health services and is provided through primary healthcare facilities and hospitals [10, 11]. Maternal Health (MH) covers antenatal, delivery, postnatal and emergency obstetric care services and is provided by the following national policies and programs:

- The establishment of a national maternal mortality surveillance system;
- The integrated management of pregnancy and childbirth through the PHC network (outpatient services);
- The establishment of mother-friendly hospitals (hospital services).

To identify the factors affecting the maternal and neonatal mortality rate (MNMR) and to design appropriate interventions, a committee has been formed in collaboration with the Deputy of Health and Deputy of Treatment to control MNMR. This committee is activated as soon as an incident of maternal death occurs and collaborates with maternal health experts at the Treatment Deputy and is responsible for conducting interviews to identify the factors that have led to the mother's death and also for performing appropriate preventive interventions [12].Maternal care is provided free of charge in all urban health centers, rural health centers and health houses. Maternal health services are provided in three stages at all levels, including pre-pregnancy, pregnancy and post-partum, and are based on the maternal health booklet and the completion of care forms by specialized primary health care workers, family health technicians and experts, midwives and physicians. Since September 2002, efforts for promoting normal vaginal delivery and establishing mother-friendly hospitals have been on top of the Ministry of Health agenda to enhance maternal health. In general, midwifery and labor and delivery services are provided at this level [12].

Materials and Methods

Focus Group Discussion (FGD) meetings with the participation of an expert panel including the Vice Chancellor of Health, MH experts, health information management, gynecologists and obstetricians and IT experts were held. MH problems were discussed during meetings. The main objectives of the FGD meetings were: 1) Determining the Minimum Data Set (MDS) required for designing an MCSS that is standardized through a comparative study; 2) Designing an information system for the integration of the set of data. As result of nature of this study (pilot study), shortcomings in data quality, and lack of robust information technology infrastructure and resource limitation, panelists decide just focusing on limit numbers of MH problems to design CIMHSS.

Objective One: The FGD meetings for the extraction of the MHSS- MDS

• Identifying the MDS

Determining an MDS for MH is among the priorities of the World Health Organization (WHO) and many countries. The purpose of determining MDSs is to improve and standardize the process of data collection at different levels of the MCSS .It is should be noted that certain MH forms are currently available in the country; however, to update the MDS and to investigate similar CIMHSS in developing countries, a non-systematic review study was conducted. The collected data were summarized and presented in the form of a guide and debated in a two-hour meeting supervised by a trained moderator (researchers). After the qualitative analysis of the data, a preliminary questionnaire was designed for the MDS. At this stage, the same expert panel (of the first stage) expressed their viewpoints about each MDS based on a three-point scale (from 'agree' to 'disagree'). MDS with a final mean score of 3 and higher were approved and those with a mean score less than 2 were eliminated; those with a final mean score of 2 to 3 were put to a second round of the Delphi technique until agreement was reached by the experts on whether to approve or eliminate them. Ultimately, 305 MDSs were presented in 16 main domains for the Maternal Health Surveillance System (MHSS).

- The confirmation of the MHSS- MDSs

In this stage, the approved MDS requirements were distributed as a questionnaire among 50 obstetricians and gynecologists and 20 maternal health experts from all over the country based on Delphi technique. This questionnaire contained the demographic details of the experts and 307 close-ended based on proposed MDS, and open ended questions to collect other comments considered by experts.

These experts had qualifications includes obstetrics and gynecology, general practitioner or master's degrees in midwifery and health management, bachelor's degrees in midwifery with at least three years of work experience in their fields. In every step of the Delphi technique, participants' anonymity was observed and participants received feedback on their responses; that is, after collecting participants' views in the first round of the Delphi technique, the views expressed through the open-ended items were emailed to all the participants. The close-ended questions were analyzed in with Statistical Package for the Social Sciences (SPSS) software by IBM; the answers were scored (disagree=0, no comments=1, and agree=2) and the frequency distribution of each requirement was calculated. The cases approved by less than 50% of the experts were eliminated and the cases approved by 75% and more were accepted. The cases approved by 50% to 74% of the experts were put to a second vote. This process continued until the consensus was obtained.

Objective Two: Developing a computerized and integrated Maternal Health Surveillance System (CIMHSS)

Following the identification of the MDS, the Entity Relationship Diagram (ERD) was drawn to depict the relationship between the MDSs. The database was then designed in the form of (SQL: Structured Query Language) server systems. As previously mentioned, CIMHSS was designed as a pilot project and more focus on limited numbers of MH problems. Proposed maternal care information system integrates data from pregnancy, childbirth and the postpartum services through the PHC network (outpatient services) with data on hospital services' delivery. In the existing system, there is no link between hospital services and outpatient services. In the proposed system, outpatient services' information, including antenatal and pregnancy care data, are integrated with the patients' labor and delivery information (hospital services) through connection to the hospital information system (HIS). Thus, the effect of each of the maternal care processes on maternal adverse outcome was realized. Figure 1 indicates the sample of screenshot of CIMHSS.

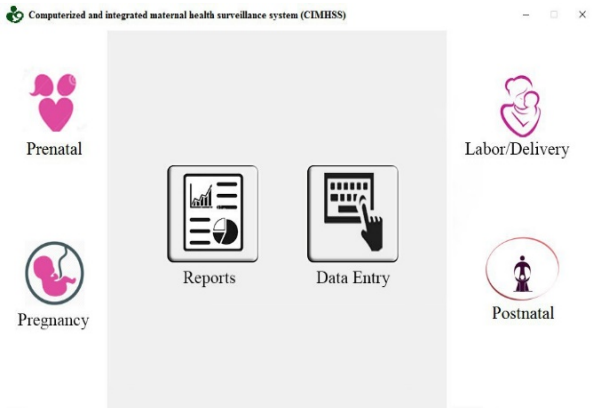

Figure 1: screenshot of computerized and integrated Maternal Health Surveillance System (CIMHSS)

Results

As shown in Table 1, of the 70 participating experts, 35 were aged 40 to 49 and formed the most frequent age group (50%), and 12 were aged 50 to 59 and formed the least frequent age group (17.1%). Furthermore, of all the participating experts, the most frequent years of work experience was 15 to 19, which was observed in 23 (32.8%) of the participants; also, the most frequent field of study was gynecology and obstetrics surgery (n=50, 71.4%). Moreover, the majority of the participants were specialists in their field (n=50, 71.4%).

Table 1: The frequency distribution of the demographic details of the experts

Demographics data	N	%
Age		
≤39	23	32.8
40-49	35	50
50-59	12	17.1
Field of Study		
Gynecologist	50	71.4
Obstetricians	17	24.2
General practitioner (GP)	2	2.8
Health care management	1	1.4
Work experience		
<5 year	5	7.1
5-9 year	13	18.5
10-14 year	18	25.7
15-19 year	23	32.8
20≥ year	11	15.7
Level of Education		
Specialist	50	71.4
General practitioner	2	2.8
Master of science	10	14.2
Bachelor	8	11.4

According to Table 2, the greatest agreement was reached among the experts with a mean of 20±0 in the domains of "pregnancy common assessment", "postpartum common assessment", "history of recent pregnancy", "history of

delivery", "history of pregnant women", "pregnancy common assessment" and "ultrasound and screening"; the least agreement was reached in the domains of "initial laboratory before pregnancy" with a mean of 16.05±6.74, "pregnancy laboratory" with a mean of 17.71±5.2) and "examinations before pregnancy" with a mean of 17.87±5.06.

Table 2: the total Frequency distribution of the expert opinions for the MDS of the MHSS

Experts ,viewpoints Data Sets		Agree	No Comments	Disagree	Total
Demographic Information	Mean	18.62	0.28	1.10	20
	Stdev	3.43	1.03	2.48	0
Obstetrical History	Mean	18.70	0.30	1.00	20
	Stdev	1.49	0.63	1.24	0
Current Status For Pregnant	Mean	18.43	0.36	1.21	20
	Stdev	1.65	0.74	1.25	0
Medical History	Mean	18.58	0.19	1.23	20
	Stdev	1.58	0.57	1.37	0
Family History	Mean	18.8	0.2	1.1	20
	Stdev	1.42	0.38	1.32	0
Initial Laboratory before pregnancy	Mean	16.05	0.53	3.54	20
	Stdev	6.74	1.12	6.37	0
Examinations before pregnancy	Mean	17.87	0.12	1.57	20
	Stdev	5.06	0.62	4.08	0
History of pregnant women	Mean	20	0	0	20
	Stdev	0	0	0	0
Current pregnancy	Mean	18.93	0.14	0.93	20
	Stdev	1.49	0.53	1.27	0
Sonography and Screening	Mean	20	0	0	20
	Stdev	0	0	0	0
Pregnancy Laboratory	Mean	17.71	0.49	1.80	20
	Stdev	5.20	1.14	4.42	0
Pregnancy Examinations	Mean	18.25	0.15	1.60	20
	Stdev	3.76	0.68	3.76	0
Pregnancy common assessment	Mean	20	0	0	20
	Stdev	0	0	0	0
History Of Delivery	Mean	20	0	0	20
	Stdev	0	0	0	0
History of recent pregnancy	Mean	20	0	0	20
	Stdev	0	0	0	0
Postpartum common assessment	Mean	20	0	0	20
	Stdev	0	0	0	0

The results of the analysis of the CIMHSS data revealed the highest frequency of adverse maternal outcomes pertain to "preterm labor in women with preeclampsia" (n=86, 85.15%). The highest frequencies observed for the adverse maternal outcomes by the three domains were as follows: [1] In the domain of "the effect of history of previous pregnancies on childbirth outcome", the highest frequency 70 (68.62%) dedicated to "preterm childbirth in women with a previous history of preterm labor"; [2] In the domain of "the effect of diseases and abnormalities of the current pregnancy on the delivery outcome", the highest frequency pertained to "cesarean complications in women with gestational diabetes" 65 (64.36%) and "preeclampsia in women with diabetes" 63 (62.38%); and [3] In the domain of "the effect of the current pregnancy conditions on the delivery outcome", the highest frequency pertained to "gestational diabetes in women with a high Body mass index (BMI) "58 (58.86%), "cesarean section in women with a high BMI" 56 (54.9%) and "preeclampsia in women with a high BMI" 54 (52.94%).

Table 3: Data analysis and reports about maternal health outcomes in the CIMHSS

Main	Reports	N (%)
The effect of previous pregnancy history on the outcome of current labor	Women who have had preterm delivery in their previous pregnancies have had preterm delivery in their current pregnancy.	70 (68.63)
	Women who have had gestational diabetes in their previous pregnancies have had gestational diabetes in their current pregnancy.	49 (48.04)
	Women who have had preeclampsia in their previous pregnancies have had preeclampsia in their current pregnancy.	48 (47.06)
The effect of current pregnancy diseases and anomalies on the outcome of current labor	Women with preeclampsia have complications of preterm labor.	86 (85.15)
	Women who have preeclampsia, their baby are born during low birth weight.	58 (57.42)
	Women who have gestational diabetes have been diagnosed with cesarean section.	65 (64.36)
	Women who have gestational diabetes have been diagnosed with preeclampsia.	63 (62.38)
	Women with gestational diabetes have complications of preterm labor.	57 (56.43)
	Women with thyroid disease have been diagnosed with preeclampsia.	62 (61.39)
	Women who have had thyroid disease have premature delivery.	58 (57.42)
	Women who have thyroid disease have their baby born during low birth weight.	49 (48.51)
	Women who have anemia have had preterm labor.	39 (38.61)
	Women who have anemia have their baby born during low birth weight.	28 (27.72)
	Women with heart disease have had preterm labor.	23 (22.77)
	Women who have heart disease have their baby born during low birth weight.	18 (17.82)
The effect of the Current pregnancy status on the outcome of current labor	Women with high BMI (obesity) have been diagnosed with gestational diabetes.	58 (56.86)
	Women with high BMI (obesity) have had cesarean delivery.	56 (54.90)

Women with high BMI (obesity) have been diagnosed with preeclampsia.	54 (52.94)
Women with high BMI (obesity) have had a baby's death.	21 (20.59)
Women who have low BMI (malnutrition) have had preterm labor.	25 (24.51)
Women who have low BMI (malnutrition) have been diagnosed with preeclampsia.	24 (23.53)
Women who have low BMI (malnutrition) have had anemia.	24 (23.53)
Women who have low BMI (malnutrition) have had cesarean delivery.	20 (19.61)
Women who have low BMI (malnutrition) have their baby born during low birth weight.	19 (18.63)
Women who have gestational age above 35 have been diagnosed with preterm labor.	25 (24.51)
Women with gestational age over 35 have been diagnosed with cesarean delivery.	24 (23.53)
Women who have had gestational age over 35 have been diagnosed with preeclampsia.	24 (23.53)

Discussion and Conclusion

The present study was conducted to implement a pilot study of a computerized integrated maternal care information system to pave the way for data analysis tools (e.g. data mining). To this end, standard MDS were first identified and approved by experts. CIMHSS designed to extract reports on the relationship between the variables affecting maternal care outcome. The results suggested that the greatest agreement among the experts about a standard MDS pertained to the domains of "pregnancy common assessment" and the "postpartum common assessment" and "pregnancy ultrasound and screening". The present findings agree with those obtained in relevant studies. According to evidence, "pre-pregnancy assessments" contribute to the reduction MH adverse outcome including preterm birth, low birth weight and small-for-gestational-age. Postpartum assessments enable the improvement of maternal and neonatal nutrition, facilitate family planning and help prevent postpartum depression [13]. Postpartum care services are considered an important maternal care service; nearly half of the cases of maternal mortality occur in the puerperal period [14]. Following the implementation of the postnatal care program in the early 20th century, the rate of maternal mortality indicates an annual reduction of 5 per 100000 by the end of the century [15]. About 10% to 30% of pregnant women are faced with early pregnancy complications including miscarriage, bleeding and pain. Maternal health programs were therefore offered to pregnant women as multi-professional services in the form of an Early Pregnancy Assessment Unit [EPAU) from 1991 [16]. According to a study conducted to investigate EPAC in the emergency department, launching EPACs reduces the duration of treatment by 55%; the need for pathology blood tests by 56%; the need for formal imaging services by 85%; making the total costs saved 63% per patient; and no adverse outcomes were reported [17]. Identifying these complications and performing appropriate interventions therefore require the use of diagnostic and screening intervention; the experts surveyed in the present study also found the use of ultrasound and screening as key MDS. Since ultrasound is considered a safe technique with a high diagnostic value during pregnancy, its application has increased by 28% in recent years [18]. By facilitating the diagnosis of normal and abnormal uterine conditions, ultrasound can be effective in reducing maternal and neonatal mortalities [19]. A review study conducted to assess the effect of compact ultrasound on maternal and perinatal care concluded that compact ultrasound reduces maternal and neonatal mortalities [20]. A cohort study conducted to assess the effect of Doppler ultrasound on pregnancy management concluded that preterm and full-term neonatal admissions were higher in the group that underwent Doppler velocimetry. Conversely, the mortality rate associated with preterm and full-term neonates was lower in the group that underwent Doppler velocimetry [21].

The results obtained from the CIMHSS report showed that the highest frequency of adverse maternal outcomes pertained to "preterm labor in women with preeclampsia" and "preterm labor in women with a history of preterm childbirth". Blood pressure disorders during pregnancy are to blame for 9% to 25% of maternal mortalities in the world. Blood pressure disorders lead to pregnancy complications in 6% to 8% of all pregnancies and are the main risk factor for stillbirth and infant mortality and morbidity [22, 23]. Preeclampsia is a hypertensive disorder during pregnancy that affects 5% of all pregnancies, and evidence suggests that this condition entails long-term complications and consequences such as hypertension later on and cardiovascular diseases [24]. Moreover, preeclampsia is regarded as a risk factor of preterm birth [25]. Previous studies have shown that a history of preterm birth leads to recurrent preterm birth in later pregnancies and is also associated with a higher risk of small-for-gestational-age infants [26, 27]. A study conducted to assess the relationships of obstetrical history and preterm birth with uterine anomalies clarifies a clear relationship between recurrent preterm birth and a previous history of preterm birth in women with uterine abnormalities [28]. Other studies have pointed out the role of genetic and environmental factors in the incidence of preterm birth [29]. In a study conducted to identify the relationship between the medicines used during pregnancy and preterm birth, Orozova found that maternal vaccination can be associated with preterm birth [30]. Given the complexity and interdependence of risk factors for maternal adverse outcome, it is essential that maternal care information systems be integrated with maternal health systems and other systems to facilitate advance data analysis using data mining tools. The in-depth analysis and accurate identification of the patterns of risk factors affecting maternal care pave the way for more targeted preventive interventions.

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References

1. Aseweh Abor P, Abekah-Nkrumah G, Sakyi K, Adjasi CK, Abor J. The socio-economic determinants of maternal health care utilization in Ghana. International Journal of Social Economics. 2011;38(7):628-48.
2. Ndour C, Gbété SD, Bru N, Abrahamowicz M, Fauconnier A, Traoré M, et al. Predicting in-hospital maternal mortality in senegal and mali. PLoS One. 2013;8(5):e64157.
3. Ivory CH, Freytsis M, Lagrew Jr DC, Magee D, Vallejo M, Hasley S. Standardizing maternity care data to improve coordination of care. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2017;46(2):284-91.
4. Pacagnella RC, Cecatti JG, Parpinelli MA, Sousa MH, Haddad SM, Costa ML, et al. Delays in receiving obstetric care and poor maternal outcomes: results from a national multicentre cross-sectional study. BMC pregnancy and childbirth. 2014;14(1):159.
5. Kashem MA, Seddiqui M, Moalla N, Sekhari A, Ouzrout Y. Review on Telemonitoring of Maternal Health care Targeting Medical Cyber-Physical Systems. arXiv preprint arXiv:160707712. 2016.
6. Foreman KJ, Lozano R, Lopez AD, Murray CJ. Modeling causes of death: an integrated approach using CODEm. Population health metrics. 2012;10(1):1.
7. Liabsuetrakul T, Prappre T, Pairot P, Oumudee N, Islam M. Development of a web-based epidemiological surveillance system with health system response for improving maternal and newborn health: field-testing in Thailand. Health informatics journal. 2017;23(2):109-23.
8. Senthilkumar D, Paulraj S, editors. Prediction of low birth weight infants and its risk factors using data mining techniques. Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management; 2015.
9. Delen D, Patil N, editors. Knowledge extraction from prostate cancer data. System Sciences, 2006 HICSS'06 Proceedings of the 39th Annual Hawaii International Conference on; 2006: IEEE.
10. Mehryar A. Primary health care and the rural poor in the Islamic Republic of Iran. Asia and Pacific Population Studies Centre, Ministry of Science and Technology: Tehran. 2004.
11. Rafiei M, Ezzatian R, Farshad A, Sokooti M, Tabibi R, Colosio C. Occupational health services integrated in primary health care in Iran. Annals of global health. 2015;81(4):561-7
12. Zolala F, Haghdoost AA. A gap between policy and practice: A case study on maternal mortality reports, Kerman, Iran. International journal of preventive medicine. 2011;2(2):88.
13. Weir S, Posner HE, Zhang J, Willis G, Baxter JD, Clark RE. Predictors of prenatal and postpartum care adequacy in a Medicaid managed care population. Women's Health Issues. 2011;21(4):277-85.
14. Pallangyo EN, Mbekenga C, Källestål C, Rubertsson C, Olsson P. "If really we are committed things can change, starting from us": Healthcare providers' perceptions of postpartum care and its potential for improvement in low-income suburbs in Dar es Salaam, Tanzania. Sexual & Reproductive Healthcare. 2017;11:7-12.
15. Fraser DM, Cullen L. Postnatal management and breastfeeding. Obstetrics, Gynaecology and Reproductive Medicine. 2006;16(2):65-71.
16. Edey K, Draycott T, Akande V. Early pregnancy assessment units. Clinical obstetrics and gynecology. 2007;50(1):146-53.
17. O'ROURKE D, Wood S. The early pregnancy assessment project: the effect of cooperative care in the emergency department for management of early pregnancy complications. Australian and New Zealand Journal of Obstetrics and Gynaecology. 2009;49(1):110-4.
18. Basama FMS, Crosfill F, Price A. Women's perception of transvaginal sonography in the first trimester; in an early pregnancy assessment unit. Archives of gynecology and obstetrics. 2004;269(2):117-20.
19. Jauniaux E, Johns J, Burton G. The role of ultrasound imaging in diagnosing and investigating early pregnancy failure. Ultrasound in obstetrics & gynecology. 2005;25(6):613-24.
20. Harris RD, Marks WM. Compact Ultrasound for Improving Maternal and Perinatal Care in Low-Resource Settings. Journal of Ultrasound in Medicine. 2009;28(8):1067-76.
21. Messawa M, Ma'ajeni E, Daghistani MH, Ayaz A, Farooq MU. The role of doppler ultrasound in high risk pregnancy: A comparative study. Nigerian medical journal: journal of the Nigeria Medical Association. 2012;53(3):116.
22. Khan KS, Wojdyla D, Say L, Gülmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. The lancet. 2006;367(9516):1066-74.
23. Gifford R. Report of the national high blood pressure education program working group on high blood pressure in pregnancy. Am J Obstet Gynecol. 2000;183:S1-S15.
24. Skurnik G, Roche AT, Stuart JJ, Rich-Edwards J, Tsigas E, Levkoff SE, et al. Improving the postpartum care of women with a recent history of preeclampsia: a focus group study. Hypertension in pregnancy. 2016;35(3):371-81.
25. Mutter WP, Karumanchi SA. Molecular mechanisms of preeclampsia. Microvascular research. 2008;75(1):1-8.
26. Connealy BD, Carreno CA, Kase BA, Hart LA, Blackwell SC, Sibai BM. A history of prior preeclampsia as a risk

factor for preterm birth. American journal of perinatology. 2014;31(06):483-8.

27. Durnwald CP, Walker H, Lundy JC, Iams JD. Rates of recurrent preterm birth by obstetrical history and cervical length. American Journal of Obstetrics & Gynecology. 2005;193(3):1170-4.
28. Khander A, Stern E, Gerber RS, Fox NS. The association between obstetrical history and preterm birth in women with uterine anomalies. The Journal of Maternal-Fetal & Neonatal Medicine. 2017:1-5.
29. Mazaki-Tovi S, Romero R, Kusanovic JP, Erez O, Pineles BL, Gotsch F, et al., editors. Recurrent preterm birth. Seminars in perinatology; 2007: Elsevier.
30. Orozova-Bekkevold I, Jensen H, Stensballe L, Olsen J. Maternal vaccination and preterm birth: using data mining as a screening tool. Pharmacy world & science. 2007;29(3):205-12.