

Applicability of ICT, Data Mining and Machine Learning to Reduce Maternal Mortality and Morbidity: Case Study Afghanistan

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Abstract

Maternal mortality and morbidity are one of the challenges all over the world. Usually, most of these phenomena are preventable. The highest mortality rates are in developing countries. Approximate 99% of maternal deaths from preventable reasons related to pregnancy and childbirth occur in developing countries. Afghanistan has one of the worse rankings in this ward. There are many challenges for pregnant women such as lack of enough doctors, lack of or poor awareness, lack of medical centers, lack of health information management system in most of the clinics and hospitals, lack of enough doctors, cultural issues, infrastructure and transportation problems, etc. In recent decades, information communication technology (ICT) has made significant advances in various fields, remarkably medicine. Thus, this paper represents how to solve most of maternal mortality and morbidity issues using ICT. Herein, it proposes the use of machine learning algorithms and data mining techniques to predict the risk level of maternal problems for pregnant women.

Key Words: ICT, Maternal Health, Maternal Mortality, Data Mining, Machine Learning, Afghanistan.

1. Introduction

For a pregnant woman, Afghanistan is one of the worst ranked countries that its maternal mortality rate exceeds the average in South Asia overall (UNICEF) [1-3]. While with global effort worldwide maternal mortality rate reduced by 40% in 2015 but this rate is different in each country. As in Afghanistan maternal mortality rate in 1995 was 1270 per 100000 live births, in 2000 it decreased to 1100, in 2005 with a significant increase 821, this rate reduced to 584 in 2010, and it was 396 in 2015, according to the WHO report [31]. However, this number may be much higher, since we do not have all the accurate statistics of mortality. Most of the maternal problems are in remote locations [3] due to lack of health centers, lack of or inadequate midwives and obstetrician doctors, lack of appropriate roads and highways, low level of education, etc.

The main goal of this paper is to propose strategies to overcome challenges toward maternal

mortality and morbidity in Afghanistan through ICT with the following research questions:

- What are existent challenges of the maternal health system in Afghanistan?
- What is the status of maternal historical data availability of Afghanistan?
- How artificial intelligence and e-health support maternal section?
- What are the barriers to implement smart health in Afghanistan?

The next section describes the current status of the maternal health system in Afghanistan and briefly indicates the current problems. Similarly, section 3 proposes four different types of ICT usage in the maternal area. In section 4 we discussed the challenges of implementing the proposed suggestions. Finally, section 5 concludes the paper and has an outlook of the future work.

2. CURRENT MATERNAL HEALTH STATUS In AFGHANISTAN AND PROBLEM STATEMENT

Every year approximately 400 from 100000 women die due to maternal issues in Afghanistan. The main factors effect on maternal mortality and morbidity in Afghanistan is economic, social [4] (maternal education, sociocultural practices, social infrastructure etc.) and medical (hemorrhage, obstructed labor, infection, high blood pressure, and unsafe abortion) problems. The shortage and even lack of doctors in many remote areas is a serious problem for pregnant women. Doctors are not interested to work in remote areas due to a variety of reasons, including security problems.

Demographic and health survey in 2013 indicate that only 18% of women completed four checkup visits before baby delivery. Additionally, the survey [32] taken by Ministry of Health in 2010 indicates poverty, long distance, transportation problems, lack of awareness, security problems, lack of female employees, poor quality of health care and family-prohibition as the main reasons for not using prenatal care. Similarly, pregnant women do not pay attention to do prenatal care for their health during pregnancy.

The Afghan government endeavors to bring many improvements in the maternity ward so that this rate is kept to a minimum. The ministry of public health of Afghanistan had some achievements via rising community awareness (by publishing guidelines and information books), capacity building, and hiring more midwives and health employees. Hence in 2015, 59% of mothers give birth to their babies in a clinic

and with maternal care and the help of midwives. This number increased to 63% in 2016 and 68% in 2017 [32] (see Fig. 1). Moreover, the Ministry of Health has developed and used of e-health system in its long-term plans to solve many existent health problems in Afghanistan. Therefore, in the early stages, it developed a health information management system.

French Medical Institute for Children (FMIC) is the first and one of the few hospitals that have e-health system in Afghanistan since 2007. It uses video conferencing and shared databases to get contact with remote locations. More than 25000 teleconsultations to this hospital were established up to now. This system connects six hospitals in the region: FMIC, Bamyan and Faizabad Provincial Hospitals, Mirwais Regional Hospital Kandahar in Afghanistan, Khorog Oblast General Hospital in Tajikistan and Agha Khan University Hospital and one Hospital in Paris [5].

Furthermore, in almost all healthcare centers, there is no electrical appointment system. The appointment can be taken from the center for the same day. They often wait many hours to get their turn. Besides, in this type of system, the transparency is low and sometimes the turn is not followed. In addition, in emergency situations, the presence of a specialist doctor is essential.

Few hospitals and clinics store patient information electronically into their computerized information management system in Afghanistan. Some of them use paper-based technique and most of them even do not save any record about a patient. Thus, a pregnant woman should always show her recent sonography and results of given tests to the doctor and briefly talk about her previous check-ups. This is not easy remarkably for uneducated ones who are not aware of maternal problems. Unfortunately, most of the women are not aware of maternal issues and there is not any center to give them information. Although a guidebook on maternal and child health has been published in recent years all over the country to raise the level of knowledge and awareness of the community, it is still not very effective. Some women do not have the ability to read, and some people are not interested in reading a book. Consequently, different techniques should be used to enhance public awareness of maternal issues.

Despite the remarkable effort of the Ministry of Health in reducing maternal mortality

rates, this number is much high. On the other hand, most of these women die of preventable pregnancy-related causes. Thus, this calls for an evaluation of the factors that affect severe maternal morbidity.

Although Afghanistan has made significant progress in reducing maternal mortality rates, it is still high, as noted earlier. Many diseases and problems of mothers before and during pregnancy cause severe morbidity for them. The Ministry's method for reducing this rate is not much effective. Although the Ministry of Health identifies some effective factors still many of them are unknown. Furthermore, the impact ration of each is not exactly recognized. Similarly, while in some healthcare centers, all maternal and child health information is available from the time the mother first goes to the hospital, these data are not analyzed, so they cannot support decision-making.

3. PROPOSED STRATEGIES TO OVERCOME CHALLENGES TOWARD MATERNAL MORTALITY AND MORBIDITY IN AFGHANISTAN

The following are some approaches against maternal challenges in Afghanistan using ICT (as briefly shown in table 1).

3.1. Awareness of Pregnant Women Through ICT

Nowadays, mobile and telecommunications carriers have countrywide coverage. The statistics show that more than 23 million Afghan people use cellular phones. The number of women using their own smartphones or a smartphone belonging to a family member is increasing day by day. According to USAID, more than 80% of Afghan women have access to mobile technologies in 2013 and this rate is growing yearly. In this case, even women who do not have enough reading and writing skills are included. Most of these women use social media like Facebook, Twitter, and Instagram.

Transferring information messages about women health through telecommunication networks is another effective solution. In addition, creating applications, informative pages and groups in social media will have a significant impact on improving awareness of society about maternal and women healthcare. In addition, either organizing distance learning and e-courses or developing maternal health mobile applications, question and answer electronic system and knowledge sharing blogs and hub are very useful for raising the women's essential knowledge and responding to their usual questions.

3.2 Maintaining the Integrity of the Specifications Utilizing Telemedicine

Telemedicine is the best choice for solving some problems of pregnant women living in remote regions and isolated communities [5]. A healthcare professional can visit patients virtually through mobile technology [7]. This reduces the cost of medical care (visit fee). Additionally, the patient does not need to go far distances to reach a clinic remarkably in remote regions and addresses the lack of doctors in those regions. Healthcare workers (particularly midwives) can improve their medical education and skills by observing medical professions in a certain field [8]. In addition, medical experts can share information and focus on the treatment of a patient from different locations [6]. This is not only an opportunity for remote regions but for all regions as the doctors get benefit from experience and skill of foreign experts.

3.3 Healthcare Information System

Although most private hospitals have their own information system this is not that in all public hospitals and clinics. Every clinic and hospital should have a healthcare information system to manage and store related data about patients. This avoids loss of information and paper-based system. So, the experts can analyze and evaluate the existent datasets for further researches certainly in biomedicine. Also, the doctor can access the health history of a patient easily in each visit for further treatment. These data are also necessary for e-health devices and medical decision support systems.

3.4 Using Decision Support Systems to Predict and Diagnose Maternal Morbidity

Prophylaxis reduces the risk of getting an illness and its prompt diagnosis increases the chance of easy and fast treatment. The reason for the death of many pregnant women is curable diseases and dangers. It happens regularly that the disease of a pregnant woman is not diagnosed or the risks that threaten personally her are not recognized. Today, different machine learning methods and datamining techniques are used to predict and discover various diseases and risks remarkably during pregnancy. The high accuracy of these systems is proofed and, in many cases, positively affects maternal mortality and morbidity ratio.

Hereby, we mention some related works in the implementation of data mining and machine learning in maternal health problems and dangerous diseases in pregnancy. For example, in [11] the author worked on an algorithm based on multiple logistic regressions. The main goal of the algorithm is to predict the risk level of preeclampsia

according to the population of Australia. This algorithm has 95% detection rate with 10% false positive rate.

In [13] the authors developed a clinical decision support system based on Multi-Layer Perceptron (MLP) network to predict pregnancy outcome in pregnant women who have systemic lupus erythematosus. Also, they indicated that this system has 90.6% accuracy employing MLP. These diagnose and prediction systems are implemented in many countries all we need to do is to customize it according to the context of Afghanistan or we can build it from scratch.

In [20] the authors claimed they obtain 90-97% accuracy in predicting prescription medicine of one with heart disease using radial basis function. The strength of KNN (K-Nearest Neighbor) is proofed in [21] with 97.4% accuracy in diagnosis of heart disease. However, its accuracy reduced to 92.7% by applying voting aggregation (combine results of many classifiers). Machine learning and data mining have the power to predict diabetic diseases for pregnant women [22,23]. Bagherzadeh et al. [24] compared multiple feature selection techniques on records of 803 pre-diabetic female to discover diabetes mellitus. Moreover, some of the researchers used artificial intelligence to in diabetic complications areas [30,28,29] such as hypoglycemia, cardiovascular diseases, microalbuminuria, ketoacidosis, proteinuria, retinopathy, and neuropathy [26,27]. Authors in [25] predicted prescription of a patient for follow up medication. Akbulut et. al. [19] developed a prediction system using 9 binary classification models to predict possible risks of fetal anomalies with the 87.5% accuracy. The system recommends daily activities during pregnancy to pregnant women and analyzes health status and history of pregnant women. They used a clinical dataset of 96 pregnant women for training the machine.

The research on [18] used data mining techniques to analyze the factors that affect postnatal care of pregnant women in Ethiopia. In [15] the author proposed a model based on cloud computing and data mining to provide desirable accessibility for pregnant women in Philippine to medicine and health supplies by making better administration of its provision. Similarly [16] employs machine learning algorithms to predict adverse prenatal outcomes.

In [17] the authors used machine-learning algorithms to develop a preterm neonates

survival assessment. It presents that machine-learning technique out performs the logistic models and can predict survival in very preterm infants. In [14] authors present a model for prediction of hypertensive disorders during first trimester pregnancy on the bases of the population of London. The proposed model has 90% accuracy and 5% false-positive detection.

In [12] the authors proposed a model to predict gestational diabetes mellitus in the first trimester of pregnancy. The model with the implementation of logistic regression has 74.1% accuracy with 20% false positive rate. In [10] the authors applied a hybrid algorithm consists of K- nearest neighbor, logistic regression, support vector machines, and multifactor dimensionality reduction to predict diabetes, comorbidity, and hypertension. In [9] the authors worked on a logistic regression model to predict severe maternal morbidity at early stages. The model is based on the population of pregnant women receiving prenatal and final cares at E.S.E Clinica de Maternidad Rafael Calvo in Cartagena, Colombia.

Consequently, we can implement machine learning and data mining techniques to predict and diagnose the risk of all diseases cause maternal mortality and morbidity such as heart and diabetic diseases of pregnant women.

4. CHALLENGES TO IMPLEMENT RECOMMENDED APPROACHES

The previous section presented some approaches to utilize ICT in order to decrease maternal mortality and morbidity but implementing these strategies face some challenges in Afghanistan. The main challenges are as follows:

A. Lack of human resources at all levels

There are not enough experts in many eras such as health and Information Technology due to decades of war and economic problems in Afghanistan.

B. Low level of literacy and poor technological skills

In most of the regions in Afghanistan. Most of the pregnant women are not able to use the system/application easily and healthcare professionals are not aware of information security and many other issues in IT systems [6].

C. Information and communication technology infrastructure

rural areas facing more shortages in infrastructure and infrastructure support utilities such as power and electricity problems, backup systems, etc.

D. Financial and sustainability issues

In a developing country such as Afghanistan limited, or unsustainable fund is a big challenge against any development. Sometimes the project, services, and programs may be hampered by reliance on donor funding.

E. Acceptance, cultural problems [8]

Typically, adapting with new systems and new technologies is somehow not acceptable and have its own cultural challenges by both people and health-care staffs at first.

F. Job security [7]

Some employees believe that the implementation and use of information technology diminish or eliminate their business opportunities due to the lack of IT skills. Privacy, congeniality, and security of electronic records and quality assurance of electronic information. The records of patients and other maternal health data should have high- quality assurance and be private and secure.

G. Internet accessibility and reliability

Although the government decreased the cost of internet accessibility and usage into a half, still it is expensive. The Internet is not accessible in some regions and the connection is not reliable in most of the regions.

H. Standard policy and e-health status policy for long period

Although, Ministry of Health is working on development and improvement of health information system still a comprehensive e-health policy is needed. On the other hand, this policy should be standard and applicable by all.

I. Disparity between urban and rural sites

The level of education, security, transportation systems, cultural issues, access to technologies have a lot of difference in rural and urban sites in Afghanistan.

J. Interoperability of existence heterogeneous databases

The existent databases in clinics and hospitals have different technologies which make interoperability of them difficult but not impossible.

5. CONCLUSION AND FUTURE WORK

Maternal mortality and morbidity are a major problem in the world. Yet in Afghanistan, a country with a high number of deaths every year it is a very critical issue. Even though the rate of maternal mortality is reduced in recent years by the effort of government and the international community, maternal mortality and morbidity have still high rate in Afghanistan.

This paper presents four recommendations for using ICT, implementing aware-ness programs through ICT, medical decision support systems, telemedicine, and healthcare information system, as approaches for maternal mortality and morbidity problem. However, there are many challenges while applying these approaches, but these problems are solvable after some time.

This paper is the first step of our work in the future we will use data mining and machine learning approaches to predict risk level of the maternal mortality and morbidity according to different issues and factors for pregnant women in Afghanistan.

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Table 1. Using ICT to improve maternal health.

Health Awareness	Telemedicine	Clinical Information System	Decision Support Systems
E-courses	Visiting patients	Management of health records of pregnant women	Predict and diagnose maternal diabetes
Distant learning based on internet	Doctors support	Management of child birth records	Predict and diagnose maternal anemia
Apps	Healthcare staff support	Recording data for further researches and evaluation	Predict pregnancy outcomes in pregnant women with special diseases
Knowledge sharing groups	Learning and practicing		Predict childbirth risk and pregnancy risk for women with health diseases
			Predict detrimental perinatal consequences
			Predict consequences of hypertensive disorders in pregnant women and its effects on fetus

Births with Maternal Care in Clinic

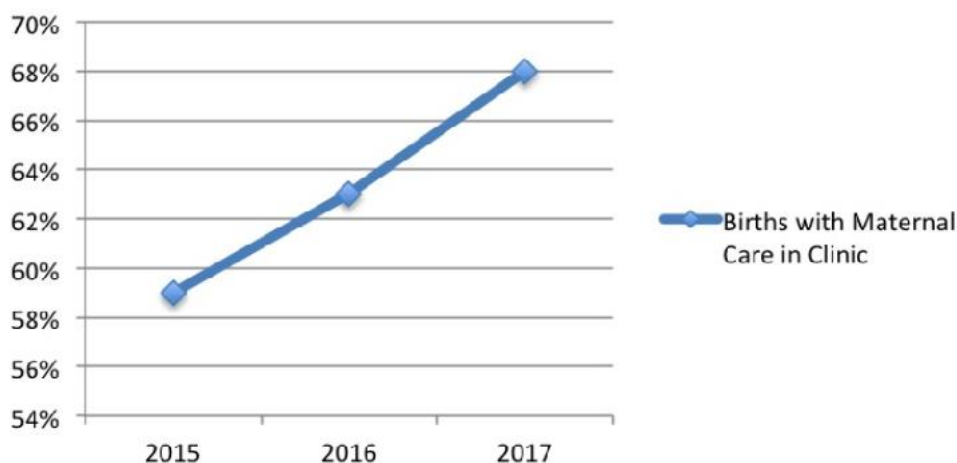


Fig. 1. Rate of given birth in a clinic with maternal care in Afghanistan.

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