Development of Application Software to guide Complications in Pregnancies

Abubakar Yakubu Zandam[1,2], Zaharaddeen Salele Iro[2], Jamilu Awwal[3], Khadija Abdulwahab[4]

[1]Department of Science Education,
Jigawa State College of Education Gumel

[2,3] Department of Computer Science,
Faculty of Computing, Federal University Dutse

Corresponding Author: zs.iro@fud.edu.ng

Abstract

Approximately one-third of pregnancies end in loss. Despite the frequency and *potentially distressing nature of pregnancy loss, the pathophysiology of loss remains poorly understood, and its natural history, including temporal ordering of signs and symptoms, in early pregnancy has yet to be fully described. Consumption of adequate balance and healthy diet during the pregnancy stages is required for a healthy and successful pregnancy upshot. However, there are many pregnant women being unaware of the importance of the prenatal nutrition. Hence, this may indirectly affect their gestational weight gain. Having obesity or underweight during the conception stage may cause pregnancy complication later. Some pregnant women don't provide sufficient care to themselves while they are pregnant which could expose them to many diseases. The rapid advancement of internet and communication technologies has allowed more pregnant women to use mobile applications to receive information related to pregnancy.*

This work provides an efficient way to help pregnant women maintain good health during their pregnancy by developing a web application that provides pregnant women with the necessary knowledge about causes, symptoms and preventive measures on complications that can occur during pregnancy. The complications briefly highlighted are Malaria, Anemia, Obstructed labour, Miscarriage, Hermorrhage, Lower Abdominal Pain and Eclampsia.

The tools utilized in implementing this work include Apache CouchDB, PouchDB, Javascript and its frameworks (Vue Js, Vuetify).

Keywords: Pregnancy, Malaria, Miscarriage, Anemia

INTRODUCTION

Pregnancy induces a number of direct and indirect physiological changes in women, and various hematologic manifestations have been described. Approximately one-third of pregnancies end in loss; however, the natural history of early pregnancy loss, including signs and symptoms preceding loss, has yet to be fully described and its underlying mechanisms fully understood [1].

Globally, there are more pregnancy applications than for any other medical topic which attests to their ever-increasing popularity. These applications have been overshadowed by online resources, especially as most (if not all) of the tools are available without installing any additional software, and in many cases, without charge [2].

In recent years, the internet has become a very popular source of health information for pregnant women [3]. Women, the majority owners of smartphones globally are reported to search for information related to pregnancy on the internet during their pregnancy stage [4]. This situation has been driven by ease of access and there is evidence to indicate that pregnant women are more likely to search for information at particular times in pregnancy and in response to certain situations [5]. As a result, many pregnant women utilize the internet as a source of information for making pregnancy-related decisions.

Although internet searching is widely used, one of the difficulties with this medium is an inability to judge the quality and accuracy of retrieved information. This lack of reliability is well recognized and a systematic meta-analysis of health website evaluations, found that the majority of evaluations (70%) concluded that quality of information was a problem on the internet and such information when used by the pregnant women can be harmful, confusing and overwhelming, which can also lead to increased and unjustifiable anxiety to the pregnant women [6].

The pregnancy applications from the literatures reviewed mostly provide information on nutrition, gestational weight gain, due date and ovulation calculators. They are mostly online; information is only accessible if there is an internet connection. In this paper, we investigate the most efficient way of helping pregnant women with information related to pregnancy.

However, there are many pregnant women being unaware of the importance of the prenatal nutrition. Hence, this may indirectly affect their gestational weight gain. Having obesity or underweight during the conception stage may cause pregnancy complication later. Some pregnant women don't provide sufficient care to themselves while they are pregnant which could expose them to many diseases. This application will provide the causes, symptoms and preventions to some complications that affect pregnant women. They are:

1) Malaria: Malaria is a mosquito-borne disease affecting both humans and other animals caused by parasitic protozoans belonging to plasmodium [7]. It remains a serious life threatening public health concern in sub-Saharan Africa with 25 million pregnant women affected by malaria, predominantly by Plasmodium falciparum [8]. Malaria infection during pregnancy is a major public health problem, with significant risk to the mother, the foetus and the newborn baby [9]. Symptoms and complications of malaria during pregnancy vary according to

the intensity and transmission of malaria in a given geographical area, as well as the individual level of acquired immunity [10]. Symptoms of malaria includes Fever, malaise, vomiting and headache etc. In severe cases it could cause jaundice, seizures, coma or death [11]. Preventive measures can include the use of mosquito nets, administering of prophylactic anti-malaria.

2) Anemia: Anemia during pregnancy is a public health problem that leads to different life-threatening complications and poor pregnancy outcomes. The highest rate of anemia during pregnancy is hosted in the Sub-Saharan region where 17.2 million pregnant women were reported to be anemic [12]. Anemia during pregnancy refers to a hemoglobin concentration of less than10.5g/dL during second trimester [13] and 11 g/dL during third trimester [14]. It is the most common hematologic disorder which affects the normal functioning of the organ system by creating a scarcity of oxygen that reaches different tissues and organs through blood circulation. The hemoglobin deprivation due to anemia during pregnancy has serious maternal and fetal complications, which could even lead to maternal mortality [15]. The main causes of anemia during pregnancy are nutritional deficiencies (iron, vitamin B12, folate), parasitic infections, (hookworm and malaria e.t.c), and acute blood loss [16]. Preventive measures include iron therapy, dietary counselling during antennal and administering of anti-malaria and hematinic during pregnancy [17].

3) Obstructed labour: Obstructed labour is a major cause of both maternal and perinatal morbidity and mortality in developing countries including Nigeria. Labour is said to be obstructed, when in spite of adequate uterine contractions, there is arrest in progress due to mechanical factors, and further progress and delivery is impossible without assistance [18, 19]. Some causes of obstructed labour include abnormal foetal lie/presentation, congenital malformations in the foetus (such as hydrocephalus), impacted pelvic tumour, cervical or vaginal stenosis, and a rigid perineum [20]. Other factors include poverty, ill-equipped health facilities, poor emergency obstetric care services and aversion to surgery. Apart from the maternal and perinatal death, obstructed labour is associated with number of debilitating and distressing maternal morbidities which includes uterine rupture, vesicovaginal fistula (VVF), recto-vaginal fistula, genital sepsis, gynaetresia, amenorrhea and

impaired fertility [21]. Some Symptoms of obstructed labour are prolonged labour, prolonged rupture of foetal membranes, dehydration, tachycardia, intrauterine foetal death, oedematous vulva, presence of malodorous vaginal discharge, warm vagina, caput and moulding of the foetal head. Maternal health education, financial empowerment schemes, antenatal care and hospital deliveries have served as preventive measures for obstructed labour [22].

4) Miscarriage: Miscarriage is generally defined as the loss of an intrauterine pregnancy before the age viability [23] .It is the termination of pregnancy by the removal or expulsion from the uterus of a foetus or embryo prior to viability. It can occur spontaneously. Symptoms includes amenorrhea, vaginal bleeding and pelvic pain. Some of the risk factors for miscarriage include Chromosomal abnormalities [24], Endometrial defects [25], Parental risk factors of miscarriage [26], Lifestyle risk factors [27] etc. Health risks associated with miscarriage includes several adverse obstetric outcomes in subsequent pregnancies, psychological consequences of miscarriage involve both trauma and bereavement, anxiety depression and suicide. Some preventive measure includes abstaining from smoking, stress management should be prioritised to improve general health, alcohol should be avoided in early pregnancy, fruit and vegetables should be thoroughly washed to avoid the risk of ingesting pesticides. Women with a history of miscarriage, particularly those with three or more miscarriages, are at an increased risk of obstetric complications including preterm birth. Therefore, these women should be treated as patients at high risk during antenatal and intrapartum care [28].

5) Hemorrhage: Hemorrhage can either be Antepartum or postpartum. Antepartum hemorrhage is defined as vaginal bleeding that occur during the second half of pregnancy (after 20 weeks of estimated gestational age until delivery) [29, 30], while postpartum hemorrhage is defined as blood loss of at least 500 mL following vaginal delivery (VD) or 1000 mL following a cesarean section (CS) within 24 hours postpartum [22]. Hemorrhage also causes of perinatal mortality and maternal morbidity worldwide. The main cause of serious vaginal bleeding in late-term pregnancy is placenta previa (PP), which occurs when the placenta implants in a location overlies or abuts the internal cervical os.

Other risk factors associated with PP include chronic hypertension, multiparity, multiple gestations, tobacco use, uterine curettage, inadequate prenatal care, and male foetal gender [31].

6) Preeclampsia/Eclampsia: Preeclampsia is a multisystem disorder of pregnancy characterized by wide-spread endothelial dysfunction resulting in elevated blood pressure and end-organ damage in the second half of pregnancy [32]. Pre-eclampsia is one of the main causes of maternal, foetal, and neonatal mortality, especially in low-income and middle-income countries. When left untreated, pregnant women with pre-eclampsia have severe complications such as eclampsia, liver rupture, stroke, pulmonary oedema, or kidney failure, which can all be lethal [33]. Pre-eclampsia is also related to foetal growth restriction and preterm birth, either spontaneous or through iatrogenic delivery. Some risk factors include previous preeclampsia, hypertension in pregnancy, chronic kidney disease, nulliparity, obesity, pre-gestational diabetes mellitus, among others [34].

7) Lower abdominal pain: Abdominal pain is a common complaint during pregnancy. It is reported by nearly all pregnant females at some time during the course of gestation. It refers to discomfort in the space between the chest and pelvis. Ectopic pregnancy, placental abruption, and non-pathological physiological changes make up the majority of abdominal pain syndromes [35]. Symptoms include vaginal bleeding and pelvic pain.

PROBLEM FORMULATION

A lot of different organizations provide different solutions to different mobile platforms which all vary in terms of features, platform support, information etc. Pregnancy guide applications help pregnant women maintain a good health throughout the pregnancy stages. They comprise of a number of essential and basic functions that add to its importance and which are enhanced by technology.

Still with the advancement of technology, pregnancy guide applications lack some functionalities and include some impurities that affects its users. They are: (1) Some pregnancy applications include advertisement which usually irritates users, and sometimes leads users to getting themselves subscribed to other services. (2) Most pregnancy applications are based on nutrition, gestational weight gain, due date and ovulation calculators. (3) Most pregnancy applications are not fully free; a user must pay to access other premium features. (4) Most pregnancy applications are accessible only online, meaning that no internet connection no pregnancy information.

Essentially, pregnancy application requires a system that will provide pregnant women all the necessary causes, symptoms and preventions to complications within the stages of pregnancy that works both online and offline.

METHODOLOGY

Data Collection

To fully understand the contents that will be used in the pregnancy application, two different surveys were conducted.

The first survey targeted pregnant women and their responses were used to examine any prior experience of using the pregnancy application and the type of information they mostly searched on the internet. The survey consisted of 11 questions and was distributed to 149 pregnant women.

The survey focused on the following domain:

1. Demographic information (Age, Educational Status)
2. Use and awareness of internet and smartphone
3. Source of information for pregnancy related issues

The survey targeted pregnant women and all the respondents were ensured to be pregnant or have given birth before. Out of the 149 respondents, 62.4% were owners of smartphone as shown in Fig. 1a below, with 39.6% of them having frequent access to internet and 34.2% not frequents. Having smartphones and frequent access to internet was mainly seen from women between the age of 24 to 31, as shown in Fig. 1b below. In order to make it useful, for those that have smartphones without having frequent access to internet, which represents 34.2% of the pregnant women, we employed the use of offline-first technology in building our pregnancy mobile application. So, the application can work both in online and offline modes.

Figure 1: (a) Pregnant Women Having Smartphones and (b) Frequency of Internet Usage

The second survey had 7 questions and targeted healthcare professionals to get their responses on usefulness of pregnancy application to pregnant women. From the survey, a total of 27 responses were obtained.

The survey focused on the following domain:

1. Duration as healthcare professional to predict working experience
2. Recommendation of using pregnancy application by the pregnant women
3. The contents that need to be included in the pregnancy application

Fig. 2 below shows the responses obtained from the healthcare professionals. About 17 of the respondents recommended complications and preventions to be part of the contents of the pregnancy application, while 8 recommended nutrition and the rest recommended symptoms.

17 of the respondents suggested that the pregnancy application works both online and offline out of which 15 of them have been working as healthcare professionals for a long period of time

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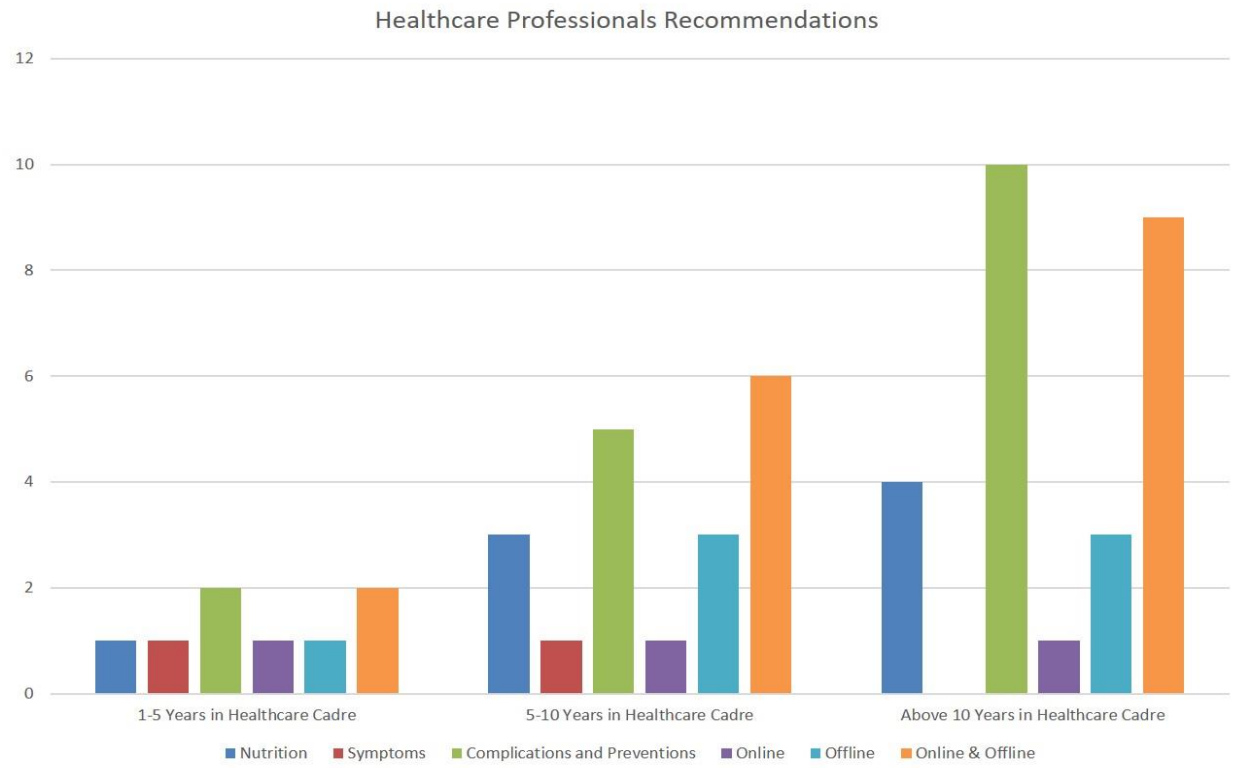


Figure 2: Distribution of healthcare professional's recommendations on pregnancy application.

The survey conducted serves as a guide on the contents that needs to be included in the pregnancy application and how it would be useful to pregnant women. The responses captured tailored the development and implementation of the pregnancy application so the application will meet the needs of the end users (pregnant women).

Software Design

To get the pregnancy application developed, we adopt water-fall model as our chosen model for software development. This model is simple and easy to used especially when the end requirements are defined. It consists of series of phases starting from top to down as shown in Fig. 3, where each phase must be completed before the next phase can begin, allowing no overlapping between the phases.

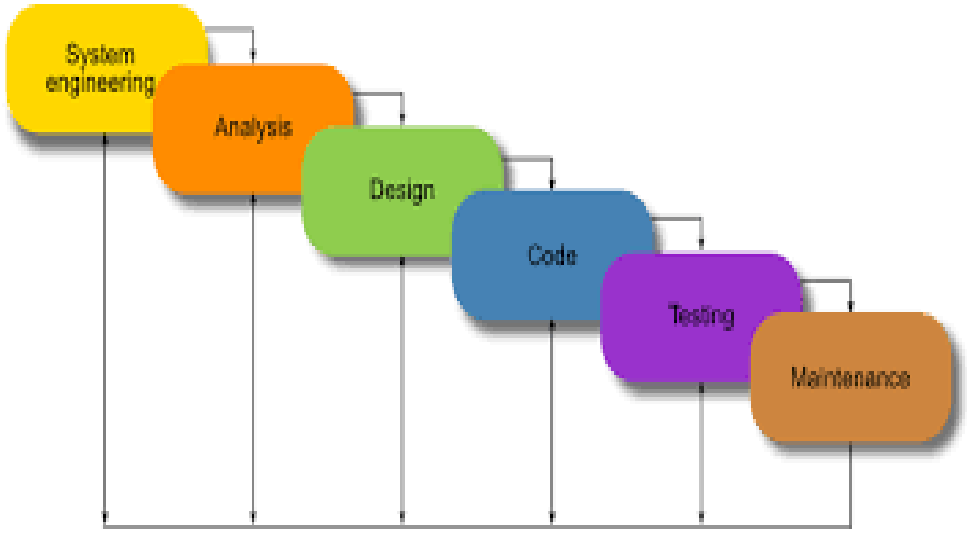


Figure 3: Waterfall Model Adopted in the Pregnancy Application Development

System Architecture

System architecture defines all the necessary components need to be coupled together to implement the overall system. The architecture of a system is the set of relationships between its components that cause the system to have certain desired properties as shown in Fig. 4 below:

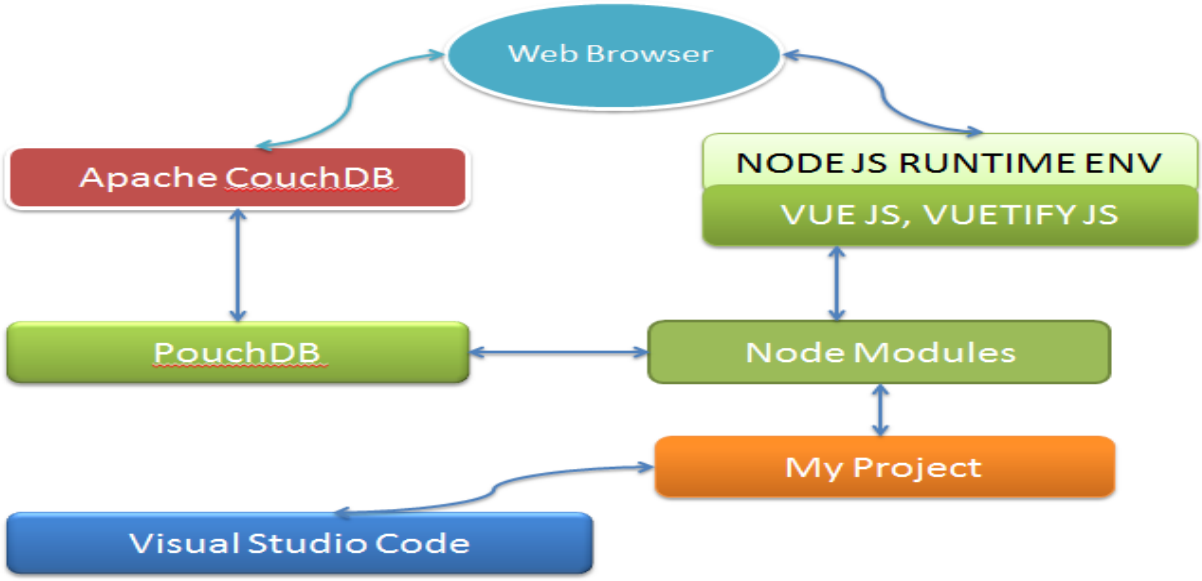


Figure 4: The Pregnancy Application System Architecture

Flowchart of the Proposed System

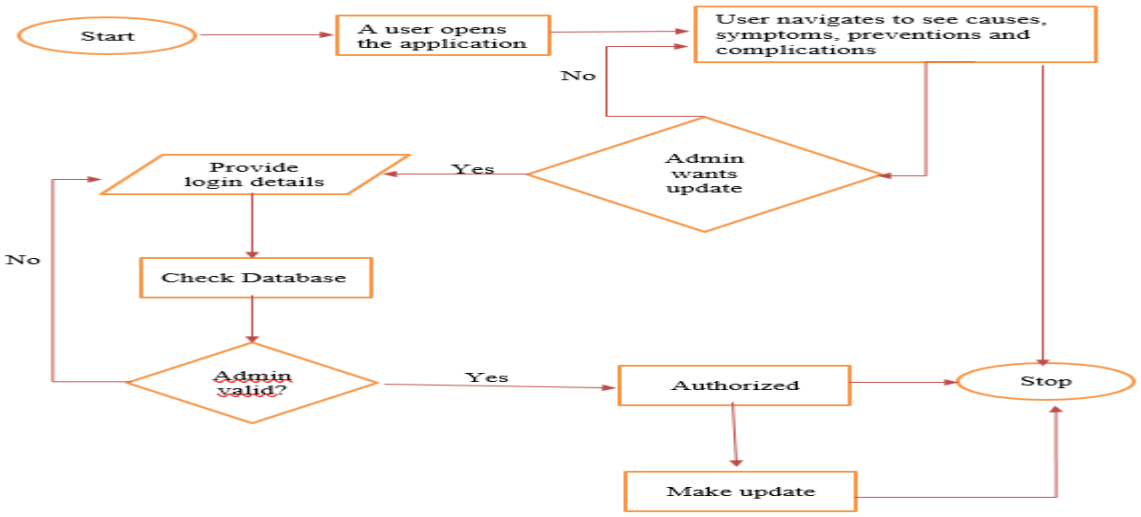
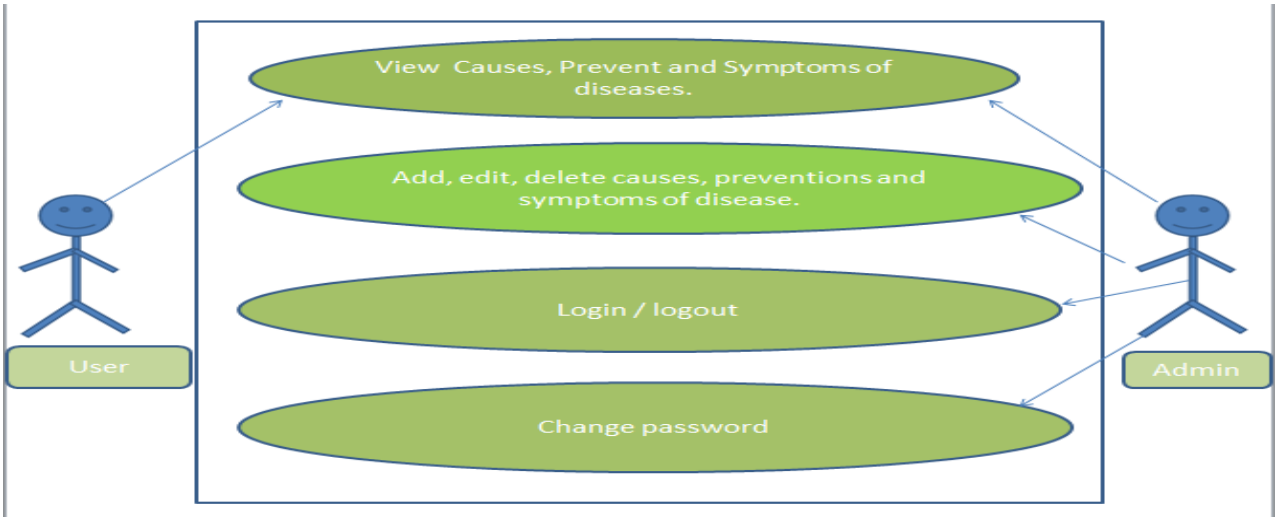


Figure 5: Flowchart of the proposed system.

Fig. 6 below shows the overview of the system functionality after been developed. A user can view causes, preventions and symptoms of diseases associated with pregnancy complications. And an admin who can update the information in the system.

Figure 6: Pregnancy Application Functionalities.

Fig. 7 (a & b) shows the designed system after been implemented. A user of the system is first presented with a homepage where causes, symptoms and treatments related to pregnancy are provided which a user can select from either of the options and to navigate to the detail content.



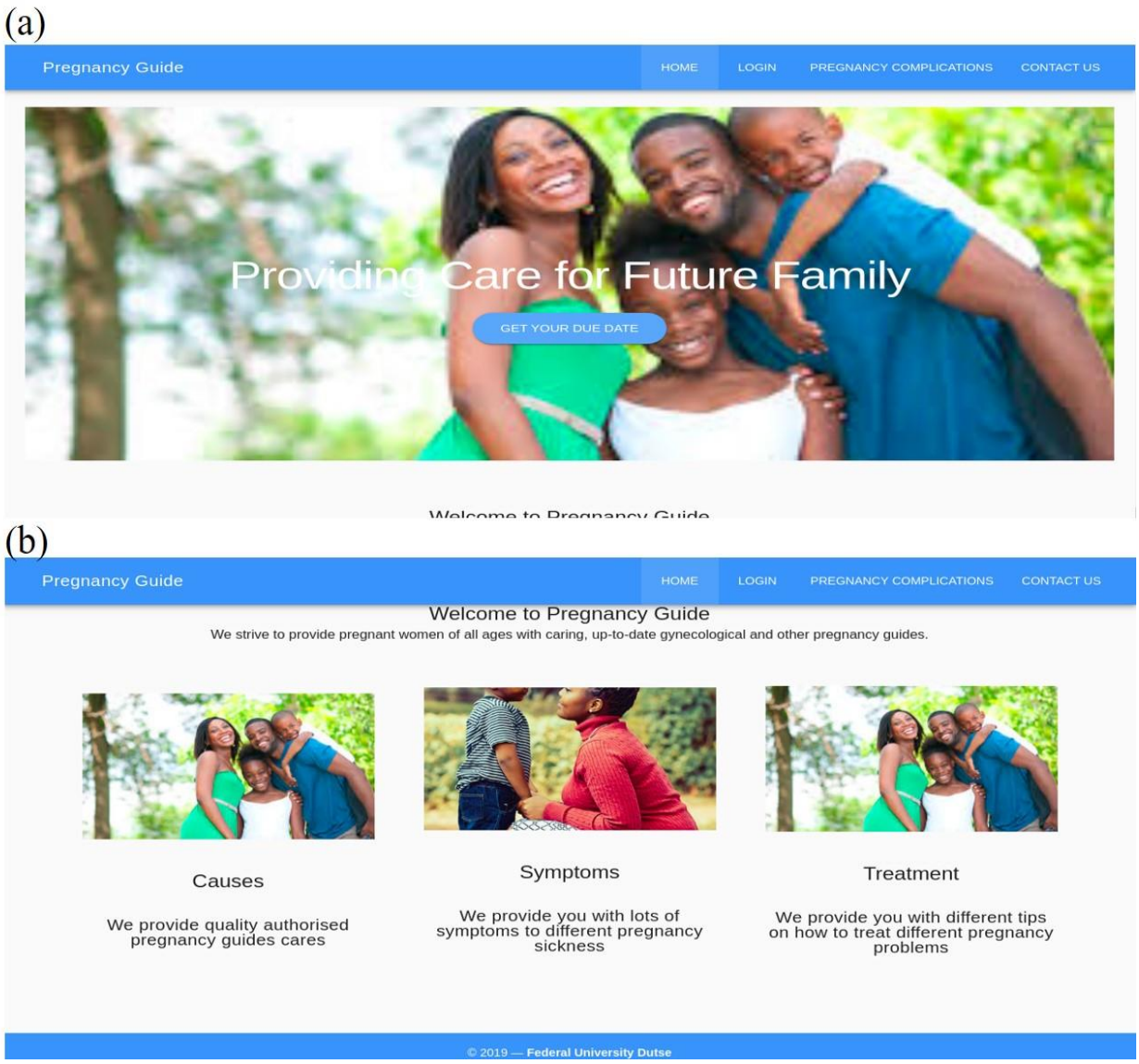


Figure 7: (a) Homepage View and (b) Services View

To control and manage the content of the pregnancy application, an admin page is provided in the system. For a user to add or remove any content in the application, an authorization is required by providing email and password as the login detail. A user needs to be registered first in order to get the valid login credentials to the system. Fig. 8a shows the login page of the application.

After been authorized into the system, the admin can add or remove any content, change password and can also log out after making the relevant changes as shown in Fig. 8b. This is to prevent random users from making unnecessary updates to the content of the application.

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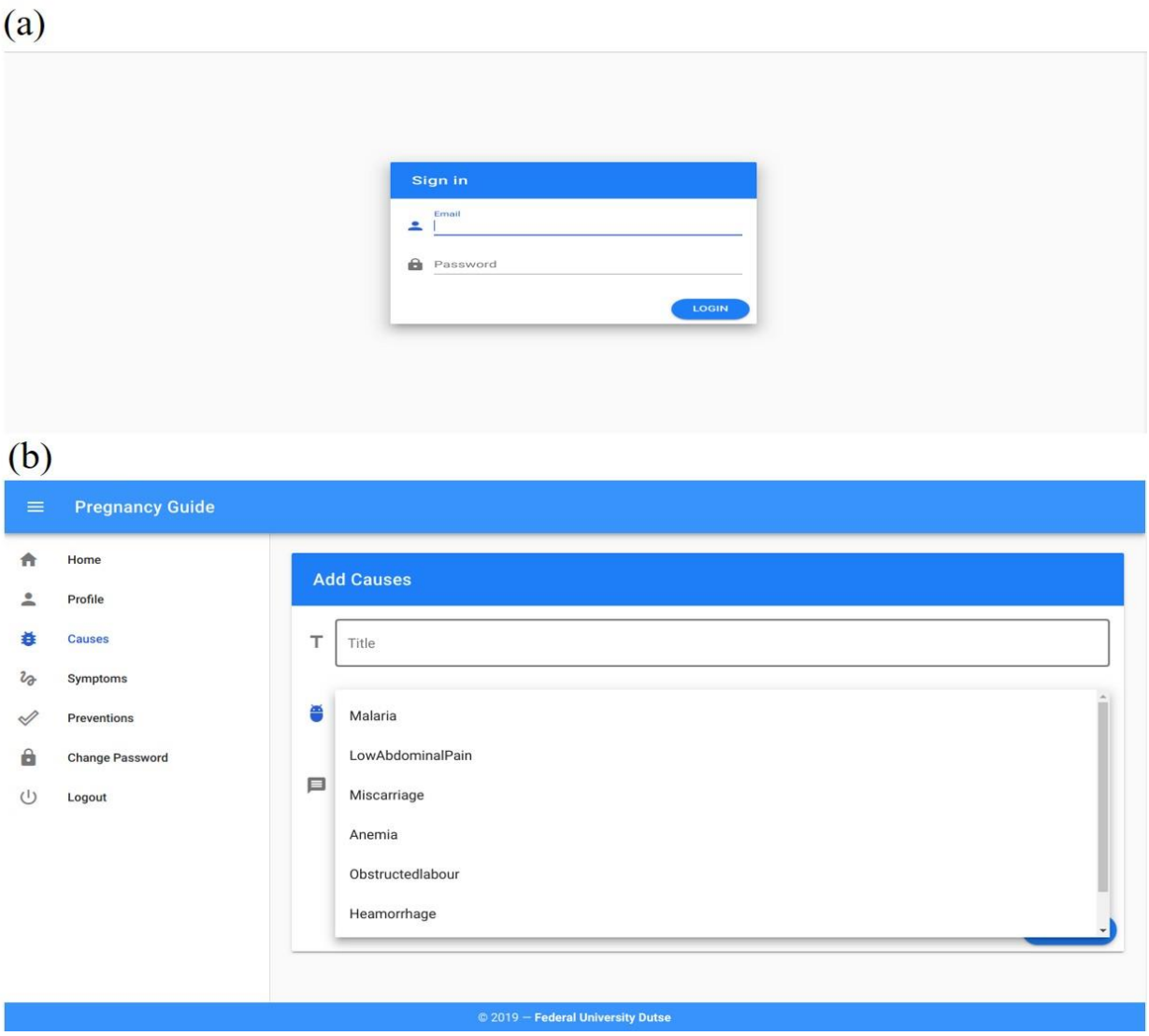

Figure 8: (a) Admin Login Page and (b) Admin Dashboard View

CONCLUSION

This paper presents an online web-based application for pregnant women. In the work, we developed an application that automates and reduces the stress of searching for information related to pregnancy complications during pregnancy. The developed application brings together information related to pregnancy in one place. The study was able to build on some of the lapses of the related works and literatures reviewed through the development of an online web platform.

REFERENCES

[1] K. J. Sapra, K. Joseph, S. Galea, L. M. Bates, G. M. Buck Louis, and C. V. Ananth, "Signs and symptoms of early pregnancy loss: a systematic review," *Reproductive Sciences*, vol. 24, pp. 502-513, 2017.

[2] N. Tripp, K. Hainey, A. Liu, A. Poulton, M. Peek, J. Kim, *et al.*, "An emerging model of maternity care: smartphone, midwife, doctor?," *Women and Birth,* vol. 27, pp. 64-67, 2014.

[3] B. M. Lagan, M. Sinclair, and W. George Kernohan, "Internet use in pregnancy informs women's decision making: a web-based survey," *Birth,* vol. 37, pp. 106-115, 2010.

[4] F. Bert, S. Passi, G. Scaioli, M. R. Gualano, and R. Siliquini, "There comes a baby! What should I do? Smartphones' pregnancy-related applications: A web-based overview," *Health Informatics Journal,* vol. 22, pp. 608-617, 2016.

[5] H. Song, E. M. Cramer, S. McRoy, and A. May, "Information needs, seeking behaviors, and support among low-income expectant women," *Women & health,* vol. 53, pp. 824-842, 2013.

[6] M. De Santis, C. De Luca, T. Quattrocchi, D. Visconti, E. Cesari, I. Mappa, *et al.*, "Use of the Internet by women seeking information about potentially teratogenic agents," *European Journal of obstetrics & gynecology and reproductive biology,* vol. 151, pp. 154-157, 2010.

[7] H. Caraballo and K. King, "Emergency department management of mosquito-borne illness: malaria, dengue, and West Nile virus," *Emergency medicine practice,* vol. 16, pp. 1-23; quiz 23, 2014.

[8] W. H. Organization, *World health statistics 2018: monitoring health for the SDGs, sustainable development goals*: World Health Organization, 2018.

[9] M. Romero, E. Leiba, F. S. Carrión-Nessi, D. C. Freitas-De Nobrega, S. Kaid-Bay, Á. F. Gamardo, *et al.*, "Malaria in pregnancy complications in Southern Venezuela," *Malaria Journal,* vol. 20, pp. 1-8, 2021.

[10] A. Florence, Z.-G. Lutécia, H. A. Marie, D. Joaquin, N. Gaffan, and H. Benjamin, "Malaria Complications in the Third Trimester of Pregnancy in Cotonou," 2021.

[11] S. Damisa and S. Hassan, "Prevalence of malaria among pregnant women attending antenatal care in General Hospital Saminaka, Lere Local Government Area of Kaduna State."

[12] T. Susan and D. Blackburn, "Maternal, fetal, & neonatal physiology: a clinical perspective," *Qualitative Health Research,* vol. 11, pp. 780-794, 2007.

[13] R. H. Beckert, R. J. Baer, J. G. Anderson, L. L. Jelliffe-Pawlowski, and E. E. Rogers, "Maternal anemia and pregnancy outcomes: a population-based study," *Journal of Perinatology,* vol. 39, pp. 911-919, 2019.

[14] A. M. Liyew, G. A. Tesema, T. S. Alamneh, M. G. Worku, A. B. Teshale, A. Z. Alem, *et al.*, "Prevalence and determinants of anemia among pregnant women in East Africa; A multi-level analysis of recent Demographic and Health

Surveys," *PloS one,* vol. 16, p. e0250560, 2021.

[15] B. De Benoist, M. Cogswell, I. Egli, and E. McLean, "Worldwide prevalence of anaemia 1993-2005; WHO global database of anaemia," 2008.

[16] W. Getahun, T. Belachew, and A. D. Wolide, "Burden and associated factors of anemia among pregnant women attending antenatal care in southern Ethiopia: cross sectional study," *BMC research notes,* vol. 10, pp. 1-7, 2017.

[17] O. Ogunbode and O. Ogunbode, "Anaemia in pregnancy," in *Contemporary obstetrics and gynecology for developing countries*, ed: Springer, 2021, pp. 321-330.

[18] O. Abodunrin, A. Daniyan, B. Okusanya, K. Ekwedigwe, S. Uguru, E. Yakubu, *et al.*, "Non-Fistulous Complications of Prolonged Obstructed Labour among Obstetric Fistula Patients in Southern Nigeria," *Open Journal of Obstetrics and Gynecology,* vol. 9, p. 1372, 2019.

[19] S. M. Rizvi and N. Gandotra, "Maternofetal outcome in obstructed labour in a tertiary care hospital," *Int J Reprod Contraception, Obstet Gynecol,* vol. 4, pp. 1410-3, 2017.

[20] A. Henok and A. Asefa, "Prevalence of obstructed labor among mothers delivered in Mizan-Aman general hospital, South West Ethiopia: a retrospective study," *J Womens Health Care,* vol. 4, p. 2167, 2015.

[21] A. E. Ubom, O. A. Ijarotimi, I. E. Ogunduyile, A. Omilakin, S. Nyeche, E. P. Igbodike, *et al.*, "Obstructed labour in a Nigerian tertiary health facility: a mixed-method study," *International Journal of Reproduction, Contraception, Obstetrics and Gynecology,* vol. 10, pp. 2937-2944, 2021.

[22] P. Oriji, D. Allagoa, D. Briggs, M. Chika, U. Mariere, C. Ikoro, *et al.*, "A 5-year review of obstructed labour and its sequalae in the Federal Medical Centre, Yenagoa, South-South, Nigeria," *Int J Clin Obstet Gynaecol,* vol. 5, pp. 6-12, 2021.

[23] E. G. G. o. RPL, R. Bender Atik, O. B. Christiansen, J. Elson, A. M. Kolte, S. Lewis, *et al.*, "ESHRE guideline: recurrent pregnancy loss," *Human reproduction open,* vol. 2018, p. hoy004, 2018.

[24] K. Hardy, P. J. Hardy, P. A. Jacobs, K. Lewallen, and T. J. Hassold, "Temporal changes in chromosome abnormalities in human spontaneous abortions: results of 40 years of analysis," *American Journal of Medical Genetics Part A,* vol. 170, pp. 2671-2680, 2016.

[25] E. S. Lucas, P. Vrljicak, J. Muter, M. M. Diniz-da-Costa, P. J. Brighton, C.-S. Kong, *et al.*, "Recurrent pregnancy loss is associated with a pro-senescent decidual response during the peri-implantation window," *Communications biology,* vol. 3, pp. 1-14, 2020.

[26] A. B. Hill, "The environment and disease: association or

causation?," ed: Sage Publications, 1965.

[27] K. M. Wall, L. B. Haddad, C. C. Mehta, E. T. Golub, L. Rahangdale, J. Dionne-Odom, *et al.*, "Miscarriage among women in the United States Women's Interagency HIV Study, 1994–2017," *American journal of obstetrics and gynecology,* vol. 221, pp. 347. e1-347. e13, 2019.

[28] S. Quenby, I. D. Gallos, R. K. Dhillon-Smith, M. Podesek, M. D. Stephenson, J. Fisher, *et al.*, "Miscarriage matters: the epidemiological, physical, psychological, and economic costs of early pregnancy loss," *The Lancet,* vol. 397, pp. 1658-1667, 2021.

[29] R. Giordano, A. Cacciatore, P. Cignini, R. Vigna, and M. Romano, "Antepartum haemorrhage," *Journal of prenatal medicine,* vol. 4, p. 12, 2010.

[30] S. Feduniw, D. Warzecha, I. Szymusik, and M. Wielgos, "Epidemiology, prevention and management of early postpartum hemorrhage—A systematic review," *Ginekologia Polska,* vol. 91, pp. 38-44, 2020.

[31] S.-Y. Long, Q. Yang, R. Chi, L. Luo, X. Xiong, and Z.-Q. Chen, "Maternal and neonatal outcomes resulting from antepartum hemorrhage in women with placenta previa and its associated risk factors: A single-center retrospective study," *Therapeutics and Clinical Risk Management,* vol. 17, p. 31, 2021.

[32] J. S. Tangren, W. A. H. Wan Md Adnan, C. E. Powe, J. Ecker, K. Bramham, M. A. Hladunewich, *et al.*, "Risk of preeclampsia and pregnancy complications in women with a history of acute kidney injury," *Hypertension,* vol. 72, pp. 451-459, 2018.

[33] B. W. Mol, C. T. Roberts, S. Thangaratinam, L. A. Magee, C. J. De Groot, and G. J. Hofmeyr, "Pre-eclampsia," *The Lancet,* vol. 387, pp. 999-1011, 2016.

[34] A. Todd, N. Akhter, J.-M. Cairns, A. Kasim, N. Walton, A. Ellison, *et al.*, "The pain divide: a cross-sectional analysis of chronic pain prevalence, pain intensity and opioid utilisation in England," *BMJ open,* vol. 8, p. e023391, 2018.

[35] A. Gurbuz and M. Peetz, "The acute abdomen in the pregnant patient," *Surgical endoscopy,* vol. 11, pp. 98-102, 1997.