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Development of Machine Learning-Based Model for Quality Measurement in Maternal, Neonatal and Child Health Services: A Country Level Model for Tanzania

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ABSTRACT

Background: *The high maternal and neonatal mortality in developing countries is frequently linked to inadequacies in the quality of maternal, neonatal and child health (MNCH) services provided. Quality measurement is among the recommended strategies for quality improvement in MNCH care. Consequently, developing countries require a novel quality measurement approach that can routinely facilitate the measurement and reporting of MNCH care quality. An effective quality measurement approach can enhance quality measurement and improve the quality of MNCH care. This study intends to explore the effectiveness of approaches available for MNCH quality measurement in developing countries. The study further proposes a machine learning-based approach for MNCH quality measurement.*

Method: *A comprehensive literature search from Pub Med, HINARI, ARDI and Google Scholar electronic databases was conducted. Also, a search for organizations' websites, including World Health Organization (WHO), USAID's MEASURE Evaluation Project, Engender Health, and Family Planning 2020 (FP2020), was included. A search from databases yielded 324 articles, 32 of which met inclusion criteria. Extracted articles were synthesized and presented.*

Findings: *The majority of quality measurement approaches are manual and paper-based. Therefore are laborious, time-consuming and prone to human errors. Also, it was observed that most approaches are costly since they require trained data collectors and special data sets for quality measurement. It is further noticed that the complexity of the quality measurement process and extra funds needed to facilitate data collection for quality measurement puts an extra burden on developing countries which always face constraints in health budgets. The study further proposes a machine learning-based approach for measuring MNCH quality. In developing this model, financial and human resource constrain were considered.*

Conclusion: *The study found a variety of quality assessment approaches available for quality assessment on MNCH in developing countries. However, the majority of the existing approaches are relatively ineffective. Measuring MNCH quality by a machine learning-based approach could be advantageous and establish a much larger evidence base for MNCH health policies for Tanzania.*

Keywords: Quality Measurement, Maternal and Neonatal Health, Child Health Quality, Quality Health Care, Machine Learning.

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1. INTRODUCTION

Over the past two decades, significant efforts have been made to ensure that mortality and morbidity among mothers and children are reduced [1]. The efforts have led to the initiation and implementation of several interventions and programmes with the prime objective of improving the provision and utilization of MNCH services [2]. In developing countries, these efforts have significantly increased the number of women with recommended four antenatal visits, the number of births in health facilities and

the proportion of births attended by skilled health personnel [3]. However, the increase in coverage and utilization of MNCH services alone seems not to be sufficient in reducing maternal and child mortalities and morbidities [4]. Quality MNCH services have been mentioned as one of the critical factors in improving the services and reduction of maternal and neonatal deaths [5-7]. Scholars argue that the majority of deaths could be prevented if women and children in developing countries had access to quality MNCH care [8-11].

In Tanzania, there have been several dedicated initiatives to develop and use ICT-based tools in providing MNCH services and information to pregnant women for the well-being of mothers and expected newborns[12]. This includes; Wired-mothers, a project that links pregnant women to primary health care using mobile phones in Zanzibar[13]; "Health pregnancy, Health baby" a text messaging service project aimed at delivering high-quality antenatal care (ANC) in Tanzania[14]; "Wazazi nipendeni" an SMS based service that aims at keeping women aware of pregnancy danger signs, diet during pregnancy, family planning methods and other important information on pregnancy and childbirth[15]. Interactive mobile applications that provide general information regarding pregnancy and childbirth, health and diet recommendations and, whenever needed, connect them to medical personnel for unique conditions currently experienced [16, 17].

Artificial Intelligence (AI) and Machine Learning (ML) technologies have recently transformed how things are done in health care. The use of ML in MNCH has gone beyond improving coverage and utilization. Currently, medical conditions and diseases related to maternity can be predicted to avoid or mitigate the risks to both the mother and the expected child. Many recent studies have successfully applied machine learning technologies in predicting different conditions pertaining to pregnancy and childbirth. Examples are the following: Machine learning was used to predict early severe maternal morbidity, lifetime risks of maternal death[18], early hypertensive disorders during pregnancy [19], risk of preeclampsia [20] and gestational Mellitus in the first trimester of pregnancy based on bio-markers and some maternal features [21]. Furthermore, machine learning was used in different MNCH scenarios, such as analyzing the reasons behind the preference for home birth among women in Bangladesh[22]. So far, in developing countries, significant efforts have been made to improve the quality of MNCH care. However, without regular quality measurement, the state of MNCH quality in developing countries will not be known. Failure to establish the current state of MNCH care quality may render all efforts geared to improve MNCH care.[23] Note that there is limited evidence linking quality improvement efforts to improved MNCH outcomes despite a number of initiatives deployed to improve MNCH care. This connotes that quality measurement is paramount in the process of improving MNCH services and reducing maternal, neonatal and child deaths. Therefore, this study aims to identify effective approaches, mechanisms and tools available for MNCH quality measurement in developing countries and Tanzania in particular. Furthermore, the study intends to establish the need for an effective quality measurement approach for MNCH quality measurement. The study findings are expected to benefit health sector authorities, health professionals and stakeholders working tirelessly to improve the quality of MNCH care in developing countries.

2. METHODOLOGY

2.1 Data Sources and Search Strategy

The study focuses on the identification of approaches and tools applied to measure the quality of MNCH services. A comprehensive literature search was conducted from Pub Med, HINARI, ARDI and Google Scholar electronic databases. Also, we searched for organizations' websites, including World Health Organization (WHO), USAID's MEASURE Evaluation Project, and Engender Health and Family Planning 2020 (FP2020). The search for relevant articles was done using a Boolean search strategy with a combination of four different key terms: (1) quality assessment tool AND maternal health OR Neonatal health OR Child health, (2) Quality assessment method AND maternal health OR Neonatal health OR Child health, (3) Quality measurement AND maternal health OR Neonatal health OR Child health and (4) Quality evaluation AND Maternal health OR Neonatal health OR Child health. Other terms were family planning, reproductive health, adolescent health and primary care. The search strategy was used for all the consulted databases.

2.2 Exclusion and Inclusion criteria

To be included in a study, an article had to meet the following inclusion criteria: (1) a scholarly or a peer-reviewed article, and (2) has an abstract or full text online, a journal article and a conference proceeding, a government document, a dissertation or a thesis. Articles that were written in other languages apart from English and did not have English translation, the articles that did not focus on quality assessment and those which do not describe or develop an approach that measures quality in MNCH were excluded.

3. SEARCH RESULTS

3.1 Approaches for MNCH Quality Measurement in Tanzania.

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Several approaches that have been developed and used to measure the quality of MNCH were identified. The focus was mainly on approaches used to measure the quality of MNCH care in developing countries, particularly in Tanzania. For better understanding, the quality measurement approaches were categorized into two groups, namely tailored quality measurement approaches and facility-based quality measurement tools and methods.

I) Tailored Quality Measurement Approaches

This category (Table 1) comprises all the quality measurement approaches tailored to suit various quality measurement needs at the facility and national levels. The study found the existence of tailored quality measurement approaches that were developed upon special quality measurement needs from international organizations and national initiatives geared to establish and improve MNCH quality. Some approaches were developed by various projects and programmes conducted to improve MNCH services, and others were developed as one research deliverable or result of the studies conducted by various scholars in the MNCH domain.

II) Facility-based quality measurement tools

This category (Table 2) includes quality measurement tools and methods used for quality measurement at the health facility level. The tools and methods in this category measure the quality of health services by assessing the ability of health facilities to provide quality health services. Therefore, to accomplish the intended goal, the tools seek information and answer the questions on the primary health facility infrastructure, capacity to provide services, medical supplies and quantities of services provided at the health facility.

3.2 Challenges of the Identified Quality Measurement Approaches

The objective of this study was to identify quality assessment approaches, mechanisms or tools for maternal, neonatal and child health care. For better understanding, a simple analysis was done by looking at the Methodology/tool(s) used, data source, the tool's primary focus and types of indicators used for tailor-made approaches and data source, the primary focus of the tool and indicator type for facility-based approach. Approaches varying from tools, frameworks, methods, and guidebooks used for quality measurement were identified.

Analysis of the type and quality component assessed shows that most approaches assess the component related to structure. The structure component depicts the context in which health services are delivered. It is beyond doubt that a well-structured facility has the potential to provide quality services. That is, the availability of required medical supplies like medicine, medical equipment and other facilities that enable care provision depicts the provision of quality care [6]. However, the situation might not be the same as expected. A facility with enough medicines and medical equipment does not necessarily provide quality health care. For example, a well-equipped health facility might have high maternal deaths compared to facilities that are not well equipped. Therefore, measuring quality by looking at a structure component alone may mislead the quality assessment results.

The current literature on MNCH emphasizes continuum care, such that a woman gets access to a set of MNCH services continuously from pregnancy to the post-delivery period [6]. MNCH care shift to continuum care fashion, quality measurement approaches also should be designed to cater for services under continuum care altogether. Analysis shows that only one (1) approach altogether targets quality assessment in maternal, neonatal and child health services. The analysis further shows that most of the approaches identified require data to be collected specifically for such exceptional quality measurement approach. Other approaches require a trained data collector(s). The need for a unique set of data or trained data collector(s) puts an extra burden on developing countries that always face health budget constraints. Setting extra funds for quality assessment may not only limit the applicability of the approaches but also limit quality measurement frequency in developing countries.

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Table 1: Summary of Tailored MNCH Quality Measurement Approaches

Study(s)	Objective	Methodology/Tool used	Data Source	Major focus	Indicator type
[7]	Measuring the quality of essential maternal care functions in delivery facilities	Service Provision Assessments (SPA) by the Demographic and Health Survey (DHS) Programme	Demographic health survey	Maternal and neonatal	Structure and Process
[24]	Creating a single "Quality Index" (QI) representing the quality of maternal and neonatal health care based upon data collected as part of the Demographic and Health Survey (DHS) program	Demographic health survey (DHS)	Demographic health survey	maternal and neonatal	Structure and Process
[25]	Development and testing of a method of measuring the quality of maternal and neonatal care that could be embedded in a larger national performance management initiative.	Direct observations and medical record reviews to score quality in nine domains of intrapartum care	Medical records review and direct observation	Maternal and neonatal	Process
[26]	They are evaluating the quality of routine and emergency intrapartum and postnatal care using a health facility assessment and evaluating "effective coverage" of skilled attendance in Brong Ahafo, Ghana.	Assessing the performance of crucial signal functions and the availability of relevant drugs, equipment and trained health professionals. By creating composite quality categories in four dimensions: routine delivery care, emergency obstetric care (EmOC), emergency newborn care (EmNC) and non-medical quality	Facility data	Maternal and Neonatal	Process and Structure
[27]	Investigation of the provision of care during labour and childbirth in comparison with national guidelines in four public hospitals in Tehran.	descriptive evaluation study and investigated the provision of care during labour and childbirth using current evidence-based practice as the	Observation and interview	Maternal	Process

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		indicator of quality			
[28]	Development of Quality Measures in Perinatal Care	Direct observation, existing records, and interview of the involved stakeholders	Direct observation, medical record review and interview	Neonatal	Process
[29]	Development and validation of an index to measure the quality of facility-based labour and delivery care processes in Sub-Saharan Africa	A comprehensive delivery observation checklist is used in quality surveys in sub-Saharan African countries.	Direct observation	Maternal and Neonatal	Process
[30]	Assessment of quality of obstetric care in Zimbabwe	hospital discharge data review	Medical record review	Maternal and Perinatal	Process and Outcome

Table 2: Summary of Facility-Based MNCH Quality Measurement Approaches

Tool	Data source	Major Focus	Indicator type
Service Provision Assessment (SPA) survey	Questioner, observation, exit interview and provider interviews	Quality of Maternal, neonatal and child health	Structure
Service Availability and Readiness Assessment (SARA)	Uses rapid data collection and analysis	Maternal, neonatal, Family planning, HIV, TB, Malaria and Child Health	Process
Needs assessment of Emergency Obstetric and Newborn care	Health facility data	equip health facilities with the capacity to provide evidence-based, cost-effective interventions to attend to the leading causes of maternal and newborn mortality	Structure and Process
Service Delivery Indicator (SDI)	Nationally representative health data	performance and quality of service delivery in primary schools and at frontline health facilities	Structure, Process and Outcome
Impact Evaluation toolkit for results-based financing in health (RBF)	Survey and direct observation	design and implement impact evaluations, with a focus on Results-Based Financing in maternal and child health programs	Maternal and Child health

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Facility-Based Assessment (FBA)	Observation of provider performance, exit interviews with child caretakers, provider interviews, record review, and an inventory of essential equipment and supplies.	The FBA evaluates the extent to which children are appropriately diagnosed and treated at health facilities.	Structure and Process
Health Facility Census (HFC)	Facility health data	This tool assesses the physical assets in the health sector with primary design for policy, planning and management of the health system	Structure
Population Council Health Facility Assessment (HFA)	Facility health data	The Population Council HFA allows reproductive health programme managers to benchmark the performance of health facilities. The tool is primarily designed for planning purposes, especially for strategic health planning, monitoring, and evaluation, although it may also be used while piloting service quality improvements.	Structure and Process
Facility Audit of Service Quality (FASQ)	Facility health data	Assesses facility infrastructure, equipment and the quality of care provided.	Structure
Rapid Health Facility Assessment (R-HFA)	Rapid Health Facility Assessment (R-HFA) Facility health data	The R-HFA measures a small set of indicators for primary care health services for maternal, newborn and child health to identify bottlenecks in service delivery.	Structure and Process

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3.3 The Proposed Quality Measurement Approach

A standard quality assessment approach is a prerequisite for MNCH quality improvement. This study proposes a machine learning-based approach for quality assessment in MNCH care. The proposed approach is thought to overcome the challenges of the existing quality measurement approaches. The machine learning model, the core part of the proposed approach, will effectively measure the quality of MNCH services based on the stated quality standards.

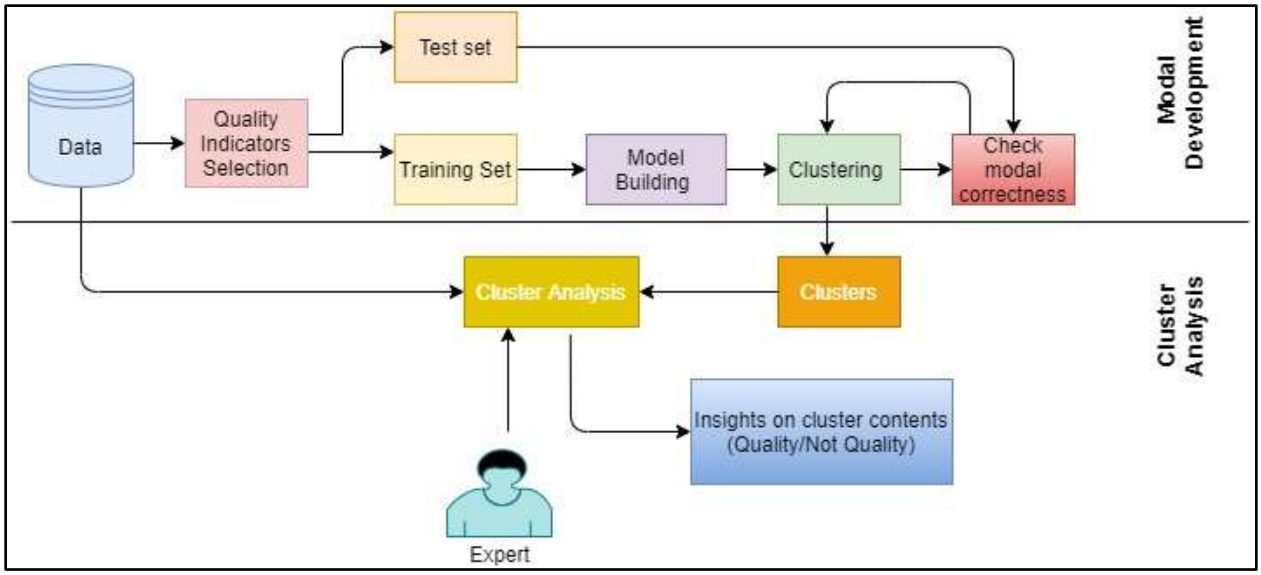

Figure 1: Proposed quality measurement approach

3.4 Why Considering Machine Learning-Based Approach

3.4.1 Data availability

Adopting the District Health Information System (DHIS 2) as a National database makes the proposed approach consider machine learning in assessing quality. DHIS 2 is currently used as a centralized database, and national health information system by several developing countries where routinely aggregated health data from all health centres are stored [31], [32]. Maternal and child health data from DHIS 2 will be used to develop and train a machine learning model [33]. After successful training, a learned algorithm (model) will provide insight into the quality of MNCH services provided to pregnant women and children.

3.4.2 Advanced Technology

Using a machine learning approach over traditional or existing quality measurement approaches is advantageous. A learned quality measurement algorithm (model) can enhance and speed up the quality measurement process, thus overcoming the costly, laborious and time-consuming task of quality measurement by traditional quality measurement approaches. Also, a learned quality measurement algorithm is not prone to human errors and can provide more valid and reliable results than manual and paper-based approaches [34]–[36].

3.4.3 Resource Efficiency

The machine learning approach requires only data to accomplish quality measurement; routine health data are readily available in District Health Information System (DHIS 2). Previous studies [19], [21], [22], [37]–[40] have also employed machine learning techniques to predict medical conditions and diseases related to maternity to mitigate the inherent risks to both the mother and the child. These studies have shown that machine learning has successfully been used in different MNCH contexts and hence holds the potential to provide insights into the quality of MNCH services.

4. CONCLUSION

The current review found a variety of quality assessment approaches available for quality assessment on MNCH in developing countries. However, none of the approaches is considered standard for quality assessment. Given the importance of quality

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assessment in MNCH quality improvement, this gap is critical. In this study, a machine learning-based approach for quality assessment is proposed. Unlike existing quality measurement approaches, the proposed approach does not require extra resources such as funds, a dedicated set of data, a dedicated task force and time to accomplish the quality assessment. The approach is suitable for resource-constrained countries such as developing countries. Because it requires only data currently collected and stored in District Health Information System (DHIS 2) and few experts, the proposed approach will enhance the quality measurement process; hence, routinely quality measurement will be witnessed in MNCH care.

REFERENCES

[1] World Health Organisation, 'WHO Fact sheet', 2016 [Online]. Available: http://www.who.int/mediacentre/factsheets/fs348/ en

[2] Z. S. Lassi, R. A. Salam, J. K. Das, and Z. A. Bhutta, 'Essential interventions for maternal, newborn and child health: Background and methodology', *Reprod. Health*, vol. 11, no. Suppl 1, p. S1, 2014 [Online]. Available: http://www.reproductive-health-journal.com/content/11/S1/S1

[3] W. Wang, S. Alva, S. Wang, and A. Fort, 'Levels and Trends in the Use of Maternal Health Services in Developing Countries. DHS Comparative Reports', vol. 26, no. June, 2011.

[4] J. P. Souza *et al.*, 'Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): A cross-sectional study', *Lancet*, vol. 381, no. 9879, pp. 1747–1755, 2013.

[5] Y. Akachi and M. E. Kruk, 'Quality of care: measuring a neglected driver of improved health', *Bull. World Health Organ.*, vol. 95, no. 6, pp. 465–472, 2017 [Online]. Available: http://www.who.int/entity/bulletin/volumes/95/6/16-180190.pdf

[6] H. Nsona, M. E. Kruk, and H. H. Leslie, 'Obstetric Facility Quality and Newborn Mortality in Malawi : A Cross-Sectional Study', 2016.

[7] M. E. Kruk, H. H. Leslie, S. Verguet, G. M. Mbaruku, R. M. K. Adanu, and A. Langer, 'Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys', *Lancet Glob. Heal.*, vol. 4, no. 11, pp. e845–e855, 2016.

[8] M. V Kinney, K. J. Kerber, R. E. Black, B. Cohen, F. Nkrumah, and H. Coovadia, 'Sub-Saharan Africa ' s Mothers , Newborns , and Children : Where and Why Do They Die ?', vol. 7, no. 6, pp. 1–10, 2010.

[9] P. A. Dalinjong, A. Y. Wang, and C. S. E. Homer, 'Are health facilities well equipped to provide basic quality childbirth services under the free maternal health policy ? Findings from rural Northern Ghana', vol. 1, pp. 1–9, 2018.

[10] V. M. Bwana, S. F. R. Id, I. R. Mremi, E. P. Lyimo, and L. E. G. Mboera, 'Patterns and causes of hospital maternal mortality in Tanzania : A 10-year retrospective analysis', vol. 24, no. 2006, pp. 1–22, 2019.

[11] J. H. Raven, R. J. Tolhurst, S. Tang, and N. van den Broek, 'What is quality in maternal and neonatal health care?', *Midwifery*, vol. 28, no. 5, pp. e676–e683, 2012 [Online]. Available: http://dx.doi.org/10.1016/j.midw.2011.09.003

[12] E. S. Kaaya, J. Ko, and E. Luhanga, 'Maternal knowledge-seeking behavior among pregnant women in Tanzania', *Women's Heal.*, vol. 17, 2021.

[13] S. B. B. N. Lund *et al.*, 'Mobile phones improve antenatal care attendance in Zanzibar : A cluster randomized controlled trial Mobile phones improve antenatal care attendance in Zanzibar : a cluster randomized controlled trial', no. January, pp. 1–10, 2014.

[14] Mobile Alliance for Maternal Action, 'Healthy pregnancy, healthy baby text messaging service: Tanzania', no. July, pp. 1–19, 2013.

[15] Emerson, Sarah. "Wazazi Nipendeni (Parents, Love Me): mHealth Initiative to Support Maternal Care in Tanzania." (2020).'.

DOI: 10.31695/IJASRE.2022.8.8.3

[16] B. P. Mramba and S. F. Kaijage, 'Design of an Interactive Mobile Application for Maternal , Neonatal and Infant Care Support for Tanzania', pp. 569–584, 2018.

[17] K. Mduma, Neema; Kalegele, 'Enhancing Management of Nutrition Information Using Mobile Application : Prenatal and Postnatal Requirements Enhancing Management of Nutrition Information Using Mobile Application : Prenatal and Postnatal Requirements', in *IST-Africa 2017 Conference Proceedings*, 2017 [Online]. Available: http://www.ist-africa.org/Conference2017

[18] M. J. Rotheram-borus, M. Tomlinson, D. Swendeman, A. Lee, and E. Jones, 'Standardized Functions for Smartphone Applications : Examples from Maternal and Child Health', vol. 2012, 2012.

[19] K. H. Poon, L.C. Kametas, N.A. Maiz, N. Akolekar, R. Nicolaides, 'Firsttrimester prediction of hypertensive disorders in pregnancy. Hypertension', vol. 53, no. 5, pp. 812–818, 2009.

[20] C. N. N. Neocleous, C.K. Anastasopoulos, P. Nikolaides, K.H. Schizas and K.C., 'Neural networks to estimate the risk for preeclampsia occurrence', in *International Joint Conference on Neural Networks, IJCNN 2009*, 2009, pp. 2221–2225.

[21] K. . Nanda, S. Savvidou, M. Syngelaki, A. Akolekar, R. Nicolaides, 'Prediction of gestational diabetes mellitus by maternal factors and biomarkers at 11 to 13 weeks. Prenat. Diagn', vol. 31, no. 2, pp. 135–141, 2011.

[22] F. Jawad *et al.*, 'Data mining techniques to analyze the reason for home birth in Bangladesh', *2015 IEEE/ACIS 16th Int. Conf. Softw. Eng. Artif. Intell. Netw. Parallel/Distributed Comput. SNPD 2015 - Proc.*, 2015.

[23] Z. Dettrick, S. Firth, and E. J. Soto, 'Do strategies to improve quality of maternal and child health care in lower and middle income countries lead to improved outcomes? A review of the evidence', *PLoS One*, vol. 8, no. 12, pp. 1–9, 2013.

[24] Z. Dettrick, H. N. Gouda, A. Hodge, and E. Jimenez-Soto, 'Measuring quality of maternal and newborn care in developing countries using demographic and health surveys', *PLoS One*, vol. 11, no. 6, pp. 1–20, 2016.

[25] M. E. Canavan, M. A. Brault, D. Tatek, D. Burssa, A. Teshome, and E. H. Bradley, 'Lessons from the Maternal and neonatal services in Ethiopia : measuring and improving quality', no. January, pp. 473–477, 2017.

[26] R. C. Nesbitt *et al.*, 'Quality along the Continuum : A Health Facility Assessment of Intrapartum and Postnatal Care in Ghana', vol. 8, no. 11, pp. 1–10, 2013.

[27] F. Pazandeh *et al.*, 'An evaluation of the quality of care for women with low risk pregnanacy : The use of evidence-based practice during labour and childbirth in four public hospitals in Tehran', *Midwifery*, pp. 1–9, 2015 [Online]. Available: http://dx.doi.org/10.1016/j.midw.2015.07.003

[28] D. Chawla and B. Darlow, 'Development of Quality Measures in Perinatal Care – Priority for Developing Countries', 2018.

[29] V. Tripathi, C. Stanton, D. Strobino, and L. Bartlett, 'Measuring the quality of maternal and care processes at the time of delivery in sub- Saharan Africa : development and validation of a short index', pp. 1–12, 2019.

[30] B. T. Guzha, T. L. Magwali, B. Mateveke, M. Chirehwa, G. Nyandoro, and S. P. Munjanja, 'Assessment of quality of obstetric care in Zimbabwe using the standard primipara', pp. 1–6, 2018.

[31] J. Karuri, P. Waiganjo, D. Orwa, and A. Manya, 'DHIS2 : The Tool to Improve Health Data Demand and Use in Kenya', vol. 8, no. 1, pp. 38–60, 2014.

[32] R. Dehnavieh, Z. Khajeh, and M. Hasani, 'The District Health Information System (DHIS2): A literature review and meta- synthesis of its strengths and operational challenges based on the experiences of 11 countries', 2018.

[33] M. M. Z. E. Mohammed, E. Bashier, and M. Bashier, *Algorithms and Applications*, no. December. 2016.

[34] M. K. Obenshain, 'Application of data mining techniques to healthcare data.', *Infect. Control. Hosp. Epidemiol.*, vol. 25, no. 8, pp. 690–5, 2004 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/15357163

DOI: 10.31695/IJASRE.2022.8.8.3

[35] T. Adirim, K. Meade, and K. Mistry, 'A New Era in Quality Measurement: The Development and Application of Quality Measures', *Pediatrics*, vol. 139, no. 1, p. e20163442, 2017 [Online]. Available: http://pediatrics.aappublications.org/lookup/doi/10.1542/peds.2016-3442

[36] N. McMillan, 'HIT Think How machine learning can speed quality measure development', pp. 1–7, 2017.

[37] S. Rodr'iguez, Euginia. Francisco, Estrada. Torres, Willium. Juan, 'Early Prediction of Severe Maternal Morbidity Using Machine Learning Techniques', vol. 10022, no. October, 2016 [Online]. Available: http://link.springer.com/10.1007/978-3-319-47955-2

[38] Y. Degninou, 'An Algorithm for Predicting Lifetime Risk of Maternal Death from the World Development Indicators', 2016 [Online]. Available: https://degninou.net/2016/06/06/algorithm-predicting-risk-maternal-death-from-development-indicators/

[39] M. M. Al-Jefri, R. Evans, P. Ghezzi, and G. Uchyigit, 'Using Machine Learning for Automatic Identification of Evidence-Based Health Information on the Web', *Proc. 2017 Int. Conf. Digit. Heal. - DH '17*, pp. 167–174, 2017 [Online]. Available: http://dl.acm.org/citation.cfm?doid=3079452.3079470

[40] Y. You, S. V Doubova, D. Pinto-masis, R. Pérez-cuevas, V. H. Borja-aburto, and A. Hubbard, 'Application of machine learning methodology to assess the performance of DIABETIMSS program for patients with type 2 diabetes in family medicine clinics in Mexico', vol. 5, pp. 1–15, 2019.

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