Kardan Publishing

Kardan Research Journal (KRJ)

Recognized by the Ministry of Higher Education, Afghanistan.
Journal homepage: krj.kardan.edu.af

Usage of Information Computing Technology, Data Mining, and Machine Learning to Reduce Child Mortality and Morbidity: Case Study Afghanistan

Ihsanullah Nazari

To cite this article: I. Nazari, "Usage of information computing technology, data mining, and machine learning to reduce child mortality and morbidity: Case study Afghanistan," *Kardan Research Journal*, vol. 1, no. 1, pp. 98–111, 2024.

Published online: 30 December 2024

Article

Usage of Information Computing Technology, Data Mining, and Machine Learning to Reduce Child Mortality and Morbidity: Case Study Afghanistan

Kardan Research Journal
1 (1) 98–111

Kardan Publications
Kabul, Afghanistan

Received: 28 Sep 24
Revised: 25 Oct 24
Accepted: 28 Nov 24
Published: 30 Dec 24

Ihsanullah Nazari

Abstract

Child mortality and morbidity are critical global health challenges, with the highest rates found in developing countries. In Afghanistan, the under-five mortality rate is 57 per 1000 live births, a significant figure in 2022, which is a staggering number. Challenges include insufficient doctors, lack of awareness among people, inadequate health facilities, poor health management information systems, cultural barriers, infrastructure and transportation issues, remote areas without health facilities, and climate challenges like prolonged snowfall in some provinces. Recently, Afghanistan has seen significant advancements in information technology. This paper proposes using machine learning and data mining techniques to predict the danger level of children's health problems, aiming to reduce child mortality and morbidity.

Keywords: *Mortality, Morbidity, Bayesian Logistic Regression, K-Nearest Neighbor*

1. Introduction

In 2022, the annual number of under-five deaths dropped to 4.9 million, a significant reduction since 2000, when the global under-five mortality rate (U5MR) was more than doubled. This vital progress has been achieved through governmental efforts, non-profit organizations, local communities, healthcare professionals, and increased family awareness [1].

Despite the progress, 221 million children have been lost worldwide between 2000 and 2022. Addressing these issues requires high-impact interventions such as skilled birth attendance, specialized neonatal care, vaccination, improved access to healthcare, and parental awareness programs about prenatal care and vaccinations. Ensuring universal access to these interventions, prioritizing quality and equity, and addressing socio-economic determinants are essential to reduce child mortality and morbidity further.

However, Afghanistan lags behind this global trend, reporting one of the highest under-five mortality rates worldwide, at 57 deaths per 1000 live births in 2022. This rate is significantly higher than the global average of 37 deaths per 1000 live births, reflecting severe disparities in healthcare delivery and access. Afghanistan's persistent health crisis demands immediate, targeted interventions.

The World Health Organization (WHO) defines infant mortality rate (IMR) as the likelihood of a child dying before reaching one year of age, calculated per 1000 live births. Similarly, child mortality refers to the number of deaths under the age of five. These metrics are crucial indicators of healthcare quality. Globally, child deaths have declined from 12.8 million in 1990 to 5 million in 2021 [1].

The primary goal of this paper is to propose strategies leveraging information technology to address child mortality and morbidity in Afghanistan, focusing on the following research questions:

- What are the current challenges related to the children's health system in Afghanistan?
- What is the status of historical health data availability in Afghanistan?
- How can AI and electronic health systems support child health in Afghanistan?
- What are the challenges of implementing smart or electronic health in Afghanistan?

Section II discusses the present child health status in Afghanistan, Section III proposes the use of ICT in addressing child health issues, Section IV outlines the implementation challenges, and Section V concludes with future suggestions.

2. Literature Review

Numerous studies emphasize the transformative role of ICT in tackling child health challenges, particularly in resource-constrained environments. ICT applications, including machine learning (ML) and data mining techniques, are pivotal for improving child health outcomes.

In a Bayesian logistic regression study, maternal education and child age were identified as significant determinants of morbidity reduction. The findings revealed that children of educated mothers and older children had lower morbidity risks. Male children were noted to have a 7% higher risk of morbidity than females, while underweight children were 31% more likely to develop respiratory diseases, diarrhoea, and other infections [7].

Machine learning models, particularly K-Nearest Neighbor (KNN), have shown impressive performance in child health classification tasks. For instance, KNN models achieved a remarkable 91% accuracy when classifying malnourished children using Euclidean distance metrics. These models also recorded an 86.6% precision and 83.8% recall, highlighting their potential for practical applications in child health diagnostics [8].

Advanced algorithms like Artificial Neural Networks (ANN) and Random Forests have effectively predicted mortality in people under five. These models attained an accuracy of 89.47% and an area under the receiver operating characteristic (AUROC) of 96%, identifying key determinants of mortality such as maternal education, wealth quintile, antenatal visits, employment status, place of delivery, and the number of children born [9].

In rural settings, the prevalence of consanguineous marriages, low birth weights, and insufficient birth spacing were strongly correlated with higher infant mortality rates. Random Forest and Naïve Bayes algorithms effectively identified these risk factors. These

models also highlighted protective factors, such as high maternal education and proper birth spacing [10].

Telemedicine, a vital ICT application, has gained attention for addressing child health disparities in remote regions. Telemedicine enables healthcare professionals to deliver virtual consultations, reducing the need for physical travel and associated costs. This approach is particularly beneficial in areas lacking medical specialists. Studies have shown that telemedicine improves access to healthcare and facilitates knowledge sharing among healthcare professionals [5], [12].

Mobile health (mHealth) interventions are another promising ICT application. For instance, a study conducted in Uganda found that mHealth interventions enhanced patient care at community-based clinics by increasing access to health information and improving the acceptability of healthcare services among patients [12]. This demonstrates the potential of mobile technologies in addressing child health challenges, especially in low-resource settings.

Furthermore, health information systems (HIS) are crucial in improving child health outcomes. HIS implementations in public hospitals provide valuable data for research and decision-making, enhancing service delivery and supporting e-health initiatives. Despite the challenges of interoperability and infrastructure, HIS systems have proven effective in data-driven healthcare management [4], [6].

Recent studies have also focused on leveraging ML and data mining techniques for disease prediction and diagnosis. For example, a study in Nigeria applied ML methods to predict under-five mortality, highlighting factors such as maternal health, socio-economic status, and access to healthcare services. These findings underscore the potential of predictive analytics in reducing child mortality [9].

Another study utilized ML to predict infant mortality in Iran, identifying factors like high blood pressure during pregnancy, dental disorders, and low birth weights as significant risk factors. Random Forest and Naïve Bayes models demonstrated high predictive accuracy, showcasing the effectiveness of ML in identifying and addressing health disparities [10].

Emerging research has also explored integrating wearable health monitoring systems with ML algorithms to track child health in real-time. These systems offer innovative early disease detection and intervention solutions, further reducing child morbidity and mortality [13], [14].

In summary, the literature emphasizes the critical role of ICT, ML, and data mining in improving child health outcomes. These technologies provide innovative tools for disease prediction, health monitoring, and healthcare delivery, making them indispensable for addressing child health challenges in Afghanistan and similar settings.

3. Problem Statement And Present Child Health Status In Afghanistan

The 2015 Demographic Health Survey in Afghanistan revealed that the under-five mortality rate was 55 deaths per 1000 live births, equating to one in eighteen children dying before their first birthday. Mortality rates are disproportionately high in rural areas compared to urban settings [2].

In 1990, the infant mortality rate was 123 deaths per 1000 live births, which reduced to 45 by 2022. Similarly, neonatal mortality rates fell from 76 in 1990 to 35 in 2022 [1]. Despite these improvements, significant disparities persist, highlighting the need for targeted interventions.

4. Proposed Strategies To Overcome Challenges In Child Morbidity And Mortality

4.1 Awareness of Parents through ICT

In Afghanistan, household ownership of ICT tools includes 85.2% mobile phone usage and 27.7% internet access. Increasingly, women in Afghanistan are gaining access to smartphones. A 2013 USAID survey found that over 80% of Afghan women owned a mobile phone, a figure that continues to grow.

Awareness programs leveraging ICT can effectively engage parents and communities in rural Afghanistan by providing accessible and culturally relevant health education. For example, mobile health (mHealth) platforms, such as SMS-based reminders, can deliver vital information about vaccination schedules and child nutrition, and voice messages in local languages, including Pashto and Dari, can overcome literacy barriers and ensure inclusively. Interactive radio programs, a widely used medium in rural Afghanistan, can disseminate health information while encouraging community participation through call-in segments.

Successful ICT initiatives in other developing countries highlight actionable strategies for Afghanistan; India's Kilkari program sends voice messages to mothers, offering maternal and child health guidance. Uganda's M Trac System enables real-time reporting on health concerns via SMS, creating a direct line of communication between communities and healthcare providers. These examples demonstrate how ICT can bridge the gap between rural populations and health services, even in resource-constrained settings.

However, Afghanistan faces unique challenges that must be addressed for ICT solutions to succeed. Low literacy rates, particularly among women, limit the effectiveness of text-based messaging. Cultural norms often restrict women's access to technology, reducing their engagement in digital initiatives. Furthermore, limited mobile network coverage and unreliable electricity supplies in remote areas impede the implementation of ICT programs.

To overcome these challenges, initiatives must adopt culturally sensitive and inclusive approaches. Voice-based solutions can effectively engage non-literate populations, while community health workers equipped with mobile devices can act as intermediaries, ensuring health messages reach families directly. Expanding solar-powered charging stations in rural areas can mitigate electricity shortages, ensuring reliable access to mobile devices. By addressing these barriers, ICT-based awareness programs can become a cornerstone of child health improvement in Afghanistan.

Transforming messages about child and women's health through a telecommunications network is effective, especially when tailored to include critical health tips, vaccination schedules, nutritional advice, and maternal care guidelines. These messages can be disseminated via various ICT platforms, such as mobile applications for tracking immunizations, SMS-based reminder services for antenatal appointments, and social media campaigns promoting healthy practices. Additionally, interactive voice response

(IVR) systems can deliver health education in local languages, ensuring inclusivity for communities with low literacy levels.

Telecommunication networks can be leveraged to deliver health-related messages through social media platforms, informative applications, and knowledge-sharing blogs. These tools can significantly improve parental awareness about child health.

4.2 Utilizing telemedicine

Telemedicine provides a solution for children in remote areas by enabling virtual consultations through mobile technology. This reduces travel costs and improves access to healthcare. Furthermore, telemedicine facilitates collaboration among healthcare professionals, enhancing the quality of care [4].

Key investments must be made in telecommunications infrastructure to establish a telemedicine network, including mobile networks, satellite internet connectivity, and community-based telemedicine hubs equipped with basic diagnostic tools and video conferencing capabilities. Solar-powered systems can address the challenge of unreliable electricity in remote areas, ensuring that equipment remains operational. Telemedicine platforms can enable remote consultations between patients and healthcare providers through video calls, mobile applications, and SMS-based communication. For example, telemedicine systems could leverage low-bandwidth solutions, such as asynchronous video or audio recordings, to facilitate consultations in areas with limited internet access. Integration with Interactive Voice Response (IVR) systems allows for voice-based consultations in local languages, bridging the literacy gap. Telemedicine services must seamlessly integrate with existing Health Management Information Systems (HMIS) to ensure comprehensive data tracking and analysis. This integration would allow healthcare providers to access patient histories, monitor trends in disease prevalence, and ensure continuity of care. A unified ICT ecosystem can also help streamline referrals to secondary or tertiary care facilities.

To ensure scalability, telemedicine services should prioritize mobile-first solutions, given Afghanistan's relatively high mobile phone penetration rate. Partnerships with mobile network operators and local NGOs can help subsidize costs, making telemedicine services affordable for underserved populations. Additionally, workforce training is crucial; community health workers can be equipped with tablets or smartphones to act as intermediaries, facilitating consultations and assisting with follow-ups. Implementing telemedicine in Afghanistan faces several challenges, including cultural barriers, low digital literacy, and distrust of technology. These can be mitigated through community engagement programs that build trust and educate residents on the benefits of telemedicine. Demonstration projects and pilot programs in selected provinces can serve as proof-of-concept models, providing valuable insights for broader implementation.

4.3 Expanding Health Management Information Systems (HMIS)

While some private hospitals in Afghanistan have HMIS, most public facilities lack such systems. Implementing comprehensive HMIS can streamline data collection, storage, and analysis, aiding in research and decision-making processes. This will enhance the efficiency and effectiveness of healthcare services.

A robust Health Management Information System (HMIS) is essential for improving healthcare delivery and decision-making in Afghanistan. Its implementation on a national or regional scale requires careful planning, local government involvement, and international organizations' support.

Implementation Strategy

A phased approach can be adopted for implementing HMIS across Afghanistan:

1. **Pilot Projects:** Begin with pilot implementations in selected provinces to assess feasibility and gather insights for scaling. Urban centres and accessible rural clinics can serve as initial test beds.
2. **National Framework:** Develop a standardized framework for HMIS that includes technical specifications, data collection protocols, and privacy safeguards. This framework should be endorsed by the Ministry of Public Health (MoPH) to ensure uniformity.
3. **Localization:** Customize HMIS to accommodate Afghanistan's diverse linguistic and cultural landscape. Interfaces should support Dari and Pashto and use symbols or visuals to assist low-literacy users.

Role of Local Government and International Organizations

In partnership with international organizations such as WHO, UNICEF, and USAID, local governments can play a pivotal role in implementing and sustaining HMIS. These collaborations can provide funding, technical expertise, and capacity-building initiatives. Local governments can help identify healthcare priorities, allocate resources, and ensure that HMIS is aligned with national policies.

Scaling HMIS in Public Clinics and Rural Areas

Infrastructure Development

- Utilize offline mobile data collection tools and synchronize with central databases when internet access is available.
- Equip clinics with solar-powered devices to mitigate challenges posed by unreliable electricity.

Capacity Building

- Train healthcare workers and administrators to use HMIS effectively, emphasizing data entry, interpretation, and reporting.
- Develop training materials in local languages and provide ongoing technical support.

Decentralized Data Centers

- Establish regional data centres to store and process data, reducing dependency on national-level infrastructure. Decentralization also enhances data security and resilience.

Overcoming Infrastructure Challenges

1. **Internet Access**
    - Leverage mobile networks to provide connectivity in rural areas, prioritizing the expansion of 4G and satellite internet services. Partnerships with telecommunication providers can facilitate this.
2. **Electricity**
    - Deploy solar-powered systems and battery backups to ensure HMIS equipment remains operational.
3. **Cost Management**
    - Implement open-source HMIS platforms like DHIS2 to reduce development costs and ensure scalability.

4.4 Decision Support Systems for Predictive Analysis

Machine learning (ML) and data mining techniques can predict and diagnose child morbidity, enabling timely interventions. For instance, Bayesian logistic regression and K-Nearest Neighbor (KNN) have proven effective in identifying risk factors and classifying health conditions with high accuracy [7][8].

Decision Support Systems (DSS) empowered by machine learning (ML) have the potential to revolutionize healthcare in Afghanistan by providing actionable insights to healthcare professionals. These systems can assist in diagnosing diseases, predicting health outcomes, and optimizing resource allocation.

Implementation in Afghanistan

To implement DSS in Afghanistan, a multi-step approach is necessary:

1. **Data Collection and Integration**
    - Collect and integrate data from multiple sources, including hospital records, regional health statistics, birth and immunization records, and survey data from public health initiatives.
    - Prioritize the digitization of existing paper records, particularly in rural clinics, to create a foundational dataset for ML models.
2. **Infrastructure Development**
    - Establish secure, centralized databases with cloud-based or decentralized storage solutions to manage the data effectively.
    - Low-cost, solar-powered devices can be used in rural areas to facilitate continuous data collection and usage.
3. **Deployment**
    - Deploy DSS as mobile or web-based applications accessible to healthcare workers. These systems should offer multilingual support (e.g., Dari, Pashto) and intuitive interfaces to ensure ease of use.

Data for Machine Learning Models

The ML algorithms used in DSS will rely on locally relevant datasets to ensure accuracy and applicability. Data types include:

- **Regional Health Statistics:** Incidence and prevalence rates of common diseases such as malnutrition, respiratory infections, and diarrhoea.
- **Demographic Data:** Birth records, vaccination schedules, and antenatal care records.
- **Environmental Data:** Geographic, climate, and infrastructure information that may impact health outcomes.

The system should continuously update and refine datasets to account for evolving health trends and population dynamics.

Training and Validation of ML Algorithms

1. **Model Training**
    - Use supervised learning for tasks like disease diagnosis and unsupervised learning for identifying hidden patterns in healthcare data.
    - Augment local data with publicly available datasets from similar regions to address gaps in data availability.
2. **Validation Process**
    - Employ cross-validation techniques to ensure models generalize well to unseen data.
    - To assess real-world performance, validate models against ground truth datasets from pilot studies conducted in select provinces.
3. **Bias Mitigation**
    - Implement techniques to mitigate algorithmic bias, ensuring equitable predictions across different population subgroups.

Communication of Results to Healthcare Professionals

DSS outputs must be actionable and comprehensible for healthcare workers:

- **Visual Dashboards:** Use intuitive dashboards with charts, heat maps, and alerts for easy interpretation.
- **Recommendations:** Based on the analysis, provide prioritized recommendations for treatment, referrals, or public health interventions.
- **Alerts:** Notify healthcare workers of critical issues, such as disease outbreaks or high-risk pregnancies, via SMS or mobile app notifications.

Challenges of Data Collection in Afghanistan

1. **Data Availability**
    - A lack of digitized records and incomplete datasets in rural areas pose significant challenges.
    - Collaborations with local NGOs, international agencies, and government programs can help initiate and maintain data collection efforts.
2. **Data Quality**
    - Ensuring data consistency and accuracy is crucial. Regular audits and feedback mechanisms should be established.
3. **Cultural Sensitivities**
    - Build trust with communities to encourage accurate reporting, particularly in areas with low literacy and limited awareness about data privacy.

5. Challenges to Implementing Recommended Approaches

1. **Human Resource Constraints:** Afghanistan faces a shortage of healthcare and IT professionals due to prolonged conflict and economic instability.
2. **Low Literacy and Technological Skills:** Many healthcare professionals lack information security and awareness of IT systems.
3. **ICT Infrastructure Deficiencies:** Rural areas often lack reliable electricity, internet access, and backup systems.
4. **Financial and Sustainability Issues:** Limited funding and dependence on donor support hinder long-term projects.
5. **Cultural Barriers:** Resistance to new technologies and cultural norms pose challenges.
6. **Job Security Concerns:** Some employees fear adopting IT systems may threaten their job security.
7. **Internet Accessibility:** High costs and limited coverage impede widespread adoption.
8. **Policy Gaps:** A comprehensive e-health policy is lacking.
9. **Urban-Rural Disparities:** Security, education, and access to healthcare vary significantly between urban and rural areas.
10. **Database Interoperability:** Different health facilities use incompatible database systems.

Implementing the recommended ICT-based interventions in Afghanistan's healthcare system involves numerous challenges. A structured analysis of these challenges, along with potential solutions, is presented below:

1. Human Resources

Challenge

Training healthcare professionals and ICT experts is limited, especially in rural areas. Many healthcare workers lack familiarity with advanced technology, which hampers the adoption of ICT solutions.

Potential Solutions

- **Capacity Building:** Conduct targeted training programs for healthcare workers using ICT tools such as telemedicine platforms and Health Management Information Systems (HMIS).
- **Partnerships:** Collaborate with international organizations to bring ICT expertise for initial system setup and training.

2. Infrastructure

Challenge

Poor internet connectivity, unreliable electricity supply, and lack of digital devices in rural and conflict-affected areas.

Potential Solutions

- **Technological Adaptations:** Use low-bandwidth ICT solutions like SMS-based health alerts and offline data storage with periodic synchronization.
- **Sustainable Power Sources:** Deploy solar-powered devices and backup power systems in rural health facilities.

3. Cultural Acceptance

Challenge

Cultural norms and traditional beliefs may hinder the acceptance of modern ICT tools, especially among women and conservative communities. For instance, in some areas, male family members may restrict women's access to mobile phones or digital services.

Potential Solutions

- **Community Engagement:** Conduct awareness campaigns tailored to local cultural contexts to build trust and educate communities on the benefits of ICT in healthcare.
- **Gender-Inclusive Approaches:** Design interventions accessible to women, such as female-led health education programs and mobile health initiatives targeting maternal and child health.

4. Low Literacy Rates

Challenge

Afghanistan’s low literacy rates, particularly in rural areas, make it difficult for many individuals to use text-based ICT solutions like mobile apps or HMIS.

Potential Solutions

- **Audio and Visual Content:** Develop voice-based health services and visual aids, such as pictograms and videos, to communicate health messages effectively.
- **Local Language Support:** Ensure all ICT solutions are available in local languages (Dari and Pashto) to enhance accessibility.

5. Financial Constraints

Challenge
Limited financial resources impede the scaling of ICT solutions and robust infrastructure development.

Potential Solutions

- **Public-Private Partnerships (PPPs):** Partner with private companies to co-fund ICT initiatives and leverage their technological expertise.
- **International Aid:** Secure funding from international organizations and donor agencies to support developing and implementing ICT solutions.

6. Data Privacy and Security

Challenge
Concerns about data confidentiality and potential misuse of sensitive health information could reduce public trust in ICT solutions.

Potential Solutions

- **Robust Policies:** Develop and enforce data protection policies aligned with international standards.
- **Encryption and Security Protocols:** Implement strong encryption methods and secure data-sharing platforms to ensure data privacy.

7. Gender Inequality

Challenge
Gender disparities limit women's participation in ICT-based healthcare initiatives as users and professionals.

Potential Solutions

- **Targeted Outreach:** Prioritize ICT programs that empower women, such as maternal health applications and female health worker training.
- **Policy Advocacy:** Work with policymakers to address systemic barriers to gender equality in healthcare and technology access.

6. Conclusion and Future Work

Child mortality and morbidity remain critical challenges globally, particularly in Afghanistan. While significant progress has been made, further reductions require targeted strategies. This paper proposed four ICT-based interventions: awareness

programs, telemedicine, HMIS, and decision support systems. Although implementation faces challenges, these are not insurmountable.

Future work will focus on developing predictive models using ML and data mining techniques to assess child morbidity and mortality risk factors in Afghanistan.

Future Work

Building on this foundation, future research will focus on developing and deploying data-driven models to enhance healthcare decision-making. Specifically:

1. **Model Development:** Machine learning algorithms such as Random Forest, Support Vector Machines, and Gradient Boosting will be developed to predict high-risk child morbidity and mortality cases. These models will utilize key factors such as birth records, maternal health indicators, vaccination coverage, and nutritional status.

2. **Data Collection:** Data will be sourced from existing health surveys (e.g., Demographic and Health Surveys) and real-time data from HMIS, supplemented by targeted field surveys in underserved areas. Strategies to address data gaps, such as using proxy indicators and community-level inputs, will be integral.

3. **Effectiveness Measurement:** The impact of these interventions will be evaluated using metrics such as reductions in under-five mortality rates, increased vaccination coverage, and improved nutritional outcomes. Comparative studies will be conducted to assess the performance of ICT-based interventions against traditional healthcare approaches.

Impact

Implementing these ICT solutions can potentially revolutionize Afghanistan's child health system. These interventions can deliver measurable improvements in child health outcomes by overcoming identified challenges, such as limited infrastructure and cultural barriers. For example:

- Expanded access to telemedicine services can ensure timely diagnoses and treatment in remote regions.

- A robust HMIS can provide policymakers with actionable insights to allocate resources effectively.

- Decision Support Systems can empower healthcare professionals with predictive tools to address high-risk cases, reducing child mortality rates significantly preemptively.

References

[1] United Nations Inter-agency Group for Child Mortality Estimation, *Levels and Trends in Child Mortality: Report 2023*, United Nations Children's Fund (UNICEF), 2023.

[2] Ministry of Public Health (MoPH), *Afghanistan Demographic and Health Survey 2015*, Central Statistics Organization (CSO), ICF International, 2015.

[3] National Statistics and Information Authority (NSIA), *Afghanistan Multi-Indicator Cluster Survey 2022–2023*, Kabul, Afghanistan, 2023.

[4] FMIC, "eHealth," [Online]. Available: https://www.fmic.org.af/AboutUs/eHealth/Pages/default.aspx. [Accessed: Nov. 8, 2018].

[5] L. W. Chang, V. Njie-Carr, S. Kalenge, J. F. Kelly, R. C. Bollinger, and S. Alamo-Talisuna, "Perceptions and acceptability of mHealth interventions for improving patient care at a community-based HIV/AIDS clinic in Uganda: A mixed methods study," *AIDS Care*, vol. 25, no. 1, pp. 1–7, 2013.

[6] Z. Omary, D. Lupiana, F. Mtenzi, and B. Tollya, "Analysis of the challenges affecting healthcare adoption in developing countries: A case of Tanzania," *Int. J. Inf. Stud.*, vol. 2, no. 8, pp. 40–45, 2011.

[7] M. Akter and M. Rahman, "Determining the risk factors of under-five morbidity in Bangladesh: A Bayesian logistic regression approach," *J. Health Stud.*, vol. 35, no. 2, pp. 123–135, 2020.

[8] N. K. Sharma and A. Gupta, "Performance analysis for classification of malnourished toddlers using K-Nearest Neighbor," *Int. J. Mach. Learn. Appl.*, vol. 10, no. 4, pp. 45–56, 2021.

[9] J. O. Adeniyi and A. A. Olatunde, "Application of machine learning methods for predicting under-five mortality: Analysis of Nigerian Demographic Health Survey 2018 dataset," *Comput. Intell. Healthcare*, vol. 28, no. 3, pp. 278–290, 2022.

[10] H. R. Abadi, A. Khosravi, and S. F. Razavi, "Predictive factors of infant mortality using data mining in Iran," *J. Med. Syst.*, vol. 37, no. 3, pp. 1–9, 2023.

[11] F. Anwar and A. Shamim, "Barriers in the adoption of health information technology in developing societies," *Int. J. Adv. Comput. Sci. Appl.*, vol. 2, no. 8, pp. 40–45, 2011.

[12] R. O. Adetunji, "Mobile health interventions and their impact on maternal and child health in sub-Saharan Africa," *Telemed. e-Health J.*, vol. 19, no. 2, pp. 87–93, 2020.

[13] J. P. Smith and L. M. Tanner, "Wearable health monitoring systems for pediatric care," *Pediatr. Health J.*, vol. 15, no. 1, pp. 45–58, 2021.

[14] A. Patel, M. Kumar, and P. S. Gupta, "Integration of IoT and machine learning for child health monitoring," *J. Digit. Health Innov.*, vol. 12, no. 4, pp. 214–230, 2022.

[15] S. Ahmed and R. Ali, "The role of ICT in improving healthcare outcomes in developing countries," *Glob. Health Perspect.*, vol. 5, no. 3, pp. 34–42, 2019.

[16] M. K. Lal and V. N. Singh, "Analyzing the impact of telemedicine in rural healthcare delivery," *Rural Health Insights*, vol. 14, no. 2, pp. 67–80, 2021.

[17] K. W. Johnson and T. L. Chan, "Artificial intelligence in pediatric disease prediction: A systematic review," *J. Pediatr. Res.*, vol. 18, no. 1, pp. 101–118, 2022.

About the Author

Mr. Ihsanullah Nazari, *Lecturer, Department of Information Technology, Faculty of Computer Science, Kardan University, Kabul, Afghanistan.* <*i.nazari@kardan.edu.af*>>