Reproductive Health

COMMENT

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Artificial intelligence and sexual reproductive health and rights: a technological leap towards achieving sustainable development goal target 3.7

Fred Yao Gbagbo[1], Edward Kwabena Ameyaw[2] and Sanni Yaya[3*]

Abstract

Target 3.7 of the Sustainable Development Goals (SDGs) aims for universal access to sexual and reproductive health (SRH) services by 2030, including family planning services, information, education, and integration into national strategies. In contemporary times, reproductive medicine is progressively incorporating artificial intelligence (AI) to enhance sperm cell prediction and selection, in vitro fertilisation models, infertility and pregnancy screening. AI is being integrated into five core components of Sexual Reproductive Health, including improving care, providing high-quality contraception and infertility services, eliminating unsafe abortions, as well as facilitating the prevention and treatment of sexually transmitted infections. Though AI can improve sexual reproductive health and rights by addressing disparities and enhancing service delivery, AI-facilitated components have ethical implications, based on existing human rights and international conventions. Heated debates persist in implementing AI, particularly in maternal health, as well as sexual, reproductive health as the discussion centers on a torn between human touch and machine-driven care. In spite of this and other challenges, AI's application in sexual, and reproductive health and rights is crucial, particularly for developing countries, especially those that are yet to explore the application of AI in healthcare. Action plans are needed to roll out AI use in these areas effectively, and capacity building for health workers is essential to achieve the Sustainable Development Goals' Target 3.7. This commentary discusses innovations in sexual, and reproductive health and rights in meeting target 3.7 of the SDGs with a focus on artificial intelligence and highlights the need for a more circumspective approach in response to the ethical and human rights implications of using AI in providing sexual and reproductive health services.

Keywords Artificial intelligence, Sustainable development goals, Sexual, Reproductive health and rights, Innovation

Introduction

Target 3.7 of Sustainable Development Goals (SDGs) envisages achieving universal access to sexual and reproductive health services by 2030, including family planning, information, education, and integration of reproductive health into national strategies [1, 2]. Growing global evidence in the use of technology has proven that Artificial Intelligence (AI) can significantly contribute to achieving SDG target 3.7 by enhancing early disease detection, improving diagnosis accuracy, optimising

*Correspondence:
Sanni Yaya
sanni.yaya@gmail.com
[1] University of Education, Winneba, Ghana
[2] Institute of Policy Studies and School of Graduate Studies, Lingnan University, Tuen Mun, Hong Kong
[3] The George Institute for Global Health, Imperial College London, London, UK

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treatment plans, and facilitating remote healthcare delivery. Because optimal sexual and reproductive health is inevitable in achieving health and wellbeing of humanity [3] the use of AI in accessing sexual and reproductive health care information and services may imply that people must take charge of their bodies and constantly educate themselves on sex control, prevention of Sexually Transmitted Infections (STIs) and unplanned pregnancies.

In recent years, AI has increasingly been integrated into various fields of medicine, including reproductive medicine. AI is now being employed to enhance the selection and prediction of sperm cells, oocytes, and embryos, as well as to develop more accurate predictive models for in vitro fertilisation [4]. Current applications of AI within Sexual and Reproductive Health (SRH) care include screening and predicting infertility and pregnancy [5]. The capacity of AI to analyse vast datasets can uncover existing and new insights into reproductive health issues, tailor treatments to individual needs, and predict health trends, potentially transforming SRH service delivery globally [6].

The use of AI in Sexual and Reproductive Health and Rights (SRHR) is embedded within the following five core components of SRH: (1) improvement of antenatal, perinatal, postpartum, and newborn care; (2) provision of high-quality services for contraception and infertility services; (3) elimination of unsafe abortions; (4) prevention and treatment of STIs including HIV, reproductive tract infections, and (5) cervical cancer [7, 8]. All these components of AI-facilitated SRH components have both human rights [9] and ethical [10] implications with respect to sexual rights and rights to sexual autonomy, which are predominantly norms derived from existing human rights and recognised in numerous international conventions that encompass freedom, equality, privacy, autonomy, integrity, and dignity.

This commentary explores innovations in sexual and reproductive health and rights aimed at achieving SDG target 3.7, with an emphasis on the role of artificial intelligence. It underscores the importance of adopting a more cautious approach to address the ethical and human rights concerns associated with using AI in delivering sexual and reproductive health services.

AI powered diagnostic tools in reproductive health

Artificial intelligence has shown considerable promise in enhancing healthcare outcomes, particularly in reproductive medicine and obstetrics. As Vladyka [11] notes, AI-driven tools have the capability to improve diagnostic accuracy, optimise treatment protocols, and reduce medical errors. Wang et al. [12] also highlight the application of machine learning techniques in reproductive medicine to enhance the performance of assisted reproductive technology. This has equally been echoed by researchers investigating innovations in assistive reproductive technology [5, 13, 14].

AI integration in obstetrics and gynaecology diagnostics enhances early pathology detection and improves survival rates [15, 16]. The study by Medjedović et al. [17] highlights the potential applications of advanced perinatal ultrasound techniques, monitoring fetal heart rates during labor, and predicting delivery modes. While Vladyka [11] noted that AI algorithms have successfully managed large volumes of genetic data, contributing to disease prediction and the creation of innovative diagnostic techniques, Chaurasia et al. [16] emphasize key challenges such as the need for standardised protocols, data privacy concerns, and potential biases. As AI technology continues to evolve, it is anticipated to greatly improve personalised healthcare delivery and decision-making processes [17].

Recent studies highlight the potential of AI in enhancing ectopic pregnancy diagnosis using ultrasound imaging, with Convolutional Neural Networks achieving 97% accuracy in first-trimester ultrasound images [18]. As noted by Akkus et al. [19], deep learning techniques can mitigate variations caused by operators, patients, and scanners, improving diagnostic accuracy and optimising clinical workflows. Early detection of ectopic pregnancies, as emphasised by Lee et al. [20], is critical for preventing complications and enhancing patient outcomes.

Chen et al. [21] argued that AI applications in obstetric ultrasound extend beyond ectopic pregnancy diagnosis and enable automatic fetal positioning, gestational age prediction, and real-time image quality assurance. AI applications in obstetrics now include fetal structure identification, gestational age prediction, and image quality assurance [21]. Advancements in pregnancy-related diagnostics have the potential to greatly improve accuracy and efficiency, especially in low-resource settings. AI's application in obstetric ultrasound includes first-trimester pregnancy assessment, placental evaluation, fetal biometry, echocardiography, and neurosonography [22]. The implementation of AI in obstetrics and gynaecology holds promise for enhancing clinical outcomes and managing reproductive health conditions, with the potential to revolutionize early-stage pregnancy diagnostics.

Personalised reproductive healthcare through AI

AI is revolutionising assisted reproductive technologies, particularly in vitro fertilisation, by improving treatment efficacy, patient outcomes, and optimising medication dosing, scheduling, and embryological assessments [23]. It has demonstrated potential in various aspects of Assisted Reproductive Technology (ART), including

ultrasound monitoring of folliculogenesis, endometrial receptivity assessment, and computerised semen analysis [6]. Though AI can personalise treatment plans based on patient characteristics, previous responses, and monitoring data, Pavlovic et al. [23] argued that ongoing validation and ethical considerations are crucial for the effective and full implementation of AI in reproductive medicine.

AI is set to revolutionise ART by improving efficiency, success rates, and personalization of fertility treatments by analysing hormonal levels, genetic information, and treatment outcomes [23]. AI's ability to process large, dynamic datasets makes it ideal for handling the complex information generated during ART cycles [14]. Although there are still obstacles in the way of clinical AI application, it has the ability to enhance important processes such as assessments of sperm and embryos [24]. Despite these obstacles, AI integration in ART offers significant potential to improve patient outcomes and operational efficiency in fertility clinics.

A recent study demonstrates how AI has the potential to completely transform the way that polycystic ovarian syndrome (PCOS) is treated [25]. To determine PCOS risk and facilitate early management, AI-driven predictive algorithms can evaluate complicated health data, such as hormone profiles, genetic markers, and lifestyle aspects. Machine learning algorithms, such as linear regression, decision trees, and random forests, are being explored to develop robust predictive models for PCOS [26]. These AI-powered tools can enhance diagnosis accuracy, optimise treatment strategies, and provide personalised management plans. Image analysis for ovarian cyst identification and segmentation is one of the revolutionary uses of AI in PCOS care [27, 28].

AI in family planning and contraception

Family planning and contraception services are evolving as a result of AI and digital health technology, especially in terms of better access and personalised suggestions. AI-driven genetic testing can mitigate adverse effects and enhance user satisfaction by anticipating individual reactions to various forms of birth control [29]. AI-powered mobile applications are equally guiding contraceptive users through contraceptive choices, providing information about long-acting reversible contraception (LARC), and offering personalised recommendations based on individual preferences and risk factors [30]. These digital health tools have empowered contraceptive users with information and resources, enhancing understanding and adherence to contraceptive methods [31].

The development of new contraceptive methods aims to address market gaps, reduce side effects, improve accessibility, and offer more options for both men and women [32]. AI and digital health technologies will support healthcare professionals in delivering more accurate guidance, thereby increasing the overall adoption and satisfaction with contraceptives [31]. Drug discovery and development procedures are being expedited by artificial intelligence (AI), which is transforming the pharmaceutical sector [33]. AI systems have the ability to provide safer and more effective medicines by effectively screening compound libraries, predicting drug efficacy and safety, and optimising clinical trials [33].

It also has the potential to resolve concerns regarding the side effects of hormonal contraceptives by helping to develop novel products with superior metabolic profiles in the field of contraception research [34]. Although there are currently few AI applications in settings like low and middle-income countries where the requisite resources for AI operations are almost absent, there is growing interest in using AI to enhance healthcare services in these locations since AI-powered solutions can alleviate resource-constrained health system issues and revolutionise the delivery of healthcare [35]. However, issues such as data quality, AI model interpretability, and ethical issues remain unresolved, including patient privacy and safety [33, 35]. These are therefore essential dimensions for greater policy consideration, to ensure that resource-constraint settings do not miss the enormous benefits AI offers to sexual and reproductive health rights and its ongoing positive contribution to the overall wellbeing of humanity.

AI in maternal health monitoring

Maternal health remains a critical concern globally, with complications such as preeclampsia, gestational diabetes, and preterm birth posing significant risks to both mothers and infants [36]. The advent of AI in healthcare offers promising solutions to enhance maternal health monitoring, predict complications, and facilitate timely interventions since AI's integration into healthcare continues to revolutionize various domains, including maternal health [37].

In our contemporary era, large-scale datasets are analyzed by artificial neural networks, natural language processing, and machine learning to forecast health outcomes, support diagnosis, and facilitate risk assessment [38]. The use of wearable technologies with AI-powered algorithms is also embraced for ongoing maternal health monitoring. Healthcare practitioners can get real-time data from these devices, which include biosensors and smartwatches, tracking vital signs including blood oxygen levels, heart rate, and body temperature [39, 40]. These complex statistics are interpreted by AI systems, which use anomaly detection and pattern recognition to identify possible health abnormalities [39]. In addition

to tracking maternal physical activities, wearable sensors can track the foetal heart rate, mobility, and electrocardiogram (ECG) [40].

A proposed framework using wearable sensors achieved an 89% recognition rate for various physical activities during pregnancy, enabling continuous feedback and monitoring [41]. These innovative systems aim to revolutionise prenatal care by enabling early identification of deviations and fostering informed decision-making among medical practitioners and expectant parents [39]. Various ML algorithms, including support vector machines (SVM), random forests, and neural networks, have been successfully employed to predict conditions such as preterm birth, gestational diabetes, and hypertensive disorders [42]. ML models have shown promising results in predicting maternal health risks, with XGBoost achieving 97.3% accuracy [43].

Chemisto et al. [37] reported that AI applications can predict 48% of maternal complications using electronic medical records, with prematurity prediction achieving an accuracy of 95.7%. Advanced AI techniques, including Machine Learning (ML), Natural Language Processing (NLP), and Artificial Neural Networks, are being utilised to analyse complex feto-maternal data, facilitating early detection of complications and informed clinical decision-making [38]. Gradient Boosting algorithms have demonstrated 90.64% accuracy in assessing pregnancy risk levels [44]. These findings underscore AI's potential to enhance maternal and child health outcomes, particularly in resource-limited regions with high maternal mortality rates [37]. The adoption of Explainable AI techniques further improves the interpretability and trustworthiness of these predictions [44].

Mobile applications are increasingly used by pregnant women to access health information and monitor fetal well-being [45]. AI-based apps can analyse complex feto-maternal data, predict health outcomes, and provide real-time alerts for deviations in maternal health parameters. As mobile apps become more prevalent in antenatal care, further rigorous studies are needed to evaluate their impact on maternal knowledge, behavior, and perinatal health outcomes [46]. While these apps have the potential to improve maternal behavior and perinatal outcomes, evidence of their effectiveness is limited, hence the need for much scholarly attention in this regard cannot be over-emphasised.

AI in maternal health is expected to further advance with emerging trends like personalised medicine, where AI tailors treatment plans to individual patients based on unique risk profiles. The integration of AI with other technologies, such as genomics and telemedicine, also holds promise for improving maternal and neonatal outcomes. However, there are still research gaps that need addressing, such as evaluating the long-term impact of AI-driven interventions and ensuring that AI models are inclusive of diverse populations to prevent health disparities [47].

Ethical concerns of AI in reproductive health

The ethical concerns surrounding the use of AI in sexual and reproductive health are multifaceted, reflecting broader issues in healthcare technology deployment [48]. AI applications in sexual and reproductive health often require sensitive personal data, raising significant privacy concerns. Users may fear breaches of confidentiality, especially regarding sexual health information, which can lead to stigmatisation or discrimination [49]. Ensuring robust data protection measures is crucial for complying with legal standards and maintaining user trust.

AI systems, particularly those utilising large language models (LLMs), can inadvertently disseminate inaccurate or misleading health information [50]. This risk is exacerbated in sexual health contexts, where misinformation can have serious consequences for individuals' health decisions. The potential for "hallucinations"—instances where AI generates plausible but false information highlights the need for stringent oversight and validation of AI outputs.

AI systems in healthcare can also perpetuate and amplify existing biases based on socioeconomic status, race, gender, and other factors, particularly impacting disadvantaged populations, such as those in LMICs [51]. This bias can lead to less accurate predictions or underestimation of care needs for marginalised groups [51]. To tackle these challenges, it is essential to integrate equity, diversity, and inclusion (EDI) principles throughout the AI lifecycle in healthcare [52]. Strategies to reduce bias include developing AI models using diverse and representative datasets and implementing robust monitoring systems [47]. Additionally, structural reforms in funding, publications, and education are necessary to ensure that biomedical AI benefits diverse populations globally [47]. By addressing these issues, AI technology in healthcare can become more generalizable, equitable, and effective in achieving health equity for all populations [51, 52].

AI in addressing inequities in reproductive healthcare

AI technologies are emerging as pivotal tools in bridging gaps in reproductive healthcare access and quality, particularly for marginalised and underserved populations. A comprehensive review of global studies on this subject matter presents key insights into how AI could enhance reproductive healthcare delivery. One notable study has emphasised the necessity of integrating AI to increase access to affordable reproductive health services [53]. The authors argued that AI could facilitate better

patient engagement and streamline healthcare delivery, ultimately improving overall health outcomes for underserved populations [53].

In the case of Africa, Ipas has reflected on the critical role of AI in identifying barriers to SRH care among marginalised communities [54]. These organisations, whose work underscores the importance of understanding local contexts, found that AI-driven analytics could effectively pinpoint gaps in service provision and inform targeted interventions. For instance, the "Nurse Nisa" chatbot, launched in Kenya and the Democratic Republic of Congo, offers information on contraception and abortion, demonstrating how AI can bridge information gaps in reproductive health [54].

Another relevant study from Bangladesh highlights how AI tools can be used to map healthcare access and identify underserved areas [44]. The authors found that AI could enhance the visibility of healthcare inequalities, hence, prompting policy changes and resource allocation to improve access for women in marginalised communities [44]. Furthermore, recent scoping reviews [55, 56] have provided a broader perspective on how health inequities affect access to assisted reproductive technologies (ART) by highlighting how AI could help track and analyse demographic data, thereby enabling healthcare providers to tailor services to the needs of different populations. Their findings indicate that historically marginalised groups experience significant barriers to ART, which AI could mitigate when integrated into health outreach and education efforts.

Predictive analytics for reproductive health outcomes

AI-driven predictive analytics is transforming reproductive health by enabling the forecasting of health outcomes and guiding preventive measures, particularly for underserved populations. One notable study has highlighted how AI technologies are being deployed to enhance clinical diagnosis and facilitate timely referrals [57]. This initiative, implemented across various countries in the Global South, aims to reduce maternal mortality rates by utilising predictive analytics to identify high-risk pregnancies early, thereby allowing for timely interventions [55].

In the context of fertility, the potency of AI applications in predicting fertile periods and optimising sperm health has been highlighted [58]. This indicates that AI can analyse vast datasets to improve natural conception chances for couples, particularly in areas where access to reproductive health services is limited. Another significant contribution worth noting is the potency of AI to aid in predicting disease progression and optimising patient treatment plans by analysing electronic health records and other health data sources. This capability is particularly relevant in reproductive health, where early detection of complications can significantly improve maternal and neonatal outcomes [59].

AI-driven innovations in menstrual health management

AI technology is enhancing menstrual health management by providing personalised and data-driven solutions that support women's health. The integration of AI into menstrual health products and apps has led to significant advancements in tracking, predicting, and managing menstrual cycles, which are critical for overall reproductive health.

One of the key areas where AI has made a substantial impact is in the development of menstrual tracking apps. These apps, powered by ML algorithms, analyse user data to predict menstrual cycles, ovulation periods, and potential health issues. For instance, apps like Clue and Flo use AI to offer personalised insights into menstrual patterns, enabling users to make informed decisions about their reproductive health.

Moreover, AI is enhancing the accuracy of menstrual tracking by considering various factors such as hormonal changes, lifestyle, and environmental influences. This allows for more precise predictions and tailored health advice [60]. The incorporation of AI in menstrual health management extends beyond tracking to include the management of menstrual disorders. AI-driven platforms can detect irregularities in menstrual cycles, such as polycystic ovary syndrome (PCOS) or endometriosis, and suggest appropriate interventions [61].

In addition, AI is playing a crucial role in destigmatising menstruation by providing educational content and resources through these platforms. By delivering accurate information and support, AI-driven apps are helping to break down societal taboos associated with menstruation and empower women with knowledge about their bodies [62].

AI in combatting sexual and reproductive health misinformation

Misinformation related to SRH is a significant public health challenge, exacerbated by the proliferation of digital platforms and the media. AI offers promising solutions to identify, debunk, and prevent the spread of SRH misinformation, thus playing a vital role in safeguarding public health [63]. AI's ability to analyse vast amounts of data in real-time enables the detection of misinformation trends across social media and other online platforms. Natural Language Processing (NLP) algorithms, for example, can identify misleading or false content related to SRH by analysing language patterns, sentiment, and context [64]. These AI-driven tools can flag potentially harmful information for further review or immediate correction. Furthermore, AI can support fact-checking initiatives

by cross-referencing information with reliable sources. ML models can be trained to distinguish between credible and non-credible sources, thereby reducing the dissemination of false information [65]. By integrating AI into public health campaigns, authorities can proactively address misinformation, ensuring that accurate and reliable SRH information reaches the public. AI also plays an invaluable role in educating users about SRH by providing personalized, evidence-based information. Chatbots powered by AI, such as those used by organisations like Planned Parenthood, offer instant access to SRH information, addressing users' concerns and debunking common myths [66]. These AI-driven tools not only provide accurate information but also empower users to make informed decisions about their SRH.

AI and mental health in sexual and reproductive contexts

The intersection of AI, mental health, and SRH is a growing area of interest, particularly in understanding how AI can support mental well-being in SRH contexts. AI-driven innovations are being utilised to address the mental health challenges associated with SRH, such as anxiety, depression, and stress, which are often intertwined with reproductive health issues [67]. AI-powered mental health apps, such as Woebot and Wysa, offer therapeutic interventions for individuals experiencing mental health concerns related to SRH. These apps use AI to provide cognitive-behavioral therapy (CBT), mindfulness exercises, and personalised mental health support [68]. By addressing mental health in the context of SRH, these apps help users navigate the psychological challenges of reproductive health decisions and conditions.

Moreover, AI is used to predict and monitor mental health outcomes in SRH. For example, ML models can analyze data from wearable devices, social media, and electronic health records to identify individuals at risk of mental health issues related to SRH, such as postpartum depression [69]. Early identification through AI allows for timely intervention and support, potentially mitigating the impact of these conditions. AI's role in mental health extends to providing educational resources and support through digital platforms. By offering personalised content and real-time support, AI-driven tools empower individuals to manage their mental health proactively, particularly regarding SRH concerns [70]. The integration of AI in mental health care within SRH contexts has the potential to enhance overall well-being and improve health outcomes.

Critical insight into AI's limitations in SRH

While AI holds significant potential to enhance sexual and reproductive health and rights (SRHR), several challenges hinder its effective implementation, particularly in low-resource settings. Issues such as inadequate infrastructure, high costs, and the need for extensive provider training must be addressed to enable widespread adoption. Additionally, AI systems, though highly proficient in pattern recognition and generating solutions from historical data, often lack creativity and contextual understanding. This limitation can lead to the amplification of biases embedded in their programming.

The implementation and maintenance of AI systems can be costly and may require continuous monitoring to ensure accuracy and reliability. Furthermore, the debate over the importance of human touch in SRHR services versus machine-driven care remains particularly relevant in low-resource and underdeveloped regions, where human-centered care is a critical quality indicator for patient satisfaction. Balancing the integration of AI with the need for compassionate, personalised care is essential for achieving success in SRHR.

Conclusion

The article provides a critical analysis of the use of AI in SRH by showing that the application of AI in sexual reproductive health and rights presents a promising avenue for addressing disparities faced by marginalized populations. By leveraging AI technologies, healthcare systems can improve access, enhance service delivery, and ultimately contribute to health equity in reproductive health services globally, particularly in LMICs where worse reproductive health conditions emanate from. Drawing from the ongoing arguments for and against the application of AI in sexual, reproductive health and rights particularly in the developing world, it is imperative for countries in the developing world that are new to AI in health care to start considering the gradual integration of AI applications in addressing the sexual, reproductive health and rights needs of people particularly amid brain drain of essential health care professionals. To this course, there is a need to have pragmatic and actionable plans in place to effectively roll out AI use in sexual, reproductive health and rights-based decisions and services since AI has come to stay. Capacity building of health workers in the use of AI for SRH services thus becomes an obligation in the light of its significant impact on achieving SDG target 3.7 which focuses on achieving universal access to sexual and reproductive health services including family planning, information, education, and integration of reproductive health into national agenda by 2030.

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SY conceived the paper and outlined the sections. FYG drafted the manuscript. EKA provided guidance and critically reviewed the manuscript. SY

had final responsibility to submit. All authors read and approved the final manuscript.

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