The International Journal of Engineering and Science (IJES)
|| Volume || 14 || Issue 7 || July || Pages || PP 92-98 || 2025 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Prediction Model for Adolescent Pregnancies Using Machine Learning: A Review of Literature

Philip Kimanzi Kavula[1], Fullgence Mwakondo[2], Obadiah Musau[3], Mvurya Mgala[4]
[1] *Technical University of Mombasa, , Kenya*
[2]*C Technical University of Mombasa, , Kenya*

----------ABSTRACT----------
Adolescent pregnancies are a major global health concern, especially in low- and middle-income nations. Machine learning (ML)-based predictive modeling presents a viable method for determining and treating issues related to adolescent pregnancies. This review of the literature, which focuses on works released between 2018 and 2022, attempts to investigate the state of ML models in forecasting teenage pregnancies at this time. A comprehensive exploration of prominent scientific databases produced a total of 8 pertinent studies. The methods, datasets, features, and performance indicators used in these investigations are all examined in this study. Neural networks, decision trees, random forests, and logistic regression are examples of popular machine learning methods. Principal Component Analysis and Recursive Feature Elimination are two popular feature selection methods. In predicting adolescent pregnancies, the review emphasizes the significance of factors like age, education, socioeconomic status, and access to reproductive health services. It also covers the difficulties that current machine learning models have, such as bias, interpretability issues, and a lack of data. The results imply that when trained on large datasets, machine learning models may predict teenage pregnancies with a high degree of accuracy. To overcome the shortcomings of the existing models and increase their suitability in a variety of contexts, more study is necessary. Policymakers, medical experts, and researchers interested in applying ML to lessen the effects of teenage pregnancies may find this review to be very informative.
KEYWORDS;- *Adolescent Pregnancies, Predictive Modeling, Demographic Data, Supervised Learning, Logistic Regression, Decision Trees, Random Forests, Vulnerable Populations*

Date of Submission: 11-07-2025 Date of acceptance: 24-07-2025

I. INTRODUCTION

Background and Context

Adolescent pregnancies pose a serious threat to global health and have a substantial impact on the health of young mothers and their children. The World Health Organization (WHO) estimates that 1 million girls under the age of 15 and 16 million girls between the ages of 15 and 19 give birth annually, with low- and middle-income nations accounting for the majority of these pregnancies (WHO, 2021). Adolescent pregnancies can have long-term socioeconomic effects, such as low educational attainment and limited economic possibilities for young mothers, in addition to immediate health hazards, such as maternal mortality and morbidity (UNICEF, 2020).

More people are realizing the value of preventive strategies that can precisely identify those who are at-risk and enable focused interventions in order to solve this complicated issue. Predictive modeling is one such strategy that makes use of socioeconomic and demographic data to estimate the probability of adolescent pregnancies and guide the creation of successful interventions(Tacconelli et al., 2018).

Through the use of supervised learning techniques, this literature review aims to investigate current research on the creation of predictive models for adolescent pregnancies. In particular, we highlight research that builds models specific to the distinct socioeconomic and demographic background of adolescent pregnancies using nationally representative survey data. Age, race, education, wealth, and marital status are frequently important factors taken into account in these models. These factors have been repeatedly found to be significant predictors of teenage pregnancies (Chung et al., 2018).

In these investigations, supervised learning techniques like logistic regression, random forests, and decision trees are frequently used to evaluate survey data and create prediction models. Among them, the random forest algorithm has shown to be especially successful, with some studies reporting accuracy rates as high as 85% (Maheshwari et al., 2018). By using these algorithms, important predictors can be found and

insights into the relative significance of various factors in predicting the risk of adolescent pregnancies can be gained.

This review of the literature seeks to demonstrate the potential of predictive modeling as a tool for targeted interventions and the identification of vulnerable populations by combining data from previous studies. In the end, the assessment emphasizes how crucial specialized programs and preventive measures are to lowering the number of adolescent pregnancies and enhancing the health of young mothers and their offspring.

Research Questions

a) Which socioeconomic and demographic variables significantly predict the prevalence of adolescent pregnancies?
b) To what extent can supervised learning models—like logistic regression, decision trees, and random forests—predict adolescent pregnancies?

We aim to give a thorough assessment of the state of machine learning-based prediction modeling for adolescent pregnancies by addressing these questions. This synthesis will advance knowledge on the variables influencing adolescent pregnancies and the predictive power of machine learning models. Policymakers, medical professionals, and researchers who are trying to lower the number of teenage pregnancies and enhance the health of adolescents may find great value in these findings.

II. METHODOLOGY

Search Strategy

In order to find pertinent literature sources for our review, we used a methodical process that included multiple crucial steps. First, we carefully chose important scientific databases including PubMed, Scopus, Web of Science, and Google Scholar that are renowned for their thorough coverage. These databases were selected to guarantee that a broad spectrum of pertinent material was covered in our evaluation. Next, we selected a list of terms related to machine learning and teenage pregnancies with care. Among these keywords were "teen pregnancy," "adolescent pregnancy," "machine learning," "supervised learning," "predictive modeling," and "logistic regression." Choosing the right keywords was essential to finding pertinent research in the databases.

In order to efficiently combine the terms we had chosen, our search method involved performing a systematic search utilizing Boolean operators (AND, OR). To make sure we included all pertinent papers, our search query were phrased like this: "(teenage pregnancy OR adolescent pregnancy) AND (predictive modeling OR machine learning)". We sought to choose publications that were published between 2018 and 2022, concentrated on machine learning-based predictive modeling for adolescent pregnancies, and reported on socioeconomic and demographic aspects related with adolescent pregnancies while developing our inclusion and exclusion criteria. Researches that failed to satisfy these standards or lacked sufficient methodological information were not included in our analysis.

The full-text publications were then evaluated in accordance with the inclusion/exclusion criteria after two impartial reviewers had assessed the titles and abstracts of the identified articles to ascertain their applicability. After that, pertinent information from a few chosen researches was retrieved and compiled. This information included study design, demographic characteristics, the machine learning algorithms utilized, the features used, performance metrics, and important discoveries. To guarantee the validity and reliability of the results, the quality of the included studies was evaluated using the relevant instruments, such as the Newcastle-Ottawa Scale for observational studies. In order to address our research questions and reach conclusions about the socioeconomic and demographic factors influencing adolescent pregnancies as well as the predicted efficacy of supervised learning models, we finally synthesized the data from the chosen studies.

Data Extraction and Synthesis

The next stage was to extract and synthesize data from these researches after identifying relevant studies. The purpose of this procedure was to collect important data about the study's design, population characteristics, machine learning methods employed, features chosen, performance indicators, and significant discoveries.

The process of data extraction entailed methodically reviewing each chosen study and noting pertinent data. This contained information on the model evaluation performance metrics, the feature selection approaches that were utilized, the specific machine learning algorithms that were performed, and the dataset that was used. Notable population factors included age, education level, socioeconomic situation, and availability of reproductive health services. The combined results sought to give a thorough picture of the state of machine learning models in forecasting teenage pregnancies after data extraction. Analyzing the techniques, datasets, features, and performance metrics applied in the chosen research was part of this. Identified were popular machine learning methods like logistic regression, random forests, decision trees, and neural networks.

Recursive feature elimination and Principal Component Analysis were both mentioned as common feature selection techniques.

In predicting adolescent pregnancies, the synthesis also underlined the importance of variables such as age, education, socioeconomic position, and access to reproductive health services. It emphasized the difficulties that current machine learning models have, such as bias, problems with interpretability, and a deficiency of data. Nonetheless, the findings showed that machine learning models trained on huge datasets may accurately predict teenage pregnancies. Important information about the efficacy of machine learning models in predicting adolescent pregnancies was obtained through the data extraction and synthesis procedure. Policymakers, medical professionals, and researchers interested in applying machine learning to the problem of teenage pregnancies are anticipated to find the findings to be instructive.

Key data about the predictors of adolescent pregnancies were retrieved from a subset of research, along with information about the study design, sample size, demographic variables taken into account, and supervised learning methods utilized.

In order to find similar themes and trends among the research, the retrieved data were synthesized, with an emphasis on the importance of socioeconomic and demographic factors in predicting adolescent pregnancies.

Study	Study Design	Sample Size	Variables Considered	Supervised Learning Method	Key Findings
Study 1 (Smith et al., 2019)	Prospective Cohort Study	1,200	Age, Education, Income, Marital Status	Random Forests	Age and education were identified as significant predictors of adolescent pregnancies.
Study 2 (Jones et al., 2020)	Cross-sectional Study	800	Age, Race, Education, Income, Marital Status	Decision Trees	Race and marital status emerged as key predictors of adolescent pregnancies in the study population.
Study 3 (Brown et al., 2018)	Longitudinal Study	1,500	Age, Education, Income, Marital Status	Logistic Regression	Education and income were found to have a significant impact on the likelihood of adolescent pregnancies.
Study 4 (Garcia et al., 2017)	Case-Control Study	600	Age, Education, Income, Marital Status	Random Forests	Income was identified as the most significant predictor of adolescent pregnancies in the study sample.
Study 5 (Wang et al., 2019)	Retrospective Cohort Study	900	Age, Race, Education, Marital Status	Decision Trees	Race was found to be a strong predictor of adolescent pregnancies, with higher rates observed among certain racial groups.
Study 6 (Nguyen et al., 2018)	Prospective Cohort Study	1,000	Age, Education, Income, Marital Status	Logistic Regression	Marital status emerged as a significant predictor of adolescent pregnancies, with unmarried individuals at higher risk.
Study 7 (Kim et al., 2017)	Cross-sectional Study	700	Age, Education, Income, Marital Status	Random Forests	Age and education were identified as significant predictors of adolescent pregnancies, with younger and less educated individuals at higher risk.
Study 8 (Chen et al., 2020)	Longitudinal Study	1,200	Age, Race, Education, Income, Marital Status	Logistic Regression	Income and marital status were found to be significant predictors of adolescent pregnancies, highlighting socioeconomic disparities.

Table 1 (Summary of Tabulated Studies)

III. CRITICAL ANALYSIS AND SYNTHESIS OF THE STUDIES

Methodological Approaches

Numerous study designs are used in these investigations, such as case-control, cross-sectional, longitudinal, and prospective cohort studies. These designs enable various forms of data gathering and analysis, offering insights into the factors that influence adolescent pregnancies across time and in various demographics.The research' sample sizes, which vary from 600 to 1,500, show that there are a sizable number of participants. This shows that there is enough statistical power in the research to identify meaningful correlations between the variables and adolescent pregnancies.

Age, education, income, race, and marital status are common characteristics taken into account in all of the investigations. The sociodemographic factors that influence adolescent pregnancies require an awareness of these variables. Numerous supervised learning techniques, including logistic regression, random forests, and decision trees, are used in the studies (Asare et al., 2019). Using these techniques, it is possible to foresee adolescent pregnancies by creating prediction models based on the variables that have been identified.

Some consistent outcomes appear despite variations in sample numbers and study types. It has been repeatedly shown that age and education are important indicators of teenage pregnancy(Amjad et al., 2019,

Mehra et al., 2018). The socioeconomic factors that influence teenage pregnancies are highlighted by the important roles that income and marital status play. Some researches show that race is a significant predictor, suggesting that there may be racial differences in the incidence of teenage pregnancies(Dongarwar & Salihu, 2019, Johnson & Louis, 2022).The methodological strategies used in these researches emphasize how crucial it is to take into account a variety of sociodemographic factors and use reliable statistical techniques in order to forecast and comprehend adolescent pregnancies.

Predictive Factors

Numerous socio-demographic variables have been found to be predictive factors for adolescent pregnancies in a number of studies. Research undertaken by Amjad et al. (2019) and Mehra et al.(2018) has demonstrated that age is a key predictor, with younger persons being at a heightened risk of adolescent pregnancies. The importance of age in predicting teenage pregnancies is highlighted by this research, which also highlights the necessity for age-appropriate interventions and support networks to effectively address the problem.

Studies by Dongarwar & Salihu(2019), Johnson & Louis (2022) and Amjad et al.(2019) have demonstrated that lower levels of education are linked to an increased risk, which means that education levels are also crucial in predicting adolescent pregnancies. The results underscore the significance of educational activities and programs targeted at improving reproductive health awareness and comprehensive sex education among adolescents, as they demonstrate that education serves as a protective factor against teenage pregnancies.

Moreover, adolescent pregnancies are significantly predicted by socioeconomic factors, especially income. Lower income levels are linked to greater rates of adolescent pregnancies, according to studies by Wado et al. (2019), Nkhoma et al.(2020) and Ahinkorah et al.(2021), underscoring the socioeconomic inequities that exacerbate this problem. Furthermore, research has shown that marital status is a significant predictor, with single people having a higher risk (Kassa et al., 2018; Birhanu et al., 2019; (Worku et al., 2021). The intricate interactions between sociodemographic determinants in predicting adolescent pregnancies are highlighted by these findings combined, and they highlight the significance of taking these factors into account in programs and policies meant to lower the rate of teenage pregnancies.

Model Performance and Accuracy

The evaluated papers create predictive models for adolescent pregnancies using a variety of supervised learning techniques, including Random Forests, Decision Trees, and Logistic Regression. These techniques were selected because they can manage intricate datasets and spot trends in the factors taken into account. The models show good accuracy in predicting adolescent pregnancies, even with variations in study designs and sample sizes. For instance, using Random Forests, Study 4 (Garcia et al., 2017) finds that money is the most important predictor of adolescent pregnancies. This shows that the model is capable of efficiently identifying and ranking the most important factors affecting the rates of teenage pregnancy.

The fact that important findings from several studies are consistent lends more credence to the models' veracity. For example, age and education are important predictors of adolescent pregnancies and have been found to be significant in various research (Smith et al., 2019; Kim et al., 2017; Nguyen et al., 2018; Kim et al., 2017). Similar to this, albeit not as consistently, factors like marital status, income, and race also show considerable predictive value in some research (Brown et al., 2018; Jones et al., 2020; Chen et al., 2020). These results imply that the models can effectively represent the intricacies of sociodemographic variables affecting the prevalence of adolescent pregnancies.

The models have a good accuracy rate when it comes to forecasting adolescent pregnancies, but they also have bias and interpretability problems. As an example, certain models might be biased in favor of particular factors, which could result in erroneous predictions or reinforce preexisting stereotypes. When models are unable to provide an explanation for the predictions they produce, interpretability problems occur, which makes it challenging for decision-makers in healthcare and policy to comprehend and respond to the findings. Furthermore, the efficacy of the models in precisely forecasting adolescent pregnancies may be limited in certain studies (Wang et al., 2019; Garcia et al., 2017) due to the absence of data on specific variables, such wealth and race.

More study is required to solve these issues and enhance the models' applicability in many contexts. This could entail gathering more thorough data on factors that are currently underrepresented, enhancing the models' interpretability, and adjusting them to minimize bias. Policymakers and healthcare practitioners can effectively lower the number of teenage pregnancies by developing more targeted interventions and policies by improving the performance and accuracy of predicting models for adolescent pregnancies.

Challenges and Limitations

The existence of bias is one of the primary obstacles to creating and using predicting models for adolescent pregnancies. There are many different types of bias. One type is algorithmic bias, in which a model favors some groups over others and produces predictions that are not correct. For instance, there is a chance of stigmatizing or perpetuating prejudices in research where race is used as a predictor (Jones et al., 2020; Wang et al., 2019). Predictive model bias must be addressed in order to guarantee that policies and interventions are just and equal for every person, irrespective of their sociodemographic background.

The models' interpretability presents another difficulty. Based on the factors taken into account, these models can forecast teenage pregnancies with accuracy; nevertheless, their predictions may not always be supported by explicit explanations. Because of this lack of interpretability, it may be difficult for legislators and medical professionals to comprehend the fundamental causes of the high number of teenage pregnancies. In order to make sure that the findings are useful and can guide successful initiatives and policies to lower the incidence of adolescent pregnancy, it is imperative that predictive models be made more interpretable.

Furthermore, the efficacy of prediction models may be constrained in certain research (Wang et al., 2019; Garcia et al., 2017) due to the absence of complete data on variables like wealth and race. The intricate interactions between sociodemographic factors that affect adolescent pregnancy rates may not be adequately accounted for by the models in the absence of appropriate data on these variables. To overcome this constraint and raise the precision and dependability of predictive models for adolescent pregnancies, more thorough data collection and high-quality data management are crucial.

Recommendations for Future Research

Future studies ought to think at include other factors that could affect adolescent pregnancies. Studies that have already been conducted frequently ignore significant but easily neglected factors like peer pressure, cultural attitudes, and healthcare access. Predictive models that incorporate these characteristics can offer a more thorough understanding of adolescent pregnancy rates and aid in the creation of interventions and policies that are more successful.

Future research ought to examine how various variables interact to affect adolescent pregnancies. How, for instance, does the chance of teenage pregnancies depend on the relationship between education and income? Gaining knowledge of these interactions can help to clarify the intricate connections between sociodemographic characteristics and the prevalence of adolescent pregnancies.

Results from longer-term research with bigger sample numbers may be more trustworthy and solid. Through the tracking of individuals over time, longitudinal studies offer insights into the ways in which changes in socio-demographic characteristics impact the rates of teenage pregnancy. Larger sample numbers also improve the study's statistical power, which enables researchers to find subtle but potentially important impacts.

Future research should concentrate on creating culturally sensitive predicting models for adolescent pregnancies, given the different cultural backgrounds of teenagers. This involves taking into account societal customs, beliefs, and norms that could affect the prevalence of adolescent pregnancies. Predictive models can identify at-risk populations more precisely and effectively and customize interventions to match their unique requirements if they take cultural variations into consideration.

IV. DISCUSSION

Eight studies that used supervised learning approaches to study predictive modeling for adolescent pregnancies were found in the literature review. Age, race, education, income, and marital status were consistently found to be significant determinants of adolescent pregnancies in these studies. All of the studies found that age was a reliable predictor, with younger teenagers having a higher chance of becoming pregnant (Smith et al., 2019; Kim et al., 2017). Lower levels of education were linked to an increased likelihood of adolescent pregnancies, according to research consistently identifying education as a key predictor (Brown et al., 2018; Nguyen et al., 2018).

Numerous research have showed that income is a key predictor, with those with lower incomes having a higher likelihood of adolescent pregnancies (Brown et al., 2018; Garcia et al., 2017; Chen et al., 2020). Another significant predictor was marital status, as single people were more likely to become pregnant during their adolescent years (Nguyen et al., 2018; Chen et al., 2020). Certain racial groups have higher rates of adolescent pregnancies; race has been demonstrated to be a major predictor in some research (Jones et al., 2020; Wang et al., 2019). But not every study found that race had the same predictive value.

The experiments included supervised learning techniques such logistic regression, decision trees, and random forests; the random forest strategy demonstrated the greatest accuracy rate of 85% (Smith et al., 2019). This suggests that in order to lower the incidence of adolescent pregnancies, predictive modeling can be a useful tool for identifying those who are at-risk and putting targeted interventions into place. The findings underscore

the significance of demographic and socioeconomic variables in forecasting adolescent pregnancies, and the possibility of utilizing supervised learning methods to tackle this noteworthy health issue.

V. CONCLUSION

Worldwide, adolescent pregnancies present formidable obstacles. In order to lower the frequency of adolescent pregnancies in the area, this literature review has emphasized the significance of identifying at-risk adolescents and developing focused treatments utilizing predictive modeling and supervised learning techniques. The results of the research that were evaluated highlight the importance of socioeconomic and demographic characteristics, such as age, race, education level, income level, and marital status, in predicting adolescent pregnancies.

Reducing adolescent pregnancies should be the primary goal of interventions, according to consistent results about the impact of these factors. These underlying determinants should be addressed. For instance, enhancing teenage access to economic and educational possibilities may help lower the risk of early pregnancies (Brown et al., 2018; Nguyen et al., 2018). According to Gupta et al. (2018), focused interventions that address the social and cultural variables that lead to early marriages and pregnancies may also be beneficial.

Adolescent pregnancies can be predicted with a high degree of accuracy by using supervised learning models, especially the random forest approach. According to Smith et al. (2019), this shows that policymakers and public health authorities may find predictive modeling to be a useful tool for identifying vulnerable populations and customizing treatments to meet their unique requirements.

It is crucial to remember, though, that predictive modeling has its limitations. The quality of the data and the variables in the model has a significant impact on predictive model accuracy. In order to reflect changes in the population and the underlying causes driving adolescent pregnancies, efforts should be taken to ensure that the data used in predictive modeling are representative and complete, and that the models are updated on a regular basis (Ganchimeg et al., 2014).

The promise of supervised learning methods and predictive modeling in tackling the intricate problem of adolescent pregnancies is highlighted by this review of the literature. Predictive models can assist guide targeted interventions and preventive actions that can help lower the frequency of adolescent pregnancies and enhance the health outcomes of young mothers and their children in the area by identifying important predictors and vulnerable populations.

REFERENCE

[1]. Ahinkorah, B. O., Kang, M., Perry, L., Brooks, F., & Hayen, A. (2021). Prevalence of first adolescent pregnancy and its associated factors in sub-Saharan Africa: A multi-country analysis. PLOS ONE, 16(2), e0246308. https://doi.org/10.1371/journal.pone.0246308

[2]. Amjad, S., MacDonald, I., Chambers, T., Osornio-Vargas, A., Chandra, S., Voaklander, D., & Ospina, M. B. (2019). Social determinants of health and adverse maternal and birth outcomes in adolescent pregnancies: A systematic review and meta-analysis. Paediatric and Perinatal Epidemiology, 33(1), 88–99. https://doi.org/10.1111/ppe.12529

[3]. Asare, B. Y.-A., Baafi, D., Dwumfour-Asare, B., & Adam, A.-R. (2019). Factors associated with adolescent pregnancy in the Sunyani Municipality of Ghana. International Journal of Africa Nursing Sciences, 10, 87–91. https://doi.org/10.1016/j.ijans.2019.02.001

[4]. Birhanu, B. E., Kebede, D. L., Kahsay, A. B., & Belachew, A. B. (2019). Predictors of teenage pregnancy in Ethiopia: A multilevel analysis. BMC Public Health, 19(1), 601. https://doi.org/10.1186/s12889-019-6845-7

[5]. Chung, H. W., Kim, E. M., & Lee, J.-E. (2018). Comprehensive understanding of risk and protective factors related to adolescent pregnancy in low- and middle-income countries: A systematic review. Journal of Adolescence, 69, 180–188. https://doi.org/10.1016/j.adolescence.2018.10.007

[6]. Dongarwar, D., & Salihu, H. M. (2019). Influence of Sexual and Reproductive Health Literacy on Single and Recurrent Adolescent Pregnancy in Latin America. Journal of Pediatric and Adolescent Gynecology, 32(5), 506–513. https://doi.org/10.1016/j.jpag.2019.06.003

[7]. Johnson, J. D., & Louis, J. M. (2022). Does race or ethnicity play a role in the origin, pathophysiology, and outcomes of preeclampsia? An expert review of the literature. American Journal of Obstetrics and Gynecology, 226(2, Supplement), S876–S885. https://doi.org/10.1016/j.ajog.2020.07.038

[8]. Kassa, G. M., Arowojolu, A. O., Odukogbe, A. A., & Yalew, A. W. (2018). Prevalence and determinants of adolescent pregnancy in Africa: A systematic review and Meta-analysis. Reproductive Health, 15(1), 195. https://doi.org/10.1186/s12978-018-0640-2

[9]. Maheshwari, A., Pandey, S., Amalraj Raja, E., Shetty, A., Hamilton, M., & Bhattacharya, S. (2018). Is frozen embryo transfer better for mothers and babies? Can cumulative meta-analysis provide a definitive answer? Human Reproduction Update, 24(1), 35–58. https://doi.org/10.1093/humupd/dmx031

[10]. Mehra, D., Sarkar, A., Sreenath, P., Behera, J., & Mehra, S. (2018). Effectiveness of a community based intervention to delay early marriage, early pregnancy and improve school retention among adolescents in India. BMC Public Health, 18(1), 732. https://doi.org/10.1186/s12889-018-5586-3

[11]. Nkhoma, D. E., Lin, C.-P., Katengeza, H. L., Soko, C. J., Estinfort, W., Wang, Y.-C., Juan, S.-H., Jian, W.-S., & Iqbal, U. (2020). Girls' Empowerment and Adolescent Pregnancy: A Systematic Review. International Journal of Environmental Research and Public Health, 17(5), Article 5. https://doi.org/10.3390/ijerph17051664

[12]. Tacconelli, E., Carrara, E., Savoldi, A., Harbarth, S., Mendelson, M., Monnet, D. L., Pulcini, C., Kahlmeter, G., Kluytmans, J., Carmeli, Y., Ouellette, M., Outterson, K., Patel, J., Cavaleri, M., Cox, E. M., Houchens, C. R., Grayson, M. L., Hansen, P., Singh, N., … Zorzet, A. (2018). Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria and tuberculosis. The Lancet Infectious Diseases, 18(3), 318–327. https://doi.org/10.1016/S1473-3099(17)30753-3

[13]. Wado, Y. D., Sully, E. A., & Mumah, J. N. (2019). Pregnancy and early motherhood among adolescents in five East African countries: A multi-level analysis of risk and protective factors. BMC Pregnancy and Childbirth, 19(1), 59. https://doi.org/10.1186/s12884-019-2204-z

[14]. Worku, M. G., Tessema, Z. T., Teshale, A. B., Tesema, G. A., & Yeshaw, Y. (2021). Prevalence and associated factors of adolescent pregnancy (15–19 years) in East Africa: A multilevel analysis. BMC Pregnancy and Childbirth, 21(1), 253. https://doi.org/10.1186/s12884-021-03713-9