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ORIGINAL RESEARCH article

Vaccination coverage and timeliness among children aged 12-23 months in Kongwa District, Dodoma, Tanzania

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Abstract: Children's vaccinations play a significant role in public health efforts, particularly in reducing morbidity and mortality rates among children worldwide. However, challenges such as the accessibility of healthcare facilities, misinformation, and perceptions continue to affect the achievement of immunization goals in Tanzania and other developing countries. Based on the need to protect the community from diseases that can be prevented by vaccination, this study aimed to assess vaccination coverage and timeliness among children aged 12-23 months who attended postnatal immunization clinics in the Kongwa district located in the Dodoma region, Tanzania. A quantitative cross-sectional study was employed, involving 200 children who visited vaccination clinics along with their caregivers. Data were obtained through a questionnaire prepared and vaccination cards. This current study revealed that 96.0% were fully vaccinated, with 4.0% partially vaccinated, while no children were found to be totally unvaccinated. Timeliness varied across vaccines assed vaccines: 75.0% of Bacillus Calmette-Guérin vaccinated on time, four doses of Oral Polio Vaccine ranged from 74.0-87.0% of on time vaccination. Three doses of the Pentavalent Vaccine and Pneumococcal Conjugate Vaccine had on-time vaccination rates ranging from 79.5% to 86.0%. Two doses of the Rotavirus Vaccine reached on-time rates of 84.5% to 86.0%. 60.5% of people received the Measles and Rubella vaccine, with 35.5% experiencing delays and 4.0% remaining unvaccinated. This study revealed that, despite the national efforts to improve vaccination rates for children, issues such as delays and incomplete immunizations persist. Strategies like community engagement, continuous training for healthcare professionals, and improving healthcare accessibility in remote areas should be reinforced to improve vaccination uptake in Tanzania.

Introduction

Vaccination involves the administration of a vaccine to boost the body's immune system for controlling infectious diseases and vaccine-preventable diseases [1]. It enables the body to build immunity against specific diseases, which makes it one of the most successful and cost-effective public health interventions [1]. Child immunization plays a crucial role in public health efforts, significantly reducing morbidity and mortality rates among children

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worldwide in developed and developing countries. This vital practice saves up to three million lives of children each year and decreases the burden of infectious diseases in that vulnerable population [2, 3]. In addition, children's immunization helps to prevent illness, disability, and death from diseases that can be controlled through vaccinations [4]. Globally, different significant measures across continents have been implemented to enhance vaccination coverage. In 2020, the World Health Assembly introduced the Immunization Agenda 2030 (IA2030), a global strategy for 2021-2030. The IA2030 aims to ensure that everyone, everywhere, and at every age fully benefits from vaccines to improve immunization coverage by setting ambitious targets [3]. For instance, the IA2030 seeks to reduce the number of children who have not received the first dose of the diphtheria-tetanus-pertussis vaccine (DTPcv1) by 50.0%. This intervention significantly achieved a global coverage of 90.0% for three doses of the diphtheria-tetanus-pertussis vaccine (DTPcv3) [5].

The World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) have been actively tracking immunization coverage trends to evaluate progress toward these goals [6, 7]. Also, reports document coverage estimates at global, regional, and national levels through 2022, showing improvements aligned with the IA2030 strategy [8]. Despite these efforts, a number of challenges still persist in many regions, such as vaccine accessibility, infrastructure, and vaccine hesitancy. Low-resource settings have significant challenges; continued collaboration and commitment to these global targets are essential to achieving broader immunization goals [9, 10]. These issues have been observed globally, including in developed countries like the United States, where reluctance to vaccinate children has contributed to lower immunization coverage, which resulted in outbreaks of preventable diseases such as pertussis (whooping cough), mumps, and measles [11]. Addressing vaccine hesitancy is crucial to improving vaccination rates and preventing such outbreaks for the well-being of the public.

In Africa, achieving full vaccination coverage remains a challenge due to difficulties in establishing robust healthcare systems, which are mostly compounded by differing beliefs and varying levels of understanding regarding immunization [2]. Despite these obstacles, immunization has proven to be highly beneficial, protecting against chronic illnesses and disabilities [12]. These efforts have reduced the overall disease burden, saving medical expenses, increasing productivity, and improving educational outcomes among children and the general public [13]. In Tanzania, there are different vaccination programs that aim to achieve different goals, like Sustainable Development Goal 3 (SDG 3), and reduce under-five mortality and morbidity. Vaccination is an essential public health strategy because of its considerable health benefits and cost efficiency, and it has received global endorsement [14]. It is essential to track and monitor progress and evaluate immunization programs such as the Expanded Programme on Immunization and the Global Alliance for Vaccines and Immunizations by estimating vaccination coverage through routine and other reliable measurements [14]. Also, Tanzania initiated the National Immunization and Vaccine Development program leads one of the top routine childhood vaccination efforts, covering eleven diseases. Despite some challenges, especially in rural areas, the program has improved significantly, reducing vaccine shortages and establishing a reliable supply chain to meet global goals [15].

The 2015-2016 Demographic and Health Survey (DHS) reported that one in four children is not fully vaccinated, while many regions have not reached the global target of 90.0%. Variations were also reported in socio-economic status, parental education, and rural versus urban areas [15]. This study aims to assess vaccination status among children aged 12 months to 23 months who attend immunization clinics in the Kongwa district of the Dodoma region in Tanzania. Addressing these issues in that predominantly rural area, which has limited vaccination data, will significantly enhance vaccination outcomes and improve community health and well-being.

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Materials and methods

Area of the study: The study focused on Kongwa District, located in the Dodoma region of Tanzania. It is one of the seven districts of the Dodoma region of Tanzania, bordered to the north by Manyara region, to the east by Morogoro region, to the south by Mpwapwa District, and to the west by Chamwino District [16]. This study was conducted in Kongwa district due to its predominantly rural characteristics with limited access to healthcare services, which may raise concerns about vaccination practices.

Research design and approach: This current study employed a cross-sectional research design to assess the vaccination status of children attending immunization clinics in Kongwa district. Furthermore, the study involved a quantitative research approach focused on collecting numerical data to assess the extent to which children attending immunization clinics in Kongwa District receive complete and timely vaccinations.

Study population: The population included all children aged 12 months to 23 months attending immunization clinics in Kongwa District. The target population is children within this age group, as it allows the assessment of the complete primary vaccination schedule by 12 months.

Sample size and sampling procedures: This study involved 200 children attending immunization clinics in Kongwa District, along with their caregivers. The study employed a simple random sampling technique by involving the selection of five healthcare facilities. Within each selected healthcare facility, all children aged 12 months to 23 months attending the immunization clinics with a vaccination card and their caregivers were included, ensuring the sample is representative of the entire population and allowing for efficient data collection, while children aged above 23 months were excluded, and those who had no vaccination card.

Data collection and analysis: The data of this study were collected using the clinic cards of children attending the postnatal clinic along with their parents or guardians. The collected data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.

Operational definition: Fully vaccination: According to the WHO, a child is considered fully vaccinated after receiving one dose of Bacillus Calmette-Guérin (BCG), three doses each of the Pentavalent Vaccine (DTP-HepB-Hib), four doses of Oral Polio Vaccine (OPV), three doses of Pneumococcal Conjugate Vaccine (PCV), and two doses of Rotavirus Vaccine and one dose of Measles and Rubella (MR) vaccine before his/her first birthday [17].

Ethical considerations: Ruaha Catholic University (RUCU) provided ethical approval for the current research study. The office of the director of the Kongwa District Council authorized the permit for data collection through the district medical officer's office and the medical officer in charge at the facility level. Informed consents were obtained from all participants involved in the study. All collected data were managed with the highest level of confidentiality, ensuring that no personal information was disclosed.

Results

Demographic characteristics of children: The study included 200 children attending immunization services in Kongwa District, Dodoma, Tanzania. The majority, 52.5%, were between 12 months and 15 months of age, followed by 29.5% children aged 20 to 23 months, and a smaller group, 18.0%, were aged 16 months to 19 months. Regarding gender, 51.5% were females and 48.5% were males. In terms of birth order, the majority, 34.5%, were firstborns. The majority of children, 84.0%, were born in health facilities, while 16.0% were born at home (**Table 1)**.

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Table 1: Demographic characteristics of children

Predictor variable	Frequency	Percent
Child's age (months)		
12-15	105	52.5
16-19	36	18.0
20-23	59	29.5
Child's gender		
Male	97	48.5
Female	103	51.5
Birth order of the child		
First	69	34.5
Second	31	15.5
Third	38	19.0
Fourth or more	62	31.0
Place of birth		
Health Facility	168	84.0
Home	32	16.0

Table 2: Demographic characteristics of mothers

Predictor variables	Frequency	Percent
Mother's age (years)		
Less than 20	52	26.0
20-29	70	35.0
30-39	54	27.0
40 and above	24	12.0
Mother's education level		
No formal education	50	25.0
Primary	108	54.0
Secondary	36	18.0
College/University	6	3.0
Mother's occupation		
Unemployed	19	9.5
Businesswoman	28	14.0
Salaried Employee	5	2.5
Farmer	145	72.5
Others	3	1.5
Marital status		
Single	38	19.0
Married	132	66.0
Divorced	24	12.0
Widowed	6	3.0
Household monthly income (Tsh)		
Low (Less than 300,000)	157	78.5
Middle (300,000 - 1,000,000)	41	20.5
High (More than 1,000,000)	2	1.0
Number of children		
1	69	34.5
2-3	64	32.0
4-5	36	18.0
More than 5	31	15.5

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Demographic characteristics of mothers: The study assessed mothers of children attending immunization clinics. The largest group of mothers, 35.0%, were between 20 years and 29 years of age, followed by 27.0% of the mothers aged 30 years to 39 years, 26.0% of the mothers were under 20 years of age, and 12.0% were 40 years of age or older. Regarding education, almost half of the mothers (54.0%) had primary education, followed by 25.0% of the mothers who had no formal education. In terms of occupation, the majority, 72.5% were farmers, while in marital status, 66.0% of the mothers were married, 19.0% were single, 12.0% were divorced, and 3.0% were widowed, as described in **Table 2**.

Prevalence of full vaccination among children attending immunization clinics: 96.0% of the children were fully vaccinated, while only 4.0% of the children were partially vaccinated by missing one among of the recommended doses of the important vaccine.

Bacillus-Calmette Guerin (BCG): 75.0% of the children got the BCG vaccine on time, while 25.0% of the children delayed getting the vaccine (**Figure 1**).

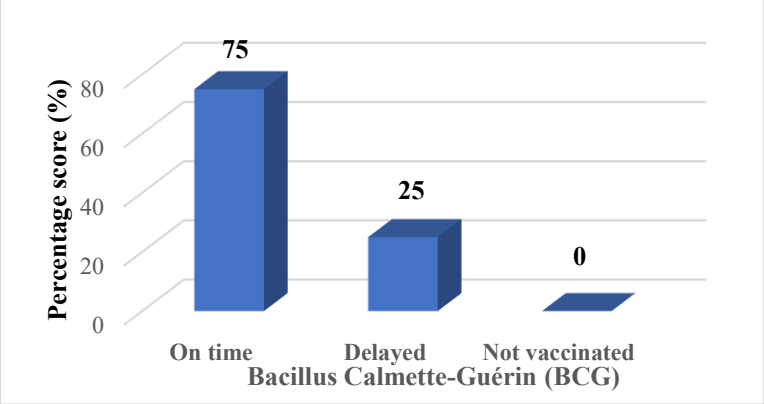

Figure 1: Bacillus-Calmette Guerin (BCG) vaccine status and timeliness

Oral Polio vaccine: For OPV dose 0, 74.0% children were vaccinated on time, while 26.0% experienced delays. For OPV dose 1, 87.0% children were vaccinated immediately, while 13.0% had delayed vaccination. For OPV dose 2, 85.0% of the children were vaccinated on time, while 15.0% experienced delays. Finally, for OPV dose 3, 79.5% of children were vaccinated on time, and 20.5% were delayed vaccination as presented in **Figure 2.**

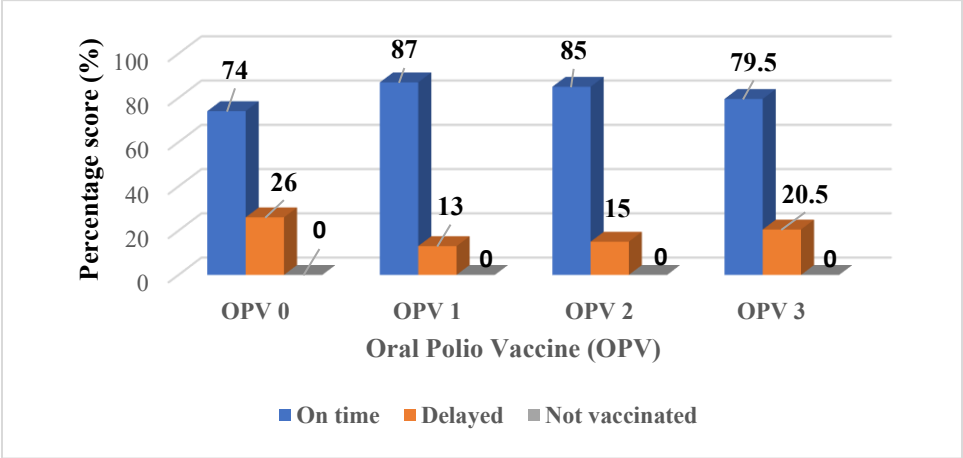

Figure 2: Oral Polio vaccine status and timeliness among children

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Pentavalent vaccine: For PENTA 1 dose, 86.0% of the children got the vaccine on the scheduled time, while 14.0% of the children were delayed in getting the vaccine. For PENTA 2 dose 85.0% of the children received the vaccine on time, while 15.0% of the children were vaccinated beyond the scheduled timeline. For the last dose, PENTA 3, 79.5% of the children were timely vaccinated, but 20.5% were delayed in getting the vaccine, as shown in **Figure 3**.

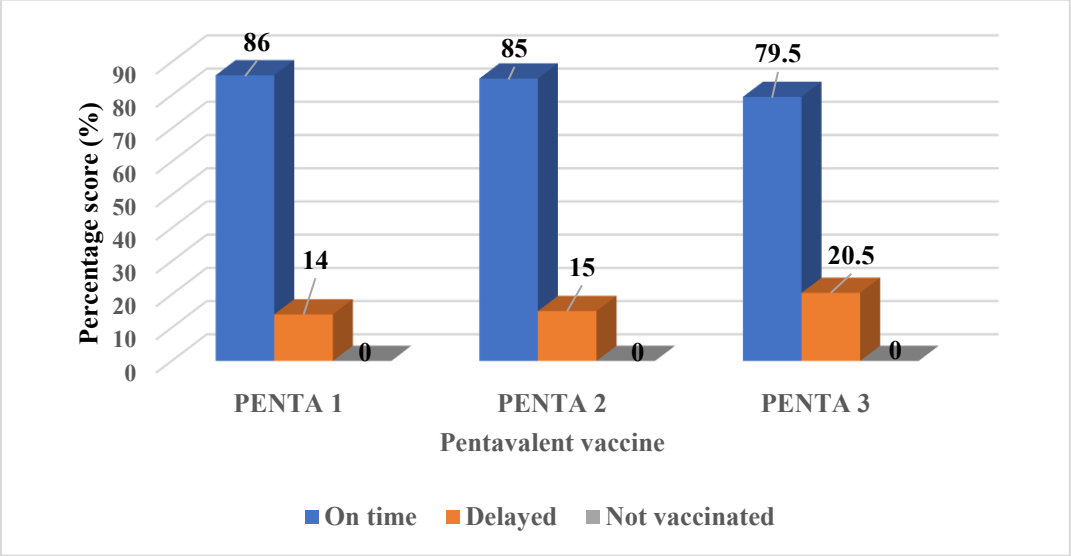

Figure 3: Pentavalent vaccine status and timeliness among children

Pneumococcal conjugate vaccine: For the PCV 1 dose, 86.0% of the children were vaccinated on time, while 14.0% were delayed. For the PCV 2 dose, 85.0% of the children were vaccinated on time, and 15.0% had delayed vaccination. For the final dose, PCV 3, 79.5% of the children were vaccinated immediately, and 20.5% were delayed **(Figure 4)**.

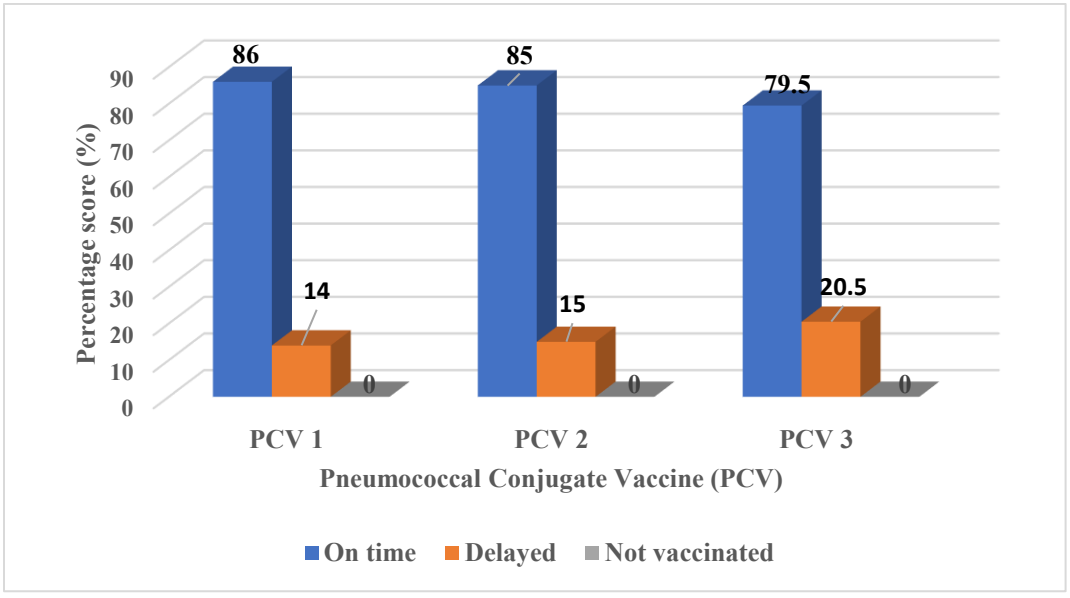

Figure 4: Pneumococcal conjugate vaccine status and timeliness among children

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Rota virus vaccine: For ROTA 1 dose, 86.0% of the children got the vaccine on time, while 14.0% of the children were delayed in getting the vaccine. For ROTA 2 dose 84.5% got the vaccine on time, while 15.5% of the children were delayed in receiving the vaccine, as presented in **Figure 5**.

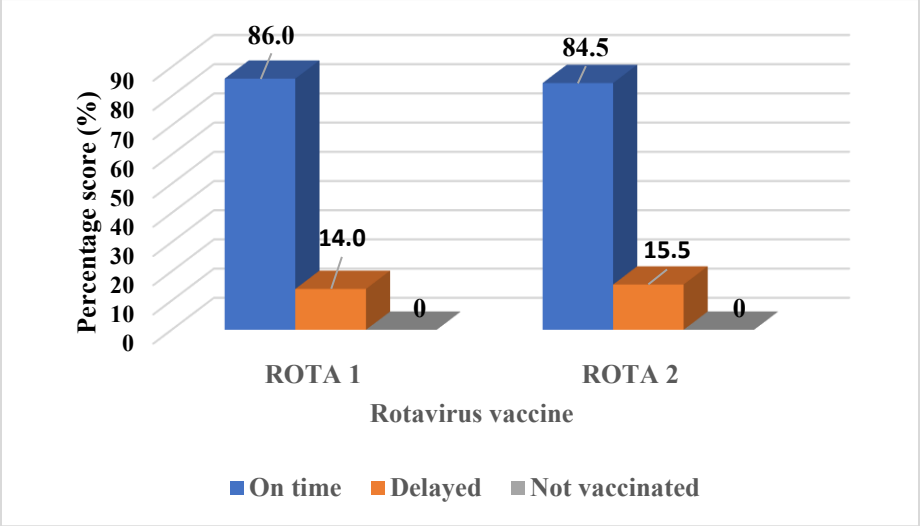

Figure 5: Rota virus vaccine status and timeliness among children

Measles and Rubella vaccine: 60.5% of the children got the MR vaccine on time, while 35.5% delayed getting the vaccine; also, 4.0% of the children were not vaccinated, as shown in **Figure 6**.

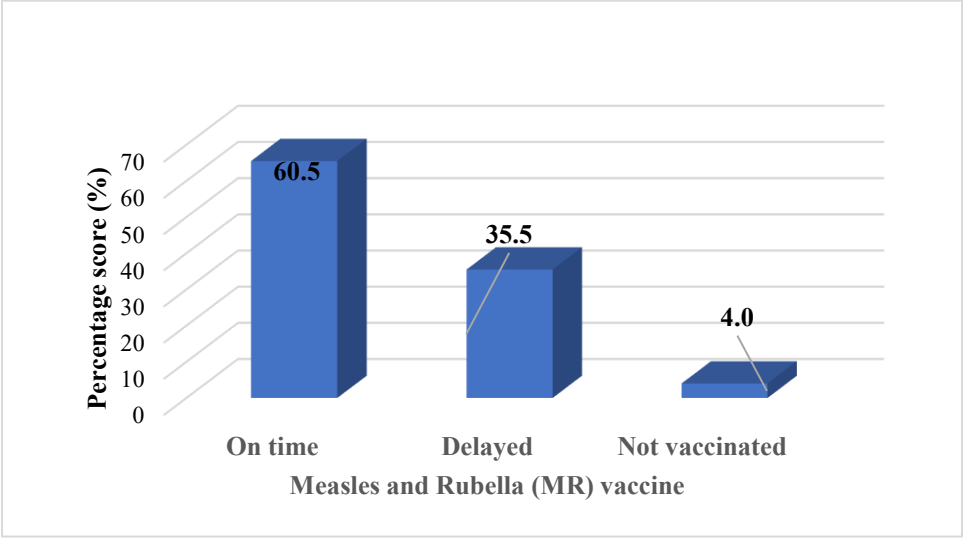

Figure 6: Measles and Rubella vaccine status and timeliness among children

Discussion

This study revealed that 96.0% of children received full vaccination, while 4.0% missed one of the proposed key vaccines. The coverage was generally high, but a timeliness problem existed among vaccines; the timing of vaccines was as follows: 75.0% of children received BCG on time, and between 79.5% and 87.0% of children received the OPV, PENTA, PCV, and ROTA vaccines according to the actual time of immunization. The decline

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in timeliness was also identified for other doses of the vaccine. For example, the timeliness declined from 86.0% PENTA 1 to 79.5% for PENTA 3. Interestingly, PCV and ROTA showed similar trends, with a decline in timeliness for subsequent doses. Only the Measles and Rubella (MR) vaccine had the lowest timeliness, with 60.5% of children who got the vaccine on time, but there were 4.0% of children did not receive it at all. These results mean that mothers decrease their efforts to attend immunization clinics as children grow. Parental perceptions, attitudes, and awareness appear to be critical determinants of timely childhood immunization in Tanzanian communities [18]. This underlines the need to address misinformation and strengthen clear and consistent public health messaging concerning childhood vaccination [19]. In comparison with other studies, a study conducted in Tanzania about rural-urban disparities in vaccination revealed the dropouts of multidose series vaccines such as the Pentavalent vaccine, similar as reported in this current study [20]. It was also reported that 47.8% rural children were delayed for the PENTA 3 vaccine. Separate research regarding childhood vaccination patterns during the COVID-19 pandemic revealed a significant drop in the timely administration of certain vaccines, including Pentavalent and Measles [21, 22]. This finding aligns closely with the results of the study carried out in the Kongwa district, Tanzania. Enhancing infrastructure in healthcare facilities, educating healthcare personnel, and supplying resources are crucial for effective vaccination practices for the vulnerable group of Tanzanian children [23]. By ensuring that healthcare providers have the necessary support in terms of resources and knowledge, we can improve vaccination rates among children and protect communities from preventable diseases more effectively [24, 3]. In comparison, a study carried out in Ethiopia regarding the vaccination status and related factors among children aged 12-23 months showed a low level of vaccination coverage, with only 35.0% of children being fully vaccinated. Meanwhile, 49.0% of the children had received partial vaccinations, while 16.0% of those evaluated had not received any of the scheduled vaccines, which is more concerning in comparison to the results of this study [25]. The higher vaccination coverage among children in Kongwa may have been influenced by the adoption of various established immunization interventions conducted in Tanzania before this study. In addition, a population-based study conducted in the Upper East Region of Ghana showed that 76.9% of children aged 12-23 months received full vaccination of all recommended vaccines [26]. Despite the fact that vaccine initiation was high but factors such as poor access to health facilities and its service delivery mode may affect the delivery of immunization services. Another study conducted in Pakistan about the determinants of timeliness in early childhood vaccination showed that only 20.8% received full vaccination of all recommended vaccines according to the scheduled time [27]. This study was conducted in one district only, which may limit the generalizability of the findings across other regions that have different capacities of health services and sociocultural contexts. The data were based on vaccination cards, which may introduce recall or reporting bias. In addition, the cross-sectional study design cannot prove a causal relationship between variables and vaccination outcomes. Despite the mentioned limitations, the study provides current valuable insights into vaccination coverage and timeliness in a rural Tanzanian setting, which will contribute to public awareness and be used as a foundation for future researchers. Enhancing vaccine timeliness requires clear public health education for mothers during antenatal and postnatal visits, supported by reminder systems such as phone alerts or monitoring cards for significant outcomes. Increasing outreach in difficult-to-access areas, especially in rural locations, and improving health financing mechanisms are essential for ensuring a consistent vaccine supply. Community engagement through local leaders and peer networks can reach target groups and boost their awareness and support. Health workers should receive ongoing training and be equipped with tools for following up on the vaccination status of children. Policymakers should integrate immunization into maternal health programs, allocating resources to education and logistical support for families to increase community outcomes.

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Conclusion: The study showed good coverage of vaccination among children in most vaccines, where vaccines scheduled late had some gaps. Only Measles displayed a gap of children who did not receive it. The remaining challenge is the timeliness of attending immunization clinics. Also, there was low timeliness of early vaccines, such as BCG and OPV 1 had the lowest timeliness among all scheduled vaccines. This shows that despite the fact that most children were fully vaccinated but some of them delayed getting vaccinated. There should be adherence to timely vaccination administration, as delayed vaccination can cause outbreaks of diseases during the vulnerable period of a child's development.

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Author contribution: AJM conceived and designed the study, and collected data. Both authors contributed to data analysis. EAM drafted the manuscript. Both authors approved the final version of the manuscript and agreed to be accountable for its contents.
Conflict of interest: The authors declare the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Ethical issues: The authors completely observed ethical issues including plagiarism, informed consent, data fabrication or falsification, and double publication or submission.
Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.
Author declarations: The authors confirm that they have followed all relevant ethical guidelines and obtained any necessary IRB and/or ethics committee approvals.