



Epidemiology of Measles in Sudan

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Authors' contributions

This work was carried out in collaboration among all authors. Authors THM, HHM, AAA, RIK, IHM and TA designed the study. Authors THM, JK, UG and NO wrote the first draft of the manuscript and together with authors AT and LF. All authors read and approved the final manuscript

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ABSTRACT

Few epidemiological studies have been undertaken of measles disease among Sudanese, although measles is the third leading cause of death since 1995 among childhood diseases that can be prevented by immunization. The measles vaccine was introduced into the EPI program in

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1985. In the run-up to the introduction of the vaccine, the country suffered from measles epidemics periodically and extensively, ranging from 50,000 to 75,000 cases and from 15,000 to 30,000 deaths per year. Simple actions can save a million lives of children through immunization coverage, eye care programs, maternal and child health education, maintaining and improving the general nutritional status of Sudanese children. Continuous surveillance and monitoring systems and evaluation are essential tasks at all levels to improve performance, identify and address problems throughout establishing and increasing the surveillance system. This review highlights a brief overview of measles epidemiology in Sudan and determinants of a measles outbreak, clinical symptoms, complications, and surveillance sites and the ways for prevention and control of measles disease. The review established that it is crucial to enforce coordination between governmental and non-governmental agencies for an effective disease surveillance system in the area, especially in those affected by civil wars.

Keywords: Measles; epidemiology; vaccine; Sudan; measles outbreak.

1. INTRODUCTION

Measles is a highly contagious vaccine-preventable disease which is easily transmitted to the human through the airborne route [1]. It remains an endemic disease in the East African region, where the disease is highly associated with high morbidity and mortality rates [2]. Measles is preventable by routine immunisation; carried out in collaboration between the governmental and non-governmental organization [1,3]. However, effective routine immunisation remains a crucial health challenge in the Eastern Mediterranean Region, particularly among Sudanese children [4]. This is due to the ongoing wars in many parts of the country [3,5], missed immunizations among the children due to the lack of inadequate information [5,6].

In Sudan, measles contributes to a high fatality rate, and according to the latest WHO report, measles is a common and fatal disease in developing countries, wherein 2017, deaths reached 2,790 (1.04%), and the age-adjusted death rate was 4.24 per 100,000. Where the death rate reached 5.70% in South Sudan in 2017 [7,8]; however, Control and elimination programme were difficult to be implemented due to the limited infrastructure resources and political instability in the country [9]. In the year of 2015, a number outbreaks occurred in the country within many cities with fatality rate noticed in central Darfur state was 4.2%, East Darfur 8.8%, Kassala 1.0%, Red sea 1.5% and west Darfur 1.4 during the week 29 epidemic outbreak report [10]. Thus the significant number of fatality rates were attributed to the vulnerable populations in Sudan and lack of sufficient funds by the health sector, hampering the implementation of the comprehensive immunization campaign beside the inadequate

health awareness towards the national measles vaccination campaign [10].

Recently, 511 measles cases were reported by Musa et al., in six health zones of Southern Darfur State, where measles infection remains to be a significant challenge and a highly acute communicable childhood disease in the area [4].

The significant increase of immunization coverage, as a result of the vaccination campaigns for the first and second doses (MCV1 and MCV2), reduced the mortality rate among the Sudanese children [11]. However, the low vaccination coverage was attained in South Sudan, explaining the constant outbreaks of measles in South Sudan.

In Sudan, despite the enormous ongoing efforts invested in measles-control activities conducted by the Federal Ministry of Health (FMOH) in collaboration with the United Nations and non-governmental organizations (NGOs), measles vaccine coverage is still low, due to insecurity situation in the country[12]. The multiple conflicts and chronic underdevelopment affected 4.1 million vulnerable children, who suffered from various diseases besides measles. The state remains highly insecure due to rebel and government fighting, intra-tribal conflicts in most parts of the country [13].

Measles remains the third leading cause of death since 1995, and it is a continuous endemic in many East African countries, where it is often associated with high morbidity and mortality. El Mubarak et al., 2002 reported measles virus to be circulating in suburban Khartoum, and Musa et al., 2017 reported recent cases in South Darfur State, Sudan[2,4], where some regions required humanitarian emergency response [14].

Therefore this mini-review aimed to highlight the recent status of measles epidemiological profiles and its clinical and case complications among the Sudanese population. This was done by searching for measles published papers, weekly and monthly reports from a government organization (FMOH) and non-governmental organizations (World Health Organization (WHO), Medecins Sans Frontieres (MSF), and United Nations Children's Fund (UNICEF). Keywords "Measles" or "Sudan," "WHO," "MSF" and "UNICEF" in both title and abstract were used to identify the online recent published papers that reported about measles in Sudan in scientific databases.

2. MEASLES DISEASE

Measles is a life-threatening disease and poses a significant public health concern among Sudanese children. It caused by a Measles virus (MV). The virus spreads by droplets in the air. The illness begins with clinical symptoms including high fever, cough, coryza, and conjunctivitis, followed by eschar or ulcers, local or systemic lymphadenopathy, and a rash appears 3 to 5 days after the first symptoms [15,16]. Based on the WHO clinical profile of measles in Sudan, the incubation period of measles appears within 2-9 days of exposure to the virus [11]. During the recent decade, Southern Sudan had endured many measles outbreaks. The most notable outbreaks occurred in October 2003, and the spring of 2015, with a total of 1730 confirmed cases and 22 deaths [17]. In May 2017, approximately 664 suspected cases and three dead cases were reported [17].

3. SIGNS AND SYMPTOMS OF MEASLES

The first sign of measles is generally a high fever (40°C), which starts about 10 to 12 days after exposure to the measles virus and lasts 4 to 7 days. A runny nose, red and watery eyes, a cough, and small temporary white spots inside the cheeks (Koplik's spots) can develop in the early stage [16,18,19]. After some days, a rash appears, typically on the face and upper neck. For about three days, the rash spreads, eventually reaching the hands as well as the feet. The rash lasts for 5 to 6 days and then fades. On average, the rash occurs 14 days after exposure to the virus (within a range of 7 to 18 days). The majority of measles-related death cases are caused by severe complications, particularly among the children below the age of 5 years, or adults over the age of 30years [4]. Such

complications range from mild ones such as diarrhoea to serious ones such as pneumonia, laryngotracheobronchitis, otitis media, acute brain inflammation, and corneal ulceration (leading to corneal scarring and potential permanent blindness) [20,21,22]. In addition, measles suppresses the immune system, contributing to bacterial superinfections such as otitis media and bacterial pneumonia [23,24,25].

In Eastern Sudan and Khartoum, severe measles cases developed conjunctivitis, diarrhoea, convulsion, pneumonia, gastroenteritis, otitis media, encephalitis, or haemorrhagic rash and death, and these were confirmed in 10% of patients during the first month after measles outbreak [9,26,27].

4. MEASLES CLINICAL CASE DEFINITION AND DIAGNOSIS

In Sudan, measles cases were defined according to the World Health Organization (WHO) guidelines. Where WHO clearly defines measles cases to be suspected, Laboratory confirmed, epidemiologically linked (EPI-Linked), clinically compatible, and discarded cases [4,8].

Measles laboratory diagnosis involves isolation of measles virus from a clinical specimen, for example, nasopharynx or urine. Then virus detection is done using either reverse transcription (RT)-PCR analysis or IgM antibody detection. A significant rise in measles IgG can be detected by any standard serologic assay such as EIA or HA, where IgM EIA testing is the commonly used technic in health-centre settings [9,28,29,30]. Besides, qualitative measles IgG EIA tests are also available as "home-made" kits, with substantial efficiency due to their rapidity, sensitivity, and specificity, and ease of performance [31,32,33].

5. RISK GROUPS OF MEASLES

Measles mostly affects unvaccinated children complications mainly occur among infants and children aged less than five years, pregnant women, adults aged over 20 years, people with compromised immune systems, and those who are malnourished or have Vitamin A deficiency [34,35,36]. Complications are usually more severe in adults who catch the virus [37]. In developing countries with high rates of malnutrition and poor healthcare, fatality rates have been as high as 28% [38], while in immune-compromised persons (such as people with AIDS), the fatality rate is almost 30% [39].

In Sudan, unvaccinated children are at risk of measles, the evidence highlights in South Darfur where 78.7% of children with measles were unvaccinated, and were from low-income families, weak health infrastructures and overcrowded residential camps such as the situation in Darfur state [4]. Another study showed that the risk of measles-associated diarrhoea mortality is mainly reported during 4-26 weeks after measles rash onset, within which the affected individuals have a high risk of other infections [40].

6. MEASLES OUTBREAK, PREVENTION AND CONTROL STRATEGIES

Sudan is among the five countries in the WHO Eastern Mediterranean Region characterized by the mortality-reduction phase of measles control since 2010 [41]. Although all evidence shows that measles can be prevented by vaccination, many outbreaks were continuously reported despite the increased coverage of measles vaccination [11]. Sudan experiences constant measles outbreaks, with the most recent happening at the beginning of 2019, in which more than 750 children were victims [42,43].

The key to measles prevention is vaccination, and live measles virus vaccines are sufficiently safe and efficacious (90-95% efficiency after one dose and nearly 100% efficiency after two doses). Proper control of measles could also be achieved through periodic vitamin A prophylaxis and proper nutrition [9,44,45].

7. CHALLENGES FACED IN MEASLES PREVENTION AND CONTROL

In Sudan, measles mortality cases were highest in young infants, adults, and among those with low socioeconomic status. Key challenges included inadequate community-knowledge about the disease, limited infrastructure as well as political instability, and the ongoing conflict in areas of Blue Nile, Kordofan, and Darfur [12,46].

In addition, continuous movement of internally displaced people (IDPs) from within neighbouring communities [17,47], limited access to measles vaccine for prevention, low level of nutrition and poverty as well as lack of health care services at primary health centres [9], all collectively limit the prevention and control of measles in South Sudan [14].

Thus Swart et al., 2001 reported that despite the availability of safe and effective live attenuated

vaccines for measles control among Sudanese's population, measles continues to be endemic, and its control and elimination will be difficult because of mainly limited infrastructure and political instability [9].

In Sudan, measles is often not identified, and cases are commonly misdiagnosed and treated as "fever." Apart from this, the unimmunized population is an essential factor for viral outbreaks, but also, cold storage of the vaccine is not always possible in many health centres [48].

8. REPORTING AND SURVEILLANCE

In Sudan, the Communicable Disease Surveillance System (CDSS) in the capital of Sudan, Khartoum state, is part of the National Surveillance System (NSS) launched since 1994.

The system depends on passive surveillance for communicable diseases but also turns into active surveillance during epidemics or outbreaks [49]. Currently, the majority of measles cases are reported by WHO, UNICEF, Medecins Sans Frontieres (MSF), and other private health care centres in collaboration with the Sudan Ministry of Health (SMH). Efforts of measles surveillance were in partnership with UNICEF and WHO sub-office in each state of Sudan [14,50]. Mothers highly contributed to their children's vaccination status before immunizing children who come to health facilities for curative care. In cases of lost vaccination cards, health workers may ask mothers if their children were vaccinated against measles, and this is vital in the child measles surveillances report system [51,52].

9. EPIDEMIOLOGY OF MEASLES

Measles is the third leading cause of death among childhood diseases that can be prevented by immunization. The movement of infected individuals within and between geographical areas will determine measles virus epidemiology [2].

In South Sudan, the immunization programme, according to the WHO-standard, was started from the year 1983, following the details of mother-child care records [53].

The status of the long civil war between Southern Sudan and north Sudan resulted in the movement and displacement of many families due to tribal conflicts and civil war [54].

The measles epidemiology mortality is more prevalent among children under five years in rural communities of Sudan and was highly reported with seasonality trend in combination with other childhood diseases[55]. High mortality is also reported during refugee emergencies, and in Juba, timely measles vaccination and health education about dangers of measles have been reported vital in control of outbreaks [47,56].

10. MOLECULAR EPIDEMIOLOGY

Africa and Southeast Asia remain one of the main reservoirs of measles infection [57]. In countries that still have an endemic transmission, most cases are caused by relatively few endemic genotypes. In countries that have eliminated measles, the few cases are caused by several different genotypes that reflect on being imported from endemic measles sources [58]. Several measles genotypes have been documented in Africa. Clade B viruses are prevalent in the central and western parts of sub-Saharan Africa, while genotypes D2 and D4 have been the most often detected genotypes in the southern and eastern regions of Africa [59,60].

Besides, a recent analysis of a large number of measles isolates from endemic areas of Ghana, Gambia, Nigeria, Cameroon, and Sudan supports the division of clade B into three genotypes, B1, B2, and B3[2,61,62]. Genotype B3 has been categorized into two clusters. Genotype B3 cluster 1 viruses are found from Cameroon, Ghana, and Nigeria and from as far east as Sudan, indicating that clade B viruses are widely found in sub-Saharan Africa. However, the circulation of genotype B3 cluster 2 viruses appears to be more limited to western Africa, but the viruses co-circulate in Nigeria and Ghana [63,64].

11. WAYS FORWARD CONTROL AND PREVENTION OF MEASLES

In the past years, based on the WHO reports, child mortality is still a big challenge in developing countries of Africa, and death due to measles was reported at 15.8% [65]. The mortality rate is associated with several socio-economic factors, including the lack of proper health facilities and poor hygiene [65]. Affected areas require programs based on sound health and should focus on the provision of adequate health care services such as shelter, food, water, and sanitation. Public health programs that prevent mortality towards infectious diseases

such as measles, and other communicable diseases, especially among young children and women, are vital strategies [66]. Furthermore, due to the risen measles death, it was previously recommended that measles vaccination should commence at six months of age in the Juba area and that intensive health education about the dangers and management of measles be instituted [56].

There are continuous efforts that have been made by the Sudan ministry of health, WHO, and UNICEF to develop a national plan to control and reduce measles outbreak and death rate by focusing on strengthening routine measles vaccination campaigns [47]. The FMOH, WHO, and UNICEF partner organizations support measles implementation of the initial response and control measures by using the measles case management guidelines organized by FMOH and Sudanese Association of Pediatricians. Furthermore, FMOH, WHO, and UNICEF alert investigation increase surveillance of measles and carry out routine health education, case management and social mobilization in addition to the community health awareness [10].

There is a joint meeting to discuss the challenges related to response activities, measles case management, and the role of pediatricians in case detection, case management, health education, and social mobilization activities. The Sudanese Medical Association of Pediatricians plays a role in distributing the measles case management guidelines, measles leaflets, among the focal points of measles control units [4,10].

WHO plays a critical role in the monitoring of the functioning of immunization systems, which enables identification of programmatic areas that are performing well and areas that need strengthening. It also encourages sub-offices to collect measles surveillance data and supports FMOH with financial and technical assistance [7,9,14]. The overall efforts of these organizations focused on reaching the targeted populations during the routine measles surveillance and cover 95% of cases by using measles vaccines, establishing an effective reporting and surveillance system based on the WHO guidelines to monitor coverage surveillance with the integration of epidemiological and laboratory information; and improving clinical management of complicated cases including vitamin A supplementation [4,10].

12. CONCLUSION

Disease surveillance is critical, more efforts for identifying the measles cases and outbreaks are needed, and this requires proper laboratory-based surveillance to detect and control periodic outbreaks among Sudanese populations. More health policies are necessary to regulate the quality and cost-effectiveness of health services and to meet the demands of health needs towards measles prevention and control.

Additionally, the country is required to conduct more research to build comprehensive strategies for prevention and control of measles and raise the vaccination coverage among the Sudanese populations, emphasizing on the extensive health education program, change of cultural attitudes and behaviours towards measles. Further studies are needed to evaluate measles vaccine failure and the secondary immune response to the vaccine in the vaccinated group. Ongoing efforts to raise measles vaccine coverage in Sudan are required to prevent measles outbreaks and related deaths. Finally, more research is necessary to understand the epidemiology of measles in Sudan and may help identify subsets of the population which are more prone to measles, in order, to develop control and prevention method.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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