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Trend and forecast of measles disease, in East Gojjam Zone, Amhara Region, Northwest Ethiopia, 2023: a crossectional study

Habitamu Wudu[1,4*], Chekol Alemu[1,4], Werkneh Minalu[2,4], Haymanot Berelie[3,4] and Dagnachew Bantie[1,4]

Abstract

Background Measles is a very contagious illness that can be clinically diagnosed and intervened quickly. It is caused by the measles virus Morbillivirus. The disease has a case fatality rate of 5% to 10% in the sub-Saharan region. Recent information on measles forecasting is limited in this study area. Therefore, this study was aimed to assess the five-year trend and next five-year prediction of measles disease in East Gojjam zone, Amhara National Regional State (ANRS), Ethiopia, 2023.

Methods A descriptive study using case based surveillance data analysis in the East Gojjam zone was conducted. Five-year data (January 1/2018-December 30/2022) was extracted from the WHO database. ARIMA (3, 1, 1) model was used for disease forecasting for the next 5 years of the zone (2023–2027).

Results For the study, 1003 participants in total were enlisted. 12.3% of the subjects were IgM positive. About 59.4% and 1.2% were epidemiologically linked and died subjects, respectively. Many of the cases (54.2%) occurred in the March season and the lowest (1%) in December. For the next five years (2024–2027), it is predicted that the number of cases will rise gradually in fluctuation.

Conclusion The disease had an upward trend over the five-year period, and for the next consecutive years, there will be a consistent increase in the number of cases in the zone. It is recommended that the East Gojjam Zone Health Office and different stakeholders have to monitor and evaluate the vaccination status of target children and vaccination coverage and strengthen the surveillance system in the dry-hot season, which is valuable for disease control.

Keywords Measles trend, Seasonal variation, Measles, Measles epidemiology

*Correspondence:
Habitamu Wudu
habitamu.stat@gmail.com
[1] Department of Statistics, College of Natural and Computational Sciences, Gambella University, Gambella, Ethiopia
[2] Departments of Public Health, College of Medicine and Health Sciences, Tropical College, Debre Markos, Ethiopia
[3] Department of Statistics, College of Natural and Computational Sciences, Assosa University, Assosa, Ethiopia
[4] Departments of Public Health, College of Medicine and Health Sciences, Dejen Primary Hospital, East Gojjam Zone, Dejen Woreda, Bahir Dar, Ethiopia

Introduction

Measles is a highly communicable viral disease transmitted from person-to-person by droplets or aerosols from the respiratory fluids of the infected persons and has an incubation period of 7–21 days. It has clinical manifestations that include fever, generalized maculopapular erythematous rash, cough, coryza, and conjunctivitis.

[1]. Before the development of the measles vaccine, measles was a leading cause of death in the 1960s, accounting for approximately 135 million cases annually and 7–8 million deaths worldwide [2]. Immunization significantly reduced the death rate by 79%, dropping from about 650,000 in 2000 to 130,000 in 2015 worldwide [2].

Globally, it is prominent in under developing countries and it is a common problem and disease in children of less than 5 years old. In those populations who do not vaccinated, many of children acquire the disease at the age of 5 years and develop clinical manifestations [3]. It is known that the disease is highly seen in those people who had a travel history of abroad. In this population, unvaccinated children were highly prone to the disease and the most commonly reported age group was 10 to 14 years [4].

The disease has widespread in the world especially in Africa continent. It is indicated that the disease has a case fatality rate of 5% to 10% in sub-Saharan region but less than 1 in 1000 children are died in industrialized countries [5]. The disease was high in non-vaccinated population (63%) than in those vaccinated population. This is common in vaccination coverage of below the standard settings and non-vaccination status against measles was considered as one of the major risk factor in children [6].

In a current study on measles, prediction in Philippines indicated that there was rapid increase in 2020 but decreasing the number of cases from 2021 to 2024. In this study there were a rapid increase in the trend of the disease from 2016 to 2019 [7]. In the previous years WHO aimed at elimination of the disease at world level for the purpose of lower and minimize annual occurrence rate to under 5 cases per million by attaining more than 95% of measles containing vaccine-1 by the end of 2020 [8]. Even if lifesaving vaccines are available, vaccine preventable disease (VPD) are not eliminated and until now measles is a common in under five years' old children every year in Africa-accounts and accounts 56% of deaths [9].

Ethiopia is listed among the top countries with a high measles burden globally. Measles outbreaks continue to pose significant public health challenges, particularly in regions with low vaccination coverage. According to the World Health Organization (WHO), measles vaccination coverage in Ethiopia has consistently remained below the 95% threshold necessary to achieve herd immunity, contributing to frequent outbreaks and high case numbers [10]. It highlighted that measles vaccination coverage varies significantly across regions in Ethiopia, with rural zones like East Gojjam experiencing lower vaccination rates compared to urban centers due to logistical challenges, vaccine hesitancy, and lack of access to health services. This disparity makes East Gojjam particularly vulnerable to outbreaks. According to the World Health Organization (WHO), measles vaccination coverage in Ethiopia has consistently remained below the 95% threshold necessary to achieve herd immunity, contributing to frequent outbreaks and high case numbers [11]. It highlighted that measles vaccination coverage varies significantly across regions in Ethiopia, with rural zones like East Gojjam experiencing lower vaccination rates compared to urban centers due to logistical challenges, vaccine hesitancy, and lack of access to health services. This disparity makes East Gojjam particularly vulnerable to outbreaks.

Historical data indicates that East Gojjam Zone has experienced multiple measles outbreaks over the past decade, with substantial morbidity and mortality, especially among children under five. For instance, the Ethiopian Public Health Institute (EPHI) reported a sharp rise in measles cases during 2019–2021, emphasizing the need for targeted intervention strategies in high-risk areas like East Gojjam. East Gojjam is predominantly rural, with significant portions of the population living in hard-to-reach areas, which complicates vaccine delivery and outbreak response. Socioeconomic factors, such as poverty and low educational attainment, also contribute to low health service utilization [11]. These factors highlight the urgent need for a comprehensive study on measles trends and predictive modeling in East Gojjam Zone. By understanding past patterns and forecasting future cases, targeted interventions can be designed to mitigate the impact of measles, reduce outbreak frequency, and ultimately save lives in this vulnerable region. Therefore the objectives of this study were:

- To describe five-year measles trend in East Gojjam zone, Amhara National Regional State (ANRS), Ethiopia, 2024.
- To predict the number of cases for the next five years from 2023 to 2027 in East Gojjam zone, Amhara Regional state.

Methods

Study area and period

A descriptive surveillance data analysis was conducted in the East Gojjam zone of the Amhara National Regional State from January 1, 2018, to December 30, 2022. The zone is located in the northeastern direction. It has one comprehensive specialized hospital, one general hospital, and 11 primary hospitals. Additionally, it has a population of over 2.7 million people and consists of 18 woreda, as well as one metropolitan area (Debre Markos). The zone is bounded by the Blue Nile River and features diverse geographic landscapes, including kola (lowlands), dega (mountainous areas), and woina-dega (plateau).

Study population

Inclusion criteria

All suspected, laboratory-confirmed, epidemiologically linked, and deceased cases were recorded in the WHO database from January 1, 2018, to December 30, 2022.

Exclusion criteria
Suspected, laboratory confirmed and epidemiologically linked cases and died cases whose reports incomplete between January 1/2018 and December 30/2022.

Sample size and sampling procedure
The dataset included all case-based surveillance data reported to the WHO database from East Gojjam zone districts between January 1, 2018, and December 30, 2022. All immediately and weekly reported measles cases within this five-year period were extracted from the WHO database, totaling 1003 cases for analysis.

Operational definitions
Suspected measles case: Any person with generalized maculopapular rash and fever plus one of the following: a cough or coryza (a runny nose) or conjunctivitis (red eyes) or any person in whom a clinician suspects measles.

Confirmed measles case: A suspected measles case that had a positive laboratory confirmation result (IgM) for the disease.

Epidemiologically linked case: Suspected measles cases that had no laboratory confirmation for the disease but had a link by place, person, and time with a laboratory confirmed cases.

Measles death: A death of a person resulted from an illness in a confirmed or epidemiologically linked case of measles within one month of onset of rash**.**

Clinically compatible case: Suspected cases that met the clinical case definition of measles disease and neither a sample for laboratory testing nor an epidemiologic link to a laboratory confirmed case were available. A "clinically compatible case" refers to a case that meets the clinical criteria for a disease based on symptoms and physical findings, even if laboratory confirmation is not available or has not been performed. This term is often used in epidemiological studies and surveillance systems when cases are identified based on clinical presentation rather than laboratory evidence.

Dry weather: A period between February—May [12].

Cold weather: A period between June-October [13].

Dry-cool weather: A period between November-January [13]

Data quality management
To assure the quality of the data, one WHO surveillance officer, one supervisor, and two PHEM officers took the orientation about data sorting and extraction from Excel spreadsheet. Trained data collectors extract the data under a close daily supervision by the supervisor and principal investigator. The supervisor crosschecked the daily collected data to assure the completeness of the data.

Data processing and analysis
Five-year data was extracted and collected from WHO database. We examined, crosschecked, and cleaned the collected data, then exported from Microsoft Excel to SPSS version 25 software for analysis. ARIMA model was used for prediction of measles disease and model fitness was based on the lowest BIC among the candidate values of the output of the model. Finally, trend and five-year prediction of the disease was presented by graphs.

ARIMA model (Autoregressive Integrated Moving Average)
It is a widely used statistical model for analyzing and forecasting time series data. The model combines three key components:

- *Autoregressive (AR) Component*: This part of the model uses the dependency between an observation and a number of lagged (previous) observations. For an AR model of order p, the value of the time series at time t is a linear combination of the past p values and a noise term.

The general form of the AR model is:

$$yt = c + \phi 1yt - 1 + \phi 2yt - 2 + \ldots + \phi pyt - p + \in t \quad (1)$$

where:

- yt is the current value of the series.
- c is a constant.
- ϕi_are the coefficients of the lagged terms.
- ϵt is white noise with mean zero and constant variance.

Integrated (I) Component: The integration part of the model involves differencing the time series to make it stationary (i.e., its statistical properties such as mean and variance are constant over time). The order of differencing is denoted by d. For instance, if $d = 1$, the series is differenced once.. A differenced series is given by:

$$y'_t = y_t - \boldsymbol{y_{t-1}} \quad (2)$$

- *Moving Average (MA) Component*: The MA component models the dependency between an observation and a residual error from a moving average model applied to lagged observations. For an MA model of order q, the value of the time series depends on the past q error terms.

The general form of the MA model is:

$$yt = c + \epsilon t + \theta 1\epsilon t - 1 + \theta 2\epsilon t - 2 + \cdots + \theta q\epsilon t - q$$

where:

- ϵt are the error terms (white noise).
- _θj are the coefficients of the lagged error terms.

BIC (Bayesian Information Criterion)

It is a statistical metric used for model selection among a set of competing models. BIC helps in identifying the best-fitting model by balancing model complexity against how well the model fits the data. It is particularly useful in time series analysis, regression models, and machine learning, where over fitting needs to be minimized.

BIC is a criterion for evaluating models based on the likelihood of the observed data, adjusted by a penalty for the number of parameters in the model. It is defined mathematically as:

$$\mathrm{BIC} = -2 \cdot \ln(\mathrm{L}) + \mathrm{k} \cdot \ln(\mathrm{n}) \quad (3)$$

where:

- L = Maximum likelihood of the model (how well the model fits the data).
- k = Number of parameters in the model.
- n = Number of observations in the dataset.

PACF (Partial Autocorrelation Function)

It is a statistical tool used in time series analysis to measure the degree of association between a time series and its lagged values, after removing the effects of intervening lags. PACF is particularly useful in identifying the appropriate number of lags to include in an autoregressive (AR) model, such as when building an ARIMA model.

Results

Measles trend analysis

A total of 1,003 suspected, laboratory-confirmed, epidemiologically linked, and deceased subjects were recorded in the WHO database between 2018 and 2022. Among them, 12.3% were IgM positive, while 59.4% were epidemiologically linked, and 1.2% was deceased. Most of the cases (54.2%) occurred in March, with the lowest number of cases (1%) in December. It can be observed that, similar to the quarterly and yearly trends, the disease exhibited a fluctuating pattern month to month, with a peak in March and a low in December (Fig. 1).

Over the years 2018, 2019, 2020, 2021, and 2022, a total of 65, 114, 130, 194, and 500 subjects, respectively, were reported. The disease shows a positive percentage change, indicating an increase in the number of cases over the past five-year period. In 2022, the number of

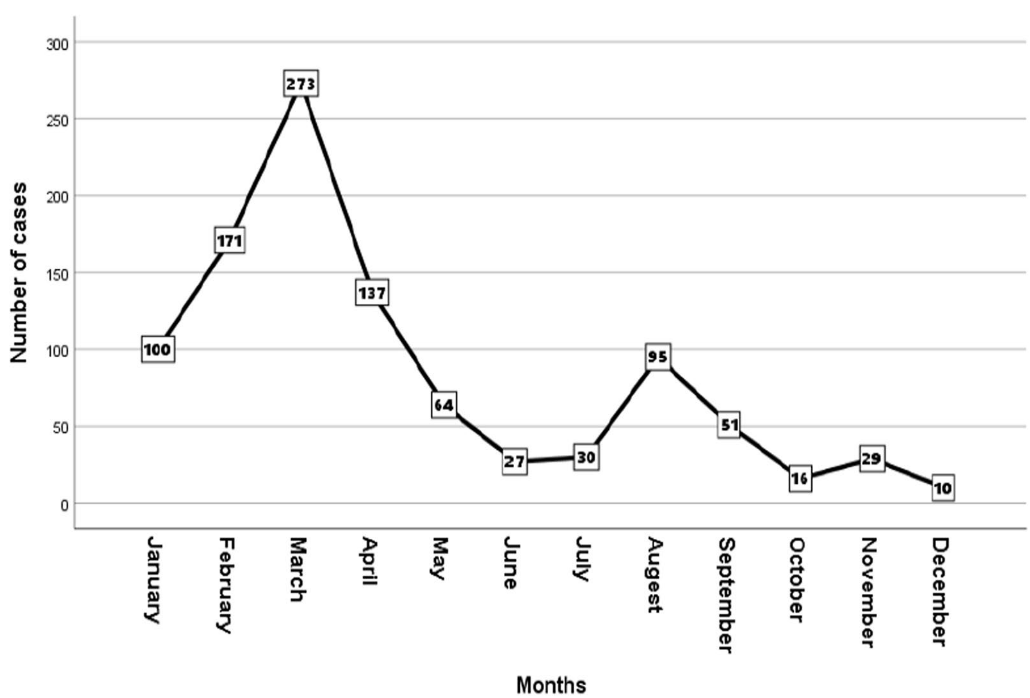

Fig. 1 tsrend of measles disease in months in East Gojjam zone, Amhara Region

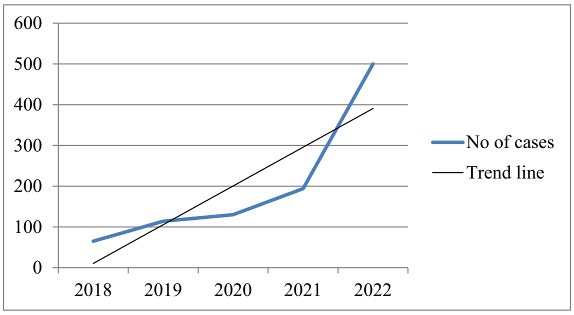

Fig. 2 Number of cases relative to trend line in East Gojjam zone

cases was above the trend line, showing a sharp increase in cases (Fig. 2). As observed in the figure, the percentage change fluctuates throughout the time period, indicating varying trends in case numbers. Positive values indicate an increase in cases compared to the previous period, while negative values represent a decrease. Notably, the graph reveals significant peaks and troughs, suggesting periods of rapid growth or decline in case numbers, which could be associated with external factors or interventions.

The symbol Δ% represents the percentage change or percentage difference in the number of cases over a specific time period. It is calculated using the formula:

$$\Delta\% \text{ of the case} = \frac{\text{Current number of cases} - \text{Earlier number of cases}}{\text{Earlier number of cases}} \times 100$$

$$= \frac{< spanclass =' convertEndash' > 500 - 65 < /span >}{65} \times 100 = 669\%$$

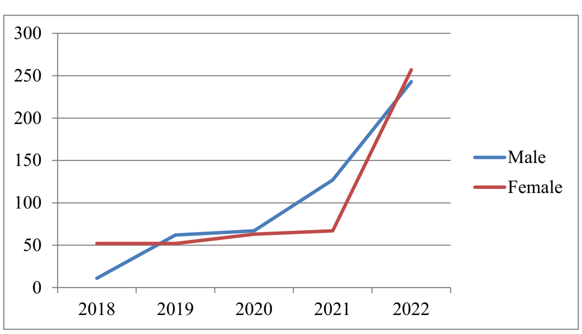

Fig. 3 Measles trend in respect to sex of patients in East Gojjam zone, Amhara Region

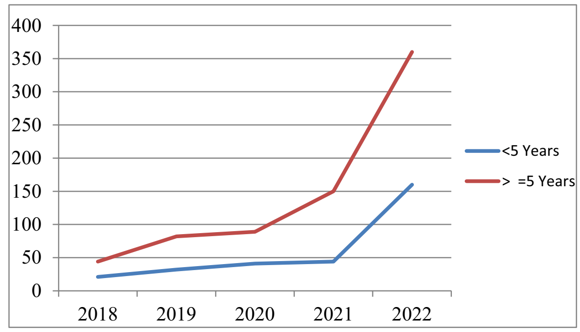

Fig. 4 Five-year trend of measles disease in relation to age in East Gojjam

Out of the total recorded population, 12 deaths were reported, with the number of deaths increasing over the years: 0 in 2018, 0 in 2019, 1 in 2020, 3 in 2021, and 8 in 2022. Of these deaths, 7 occurred in children under five years old, while 5 were in individuals over five years old. Additionally, among the 12 deaths, 5 were males and the remaining 7 were females. However, the majority of cases (70.5%) were in individuals over five years old, while 27.9% were in the under-five population. The disease was slightly more prevalent in males (51%) compared to females (49.3%) (Fig. 3).

Regarding the trend of measles with respect to age, there was a sharp increase in cases for both the under-five and five and above year's age groups. However, the trend of the disease was more pronounced in the above-five age group compared to the under-five age group (Fig. 4).

Based on the trend of measles across different weather conditions, the disease increased significantly (64.3%) during hot weather, while it decreased to 21.8% during

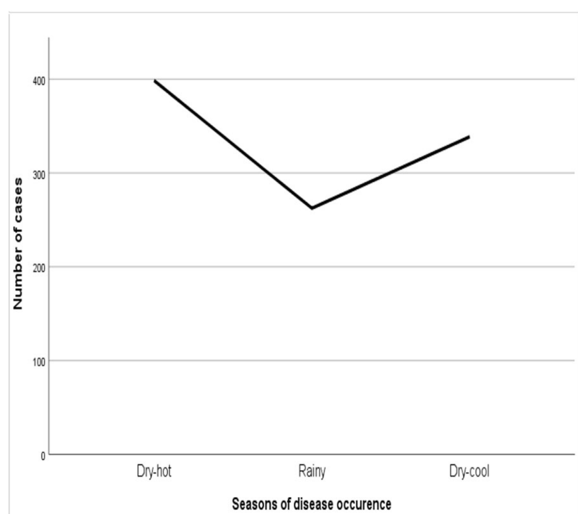

Fig. 5 Five-year trend of measles disease in different weather classes in East Gojjam zone, Amhara Region

rainy weather in the zone. Dry-cool weather contributed only 13.9% to the occurrence of the disease (Fig. 5).

The data was organized into four quarters from 2018 to 2022, with each quarter representing three months: 1st quarter (January-March), 2nd quarter (April-June), 3rd quarter (July–September), and 4th quarter (October-December). To analyze the time series, we performed data decomposition to separate the trend, seasonal, and irregular components, and calculated a 3-quarter moving average to smooth the data. This approach allowed us to clearly identify the trend, represented by Tt, and the number of cases in each quarter, represented by Yt. The trend analysis revealed a rising pattern, peaking in the 1st quarter of 2022 (January-March), indicating a significant increase in cases during this period, followed by a noticeable decline in the 4th quarter of 2022 (October-December) (Fig. 6).

Autoregressive Integrated Moving Average (ARIMA) model analysis

ARIMA stands for Autoregressive Integrated Moving Average and is a model used for forecasting time-series data based on past values. The model employs autocorrelation analysis and partial autocorrelation analysis procedures to analyze the moving average (q parameter) and autoregressive (p parameter), respectively. Differencing (d parameter) of the raw time-series data is used to make it stationary. The "AR" component of the model indicates the dependent relationship between the actual observed values and their lagged observations. "I" refers to the number of differences needed to make the time series stationary (i.e., having constant mean and variance). The MA component captures the dependency between the observed values and the residual errors applied to lagged observations. The autocorrelation function (ACF) and partial autocorrelation function (PACF) graphs are important for checking autocorrelation in the correlogram. The best-fit model is preferable for accurate prediction. Among the models tested in the correlogram, three models were candidates. According to the goodness-of-fit and normalized Bayesian Information Criterion (BIC) criteria, the ARIMA model with the smallest BIC should be selected for forecasting. Based on this, the ARIMA (3, 1, 1) model was chosen for forecasting (Table 1).

Table 1 Comparison of ARIMA models by using their model fit parameter

ARIMA (p, d, q) model	Stationary R^2	RMSE	MAPE	Normalized BIC
(3,1,1)	0.726	56.553	211.467	**8.845**
(3,1,3)	0.761	57.071	242.255	9.173
(3,1,4)	0.784	56.677	158.674	9.314

Bold indicates the comparison of ARIMA (p, d, q) models, the model with the minimum value of the Normalized BIC is considered the best. The minimum value of the Normalized BIC is 8.845, indicating that the ARIMA (3, 1, 1) model is the best among the others. This suggests that this model best fits the data

RMSE Root Mean Square Error, *MAPE* Mean Absolute Percentage Error

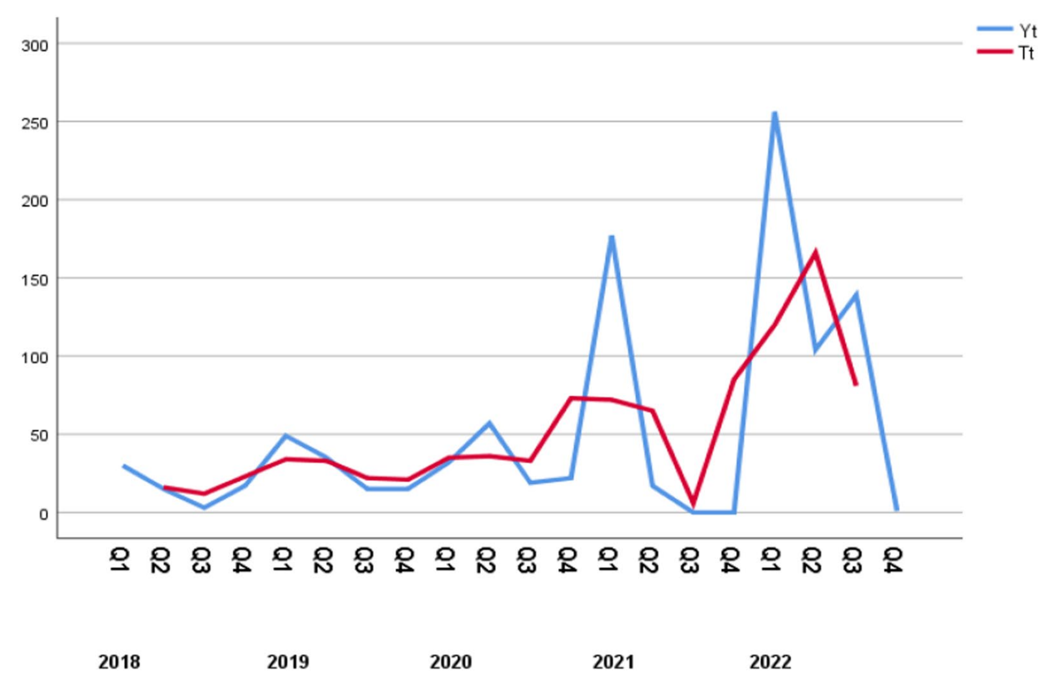

Fig. 6 Five-year measles trend in quarters and years in East Gojjam zone, Amhara Region

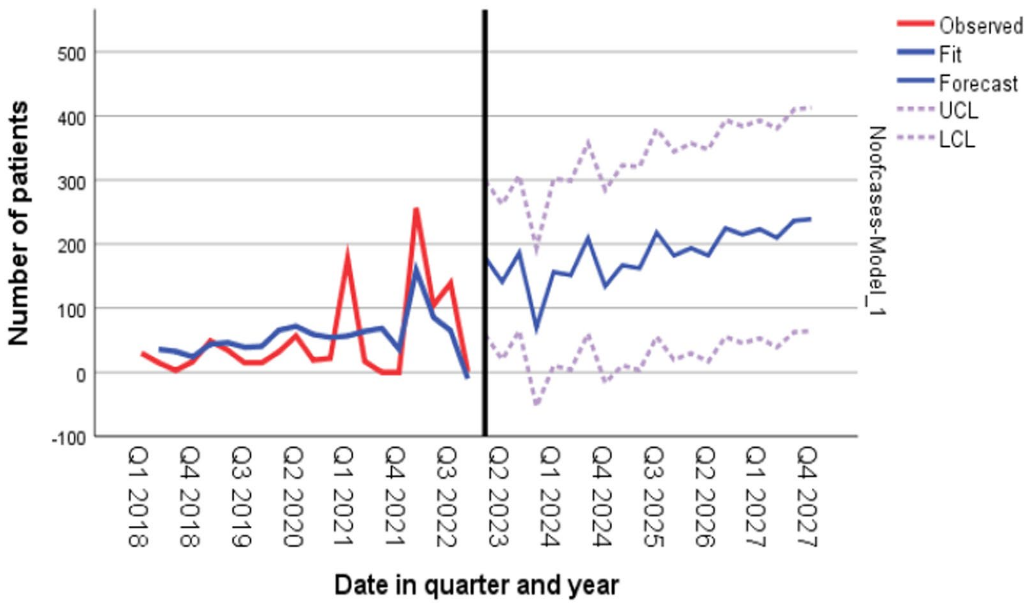

Fig. 7 Prediction of measles cases for the next five years (2023–2027) in East Gojjam zone Amhara Region

Measles disease trend forecasting

Over the next five years (2023–2027), the predicted number of measles cases in the East Gojjam zone is expected to be 576 in 2023, 650 in 2024, 729 in 2025, 815 in 2026, and 908 in 2027 (Fig. 7).

It can be observed that the disease is expected to exhibit a fluctuating upward trend over the sequence of years and quarters in the general population of the zone over the next 5 years. The disease appears to show a consistent increase in cases starting from the fourth quarter of 2024 to the fourth quarter of 2027. However, there will be a decrease in cases during the first quarter of 2024. This prevalence of cases will elevate the health impact and case fatality rate in the zone, serving as an alarm for concerned authorities to prepare and adjust their resources accordingly.

Discussion

The aim of the study was to analyze the trend of measles cases over the past five years (2018–2022) and forecast the number of cases for the next five years (2023–2027). A total of 1,003 subjects were included in the analysis. Among these cases, 1.23% was laboratory-confirmed, while 59.4% were epidemiologically linked.

Measles had difference in the trend of the occurrence between under and above five age groups. It was indicated that the disease was highly observed in more than above five age groups than the lower one. This may be most above 5 years were missed second dose of measles containing vaccine since it was started recently (5 around years back). This result is consistent with earlier research conducted in Rajasthan, northwestern India in 2024, reported 90% of occurrences in the under-10 age range [14]. According to a study conducted in India, 41% of instances involved people ages 1–4 and 37% involved people ages 5–9 [15]. Two peaks were seen in Madhya Pradesh reports: one in the 2–3 year age group and another in the 5–9 year age group [16].

The disease was recorded more frequently in males (51%) than in females (49.3%), indicating that men were more affected than women in the current study. This finding aligns with studies from Shivpuri, Madhya Pradesh, India [17], Kerala, India, and Northeast India [18, 19]. This gender difference could be attributed to variations in gender ratios within the regions where the samples were collected or differences in parental attitudes or concerns towards their female children. However, this finding contradicts another study that showed a higher prevalence of the disease in the under-five age group (76.3%) compared to those above 5 years of age (27.7%). This difference could be due to factors such as incomplete vaccination coverage or low herd immunity (10).

It was indicated that more than half of the cases (54.2%) were occurred in March season and the lowest (1%) in December and the disease decreases from March to December. It was indicated that the case was highly observed in the above five years (70.5%) than under five (27.9%) populations. This finding has agreement in a five-year study in Nigeria that most of the cases were occurred in March, and in a similar vein, a study conducted in Kerala revealed that the months of January through April had an increase in incidents [18]. This may suggest dry month is a suitable for the disease propagation, and certain weather patterns, such as dry-hot conditions, contribute to measles outbreaks by affecting virus transmission and human behavior. In hot, dry weather, people tend to gather indoors in air-conditioned spaces, increasing close contact and spreading the virus. Dry air also weakens the respiratory system's defenses, making infection easier. In cold weather, similar indoor crowding occurs, and dry heated air can reduce the body's ability to fight off infections. Additionally, weakened immune systems in colder months and disrupted vaccination access during extreme weather can further increase the risk of outbreaks [20].

However, there had a fluctuating decreased trend of the case in months**.** Measles disease had seasonal variation that high numbers of cases (64.4%) were in dry-hot weather (February-May) conditions**.** The finding was agreed with other former finding that many cases were happened in the same weather, but had differences in that increment in March in this finding and in May in previous one [13].

However, there is no biological evidence that the resurgence of measles was tend to increase in dry-hot weather, that the virulence of the disease is low in dry-hot season because of the virus is temperature sensitive by nature and can survive between 15 °C and 20 °C.

The trend line representing the number of cases showed that, after 2021, the number of cases exceeded the straight trend line and the disease's percentage changed by 669%, indicating a positive increase in the number of instances. For the following 5 years, it was anticipated that the zone would see an increase in the number of measles cases every quarter and year.

From the output of Autoregressive Integrated Moving Average (ARIMA) model 3, 1, 1, in 2024,2024,2025,2026 and 2027, there will be 576, 650, 729, 815, and 908 numbers of cases respectively in the zone. It would reduce in quarter one 2024 and increase in quarter four 2024**.** The finding is in line with a current forecast result in Philippines between 2020 and 2024 that the numbers of cases were increased in a consistent situation. This may be missing of measles doses and low vaccination coverage [7].

But has discrepancy in forecasting the number of cases in America in 2019 that the number of cases will occurred as an outbreak were 400, this suggest that there is a good MCV1 and MCV2 vaccination habit and vaccination coverage in America and vaccination problem in the former study setting [13]. Comparing vaccination coverage between East Gojjam Zone and similar regions helps illustrate how immunization gaps contribute to measles outbreaks. In East Gojjam Zone, vaccination rates are often below the national target, especially in rural areas, leading to vulnerable populations. Periodic measles outbreaks are more likely during dry seasons, when people gather indoors. The financial impact of rising measles cases is substantial, with increased healthcare costs, loss of productivity, and potential long-term developmental impairments among affected children. This economic strain affects both families and the broader national economy.

Limitation

Despite the valuable insights gained from the analysis of measles trends in Ethiopia, several limitations must be acknowledged, particularly concerning data collection and analysis (i.e. Data Quality Issues from WHO Database).

Incomplete or inconsistent reporting

The data used in this analysis primarily relies on reports from the WHO database, which may suffer from incomplete or inconsistent reporting from health facilities, especially in remote or conflict-affected areas. Underreporting of measles cases is common due to limited access to healthcare, lack of awareness, and logistical challenges.

Delayed data submission

Delays in data submission can result in outdated information, affecting the timeliness of the analysis. This lag can obscure real-time trends, making it difficult to respond swiftly to emerging outbreaks.

Conclusion

Measles exhibited a fluctuating upward trend over the five-year period, peaking in 2022. Most cases were reported in March, while the fewest were recorded in December, particularly during the dry-hot season. Males were more affected by the disease than females. While the overall trend increased from 2018 to 2022, there was a decrease in cases from March to December. The disease was more commonly observed in the population aged five and older compared to those under five.

For the next five years, it is expected that there will be 576 cases in 2023, 650 in 2024, 729 in 2025, 815 in 2026, and 908 in 2027 in the zone. It is recommended that the East Gojjam Zone health office and various stakeholders monitor and evaluate the vaccination status of target children, improve vaccination coverage, and strengthen the surveillance system, particularly during the dry-hot season, as this is crucial for effective disease control.

Abbreviations

ACF Autocorrelation function
ARIMA Autoregressive Integrated Moving Average
ARNS Amhara Regional National State
BIC Bayesian Information Criterion

CI Confidence Interval
EPI Expanded program on immunization
GoE Government of Ethiopia
HEWs Health Extension Workers
IgM Immunoglobulin
IRERC Institutional Research Ethical Review Committee
MCV1 Measles Containing Vaccine1
MCV2 Measles Containing Vaccine2
PACF Partial autocorrelation function
PHEM Public Health Emergency Management
RFNN Recurrent fuzzy neural network
SPSS Statistical Package for Social Sciences
WHO World Health Organization
VPD Vaccine preventable disease

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Author contributions
Habitamu Wudu, Werkneh Minalu and Dagnachew Bantie conceived and put together this study, as well as for the formulation of the central research questions, identification of the problems and selection of the most appropriate statistical models, and for the gathering, analyzing, interpreting, and critical evaluation of the data and the publication. Chekol Alemu and Haymanot Berelie gave assistance in writing the manuscript and the study's overall advancement. Each author reviewed and gave their approval to the finished work.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The Debre Markos University College of Medicine and Health Sciences Ethical Review Committee granted ethical approval (reference number: GURPGC/301/2014). The ethical clearance obtained from Ethical Review Committee of Debre Markos University College of medicine and health sciences indicated that informed consent was not required for the use of such secondary data for as long as personal identifiers were omitted from the data. All methods were carried out in accordance with the Declaration of Helsinki and other relevant ethical guidelines and regulations. The Institutional Review Board (IRB) of Debre Makos University granted ethical approval, with reference number: GURPGC/20/7/2015).Written permission letter for extracting data from the patients' chart was also obtained from the East Gojjam Health Bureau. Privacy and confidentiality of information were kept properly and names of patients, as well as other personal identifiers, were not recorded.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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