



Evaluation of economic costs of a measles outbreak and outbreak response activities in Keffa Zone, Ethiopia[☆]



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ABSTRACT

Objective: To estimate the economic impact of a measles outbreak and response activities that occurred in Keffa Zone, Ethiopia with 5257 reported cases during October 1, 2011–April 8, 2012, using the health sector and household perspectives.

Methods: We collected cost input data through interviews and record reviews with government and partner agency staff and through a survey of 100 measles cases-patients and their caretakers. We used cost input data to estimate the financial and opportunity costs of the following outbreak and response activities: investigation, treatment, case management, active surveillance, immunization campaigns, and immunization system strengthening.

Findings: The economic cost of the outbreak and response was 758,869 United States dollars (US\$), including the opportunity cost of US\$327,545 (US\$62.31/case) and financial cost of US\$431,324 (US\$82.05/case). Health sector costs, including the immunization campaign (US\$72.29/case), accounted for 80% of the economic cost. Household economic cost was US\$29.18/case, equal to 6% of the household median annual income. 92% of financial costs were covered by partner agencies.

Conclusion: The economic cost of the measles outbreak was substantial when compared to household income and health sector expenditures. Improvement in two-dose measles vaccination coverage above 95% would both reduce measles incidence and save considerable outbreak-associated costs to both the health sector and households.

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1. Introduction

Measles is a highly contagious disease, which caused an estimated 2.6 million deaths worldwide in 1980, prior to the start of routine measles immunization programs in many countries [1]. By 2001, estimated measles deaths had decreased to 158,000 through widespread vaccination [2,3]. In 2012, the Global Vaccine Action Plan [2] set a goal to eliminate measles in five of six World Health Organization (WHO) regions by 2020. To reach the goal, the Global

Measles and Rubella Strategic Plan 2011–2020 recommends key strategies for countries [4], including developing and maintaining measles outbreak preparedness and rapidly responding to outbreaks. Rapid outbreak response is necessary to reduce mortality, morbidity, and the economic impact of measles.

Economic impact studies of measles outbreaks in high-income countries illustrate a high cost of measles outbreaks and response activities [5–11]. However, little information is available on the economic impact of measles outbreaks in low and middle-income countries (LMICs), and in 2011, it was identified as a global research priority [12]. Measles outbreak cost estimates from LMICs could provide a better understanding of the economic benefits of increasing routine measles vaccination coverage and implementing other recommended elimination strategies. A measles outbreak in Ethiopia provided an opportunity to estimate this economic impact.

[☆] *Disclaimer:* The findings and conclusions in this report are those of the authors and do not necessarily represent the official positions of the World Health Organization (WHO) or the U.S. Centers for Disease Control and Prevention (CDC).

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In coordination with other WHO African region countries, Ethiopia has set a goal of measles elimination by 2020 [4]. The elimination strategy includes a first dose of measles vaccine at age 9 months through routine immunization services and a second dose given through measles campaigns conducted every few years. Ethiopia's national routine measles first-dose vaccination coverage doubled from 33% in 2000 to 66% in 2012 [13,14]. However, two-dose coverage of $\geq 95\%$ is needed for measles elimination [4]. Outbreaks are common; during 2005–2009, 377 measles outbreaks were reported in Ethiopia [15,16].

In 2011/October, Ethiopian health officials were alerted to a suspected measles outbreak in Keffa Zone, located in Southern Nations, Nationalities and Peoples' Region (SNNPR). After laboratory testing confirmed measles as the cause of the outbreak, response activities started immediately throughout Keffa zone and the outbreak ended on 2012/April/8 with a reported total of 7 measles-associated deaths and 5257 measles cases, of which 2590 (46%) were among children aged 0–5 years, 2645 (47%) were among children aged 5–14 years, and 445 (8%) were among children aged ≥ 15 years [17]. We estimated the economic cost of this outbreak and response activities incurred by the health sector and households of persons infected with measles.

2. Methods

2.1. Definitions and costs

We defined economic cost as the sum of financial costs and opportunity costs (i.e., the value of the best alternative forgone by the health sector or households due to measles illness and/or treatment) (Table 1). We determined costs for health sector, household, and societal perspectives; societal cost was defined as the sum of health sector costs and household costs. We defined a household as a person with measles and his or her caretaker, and defined household costs as both financial and opportunity costs incurred by the household regarding measles illness, treatment such as travel-related costs and lost workdays. We defined the health sector broadly as government departments and partner agencies that supported the measles outbreak response activities at all administrative levels. Health sector costs for outbreak response included the following components: outbreak investigation, health-facility based treatment of persons with measles, community-based case management, active surveillance for measles cases, immunization campaign, and partner visits to health facilities to strengthen routine immunization services as part of partner outbreak response activities which were beyond the standard routine immunization activity. The statistical value of life related to measles-associated deaths was excluded in all costing perspective estimates because of methodological challenges associated with the current procedures [18,19]. All costs were converted to US dollars using the 2011 annualized exchange rate of 16.90 Ethiopian Birr to 1 US dollar [14].

2.2. Ethiopia and Keffa zone health structure

Ethiopia's health services are managed nationally by the Federal Ministry of Health (FMOH). FMOH collaborates with each region's regional health bureau (RHB). Zonal health departments (ZHDs) oversee woreda health offices which, in turn, manage health services. In each woreda, health services are provided by health extension workers at health posts and by health workers at health centers and hospitals. Keffa Zone in 2011 had an estimated population of 1 million people, 10 woredas, 1 city administration, 39 health centers, 288 health posts, 537 health workers, and 576 health extension workers.

2.3. Health sector costs data collection

In May 2012, we identified all organizations involved in the outbreak response, specifically, the WHO, United Nations Children's Fund (UNICEF), national, regional, zonal, woreda, health center and health post government health sector staff. Semi-structured interviews of staff and data abstraction of financial and operational records were conducted at the national level, SNNPR RHB, Keffa ZHD, and 6 of 10 woreda health offices, which accounted for 99% of reported measles cases during the outbreak. In each selected woreda, we included all health centers for data collection.

2.4. Household cost data collection

We developed a household questionnaire that was used by five teams of two enumerators, who were local health professionals with experience conducting household surveys. Household interviews were conducted in May 2012 in the four woredas with the highest number of reported outbreak cases; these woredas accounted for 85% of all reported cases and were also part of the six woredas selected for health sector interviews.

Using the ZHD measles surveillance database, each enumeration team identified the 30 most recent outbreak cases from a specified woreda and conducted household interviews of measles patients and their caretakers until 20 households were enrolled the woredas; one woreda had two teams so 40 households were interviewed in this woreda, including interviews with at least four persons with measles ≥ 15 years of age, which we defined as working age in Ethiopia. For patients < 15 years of age, interviews were held jointly with caretakers.

2.5. Data analysis

We calculated cost inputs using collected data. When cost input data were available from multiple data sources, we calculated a median value and interquartile range. We used cost inputs to estimate the opportunity and financial costs of each outbreak component from health sector and household perspectives (Fig. 1). To calculate opportunity costs, we used daily wage rates for health workers or households and number of lost workdays. To determine costs per case, we divided costs by the number of reported outbreak cases.

We compared outbreak costs to 2012 Ethiopian public health expenditures by dividing financial outbreak costs by the number of targeted routine immunization beneficiaries in Keffa zone to provide a comparison to Keffa Zone routine immunization costs per beneficiary. We divided financial outbreak costs by the Keffa Zone health program expenditures to obtain a ratio between outbreak costs and other expenditures. We analyzed the proportion of financial and opportunity costs covered by the government and non-governmental/multi-national partners (e.g. WHO, UNICEF) as part of the health sector perspective.

One-way sensitivity analyses of cost were performed (i) varying the measles case and caretaker monthly income levels by the calculated interquartile range values, (ii) varying the length of illness by the calculated interquartile range values, and (iii) varying the reported number of outbreak cases by $\pm 10\%$. The latter variation in number of reported cases was included because of the common and substantial underreporting of the true number of measles cases [20–22].

2.6. Approvals

Interviewers informed each interviewee of the assessment objectives and explained that information would be kept confidential; participants would not be identified by name when data were

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