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Measles outbreak in Tanzania, 2006–2007

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ABSTRACT

We conducted a measles outbreak investigation in Dar es Salaam, Tanzania. Surveillance data were analyzed; a susceptibility profile developed, and case–control study conducted. The age distribution of cases peaked among those <2, 5–7, and ≥18 years, corresponding to the age distribution of susceptibles. Risk factors included being unvaccinated (aOR = 5.7, $p < 0.01$) or having received one dose of vaccine compared to two (aOR = 2.4, $p = 0.01$), being younger, and having a less-educated caretaker. Vaccine effectiveness was 88% (one dose) and 96% (two doses). Results highlight the importance of receiving one dose of measles vaccine, and the added benefit of two doses.

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1. Introduction

In 2001, the World Health Assembly set a global goal to reduce measles mortality 50% by 2005, compared to 1999 [1,2]. Through accelerated disease control strategies, including increased routine immunization efforts and mass vaccination campaigns, this goal was achieved [2] and a new goal was established to achieve 90% reduction by 2010 compared to 2000 [3–5]. The World Health Organization (WHO) African Regional Office (AFRO) adopted this as a regional goal, and WHO estimates that from 2000 to 2008 measles deaths declined 92% in the region, from approximately 395,000 in 2000 to 28,000 in 2008 [6].

The WHO/United Nations Children's Fund (UNICEF) strategic plan for measles mortality reduction in the African region recommends administering one dose of measles vaccine to all children through routine services, with a second opportunity for measles vaccine to be given through supplemental immunization activities (SIAs) [7]. The latter part of this strategy generally consists of a one-time wide-age-range "catch-up" SIA which aims to sharply reduce susceptibility to measles in the population. This is followed by periodic "follow-up" SIAs targeting children born since the last SIA, and thus reducing the accumulation of susceptible children in new birth cohorts. SIAs provide an initial dose of measles vaccine for children who do not access routine services, as well as a second dose for those previously vaccinated. Implementation of this vaccination strategy has brought annual case counts to the lowest levels ever reported in many countries in Africa [8,9].

In Tanzania, prior to the introduction of measles vaccine in 1975, more than 60,000 clinically diagnosed cases of measles were reported each year [10]. After strengthening routine vaccination services throughout the 1980s, reported cases declined 75% to approximately 15,000 in 1990 (Fig. 1). During the 1990s, the proportion of children receiving measles vaccine through routine services at 9 months of age reached a plateau of approximately 79% [11], and annual measles cases fluctuated between 3100 and 16,000. In 1999–2000, Tanzania conducted measles SIAs targeting children aged 9–59 months in high-risk districts. In 2001 the Ministry of Health (MOH) adopted the WHO/UNICEF strategic plan for measles mortality reduction and conducted an initial wide-age-range catch-up SIA in phases from 2001 to 2002. This phased approach excluded age groups covered in previous SIAs, however, also missed one and a half birth cohorts (children aged 6–7.5 years in July 2006). In July 2005, a nationwide follow-up SIA targeted all children aged 9–59 months and achieved 93% coverage according to administrative data.

These activities, along with an increase in estimated coverage with the first dose of measles vaccine through routine services

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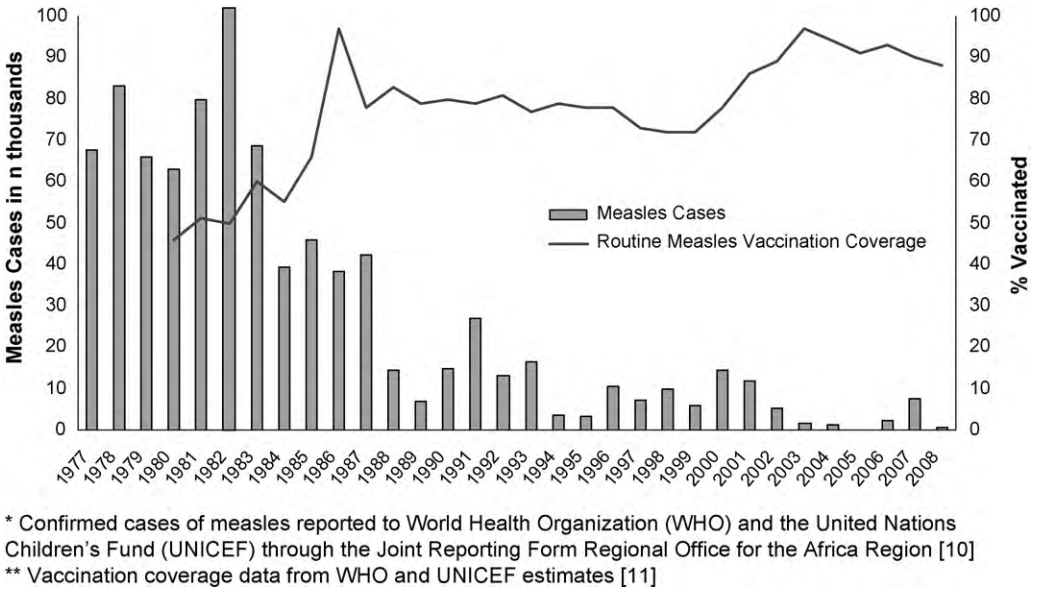

Fig. 1. Number of measles cases (*) reported and estimated percentage of children who received measles vaccine through routine services (**), Tanzania, 1977–2008. *Confirmed cases of measles reported to World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) through the Joint Reporting Form Regional Office for the Africa Region [10]. **Vaccination coverage data from WHO and UNICEF estimates [11].

from 78% in 2000 to 93% in 2006, led to a 56% reduction in annual measles incidence, from 14.1 per 100,000 during 2001–2004 to 6.2 per 100,000 during 2005–2008 [9].

Despite these improvements, Tanzania experienced a measles outbreak starting in July 2006, with a large number of cases in Dar es Salaam, Tanzania's largest city and commercial capital. In response to the outbreak, the MOH conducted an immunization campaign in Dar es Salaam targeting children 6 months to 14 years of age [12].

In an effort to identify the cause of the outbreak, we conducted an investigation which included three main activities: (1) a description of the outbreak, (2) development of a susceptibility profile based on historical coverage of vaccination through routine services and previous SIAs, and (3) a case–control study to determine the role of vaccination status and socio-demographic risk factors and to estimate vaccine effectiveness.

2. Methods

2.1. Description of the outbreak

A suspected measles case was defined as any person with a generalized maculo-papular rash and fever, and at least one of the following: cough, coryza (runny nose), or conjunctivitis. Surveillance officers used individual case investigation forms to collect data on suspected cases (age, sex, address, number of measles vaccine doses received, and date of last measles vaccination). Serum samples were collected within 30 days of rash onset for laboratory testing; confirmation was made by detection of measles immunoglobulin M (IgM) antibody at the National Measles Laboratory at Muhimbili University College of Health Sciences using a standard commercial indirect enzyme-linked immunosorbant assay (Enzygnost for IgM, Dade Behring, Marburg, Germany) kit [13]. Laboratory confirmation of cases was discontinued after the outbreak had been confirmed as measles as per WHO-AFRO measles surveillance guidelines [14]. For those not laboratory tested, an epidemiological link was established if they met the suspected measles case definition and either had contact with a laboratory-confirmed case that had rash onset within the preceding 30 days or lived in the same or adjacent district of a laboratory-confirmed case with plausibility of measles virus transmission. Case investigation form data, along with laboratory results, were entered into the national measles case-based surveillance system.

To determine which measles genotypes exist in Tanzania and to identify the likely origin of the virus circulating during the outbreak, oral fluid specimens were collected from 5 laboratory-confirmed cases that had acute, febrile, maculo-papular rash and were admitted to the Buguruni Hospital in Dar es Salaam between October 20 and November 6, 2006. Samples were shipped on dry ice to the regional measles reference lab at the Uganda Virus Research Institute and the Global Specialized Laboratory at the US Centers for Disease Control and Prevention.

2.2. Susceptibility profile

A basic mathematical model was used to estimate the number of susceptible individuals for each birth cohort in Dar es Salaam during the 30 years prior to the start of the outbreak. Inputs for the model included 2002 census figures with estimated population growth rates, WHO/UNICEF estimates for national measles vaccination coverage through routine services, and district-level coverage estimates for measles vaccination during SIAs (calculated by dividing the number of doses administered to children in the target age groups by the census-projected number of children in that age group). A susceptibility profile was developed assuming (1) vaccine effectiveness for measles vaccination was 85% through routine services and 90% through SIAs, (2) the likelihood of vaccination at each opportunity was independent, (3) infants <6 months of age were protected by maternal antibodies, (4) unvaccinated children 6 months to 14 years of age were susceptible, (5) half of unimmunized individuals 15–29 years of age were protected by natural immunity, and (6) adults ≥30 years were no longer susceptible.

2.3. Case–control study

Case–control fieldwork was performed in November 2006 by MOH district surveillance officers and medical students from the Muhimbili University College of Health Sciences in Dar es Salaam. Lab-confirmed cases 0–18 years of age in Dar es Salaam with rash onset during July–September 2006 were traced using addresses and phone numbers from case investigation forms, health facility regis-