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Changing trends in measles vaccination status between 2004 and 2014 among children aged 12–23 months in Bangladesh

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Published in:
Tropical Medicine and International Health

DOI:
10.1111/tmi.13366

Published: 01/04/2020

Document Version
Peer reviewed version

Link to publication

Citation for published version (APA):
Jahan, Y., Moriyama, M., Rahman, M. M., Shahid, A. S. M. S. B., Rahman, A., Hossain, N., Das, S. K., Hossain, M. I., Golam Faruque, A. S., & Chisti, M. J. (2020). Changing trends in measles vaccination status between 2004 and 2014 among children aged 12–23 months in Bangladesh. *Tropical Medicine and International Health*, *25*(4), 475-482. https://doi.org/10.1111/tmi.13366

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Abstract

OBJECTIVE The present study aimed to understand the current measles vaccination status in Bangladesh, explain the changing differentials in measles vaccination, and determine contexts that may improve further the present measles vaccination coverage.

METHODS A secondary data analysis utilizing datasets (2004 to 2014) from the nationally representative Bangladesh Demographic and Health Surveys that followed stratified, multi-stage cluster sampling design conducted both in urban and rural contexts.

RESULTS Total 5,468 children aged 12–23 months were surveyed, of them 892 children (16%) reported non-compliance to measles vaccine. After simultaneous adjusting for covariates in multivariate logistic regression; children from poor socio-economic background, having mothers with no formal schooling, underweight, being higher birth order (≥4), having adolescent mothers, giving history of home delivery, and having no exposure to media were observed to be significantly associated with lack of measles vaccination. Measles vaccination coverage among children of adolescent mothers was consistently low, however, despite lack of media exposure, a gradual increase of measles vaccination status from 26% in 2004 to 33% in 2014 was revealed. Lack of maternal education was no longer associated with measles vaccination status in 2007, 2011, and 2014. Stunted children continued to be associated with lack of measles immunization in 2014. Children with higher birth order demonstrated 53% excess risk for not being immunized with measles vaccine. Mothers with absence of exposure to mass media were two times more likely to have children without measles immunization as indicated by BDHS 2014 data.

CONCLUSIONS These findings will help policy makers formulating strategies for expanding measles vaccination coverage in order to achieve further reduction in disease burden and mortality in Bangladesh.

keywords vaccination, changing trends, children, Bangladesh

Introduction

According to World Health Organization (WHO) (2005), death due to measles is the fifth common cause of mortality in Bangladeshi children [1]. The disease is almost entirely preventable through a safe and effective vaccine. Initiation of Expanded Program on Immunization (EPI) by WHO to avert child deaths including that due to measles was a major breakthrough in public health [2]. In 1999, the Global Alliance for Vaccines and Immunization (GAVI) and United Nation (UN) agencies prioritized low income and poorest countries of the world to address their high childhood disease burden through immunization services [3]. Hence, they put forth more attention in expanding coverage to prevent morbidity, disability and mortality from vaccine preventable infectious diseases [4, 5]. However, for several years, global coverage with measles vaccine has held up at 85%. This is still short of the 95% coverage needed to prevent outbreaks, and consequent to that large numbers of children in many communities remain at risk of measles morbidity and mortality. According to WHO estimates, globally measles cases have augmented almost 300% and among them 40% increases are in Southeast Asia and the Western Pacific region [6]. Nonetheless, campaigns for mass vaccination are important strategies to minimize the burdens of infectious diseases in low- and middle-income countries (LMICs) [7–9].

In Bangladesh, immunization services are delivered through various clinics and outreach activities. Outreach staff members of health systems are mostly involved in updating and motivating mothers on vaccination by community visits. Such service deliveries are commonly undertaken at outreach sites known as EPI sites which are exclusively for vaccine deliveries. Additional sites are mostly for delivery of primary health care services either known as satellite clinics or static health facilities. In rural areas, EPI services are delivered once a month and vaccines are administered free of charge in these places [10–14]. Although the success of EPI well acclaimed but approximately 1.5 million deaths in children occur each year because of vaccine-preventable diseases [15]. These vaccine-preventable diseases because of low vaccination coverage continue to exert potential public health threats in South-East Asia (including Bangladesh) and sub-Saharan Africa [16]. To achieve better success, WHO has emphasized on age-appropriate vaccination of infants and recommended strengthening of monitoring and surveillance activities in LMIC including Bangladesh [15].

Although Bangladesh has achieved a high immunization status against vaccine-preventable diseases, coverage for measles vaccine is still falling behind its desired target level of >90%. A few studies have reported the accelerating trends of measles immunization status as well as reductions in its coverage differentials. This study utilized the nationwide

Demographic and Health Survey (DHS) dataset which provides reliable and updated information on childhood immunization coverage as well as identifies a range of associated factors that are likely to influence childhood immunization practices in Bangladesh. We have hypothesized that despite improvements in maternal education and poverty; adolescent mothers, malnutrition in children, higher birth order of infants, place of delivery, and absence of exposure to media are holding back the increase in measles vaccine coverage in Bangladesh. The objectives of this study are to understand the current measles vaccination status in Bangladesh, explain the changing differentials in measles vaccination, and determine contexts that may improve further the present measles vaccination coverage.

Methods

For this study, we performed a secondary data analysis after extracting data from Bangladesh Demographic and Health Surveys (BDHS) [17–22]. BDHS is the nation-wide demographic and health survey and conducted periodically by the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare. It captures a nationally representative sample of ever married women of 10–49 years old and their children aged 0-59 months that were born before the survey. The study follows stratified, multi-stage cluster sampling design. It collects information from both urban and rural sites. At the beginning primary sampling units are selected on the basis of probability proportional to size. After that mapping of all households in each selected area is performed this is followed by listing of these households. Then a sample of households is selected following systematic sampling from these lists and households from the urban and rural clusters are included. Field staff members are trained to carry out the listing of households and administer the field-tested questionnaire. In Bangladesh, when vaccines are administered to children, the delivery of these services is immediately recorded in a vaccination card on a routine basis. At the time of data collection, information on childhood vaccination status is obtained for all surviving children aged 12–23 months. According to BDHS reports, in 2004, at the time of interview, vaccination cards were produced by families of 43% children aged 12–23 months, 2007 for 58%, 2011 for 67% and 2014 for 74%. Among the children, 78% received measles vaccine in 2004, 83%, 88% and 85% received measles vaccine in 2007, 2011 and 2014 respectively. To obtain that information, respondents were asked to demonstrate the vaccination card of the child, if they were able, the information on vaccination status from the card was recorded. In case of households without vaccination card, the mothers were asked whether the child received each of the six vaccines: BCG, DPT (and the doses), Polio (and the doses), as well

as Measles. The detailed methodology and data collection procedure of BDHS 2004, 2007, 2011, and 2014 have been described previously [17–22].

Data analysis

Statistical Package for Social Sciences (SPSS) Windows (Version 25, Chicago, IL) and Epi Info (Version 7.0) were used for data management and analysis. Statistical analyses included descriptive as well as analytic methods. For the categorical variable of interest, the significance of differences was evaluated by chi-square ($\chi 2$) test. Odds ratios (ORs) were calculated to assess the strength of association between measles vaccination status and the independent variables of interest. In addition to ORs, their 95% confidence intervals (CIs) were also estimated. Household socio-economic status was measured based on wealth index generated by the composition of selected household assets using Principal component analysis technique. Variables that were studied in this analysis included; wealth index: poor (poorer and lower middle), rich (upper middle, middle and richer); maternal age categorized as ≤19 years and ≥20 years, maternal education: educated (primary to higher secondary education), non-educated (no formal schooling), birth order: ≤3 and ≥4, media exposure: yes (less than once a week, more than once a week and every day), no (not at all). Measles vaccination was considered as dependent variable and its options were: not vaccinated (coded as 1) and vaccinated (coded as 0). Independent variables were: (wealth index (poor = 1, rich = 0); place of residence (rural =1, urban = 0); maternal education (illiterate i.e., no formal schooling = 1, literate = 0); nutritional status (stunted; Z-score = < − 2.00 = 1, not stunted = 0; underweight; Z-score = < −2.00=1, not underweight=0; wasted; Z-score = <−2.00=1, not wasted = 0); gender (female = 1, male = 0); birth order (4th and more = 1; 1st-3rd = 0); diarrhea (yes = 1, no = 0); mother's age (19 and below = 1, 20 and above = 0); place of delivery (home = 1, hospital = 0); media exposure (no = 1, yes = 0), and mother currently working (yes = 1, no = 0).

The analysis was performed in three stages. Firstly, univariate analyses were undertaken for both dependent and independent variables. Then, bivariate analysis was performed to examine association between the dependent variable and all independent variables separately. Finally, multivariate analysis was undertaken by constructing the logistic regression models for measles vaccination status to examine the factors that were associated with not immunizing children with measles vaccine after controlling for the co-variates. For the multivariate modeling (back-ward stepwise logistic regression) those variables that were demonstrated to be statistically significant in the bivariate analysis were included in the models.

Results

Table 1 describes the profile of different independent variables of interest in relation to measles vaccination status. In case of measles vaccination; out of 5,468 children aged 12–23 months, 892 children (16%) were not vaccinated during the study period (2004–2014). In an attempt to detect unadjusted significant factors associated with children not being immunized with measles vaccine, variables that were observed included; children from poor wealth index families, living in rural areas, having mothers with no formal schooling, with stunting, underweight or wasting, being female child, with higher birth order (≥4), having adolescent mother (mother aged ≤19 years), had home delivery, absence of exposure to mass media, and having mother who has a paid job. However, after simultaneous adjustments for covariates in logistic regression; poor socio-economic background, rural residence, children of mothers with no formal schooling, stunted and underweight children, those having higher birth order, children of adolescent mothers, history of home delivery, and absence of exposure to media were observed to be significantly associated with lack of measles vaccination (Table 2).

Measles vaccination coverage among children of adolescent mothers has been observed to range from 21% to 20% over the study periods in 2004–2014 (Figure 1). Despite lack of exposure to mass media, a gradual increase of measles vaccination status from 26% in 2004 to 33% in 2014 was revealed (Figure 2).

Changes in factors associated with non-compliance to measles vaccination were reviewed in different time points (2004, 2007, 2011 and 2014). Lack of maternal education was no longer associated with measles vaccination status in 2007, 2011, and 2014. Stunted children continued to be associated with lack of measles immunization in 2014. According to BDHS 2014, children with higher birth order demonstrated 53% excess risk for not being immunized with measles vaccine. Mothers with absence of exposure to mass media were two times more likely to have children reporting lack of measles immunization as indicated by BDHS 2014 data (Table 2).

Discussion

Immunization coverage in children is defined as the proportion of vaccinated children (12–23 months old) among the children of that age group. Assessment of percentage of children immunized is an important indicator of a successful immunization program. For elimination of disease and reduction of deaths due to disease it has become imperative to attain and continue a high coverage (>90%) in all children by the age 12 months during routine vaccination of young children [2]. Global estimates indicate that approximately 2–3 million

deaths due to diphtheria, tetanus, pertussis, and measles are averted by EPI [10]. EPI in Bangladesh follows the international guidelines recommended by WHO [12]. In Bangladesh, <1year old children receive vaccines according to EPI against major vaccine-preventable diseases (tuberculosis, diphtheria, pertussis, tetanus, hepatitis B, Hemophilus influenza B, disease, poliomyelitis, and measles) [12]. At present, for all the vaccines except measles the coverage is >90%. There are vaccination coverage differentials in urban and rural areas, other differentials are; gender, maternal education, birth order, birth places, geographic location, and wealth quintile. These differential gaps are getting minimized over the period [17–22]. Leading tasks played in these high coverages were; wide access to mass media, better interactions between mothers and outreach staff members, and participation of mothers in periodic health and education campaign sessions being conducted by these outreach staff members in the community [17–22]. These extensive efforts made mothers well convinced about the importance of immunization and largely motivated them to vaccinate their children.

It has been observed that the coverage of measles vaccine has increased all the way through the period (1993–1994 to 2014) [17–22]. However, the coverage failed to exceed the desired level of more than 90% during the study period. Likely explanations are that in Bangladesh the present community awareness programs are more focused towards tuberculosis, polio, diphtheria, pertussis, and tetanus. Promotion of EPI vaccines often takes place among women in ANC (Antenatal care) facilities either during later part of their pregnancy or as soon as their babies are born. However, similar sessions for measles vaccine are not getting momentum because of its single and separate administration schedule (after 9 months). Thus, there is a need for separate promotion campaign sessions as soon as children reach their nine months of infancy. Such endeavor is likely to succeed in enhancing measles vaccination coverage >90%. A study in urban Bangladesh reported that children without measles immunization were two times more likely to be malnourished (stunted, underweight, and wasted) than their peers who received measles vaccine. The study emphasized on campaigns to enhance measles immunization coverage in infants by prioritizing those mothers without formal schooling and children who are females or malnourished [17–22].

The present analysis observed an inverse relationship between birth order and measles vaccination status. Birth order is also a determining factor of lower measles vaccination coverage. A study reported that children of higher birth order (≥4) had increased risk of failure to receive vaccine on time (age-appropriate); similar findings have also been indicated by studies from other developing countries [23].

Adolescent motherhood is a major global concern due to the wide range of health effects and socioeconomic consequences both for mothers and their children as both are interlinked. Adolescent motherhood is commonly seen (95%) in low- and middle-income countries [24-26]. Our study demonstrated that lower (19 or below) maternal age is significantly associated with lack of measles vaccination. Studies have indicated that adolescent mothers often due to their minimal school attainments accentuated by lack of self-confidence often fail to initiate lactation of their newborn babies; if they succeed, they tend to wean their babies much earlier. Moreover, they less often seek care from health facilities as well as have their babies immunized in a timely fashion [24, 27–30]. In Bangladesh 1 in 3 adolescent married girls become mother or attain their pregnancy by the age of 19 [24]. According to BDHS reports, the proportion of the teenage girls who started childbearing by age 19 was 23% in 2004, 25% in 2007, 19% in 2011, and 21% in 2014 [22].

With increasing birth order, vaccination coverage was observed to be declining. In many cultures of South Asia, first birth order children always get more preference than the children with higher birth order. This analysis noted lowest vaccination coverage among children with 4^{th} or more birth order. In 2014, children of ≥4 birth order had overall vaccine coverage below 90% [17–22].

We explored that the role of maternal education plays important role in determining the possibility that a child will receive measles immunization more often with increasing maternal years of schooling. The results of the current study comply with previous studies that examined factors associated with compliance to measles vaccination status in developing countries. A study reported that children whose mothers have attended secondary school or higher, have nearly 40% higher immunization status rates than those children whose mothers reported absence of formal schooling [31, 32]. The relative increases in female education have been attributed partially for significant improvements in measles immunization coverage. Thus, the critical role of maternal schooling should be given due attention in efforts to expand childhood immunization coverage. Earlier observations from BDHS reports indicated association between lower vaccination coverage and lack of schooling of mothers. Due to lack of electricity, existing poor road communication system, and non-availability of local transports women particularly from rural areas remained away from radio or television-based awareness programs or individual-to-individual awareness building sessions conducted by outreach workers at household level. Children belonging to mothers with completed secondary level education demonstrated much higher vaccination coverage (>90%) than mothers of children without formal schooling. It has been observed in Bangladesh that gender

discrimination and birth order prejudice are closely related with formal schooling of mother. Educated mothers are more likely to know the vaccination schedules and are more concern about their child's health. A literate mother knows the consequences of vaccine non-compliance such as incidence of childhood infectious diseases hence she acts wisely by vaccinating her child. One literate mother in a village can also convey the facts about the merits of proper vaccination to others who are less knowledgeable or not motivated. Over the years, girls are getting educated by their consistent school turnout in Bangladesh and hence their responsiveness is making them more careful about immunization of their child [17–22].

The study found that those children who came from lower socioeconomic strata failed to utilize the immunization services of health systems of Bangladesh. Those from lower socio-economic strata often tend to be getting deprived of the benefits of vaccination. This happens due to lack of awareness or other related problems including financial constraints i.e., time or resource limitations to access nearby facilities for immunization. Children from urban areas have been reported to have enhanced vaccination status compared to their rural counterparts. This result confirmed findings from previous studies [33, 34]. This could be attributed to availability of better health services in urban areas compared to the rural settings [35].

Our study also found that children who were born at home were less likely to receive the measles vaccine more frequently than those who had their institutional birth. This may be due to lack of promotional as well as motivational messages during the hospital stay of pregnant women who sought delivery care there.

As malnourished children are at higher risk of infectious morbidity and mortality, vaccinations have been indicated to be the most cost-effective medical intervention to prevent death and diseases in developing countries. Moreover, immunization programs have already reduced substantially the burden of many infectious diseases of childhood. Such achievement can be measured as one of the most remarkable public health accomplishments in the history of medicine [36].

Furthermore, researchers have indicated that childhood vaccinations may play pivotal role within a multi-sectoral package of interventions that aimed at preventing malnutrition in early life. Percentages of stunting were 51% in 2004, 43% in 2007, 41% in 2011, 36% in 2014, wasting were 15% in 2004, 17% in 2007, 16% in 2011, 14% in 2014, underweight were 43% in 2004, 41% in 2007, 36% in 2011 and 33% in 2014 [22]. The present study observed significant higher rate of measles vaccination among the children from families who were exposed to the media compared to those who were not exposed. This approach

could reflect presence of community-based behavior change programs, such as immunization campaigns through radio, television and other culturally acceptable low-cost means of reaching the community people in order to make them better understand about the beneficial role of immunization so that they are encouraged to vaccinate their children on time. Exposure to mass media has enabled women to participate in daily affairs outside home, including education, health, governance, and other areas [37]. Access to information through the media is essential to increase one's understandings and awareness of what takes place in the surroundings. Exposure to media is positively associated with educational attainment; such access to all three conventional media (radio, television and newspaper) outlets has been observed to get strengthened with increasing educational level of mothers. Exposure to mass media has been observed to be positively associated with vaccination of children. Newspaper and television watching are known to be significantly associated with better child health care seeking including have them immunized in developing countries [38–40].

The study has several limitations; thus, cautious interpretation of results is important. The study is based on secondary data analysis and the status of child immunization was based on either immunization cards or self-reporting of the mothers. Therefore, the potential effect of recall bias on study findings cannot be ignored. However, the study results can be generalized at the country level as attempts were made to address the issues of diversity and complexity of social and geographical dynamics of Bangladesh.

Conclusions

The study recognized some of the crucial determinants of failure to comply with measles vaccination for young children in Bangladesh. These findings will contribute to the improvement of measles vaccination coverage and support policy makers to develop the necessary intervention strategies in Bangladesh. Targeted interventions should be urgently undertaken to enhance the measles immunization coverage in order to achieve further reduction in disease burden and mortality. These interventions need to focus on those of lower maternal age, socio-economic and educational status and media exposure in Bangladesh.

Acknowledgments and disclaimer

Authors are grateful to NIPORT, Dhaka, Bangladesh, Government of Bangladesh and MEASURE DHS, Calverton, MD, USA for granting permission to use the BDHS dataset.

Conflict of Interest

None declared.

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Table 1 Association between measles vaccination status and selected independent variables of interest

Variables	Measles Vaccination n (%) No n=892 (%)	Yes n=4576 (%)	Unadjusted ORs	95% CI	P Value	Adjusted ORs	95% CI	P Value
Poor wealth index	478 (53.6)	1667 (36.4)	2.01	(1.74–2.32)	<0.001	1.22	(1.02–1.45)	0.024
Rural residence	674 (75.6)	3012 (65.8)	1.60	(1.36–1.89)	<0.001	1.09	(0.91–1.31)	0.332
No maternal formal schooling	333 (37.3)	1090 (23.8)	1.90	(1.63–2.21)	<0.001	1.51	(1.28–1.78)	<0.001
Stunted	436 (48.9)	1716 (37.5)	1.59	(1.37–1.84)	<0.001	1.09	(0.91–1.30)	0.320
Underweight	536 (60.1)	2088 (45.6)	1.79	(1.55–2.07)	<0.001	1.44	(1.18–1.75)	<0.001
Wasted	219 (24.6)	946 (20.7)	1.24	(1.05–1.47)	0.010	0.901	(0.74–1.09)	0.293
Female gender	464 (52.0)	2298 (50.2)	1.07	(0.93–1.24)	0.340	1.08	(0.93–1.25)	0.269
Higher birth order (4th and more)	400 (44.8)	1514 (33.1)	1.64	(1.42–1.90)	<0.001	1.29	(1.08–1.54)	0.004

Diarrhea present	109 (12.2)	431 (9.4)	1.33	(1.07–1.67)	0.010	1.20	(0.95–1.51)	0.123
Maternal age 19 and below	197 (22.1)	933 (20.4)	1.10	(0.93–1.31)	0.270	1.34	(1.10–1.64)	0.003
Home delivery	765 (85.8)	3225 (70.5)	2.52	(2.07–3.07)	<0.001	1.69	(1.36–2.09)	<0.001
No media exposure	439 (49.2)	1454 (31.8)	2.08	(1.79–2.40)	<0.001	1.42	(1.20–1.68)	<0.001
Currently working mother	163 (18.3)	707 (15.5)	1.22	(1.01–1.47)	0.035	1.14	(0.94–1.39)	0.170

Table 2 Associations between socio demographic status and measles vaccination coverage in different survey times

	2004			2007			2011			2014		
Variables	Adjusted ORs	95% CI	P Value	Adjusted ORs	95% CI	P Value	Adjusted ORs	95% CI	P Value	Adjusted ORs	95% CI	P Value
Poor wealth index							1.89	(1.33–2.67)	<0.001			
Rural residence	1.65	(1.15–2.38)	0.007	1.45	(1.06–2.10)	0.046	0.66	(0.45–0.97)	0.036			
No maternal formal schooling	2.05	(1.53–2.76)	<0.001									
Nutritional status Stunted										1.60	(1.20–2.13)	0.001
Underweight	1.42	(1.06–1.91)	0.019				1.90	(1.37–2.64)	<0.001			
Higher birth order (4th and more)							1.50	(1.08–2.06)	0.013	1.53	(1.10–2.13)	0.010
Home delivery	2.01	(1.11–3.66)	0.026	2.31	(1.38–3.88)	0.001	1.95	(1.24–3.09)	0.004			
No media exposure	1.42	(1.04–1.95)	0.026							2.21	(1.65–2.95)	<0.001

Figure 1. Measles vaccination coverage and maternal age (19 years and below) over the study period

Figure 2. Measles vaccination coverage with lack of media exposure during the study period