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## Research Article

### ROLE OF TIMING OF VACCINATION IN MEASLES OUTBREAK IN TATHLEETH REGION, SAUDI ARABIA, 2007

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#### ABSTRACT

**Objective:** Assess the status of vaccination against measles among children registered in EPI program at PHCC in Tathleeth area during period 2000-2005.

**Methodology:** A cross-sectional study for current outbreak

A retrospective cohort study for children registered in PHCC for EPI vaccination during period 2000-2005 was conducted to evaluate the role of timing of vaccination in occurrence of measles cases.

**Results:** Among the whole 132 cases 57.6% did not receive any vaccine. 13.6 % received partial vaccination. 28.8% were completely vaccinated.

Among 5447 studied children, 12.8% of them were not vaccinated at all. 33.1% were completely vaccinated and 54.1 % were partially vaccinated.

Delay in MMR1 vaccination was defined as any child who did not receive his/her MMR1 or received MMR1 at or after 13th month of his birth. 50.7 % had delayed MMR1 vaccination.

When delay in vaccination was assessed keeping in view the current age of children. It was observed that among age 19-42 months 82.5% have received MMR1 before 13 months indicating that they were on schedule for the EPI. Among the children 67-92 months of age only 9.1% received MMR2, thus were on schedule, while 90.9% were not on schedule according to EPI.

**Conclusion:** This is the first measles outbreak (132 cases) in Tathleeth region and the most probably risk factors are reduced herd immunity and low vaccine coverage.

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#### INTRODUCTION

Measles is a highly infectious viral disease caused by a Morbillivirus and for which humans are the only reservoirs. Transmission is primarily person-to-person via aerosolized droplets or by direct contact with the nasal and throat secretions of infected persons. The incubation period range is 7-18 days, after 2 - 4 days of the prodromal symptoms, maculo-papular rash appears with a high fever. There is probably lifelong immunity, both after natural infection or effective vaccination. The efficacy of measles vaccine is 85.0% globally and 90.0% if administered at 9 months and higher if given later(1).

Expanded Program on Immunization (EPI) has been shown to be one of the most cost-effective health programs and to prevent deaths and disabilities each year from measles. Despite the availability of measles vaccine for more than 40 years, million cases and deaths were reported annually, e.g. over 30 million cases and 530000 deaths in the world in 2003 and the World Health Organization estimates that measles infects 30 million persons and causes 454000 deaths annually worldwide in average(2, 3).

Improvements in measles control can reduce the risk for importation and subsequently measles incidence (4).

The Efforts to reduce the measles disease burden have led to Measles Elimination Initiatives. The Measles Initiative plays an important role in providing technical and financial support to measles priority countries and in strengthening political and social commitment in the fight against measles. Furthermore, the demonstrated decline in measles burden of disease in countries fully implementing the strategy has acted as a powerful advocacy tool for countries and partners supporting the fight against the disease. The Measles Initiative is spearheaded by the American Red Cross, the Canadian International Development Agency, the United Nations Foundation, CDC, UNICEF and WHO(5).

A measles incidence of <1 per million population has been identified as an indicator of measles elimination. Some developed countries have achieved measles elimination through routine immunization programs, which maintain high measles-vaccine coverage using a two-dose schedule (2).

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The availability of MMR vaccine since 1988 produced a marked decline in measles cases over the subsequent decades (6).

The population biology of measles depends on many factors, such as seasonality of transmission and the social, spatial, and age structure of the population(7).

The incomplete observation of dynamics of measles infections and susceptible presents a serious problem to measuring the effectiveness of measles vaccination programs. Accurate notification can help to overcome the problem of incomplete observation of dynamics of measles infections. The problem of incomplete observation of temporal changes in proportion of susceptible can be overcome by integrating information from case-notification data, serological survey data and vaccination coverage data (8).

In Saudi Arabia, measles vaccination started in 1974 for children aged 1 to 9 years. In 1979, a royal decree was issued to enforce the EPI and one-dose Schwartz vaccine became a compulsory requirement for obtaining a birth certificate in 1982, a step aimed to increase the coverage rate. Accordingly, the coverage rate increased from 8.0% in 1980 to 80.0% in 1984 and to more than 90.0% in 1990. Although this was accompanied by a remarkable decrease in measles incidence, the overall impact of measles immunization was unsatisfactory. Hence, there was a need for change of measles vaccine policy. The policy of implementing the two-dose schedule started in 1991, i.e. the first dose was given at age of 6 months followed by the second dose at age of 15 months. In 2002, schedule was changed to first dose of MMR at age of 12 months followed by the second dose at 5 years of age. However, since the change of the schedule a number of small and large outbreaks of measles have been reported in different parts of the kingdom(9).

Several studies have shown that measles epidemics can occur even in highly vaccinated populations. A variety of factors are likely to be contributory to this observation including failure to seroconvert and waning of vaccine-induced immunity. The mean duration of vaccine-induced protection in the absence of reexposure to be 25 years. After long-term absence of circulatory virus, the mathematical model predicts that all seroconverted vaccines have titers below the protective threshold. It is well documented from outbreak investigations that current measles vaccines protect between 90-95% of vaccine from typical measles. However; evidence is accumulating which suggests that vaccine-derived immunity might be less protective than previously assumed. There is a growing concern that among individuals who respond to vaccine, a substantial proportion are or will become susceptible to clinical or subclinical infection(10).

Reconstructing the dynamics of measles infections in vaccinated populations greatly increases our understanding of how vaccination influences the epidemiology of measles, it indicates when the vaccination program fails to provide herd immunity that prevent measles occurrence(11)

Vaccine failure may be due to many reasons including; failure to maintain cold chain, mishandling of vaccine with respect to reconstitution, less accurate vaccination histories, or greater intensity of exposure during outbreak (12).

### **Objective**

1. To describe the dynamics of current measles outbreak and vaccinations in Tathleethregion.
2. To assess the status of vaccination against measles among children registered in EPI program at PHCC in Tathleeth area during years 2000 to 2005G.

## **METHODOLOGY**

### **Study design**

A cross-section study for current outbreak.

A retrospective cohort study for timing of vaccination.

### **Study setting**

Tathleeth sector is part of Assir region. It represents the largest sector among all Assir region sectors. Its area is about one third of Assir region. It is located in the east of Assir region which is in the southern west of Saudi Arabia about 1000km from Riyadh. Tathleeth city is capital of the sector. The population of Tathleeth is about 70000 people in the main city and surrounding villages and hijras (scattered houses).

### **Study population**

Cases of measles outbreak in 2007.

The children registered in Primary Health Care Centers in Tathleeth region for EPI vaccination during period 2000-2005. Four PHCCs were covered; Tathleeth PHCC, Amwah PHCC, Jash PHCC and Subaikhah PHCC.

### **Sample calculation**

132 measles cases in current outbreak, 2007.

5447 children were registered in the participating PHCCs, which were included in the study.

### **Case definition**

The case was defined as any person who had fever and skin rash and/or laboratory confirmed in Tathleeth sector from January to July 2007.

### **Data collection**

There were two formats for data collection.

A cross-section study format for current outbreak.

A retrospective cohort study format including identification data, vaccination status of the child, with date of vaccination, types of received vaccines, and number of doses. The EPI registers for the children during period 2000-2005 were reviewed to extract the data to fill the formats

### **Analysis plan**

Epi-Info software (version 3.5.4) from CDC, was used to data entry and for analysis. The data were analyzed to respond to the objectives of the study.

### **Ethical concerns**

Ethical considerations were according to regulations and rules.

## **RESULTS**

Regarding cross-sectional study for current outbreak.

Among females, there were 52 (77.6%) non-vaccinated cases, 8 (11.9%) partially- vaccinated cases and 7 (10.4%) completely

vaccinated. Among males, there were 24 (36.9%) cases non-vaccinated, 10 (15.4%) cases partially vaccinated and 31 (47.7%) completely vaccinated. Partial vaccination was defined as receiving only single dose of either MMR1 or measles vaccine. Complete vaccination was defined as receiving 2 doses either (MMR1+measles vaccine) or (MMR1+MMR2) or receiving 3 doses (MMR1+MMR2+measles vaccine). (Table 1).

**Table 1** Cross tabulation between gender and Vaccination status of cases of Measles outbreak in Tathleeth sector during 2007G Vaccination status

Gender	None	Single dose (Partial vaccination)	Complete vaccination		Total
		Two doses	Three doses		
Female	52(78.0%)	8(12.0%)	7(10.0%)	0	67(50.8%)
Male	24(37.0%)	10(15.0%)	30(46.0%)	1(2.0%)	65(49.2%)
Total	76(57.6%)	18(13.6%)	37(28.0%)	1(0.8%)	132(100.0%)

**Regarding retrospective cohort study**

During the study period from year 2000 to 2005 G (6 years), 5447 children were registered in the participating PHCCs. which were included in the study.

Among the children studied, 1801 (33.1 %) were completely vaccinated by receiving either three doses (MMR1+ MMR2+ measles vaccine) or two doses (MMR1 + MMR2) or (MMR1+ measles vaccine) and 2949 (54.1 %) were partially vaccinated by receiving single dose of either MMR1 or measles vaccine. (Table 2)

**Table 2** Frequency of completely vaccinated and partially vaccinated among Children registered in Primary Health Care Centers in Tathleeth sector for EPI Vaccination during period 2000-2005 G

Frequency		
Vaccination status	Number	Percentage
Completely vaccinated	1801	33.1%
Partially vaccinated	2949	54.1%
Non vaccinated	697	12.8%
Total	5447	100.0%

4615 (84.7%) had received MMR1 vaccine (i.e. 1st dose of MMR vaccine) by the time of review of record. Highest percentage was among those who were registered during year 2000 i.e. 722 (98.2%), and regarding PHCCs among those who were registered in Subaikhah i.e. 586 (99.8%); while lowest percentage was observed among those registered during year 2005 i.e. 719 (80.0%) and regarding PHCCs among those who were registered in Amwah PHCC i.e. 774 (71.4%). Almost perfect MMR1 vaccination pattern was observed in Subaikhah PHCC throughout the study period, while in other PHCCs vaccination was not so high. Jash showed consistent over 90.0% MMR1 vaccination with minor fluctuation, while Amwah showed a very high peak of 98.6% in year 2000 which dipped to only 21.0% in 2001 and since then had widely fluctuating vaccination percentages. Tathleeth showed a gradual uneven decline from 97.7 % in 2000 G to 75.4% in 2005G. (Table 3)

**Table 3** MMR1 vaccination status among children registered in Primary Health Care Centers in Tathleeth sector for EPI vaccination during period 2000 – 2005G, according to PHCC and year of registration

PHCC	Year	2000	2001	2002	2003	2004	2005	Total
Amwah	N	141	176	206	197	194	170	1084
	Freq	139	37	121	182	153	142	774
	%age	98.6%	21.0%	58.7%	92.4%	78.9%	83.5%	71.4%
Jash	N	120	92	122	103	107	78	622
	Freq	118	83	117	94	100	75	587
	%age	98.3%	90.2%	95.9%	91.3%	93.5%	96.2%	94.4%
Subaikhah	N	83	118	95	111	97	83	587
	Freq	83	118	94	111	97	83	586
	%age	100.0%	100.0%	98.9%	100.0%	100.0%	100.0%	99.8%
Tathleeth	N	391	556	516	575	560	556	3154
	Freq	382	518	443	447	459	419	2668
	%age	97.7%	93.2%	85.9%	77.7%	82.0%	75.4%	84.6%
Total	N	735	942	939	986	958	887	5447
	Freq	722	756	775	834	809	719	4615
	%age	98.2%	80.3%	82.5%	84.6%	84.4%	80.1%	84.7%

Regarding MMR2 vaccine (i.e. 2nd dose of MMR vaccine) only 329 (6.0%) children received it by the time of review of record in July 2007. Highest percentage was among those who were registered during year 2002 i.e. 205 (21.8%) followed by year 2003 i.e. 109 (11.1%) then by year 2001 i.e. 13 (1.4%) and by year 2000 i.e. 2 (0.3%). Children registered in years 2004 and 2005 did not receive the MMR2. Despite overall low MMR2 vaccination rates, Subaikhah and Jash performed better than other PHCCs. (Table 4).

**Table 4** MMR2 vaccination status among children registered in Primary Health Care Centers in Tathleeth sector for EPI vaccination during period 2000 – 2005 G, according to PHCC and year of registration

PHCC	Year	2000	2001	2002	2003	2004	2005	Total
Amwah	N	141	176	206	197	194	170	1084
	Freq	1	0	27	19	0	0	47
	%age	0.7%	0.0%	13.1%	9.6%	0.0%	0.0%	4.3%
Jash	N	120	92	122	103	107	78	622
	Freq	1	11	72	12	0	0	96
	%age	0.8%	12.0%	59.0%	11.7%	0.0%	0.0%	15.4%
Subaikhah	N	83	118	95	111	97	83	586
	Freq	0	0	75	36	0	0	111
	%age	0.0%	0.0%	78.9%	32.4%	0.0%	0.0%	18.9%
Tathleeth	N	391	556	516	575	560	556	3154
	Freq	0	2	31	42	0	0	75
	%age	0.0%	0.4%	6.0%	7.3%	0.0%	0.0%	2.4%
Total	N	735	942	939	986	958	887	5447
	Freq	2	13	205	109	0	0	329
	%age	0.3%	1.4%	21.8%	11.1%	0.0%	0.0%	6.0%

Among the study subject, 1626 (29.9%) children received Measles vaccine as part of EPI vaccination program. As a result 95.1% of the children registered in 2000 and 78.7% of the one registered in 2001 were vaccinated with Measles vaccine. And for these two years all the PHCCS performed well, Amwah performance was poorer than others and especially for the year 2001. (Table 5)

When the vaccination status was stratified for the current age of the children, it was observed that 80.7% of the children 19-30 months and 84.4% of the children 31-42 months received MMR1 dose alone. Among the children 43-54 months 73.6% received MMR1 alone and 11.0% received MMR2, while among children 55-66 months 60.7% received MMR1 and 21.9% received MMR2. However disappointingly, 77.4% of

children 67-78 months old received MMR1 alone and 1.5% received MMR2, while 97.9% of the children 79 months and above had received only MMR1 and only 2 (0.2%) children received MMR2 vaccine. (Table 6).

**Table 5** Measles vaccination status among children registered in Primary Health Care Centers in Tathleeth sector for EPI vaccination during period 2000 – 2005 G, according to PHCC and year of registration

PHCC	Year	2000	2001	2002	2003	2004	2005	Total
Amwah	N	141	176	206	197	194	170	1084
	Freq	128	131	1	0	2	0	262
	%age	90.8%	74.4%	0.5%	0.0%	1.0%	0.0%	24.2%
Jash	N	120	92	122	103	107	78	622
	Freq	115	80	0	1	0	2	198
	%age	95.8%	87.0%	0.0%	1.0%	0.0%	2.6%	31.8%
Subaikhah	N	83	118	95	111	97	83	586
	Freq	83	102	2	0	0	0	187
	%age	100.0%	86.4%	2.1%	0.0%	0.0%	0.0%	31.9%
Tathleeth	N	391	556	516	575	560	556	3154
	Freq	373	428	32	35	52	59	979
	%age	95.4%	77.0%	6.2%	6.1%	9.3%	10.6%	31.0%
Total	N	735	942	939	986	958	887	5447
	Freq	699	741	35	36	54	61	1626
	%age	95.1%	78.7%	3.7%	3.7%	5.6%	6.9%	29.9%

**Table 6** MMR vaccination status according to current age group among children registered in Primary Health Care Centers in Tathleeth sector for EPI Vaccination during period 2000-2005 G

Vaccination status	19-30 Months	31-42 Months	43-54 Months	55-66 Months	67-78 Months	79 Months and above	Total
Mmr1 alone	716 (80.7%)	809 (84.4%)	726 (73.6%)	569 (60.7%)	676 (77.4%)	787 (97.9%)	4283 (78.6%)
Mmr2	0 (0.0%)	0 (0.0%)	109 (11.0%)	205 (21.9%)	13 (1.5%)	2 (0.2%)	329 (6.0%)
None	171 (19.3%)	149 (15.6%)	152 (15.4%)	164 (17.4%)	184 (21.1%)	15 (1.9%)	835 (15.4%)
Total	887 (16.3%)	958 (17.6%)	987 (18.1%)	938 (17.2%)	873 (16.0%)	804 (14.8%)	5447 (100.0%)

According to the Saudi EPI program recommended schedule since year 2000, all children should receive MMR1 dose at 12 months of age and MMR2 at school entry (4-6 years). In line with these recommendations, delay in MMR1 vaccination was defined as any child who did not receive his/her MMR1 or received MMR1 at or after 13th month of his birth. Among the children studied, 2762 (50.7 %) had delayed MMR1 vaccination. Proportion of those who had delayed vaccination did not show any specific trend and has been fluctuating over the years between 41.9% and 60.0%. Within the PHCCs, Subaikhah performed better than others with 28.5% delayed vaccination and poorest in Amwah with 67.2% delayed vaccination. The best year for any PHCC was 2001 for Subaikhah with only 8.5% delayed vaccination and worst was also 2001 for Amwah with 83.5% delayed vaccination. (Table 7).

When delay in vaccination was assessed keeping in view the current age of the children it was observed that among the children 19-42 months of age 82.7% have received MMR1 before 13 months of age indicating that they were on schedule for the EPI recommendation for MMR1. Among the children 67-92 months of age only 0.9% received MMR2 and thus were on schedule, while 99.1% children did not receive MMR2 and

thus were not on schedule according to EPI recommendation for MMR at this age.

**Table 7** Delay in MMR1 vaccination among children registered in Primary Health Care Centers in Tathleeth sector for EPI vaccination during period 2000 – 2005 G, according to PHCC and year of registration

PHCC	Year	2000	2001	2002	2003	2004	2005	Total
Amwah	N	141	176	206	197	194	170	1084
	Freq	54	147	143	108	155	122	729
	%age	38.3%	83.5%	69.4%	54.8%	79.9%	71.8%	67.2%
Jash	N	120	92	122	103	107	78	622
	Freq	56	40	36	59	52	36	279
	%age	46.7%	43.5%	29.5%	57.3%	48.6%	46.2%	44.9%
Subaikhah	N	83	118	95	111	97	83	586
	Freq	20	10	31	52	26	28	167
	%age	24.1%	8.5%	32.6%	46.8%	26.8%	33.7%	28.5%
Tathleeth	N	391	556	516	575	560	556	3154
	Freq	221	368	183	227	241	347	1587
	%age	56.5%	66.2%	35.5%	39.5%	43.0%	62.4%	50.3%
Total	N	735	942	939	986	958	887	5447
	Freq	351	565	393	446	474	533	2762
	%age	47.8%	60.0%	41.9%	45.2%	49.5%	60.0%	50.7%

Although 16.3% of the children aged 43-66 months received MMR2 vaccine, but keeping in view the recommended age of vaccination i.e. 4-6 years it is not possible to comment about the proportion not on schedule at this stage of observation, as some of them may still get the vaccination in time. (Table 8).

**Table 8** Timeliness of MMR vaccination in relation to EPI schedule according to current age among children registered in Primary Health Care Centers in Tathleeth sector for EPI Vaccination during period 2000-2005 G

EPI status	19-42 Months	43-66 months	67-92 Months	Total
On schedule	1525 (82.7%)	314 (16.3%)	15 (0.9%)	1854 (34.0%)
Not on schedule	320 (17.3%)	1611 (83.7%)	1662 (99.1%)	3593 (66.0%)
Total	1845 (33.9%)	1925 (35.3%)	1677 (30.8%)	5447 (100.0%)

## DISCUSSION

In Tathleeth region; there was no reported measles outbreaks before the current outbreak (132 measles cases); hence there was an absence of circulating measles virus, therefore the herd immunity was expected to be low leading to increased number of susceptible individuals. It is known that there is periodicity in measles outbreaks, especially in unvaccinated population. These factors may play a major role in the occurrence of the measles infections in the current outbreak.

The EPI registers of children registered from 2000-2005 showed that, 12.8% of registered children were not vaccinated at all, 54.1% were partially vaccinated and 50.7 % had delayed vaccine; especially among older children. From these percentages we notice that; the vaccination coverage was low and the administration of vaccination in the proper age was poor, so these factors in addition to the previously mentioned factors can further increase the risk of infection by measles. By investigating the current measles outbreak, it was found that; 57.6% of cases were not vaccinated and 13.6% were partially vaccinated, so the lower the vaccination coverage the more chances of measles infections. Also it is known that the vaccination against measles is 90-95% protective that means

even among vaccinated individuals, measles infection can occur and this may explain that 28.8% of cases were 18 completely and properly vaccinated. There was only one non-Saudi, 40 years, and living in Tathleeth long time before the outbreak onset. He did not have vaccination against measles in his country or in Saudi Arabia. He developed the disease in April not in the beginning of the outbreak. So, importation did not seem to play a role in the current outbreak development.

The most likely incriminated factors in the development and spread of the current measles outbreak in Tathleeth region were reduced herd immunity, low vaccination coverage and delayed administration, increased susceptible, nature of the measles epidemiology and nature of vaccines against it, and congested populations. The enhancement of EPI may improve the vaccination status to decrease the possibility of measles recurrence to the lowest level.

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#### Declaration of Interest

The author report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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