



Delayed Vaccination and Related Predictors among Infants

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Abstract

Background: Vaccination status is more often evaluated by up-to-date vaccination coverage rather than timeliness of immunization. This study was conducted to evaluate delayed vaccination during infancy period and to determine the predictors effecting on vaccination delay.

Methods: This cross-sectional study was conducted from June to September 2011 in Hamadan Province, the west of Iran, recruiting 2460 children from 12 to 24 months of age via stratified cluster random sampling with 123 clusters of 20 persons. Data on vaccination were extracted from children's vaccination card. Additional data were collected through interview.

Results: Vaccination coverage of infants was >99.4% for all vaccines. However, 42% to 67.6% of infants received vaccine with delay. The delay time was longer in urban areas ($P<0.001$), among children with high educated mothers ($P<0.001$), and for the vaccines delivered at the end of infancy period. Delay time had a direct correlation with vaccinators' education level ($P<0.001$) and an inverse correlation with the number of periodical visits of health centers ($P<0.001$). No correlation was detected between delay time and gender ($P=0.507$) and distance from health centers ($P=0.627$).

Conclusions: Considerable number of the infants received delayed vaccine, although, vaccination coverage was nearly completes. This issue indicates that delay time is very problematic to be resolved in any given situation even in areas with nearly full vaccination coverage and may require a major effort to be corrected. Furthermore, this study assessed the effect of some factors on delayed vaccination which may help policy makers who plan immunization programs.

Keywords: Immunization, Vaccination, Infant; Cross-sectional study, Iran

Introduction

Full immunization coverage during infancy is essential to ensure prevention against childhood life-threatening infections. However, this is not sufficient alone and delivering vaccines within the deadline is also essential. Immunization status is more often evaluated by up-to-date vaccination coverage rather than timeliness of vaccination. Whereas, monitoring age-appropriate immunization status is an important predictor for establish-

ing disease risk in the population, particularly for those diseases in which age is related to sever morbidity or higher mortality rates (1).

Available evidence has shown that high immunization coverage rates do not necessarily imply age-appropriate vaccination status (2-4). In such situation, there may be so many children who are unprotected by vaccination for several months, although they may eventually receive the vaccines

(5). Delayed immunization can play a role of risk factor for some diseases in particular for pertussis (6) and *Haemophilus influenzae* infections (7). In addition, early administration of Bacille Calmette-Guérin (BCG) during the first 6 months of life is associated with reduced risk of death whereas late vaccination is associated with reduced survival (8). Therefore, taking into account the timeliness of vaccination is important because only relying on immunization status may lead to overestimation of the real assumption of disease protection.

Although several studies have investigated timely vaccination (4, 5, 9), however, the timeliness of children's immunization varies widely between and even within countries (3). Thus, the present study was conducted to evaluate the immunization coverage of children during the first year of life, in order to determine whether children were being immunized in a timely manner, and to investigate the reasons for which children not being immunized on schedule time. To our knowledge, this is the first survey in Iran addressing timeliness for all the recommended vaccines for infants.

Materials and Methods

Local Human Subject Review board of Hamadan University of Medical Sciences approved this study. This cross-sectional study was carried out from June to September 2011 in Hamadan Province, the west of Iran. In this province, there were 28,139 children aged 12 to 24 months (15,537 children in rural area and 12,602 in urban). A stratified cluster random sample of 2460 children was derived from the children population. Children who had immigrated from other provinces were excluded from the study. The children who had been banned from some vaccines due to medical reasons were excluded too.

To date, nine vaccines are introduced in the national immunization program of Iran including oral polio vaccine (OPV), hepatitis B vaccine, BCG vaccine, DPT vaccine, and mumps-measles-rubella vaccine (MMR). The schedule time of vaccination in Iran is as follows: at birth, second, fourth, sixth and twelve months. The outcome of

interest was the duration of vaccination delay from the scheduled time. We categorized the delay time into three groups including 1-2, 3-4, and ≥ 5 days.

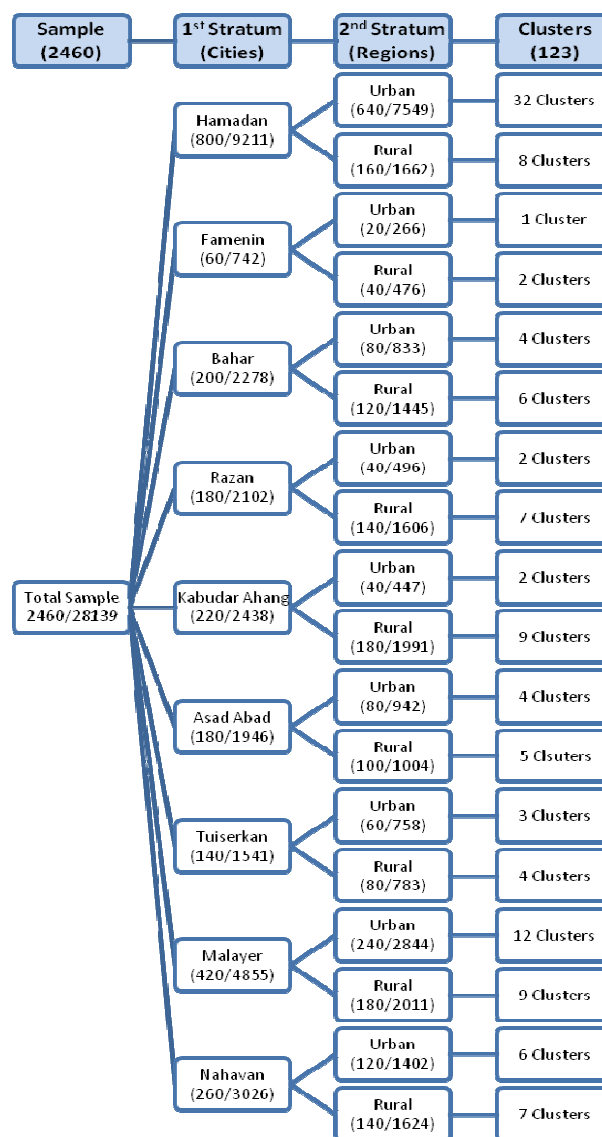


Fig. 1: Stratified cluster random sampling (2460 out of 28139 infants) including a total of 123 clusters of 20 each derived from the urban and rural areas according to their population size

A stratified cluster random sampling was done as follows (Fig. 1). The province was divided into nine cities (first stratum). Each city was divided into two areas, urban and rural (second stratum).

The children population around each health center in either area was considered as a study population. A cluster of 20 children between 12 to 24 months of age was randomly selected from the population around each health center. A total number of 123 clusters were selected involving 2460 children. For this purpose, the address of one household around each health center was randomly selected as the start point for sampling. Visiting householders, the vaccination cards of the children were controlled. Additional data were collected through interview with parents who participated voluntarily in this study. If during a visit, a householder was absent, we returned once again. If the second visit failed, we excluded the household from the sampling list and replaced it with another one.

A checklist and a questionnaire were used for data collection. The data on children's birth date, gender, region of residence, and date of previous vaccinations were extracted from the vaccination cards, using a checklist of items. Additional data were collected through interview using a question-

naire including maternal education level, distance from the nearest health center, vaccinators' education level, years of work experiences and number of periodical visiting health center by supervisors in order to assess the status of immunization and other activities of health house.

Duration of delayed vaccination during infancy period was assessed using Kaplan-Meier hazard function. In addition, chi-square test was used for data analysis at the 5% significance level ($P < 0.05$) using the statistical software Stata 11 (StataCorp, College Station, TX, USA).

Results

From 2460 children of 12 to 24 months of age enrolled into the study, 1328 (54%) boys and 1132 (46%) girls, 1340 from urban areas and 1120 from rural ones. Almost 99.4% (2446 of 2460) of the children received all vaccines during infancy period. Immunization coverage rate and delay time for all vaccines of infancy period are shown in Table 1.

Table 1: Immunization coverage of infants at birth, second, fourth, and twelfth months

	On time (%)	Delay (%)					Not-delivered (%)	Total
		1-2 days	3-4 days	5-13 days	14-27 days	≥28 days		
At birth								
OPV 0	1291 (52.5)	965 (39.2)	81 (3.3)	96 (3.9)	21 (0.9)	5 (0.2)	1 (0.04)	2460
HBV 1	1289 (52.4)	958 (38.9)	85 (3.5)	102 (4.2)	21 (0.9)	5 (0.2)	0 (0.00)	2460
BCG	1294 (52.6)	965 (39.2)	79 (3.2)	94 (3.8)	21 (0.9)	7 (0.3)	0 (0.00)	2460
2nd month								
OPV 1	1426 (58.0)	622 (25.3)	196 (8.0)	178 (7.2)	32 (1.3)	5 (0.2)	1 (0.04)	2460
HBV 2	1413 (57.4)	626 (25.4)	201 (8.2)	180 (7.3)	34 (1.4)	5 (0.2)	1 (0.04)	2460
DPT 1	1417 (57.6)	626 (25.4)	196 (8.0)	181 (7.4)	33 (1.3)	5 (0.2)	2 (0.08)	2460
4th month								
OPV 2	1358 (55.2)	612 (24.9)	224 (9.1)	222 (9.0)	39 (1.6)	4 (0.2)	1 (0.04)	2460
DPT 2	1356 (55.1)	613 (24.9)	225 (9.2)	221 (9.0)	39 (1.6)	5 (0.2)	1 (0.04)	2460
6th month								
OPV 3	1305 (53.1)	529 (21.5)	268 (10.9)	293 (11.9)	56 (2.3)	8 (0.3)	1 (0.04)	2460
HBV 3	1305 (53.1)	523 (21.3)	266 (10.8)	301 (12.2)	56 (2.3)	8 (0.3)	1 (0.04)	2460
DPT 3	1309 (53.2)	525 (21.3)	265 (10.8)	296 (12.0)	56 (2.3)	8 (0.3)	1 (0.04)	2460
12th month								
MMR	797 (32.4)	452 (18.4)	373 (15.2)	649 (26.4)	164 (6.7)	21 (0.9)	4 (0.16)	2460

OPV: oral polio vaccine, **HBV:** hepatitis B vaccine, **BCG:** Bacille-Calmette-Guerin vaccine, **DPT:** diphtheria-pertussis-tetanus vaccine, **MMR:** mumps-measles-rubella vaccine

Based on these results, 42% to 67.6% of the vaccines of various types were delivered out of the definite deadline. Delay time of ≥ 5 days varied from 5% at birth to 33.9% in twelfth month. As shown in Fig. 2, the duration of delay time was relatively short for vaccines delivered at birth and then prolonged with age toward the end of infancy period and reached maximum in twelfth month.

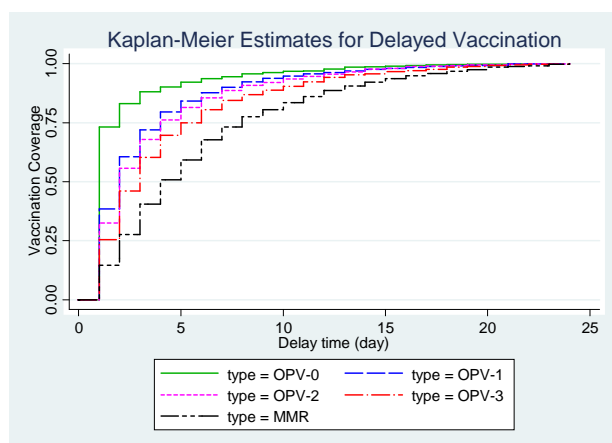


Fig. 2: Delayed vaccination during infancy period using OPV as representative the vaccines prescribed at birth, second, fourth and sixth months and MMR as representative vaccine of the twelfth month

According to the results of Table 1, only 14 cases of the vaccines had not been delivered during infancy period, nine of which related to a boy lived in an urban area of Malayer City. He had not received vaccines during infancy period except those delivered at birth because of his parents' familial conflict. This case was followed by health center of the city and the necessary vaccines were delivered to the boy.

Because most of the delay time had occurred in twelfth month at the time of MMR delivery, the correlation between delay time and its associated factors was evaluated at this point of time (Table 2). The delay time in urban areas was longer than rural areas ($P < 0.001$). Delay time was longer among children whose mothers had higher education level ($P < 0.001$) Delay time had a positive correlation with vaccinators' education level ($P < 0.001$) and negative correlation with the number of monthly visits from the health centers by supervisors ($P < 0.001$). There was significant correlation between delay time and years of vaccinators' work experiences ($P < 0.001$). The delay time was longer for the vaccines delivered at the end of infancy period. Delay vaccination had correlation with neither gender of the children ($P = 0.337$) nor with the distance from the nearest health center ($P = 0.577$).

Table 2: Distribution of MMR vaccine by various predictors using chi-square test

Variables	On time (%)	Delay (%)					Not-delivered (%)	Total N=2460	P value
		1-2 days	3-4 days	5-13 days	14-27 days	≥ 28 days			
Gender									0.337
Female	357 (31.6)	217 (19.2)	164 (14.5)	300 (26.5)	79 (7.0)	14 (1.2)	1 (0.1)	1132	
Male	443 (33.4)	235 (17.7)	209 (15.8)	349 (26.3)	85 (6.4)	7 (0.5)	3 (0.2)	1328	
Region									<0.001
Urban	325 (24.3)	228 (17.0)	232 (17.3)	421 (31.4)	113 (8.4)	18 (1.3)	3 (0.2)	1340	
Rural	472 (42.1)	224 (20.0)	141 (12.6)	228 (20.4)	51 (4.6)	3 (0.3)	1 (0.1)	1120	
Distance from nearest health center (km)									0.577
<1	581 (32.2)	336 (18.6)	278 (15.4)	475 (26.4)	114 (6.3)	14 (0.8)	4 (0.2)	1802	
1-5	202 (32.7)	113 (18.3)	87 (14.1)	160 (25.9)	49 (7.9)	7 (1.1)	0 (0.0)	618	
6-10	14 (35.0)	3 (7.5)	8 (20.0)	14 (35.0)	1 (2.5)	0 (0.0)	0 (0.0)	40	

Table 2: Cond...

Maternal education level								<0.001
Primary school	364 (37.1)	191 (19.5)	131 (13.4)	232 (23.7)	55 (5.6)	5 (0.5)	2 (0.2)	980
Middle school	188 (34.4)	103 (18.9)	79 (14.5)	129 (23.6)	38 (7.0)	7 (1.3)	2 (0.4)	546
High school	198 (27.3)	129 (17.8)	119 (16.4)	219 (30.1)	56 (7.7)	5 (0.7)	0 (0.0)	726
Academic	47 (22.6)	29 (13.9)	44 (21.2)	69 (33.2)	15 (7.2)	4 (1.9)	0 (0.0)	208
Vaccinators' education level								<0.001
Primary school	70 (48.0)	23 (15.8)	20 (13.7)	26 (17.8)	7 (4.8)	0 (0.0)	0 (0.0)	146
Middle school	183 (34.9)	109 (20.8)	61 (11.6)	136 (26.0)	30 (5.7)	4 (0.8)	1 (0.2)	524
High school	418 (32.9)	244 (19.2)	202 (15.9)	324 (25.5)	69 (5.4)	11 (0.9)	2 (0.2)	1270
Academic	126 (24.2)	76 (14.6)	90 (17.3)	163 (31.4)	58 (11.2)	6 (1.2)	1 (0.2)	520
Vaccinators' work experiences (yr)								<0.001
1-10	184 (26.8)	130 (19.0)	119 (17.4)	197 (28.7)	51 (7.4)	5 (0.7)	0 (0.0)	686
11-20	378 (37.2)	182 (17.9)	139 (13.7)	235 (23.2)	68 (6.7)	9 (0.9)	4 (0.4)	1015
21-30	235 (31.0)	140 (18.5)	115 (15.2)	217 (28.6)	45 (5.9)	7 (0.9)	0 (0.0)	759
Number of monthly visits by supervisor during the last year								<0.001
None	325 (24.3)	228 (17.0)	232 (17.3)	421 (31.4)	113 (8.4)	18 (1.3)	0 (0.0)	1340
Once	207 (41.5)	90 (18.0)	64 (12.8)	108 (21.6)	28 (5.6)	2 (0.4)	0 (0.0)	499
Twice	103 (40.1)	44 (17.1)	37 (14.4)	60 (23.4)	12 (4.7)	1 (0.4)	0 (0.0)	257
Thrice	125 (44.0)	70 (24.7)	35 (12.3)	42 (14.8)	11 (3.9)	0 (0.0)	1 (0.4)	284
≥4 times	37 (46.3)	20 (25.0)	5 (6.3)	22.5	0 (0.0)	0 (0.0)	0 (0.0)	80

Discussion

Immunization Vision and Strategy 2006-2015 developed by WHO and UNICEF suggested a national vaccination coverage of at least 90% by 2010 or earlier for all countries worldwide (10). Islamic Republic of Iran achieved this goal by 2008 (11). Our findings confirmed this result and indicated that almost all children under 12 months of age had received all vaccines of the infancy period. Nonetheless, 42% to 67.6% of the infants received vaccine with delay. The duration of delayed vaccination was longer in subsequent vaccines toward the end of the infancy period. Dombkowski et al. (12) conducted a similar study

in the USA and reported that 48% of them had experienced delays relative to standard schedule time. More than 75% of the mothers had postponed bringing their children for immunization (13). In most cases, vaccination coverage in rural areas was higher than urban areas. The reason was that health workers in rural areas had good control on the population under coverage of the health centers and were familiar with most of the people. Hence, if mothers did not bring their infants for immunization, the health workers vaccinate the infants actively by referring to their houses. On the contrary, in urban areas, health workers were not familiar with their surrounding population. Hence, infants were vaccinated passively just

when mothers brought their infants to the health centers for vaccination.

The delay time was much longer for MMR vaccine at the end of infancy period. One reason for this delay is that each vial of MMR vaccine has 10 doses and ought to be used within six hours from the time of opening otherwise it would be useless and have to be discarded. In order to save the vaccine, health workers asked the mothers to bring their infants for MMR vaccination once a week. This issue might lead to intentional delayed vaccination in twelfth month. However, this intentional delay can be avoided if single-dose MMR vaccine is produced and replaced 10-dose vaccine. Against our expectation, the duration of delay time increased with maternal education level. Parents' education level had no effect on immunization delay (12). Whereas, delayed vaccination was much more common among infants with illiterate or low educated mothers (14). This issue may be attributed to lack of sufficient knowledge about benefit of vaccination. However, unusual delayed vaccination among the infants with high educated mothers, as shown in our study, may have another reason. It can be attributed to their occupational status. It is more likely that an educated women to be working than an illiterate women. Accordingly, mothers who are working have less free time and are more likely to bring their infants with delay to health centers for immunization.

According to our finding, no relationship was observed between delayed vaccination and distance from nearest health center. One reason is that the distance from nearest health center was similar with no significant difference. In other words, the distance from the nearest center was less than one kilometer for majority of the cases (1802 children) and less than five kilometers for most of the rest (618 children). However, it is likely that long distance from the health center may increase the possibility of the delayed vaccination (15).

There was significant correlation between delayed vaccination and years of vaccinators' work experiences. The delay time was shorter among those health workers who had 11 to 20 years of work experiences. The delay time was longer among those workers with work experiences less than 10

years or more than 20 years. Longer delay time among juniors may be attributed to their lack of sufficient work experiences while that of seniors with work experiences more than 20 years may be attributed to their lack of motivation or due to burnout.

According to our findings, the less was number of periodical visiting health centers, the longer was delay time. This issue confirms the significance of periodical monitoring of health centers. Whereas, Topuzoglu et al. (16) conducted a similar study in Turkey and reported opposite results. They stated that number of periodical visits had no significant effect on the number of delayed vaccination.

This study was associated with a number of limitations. First, we measured the delay time according to the birthdates of the infants and the dates of previous vaccinations recoded in the vaccination cards. However, some of delayed vaccination may be inevitable because of official holidays or accidentally developing infectious diseases at the time of vaccination. This issue may raise the possibility of information bias and might lead to overestimation of duration of delay time. Second, we selected the maximum delay time at the end of infancy period for analysis. This issue may again introduce selection bias and lead to overestimation of duration of delay time. Furthermore, intentional delayed MMR vaccination in twelfth month might help overestimating the duration of delay time.

In conclusion, the results of this study indicated that vaccination coverage of the infancy period was nearly complete. Nonetheless, considerable number of the infants received delayed vaccine and the duration of delay time was longer for subsequent vaccines toward the end of the infancy period. This issue indicated that delay time is very problematic to resolve in any given situation even in areas with nearly full vaccination coverage during infancy and may require a major effort to be corrected. Furthermore, this study could indicate the correlation of some factors on delayed vaccination. These results may help policy makers who plan immunization programs.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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