Factors influencing immunisation coverage among children under five years of age in Khartoum State, Sudan

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Abstract

Background

This article explores the hypothesis that predisposing and enabling factors of households influence the vaccination status of the children under the age of five in Khartoum State, Sudan.

Method

The study was a cross-sectional survey among a representative sample of 410 male and female children under five years of age from households with varying socio-economic status and mothers with varying levels of education, from both urban and rural localities in the state.

Results

The correct vaccination coverage rate for children was found to be high. Children in urban and rural areas differed substantially in their correct vaccination rates and their receipt of each vaccine separately. Walking or travelling time to the place of vaccination was found to be longer in rural areas when compared with urban areas. The vaccination rate increased with an increase in the age of the children and the education level of the mother. Children of older mothers were more likely to have had the correct vaccinations. The mothers' knowledge of and attitudes to vaccination showed a strong relationship with the vaccination status of their children. When the coverage rate for each vaccine was taken separately, the economic level of the households significantly affected only the BCG vaccine coverage. Most vaccinations occurred in public outlet agencies.

Conclusion

The large differences found in vaccination coverage by place of residence and level of mother's education suggest that much greater efforts are required by the government if better rates of correct vaccination are to be achieved in rural areas.

SA Fam Pract 2007;49(8):14

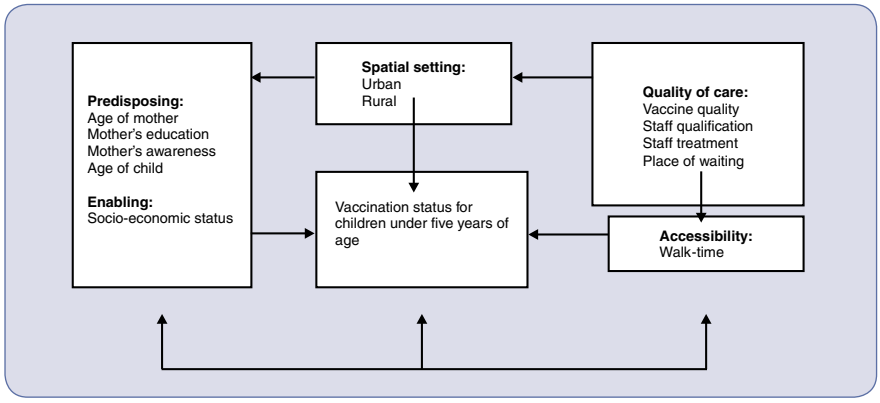
Introduction

Morbidity and mortality caused by diseases that are preventable by vaccine are still very high in many developing countries across the world. Fifteen per cent of deaths in children under five years of age are attributed to these diseases.[1] The situation is similar in Sudan. Although no data are available on deaths caused by vaccine-preventable diseases, the figures pertaining to the average under-five mortality rate in the country have been fluctuating over the past two decades: estimated at about 123 per 1 000 live births in the early 1990s, declining to 104 during the late 1990s, and recently rising to 108.[2]

Immunisation is the most cost-effective and highest-impact health intervention, reducing hospitalisation and treatment costs through prevention.[3,4] The proportion of the world's children immunised against the major vaccine-preventable diseases has increased from 20% in 1980 to over 80% in 1996, preventing more than 2.8 million child deaths annually.[5,6] Despite the success of the expanded programme of immunisation (EPI), such as the eradication of smallpox, many vaccine-preventable diseases remain prevalent in developing countries, related to 20% to 35% of all deaths in children under the age of five.[7] With routine coverage against measles at 88% in 2003, the Middle East/North Africa region is on course to achieve the goal of 90% coverage.[8] Of the 20 countries and territories in the region, however, Sudan has never reached immunisation coverage above two-thirds.[8] Sudan adopted the UNICEF and WHO guidelines for childhood immunisation. These guidelines require BCG vaccination (against tuberculosis), three doses of DPT (diphtheria, pertussis and tetanus) vaccine, three doses of polio vaccine, and measles vaccine by the age of 12 months. The percentage of children aged 12 to 23 months who had all eight recommended vaccinations in the year 2000 was 26.4% in Northern Sudan and 27.5% in the towns of the south.[9]

Children living in the urban areas in the country are more likely to be vaccinated than those living in rural areas, and vaccination coverage is highest among children whose mothers have a secondary or higher education. Male and female children are vaccinated at roughly the same rate in northern Sudan, but at different rates in the southern towns (31% of males and 25% of females).[9] Utilisation is higher when vaccination centres are easily accessible and provide good quality care.[10,11] Studies have shown that fixed immunisation clinics often fail to reach those children who are at highest risk, i.e. those who fail to attend health centres.[12,13,14]

Figure 1. Hypothetical model for the study of vaccination coverage among children younger than five years old in Khartoum State, Sudan (Adapted from Andersen and Newman, 1973).



Sudan's Triple Capital (Khartoum, Khartoum North and Omdurman) has experienced exceptionally rapid urban growth over the past few decades, but this growth has not been matched by improvements in the delivery of health services. Also, due to war and a lack of stability in some parts of the country, Khartoum was subjected to massive immigration and displacement of people (the majority children and women) from remote areas of the country, mainly the south (before the North-South peace agreement) and the west. Displaced people settled mainly in the peripheral rural areas of the state, which already were underserved with health services compared to the central urban areas. Health services had also declined due to population growth, leading to unsatisfactory and unequal geographical distribution of healthcare facilities and personnel. Research is needed on the distribution and utilisation of health services, taking into account population and migratory pressures, the health of and care for vulnerable groups (children), households (poor) and communities (rural/urban), including those affected by war.

The specific objectives of this study were to:

a. Assess the immunisation coverage among children under the age of five in the state of Khartoum, Sudan.
b. Examine the differences in utilisation of vaccines against six killer diseases between children in the urban and rural areas of the state.
c. Assess the impact of socio-economic status of the households on the utilisation of immunisation services.
d. Examine the impact of the mother's age, level of education and attitudes on child immunisation.

Conceptual framework

The hypothetical model applied in this study (see Figure 1) is an extension of Dutton's (1986) access and utilisation model for health services, which, in turn, builds on Andersen and Newman's (1973) predisposing-enabling-need (PEN) explanatory model for health services utilisation.[15,16]

Methods

The study design

The study was a cross-sectional survey among a representative sample of children under the age of five years from households with varying socio-economic levels in both urban and rural localities in the state of Khartoum in Sudan.

Selection of the study area and sampling

The population of the state of Khartoum is 5 548 784 (CBS, 2002).[17] The state consists of three major provinces divided into a total of 26 localities. Seventeen of these localities are classified as urban and nine as rural. The ratio of the total number of rural localities to the total number of localities in the state is 9/26 = 0.346, and the ratio of the total number of urban localities to the total localities is 17/26 = 0.654. Applying the above ratios within each province (due to the heterogeneous nature of the population of the state), a total of 16 localities were selected, 12 of which are urban and four

which are rural. Within each province, urban and rural localities were selected randomly.

Sample size

A sample size of 412 children aged under five years from the target population was used for the study. . The ratio of children under five years of age in the State to the total population of the state for the year 2002 was considered as the study population frame. The baseline data for the 2003 population census of the Central Bureau of Statistics was used to define number of households in each locality of the state. The total sample of the study group was derived using the formula:

$$n = \frac{Z^2\ P\ Q \times deff.}{d^2}$$

Where n is the projected number of the targeted study population (children under five years old), Z is the Z score, which is a standard = 1.96 ≈ 2, P is the expected prevalence of the study group population (ratio of children under five years of age in the State to the total population of the state)), which is 15.2% (.152), Q = 1-P, d is the marginal error (degree of precision) → alpha error = 0.05 = 5%, and deff. stands for the design effect (1.5- 2) ≈ 2.

$$n = \frac{2^2 \times 0.152 \times 0.848}{0.05^2} \times 2 = 412.$$

The total sample was divided between the localities according to the ratio of the number of households in each locality to the total number of households in all selected localities, which was 482 854 households (CBS, 2002).[17] Each locality was divided into four blocks, and the every-other-household rule was applied in each block to cover the projected number of children. If there was no child under the age of five years or if no one was at home, he/she was compensated for in the next household. If there was more than one child under five in the household, the eldest was chosen.

Ethical considerations

Ethical approval was obtained from the Ethical Committee, Ministry of Health in Khartoum State. This permission, in the form of official letters, was taken to the public committee leaders in the localities. The respondents were adequately informed about all relevant aspects of the study, including its aim, interview procedures and potential benefits, before the main data-collecting team arrived. The interviewers outlined the scope of the interview and its approximate length prior to the start of the interview and the respondents were informed that participation was entirely voluntary, would be conducted in privacy and confidentiality, and that they had the right to do the interview, to refuse or to stop it whenever they wanted.

Participants, data collection and data analysis

Data on the immunisation status of the children were collected from married women of reproductive age who had at least one child. A pre-structured questionnaire was used in the interviews with the mothers. The immunisation status of the children was recorded as completely and correctly immunised, or not, and was considered as the dependent variable. Different doses of incomplete immunisation were also registered. In addition to the demographic variables of the mother's age and place of residence, socio-economic indicators of the households' economic level and the mothers' educational level were also studied. The collection of data on socio-economic status was guided by the methods used in the Sudan Safe Motherhood Survey 1999. The data collected related to ownership of durable goods and standards of living. These included ownership of radio, TV, refrigerator, receiver, bicycle, motorcycle, car and tractor. The type of building material, the fuel used for cooking, toilets and source of water are also considered to be indicators of the standard of living. Using factor analysis, a new variable of the socio-economic level of individuals was derived and recoded as 0 (low level), 1 (medium level) or 2 (high level).

Accessibility to vaccine services was studied by looking at the walking time needed to reach the nearest services outlet. Items that were considered in measuring the mothers' knowledge of, attitude to and practice regarding vaccine-preventable diseases were awareness that the child should have been immunised, the availability of an immunisation card, immunisation status of children under the age of five, reasons for not vaccinating the child, and place from which vaccination was preferred. Quality of services was measured by means of the variables perceived vaccine quality (implies valid and effective vaccines), staff qualification (implies technically qualified and expert staff), staff treatment during vaccination and place of waiting before having the vaccine. Questions regarding quality were asked, including how the respondent graded these variables, and the answers were recorded as good or poor. The overall response rate for the household questionnaire was 100%. The major factor for this high rate was that the data collectors were women who had easy access to the mothers, in contrast to males, who usually find it difficult to interview women because of Sudanese norms and the religious values in the country. The interviewers were well-trained university graduates who had a lot of experience in interviewing. The interviewers got the impression that the mothers were expecting better chances of good immunisation of their children if they cooperated in the interview.

The data were collected in the period from August to December 2002, after the collectors had been trained and the questionnaires had been tested. Bivariate (cross-tabulation and chi-square tests), factor analysis and multiple regression analysis were used for the analysis of the data (SPSS, version 11). Factor analysis was applied to construct an indicator for socio-economic status. Logistic regression analysis was used to measure the relative impact of the selected independent variables on immunisation service utilisation.

Results

Utilisation of vaccine services

Table I shows the frequencies and percentages of children under the age of five who had been vaccinated correctly, according to background characteristics of area of residence, mother's age, mother's level of education, child's age, mother's awareness, economic level of household, walk time, mother's attitude and quality of care. Approximately 75.1% of children under the age of five had been vaccinated correctly either completely or had received the specific dose of vaccination for their age against one or more of the six killer diseases. Mothers of children from urban areas reported correct vaccination more than mothers of children in rural areas (79.2% and 35.9% respectively). Children of older mothers were correctly vaccinated more than children of younger mothers (82.6% versus 68.6%), and children of highly educated mothers were more likely to be correctly vaccinated than children of illiterate mothers (82.4% versus 60.4%). Other background variables related to correct vaccination cov-

erage were: age of the child, socio-economic status of the family, the mother's awareness of the purpose of vaccination, possession of a vaccination card, walking time to vaccination facility, comfort of waiting place for vaccination, and perceived vaccination quality. Variables not related to correct vaccination were social treatment by staff and staff qualification (see Table I).

Vaccination coverage for different vaccines

Table II shows the frequencies and percentages of receiving each vaccine separately and correctly (completely or per specific dose) by different background characteristics. Differences in vaccine coverage for the different vaccines were found for children from urban areas, ranging from 74.4% for measles to 88.7% for BCG, and for children in rural areas, ranging from 33.3% for measles to 46.2 for BCG. Children of mothers aware of the importance of vaccination are more likely to be vaccinated compared to those of mothers not aware of the importance of vaccination. Table II also confirms that walking time to the vaccination facility and the possession of a vaccination card are relevant for vaccination, but that differences between the different kinds of vaccination are relatively small. The mother's education was significantly associated with vaccination for most of the vaccines. Economic status was associated only with BCG vaccination.

Vaccination facilities

Public outlet agencies (health centres, hospitals, dispensaries and periodic campaigns) were the main source of vaccination for the entire sample. Eighty-seven per cent of the entire sample was vaccinated in public outlet agencies. For 61.5% of women in rural areas, local health centres were the core source of vaccination services for their children, compared with 57.7% of women in urban areas. Although not many do so, women in urban areas reported using the private sector for vaccinating their children more than women in rural areas (7.3% and 2.6% respectively). For the entire sample, the most important reasons for not vaccinating the child were that the child was too young (37.5%), they were unaware of the importance of child vaccination (16.7%), the child was ill (16.7%), and the unavailability of vaccination services (12.5%).

Table I. Frequencies and percentage of correct vaccination for specific age by different background characteristics (N=410)

	Percentage vaccination				
			Correct	Incorrect	
Overall	**(n)**	**%**	**75.1**	**24.9%**	**chi-square**
Area					
Rural	39	9.3	79.2	20.8	35.482***
Urban	371	90.7	35.9	64.1	
Age of mother					
15–29	219	53.5	68.6	31.4	10.685*
30–45	190	46.5	82.6	17.4	
Missing	1				
Mother's education					
No schooling	53	12.9	60.4	39.6	9.719*
Primary	56	13.7	69.6	30.4	
Intermediate	131	32.0	77.1	22.9	
Secondary	119	29.0	79.0	21.0	
University +	51	12.4	82.4	17.6	
Age of child					
Less than 1 month	27	6.6	70.4	29.6	22.123***
1–12 months	169	41.2	63.9	36.1	
3–24 months	163	39.8	85.3	14.7	
25–60 months	51	12.4	82.4	17.6	
Mother awareness					
Not aware	15	3.7	0.00	100.0	47.14***
Aware	395	96.3	78.0	22.0	
Economic level					
Low	138	33.7	68.8	31.2	5.993*
Medium	133		75.2	24.8	
High	136		81.6	18.4	
Missing	3				
Walk time					
Less than 30 min	368	89.8	78.3	21.7	18.939***
More than 30 min	42	10.2	47.6	52.4	
Vaccination card					
Don't have card	69	16.8	10.1	89.9	187.420***
Have card	341	83.2	88.3	11.7	
Vaccine quality					
Poor	86	21.0	64.0	36.0	7.263**
Good	324	79.0	78.1	21.9	
Staff qualification					
Poor	69	16.8	71.0	29.0	.749
Good	341	83.2	76.0	24.0	
Staff treatment					
Poor	61	14.9	82.0	18.0	1.797
Good	349	85.1	73.9	26.1	
Place of waiting					
Poor	79	19.3	63.3	36.7	7.329**
Good	331	80.7	77.9	22.1	

* = P ≤ .05
** = P ≤ .01
*** = P ≤ .001

Table II. Frequencies and percentages of using each vaccine by different background characteristics (N=410)

		Percentage of vaccination children							
Overall	**(n)**	**BCG**	**Polio1**	**Polio2**	**Polio3**	**DPT1**	**DPT2**	**DPT3**	**Measles**
Area									
Rural	39	46.2	43.6	43.6	41.0	43.6	43.6	41.0	33.3
Urban	371	88.7	83.3	82.7	81.7	83.8	82.7	81.7	74.4
Chi-square		49.07***	34.14***	32.65***	33.76***	34.14***	32.65**	33.76***	28.60***
Age of mother									
15-29	220	81.4	77.7	76.8	75.0	77.7	76.8	75.0	65.5
30-45	190	88.4	81.6	81.6	81.1	81.6	81.6	81.1	76.3
Chi-square		3.91	.93	1.39	2.16	.93	1.39	2.16	5.78**
Mother education									
No schooling	53	69.8	66.0	64.2	64.2	66.0	64.2	64.2	65.6
Primary	56	83.9	82.1	80.4	80.4	82.1	80.4	80.4	67.9
Intermediate	131	83.2	79.4	78.6	77.1	79.4	78.6	77.1	73.3
Secondary	119	90.8	85.7	86.6	84.0	85.7	86.6	84.0	74.8
University +	51	90.2	76.5	76.5	76.5	76.5	76.5	76.5	70.6
Chi-square		13.82**	9.25	11.42*	8.70	9.25	11.42*	6.70	6.49
Age of child									
Less than month	27	70.4	-	-	-	-	-	-	-
1-12 months	169	82.2	82.2	81.1	77.5	82.2	81.1	77.5	63.9
13-24 months	163	90.2	89.0	89.0	89.6	89.0	89.0	89.6	85.3
25-60 months	51	82.4	82.4	82.4	82.4	82.4	82.4	82.4	82.4
Chi-square		9.03*	3.30	4.19	8.70*	3.30	4.19	8.70*	21.97**
Mother awareness									
Not aware	15	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0
Aware	395	87.8	82.5	82.0	80.8	82.5	82.0	80.8	73.2
Economical level									
Low	137	77.4	76.8	75.4	74.6	76.8	75.4	74.6	68.1
Medium	133	85.7	80.5	80.5	78.2	80.5	80.5	78.2	69.9
High	136	91.2	81.6	81.6	80.9	81.6	81.6	80.9	73.5
Chi-square		10.01**	1.06	1.86	1.56	1.06	1.83	1.56	1.00
Missing	4								
Walk time									
Less than 30 min.	368	87.5	82.1	81.5	80.2	82.1	81.5	80.2	73.4
More than 30 min.	42	59.5	57.1	57.1	57.1	57.1	57.1	57.1	45.2
Chi-square		22.69***	14.37***	13.52***	11.57***	14.37***	13.52**	11.57***	14.34***
Vaccination cared									
Don't have card	69	11.6	11.6	11.6	11.6	11.6	11.6	11.6	10.1
Have card	341	99.4	93.3	92.7	91.2	93.3	92.7	91.2	82.7
Chi-square		340.3***	234.9***	227.6***	210.6***	234.9***	227.6**	210.6***	145.2***
Vaccine quality									
Poor	86	70.9	68.6	69.8	67.4	68.6	69.8	67.4	62.8
Good	324	88.3	82.4	81.5	80.6	82.4	81.5	80.6	72.5
Chi-square		15.72***	7.95**	5.63*	6.77*	7.95**	5.63*	6.79*	3.10
Staff qualification									
Poor	69	78.3	75.4	76.8	73.9	75.4	76.8	73.9	69.6
Good	341	85.9	80.4	79.5	78.6	80.4	79.5	78.6	70.7
Chi-square		2.59	.88	.25	.73	.89	.25	.73	.03
Staff treatment									
Poor	61	83.6	80.3	82.0	80.3	80.3	82.0	80.3	80.3
Good	349	84.8	79.4	78.5	77.4	79.4	78.5	77.4	68.8
Chi-square		.06	.03	.37	.26	.03	.37	.26	3.336

Table II (cont.). Frequencies and percentage of using each vaccine by different background characteristics (N=410)

		Percentage of vaccination children							
Overall	**(n)**	**BCG**	**Polio1**	**Polio2**	**Polio3**	**DPT1**	**DPT2**	**DPT3**	**Measles**
Place of waiting									
Poor	79	73.4	70.9	69.6	67.1	70.9	69.6	67.1	62.0
Good	331	87.3	81.6	81.3	80.4	81.6	81.3	80.4	72.5
Chi-square		9.47**	4.47*	5.22*	6.51*	4.47*	5.22*	6.51*	3.37

Determinants of child vaccination

Logistic regression analysis was used to identify the most relevant determinants of the immunisation of children under the age of five. Table III presents the results of the direct logistic regression analysis, with correct vaccination for age as the dependent variable, after the categorical variables were identified. The Hosmer-Lemeshow goodness-of-fit shows a non-significant Chi squire (df 8, Chi-squire 6.866, sign. = .551), indicating a good model fit. With all predictors included, 78.5% of the children overall were correctly classified.

Table III shows that residence (urban/rural), age of child, accessibility (walking time to facility), age of the mother and mother's level of education were significant predictors of correct vaccination for the child's age. The odds ratio (OR) indicates that children from urban areas were 7.4 times more likely to have had the correct vaccinations for their age than were children from rural areas. The age of the child was strongly related to his or her vaccination status. Children between 13 and 60 months of age were 3.2 times more likely to have had the correct vaccinations for their age than were their counterparts aged 12 months or younger. Walking time to the nearest place of vaccination strongly influenced the correct vaccination status of the child. Children of mothers who have better access to vaccine services (less than 30 minutes walking time to the nearest place of vaccination) were 3.4 times more likely to have had the correct vaccinations than were children of mothers who have to walk 30 minutes or longer. The mother's age also had a statistically significant influence on the odds of the child being correctly vaccinated. Children of mothers older then 30 years of age were 2.17 times more likely to be correctly vaccinated than were children of mothers younger then 30. The mother's level of education had a statistically significant influence on the odds of the child being correctly vaccinated. Mothers with intermediate, secondary, university and higher education were 1.99 times more likely to report correct vaccination of their children than were those with no schooling or with primary schooling. In this multivariate analysis, the socio-economic status did not have a unique association with vaccination status.

The variables mother awareness and availability of a vaccination card were excluded because of the skewed frequency distribution of these variables. The service quality variables (vaccine quality, staff qualification, staff treatment and place of waiting) were also excluded because of their subjective nature, while those who had not had their children vaccinated were not expected to be able to correctly assess vaccine quality, staff qualification or place of waiting.

Discussion and conclusion

In the present study, the correct vaccination coverage rate among children under five years of age in the state of Khartoum, Sudan, was found to be 75.1%. The principal factors affecting the immunisation status of these chil-

Table III. Results of the logistic regression analysis of the determinants of child immunisation

Variable	OR	95.0% CI	P value
Area			
Rural	1*		
Urban	7.40	3.41-16.07	0.000
Age of mother			
15-30	1*		
31-45	2.17	1.25-3.74	0.006
Education			
No education and primary	1*		
Secondary and university +	1.99	1.13-3.51	0.017
Age of child			
12 months and younger	1*		
13-60 months	3.21	1.89-5.47	0.000
S.E.S.			
Lower	1*		
Higher	1.09	0.61-1.95	0.770
Walk-time			
30 minutes and more	1*		
29 minutes and less	3.36	1.61-7.02	0.001
Constant	**.05**		**0.000**

*= the reference category

dren in terms of magnitude were area of residence, accessibility to vaccination services in terms of walking time to the nearest place of vaccination, the child's age, age of the mother, and the mother's education.

Substantial differences in correct vaccination rates were found for children in urban and rural areas. Children from urban and rural areas also differed widely in the receipt of each vaccine separately. Urban areas had the highest coverage rates for most vaccinations when taken separately, and the highest percentage of children who had received the correct vaccines. This is probably partly due to the general distribution of healthcare facilities in the state, which tends to favour disproportionately the urban areas of the country. It could also be attributed to the lack of awareness of the importance of vaccination among mothers in rural areas in comparison to those in urban areas, as indicated by this research.

Apart from the effect of living in a rural versus an urban area, accessibility to services in terms of walking time was also found to be a very significant factor. Other studies in developing countries have also suggested that walking or travelling time and distance are key factors that influence the utilisation of healthcare services.[18,19] Most people will not travel further than five kilometres to basic preventive and curative care.[20,21]

Vaccination rates also increased with an increase in age of the child. This may be due to the fact that women tend not to vaccinate young children due to a fear of the side effects of the vaccines, which seems to reflect a gap in knowledge regarding vaccination. Studies have shown that increasing maternal knowledge regarding vaccines improves immunisation status.[21, 22]

Maternal age and education were also found to have a relationship with the immunisation status of the children. Children of older mothers and mothers with a higher education had higher rates of correct immunisation than had the children of younger and less educated mothers. The age differences were greatest for BCG and measles vaccines. The mother's awareness of the importance of vaccination and the availability of a vaccination card showed a strong relationship with correct vaccination status. Seventy-eight per cent of mothers who were aware of vaccination benefits reported that their children had received the correct vaccines for their age, while none of the unaware mothers reported that their children had received the correct vaccines for their age. The rates were also much higher for separate doses among children of mothers aware of the importance of vaccination. Awareness of vaccination importance was higher among mothers in urban areas than among those in rural areas. This higher awareness also seemed to be reflected in a higher availability of the vaccination card. Availability of the vaccination card may facilitate the follow up of different vaccines doses, remind mothers to avoid dropout doses and hence encourage them to complete the vaccination of their children.

From the present study it may be concluded that the main limiting factors for correct vaccination coverage in the state are inadequate distribution of vaccination facilities, particularly in rural settings, illiteracy and a lack of awareness among mothers of the importance of immunisation in general and the correct vaccination for the child's age in particular.

This research provides evidence for the need to launch an adequate health education strategy that targets mothers in order to reinforce their knowledge and awareness of immunisation. The fact that immunisation is the most effective (and cost-effective) means of reducing morbidity, disability and mortality among children has to be the principle message to every mother and child caretaker. The tailoring of adequate national and state vaccine delivery systems, especially at rural levels to reach underserved populations in all areas, as well as designing adequate public health programmes to reach families living in remote locations, should be guiding principles for improving correct vaccination coverage. Special vaccination campaigns to compensate for dropout doses are essential, especially for children older than one year who did not receive the full recommended doses. Effective, informal basic education programmes should be undertaken among illiterate mothers.

The most important limitation or shortcoming of the present study is that the sex of the child was not recorded while collecting the data. This shortcoming creates an unclear picture with regard to the role of gender as a factor that might have an effect on vaccination coverage among children under the age of five, especially in a multiethnic country like Sudan, with its different cultural and religious beliefs. A study exploring the vaccination coverage among male and female children is therefore recommended.

Acknowledgements

This study was supported by a grant from the Government of Sudan and the University of Maastricht.

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