

## Research Article

### Assessment of Routine Immunization Coverage in Nyala Locality, Reasons behind Incomplete Immunization in South Darfur State, Sudan

<sup>1</sup>Ismail Tibin Adam Ismail, <sup>2</sup>Elsadeg Mahgoob El-Tayeb, <sup>3</sup>Mohammed Diaaeldin F.A. Omer,

<sup>4</sup>Yassir Mohammed Eltahir, <sup>5</sup>El-Tayeb Ahmed El-Sayed and <sup>6</sup>Kebede Deribe

<sup>1</sup>PHC Department, Ministry of Health, North Darfur State, Elfasher, Sudan

<sup>2</sup>Federal Ministry of Health, Khartoum, Sudan

<sup>3</sup>UNICEF, South Darfur and Nyala, Sudan

<sup>4</sup>Department of Preventive Medicine and Veterinary Public Health, Faculty of Veterinary Science, Nyala University, Nyala, Sudan

<sup>5</sup>Department of Preventive Medicine and Public Health, Federal Ministry of Health, Khartoum, Sudan

<sup>6</sup>Merlin Sudan Program, South Darfur, Nyala, Sudan

**Abstract:** Little is known about the coverage of routine immunization service in South Darfur state, Sudan. Therefore, this study was conducted to determine the vaccination rate and barriers for vaccination. A cross-sectional community-based study was undertaken in Nyala locality, south Darfur, Sudan, including urban, rural and Internal Displaced Peoples (IDPs) population in proportional representation. Survey data were collected by a questionnaire which was applied face to face to parents of 213 children 12-23 months. The collected data was then analyzed with SPSS software package. Results showed that vaccination coverage as revealed by showed vaccination card alone was 63.4% while it was increased to 82.2% when both history and cards were used. Some (5.6%) of children were completely non-vaccinated. The factors contributing to the low vaccination coverage were found to be knowledge problems of mothers (51%), access problems (15%) and attitude problems (34%). Children whose mother attended antenatal care and those from urban areas were more likely to complete their immunization schedule. In conclusion, the vaccination coverage in the studied area was low compared to the national coverage. Efforts to increase vaccination coverage and completion of the scheduled plan should focus on addressing concerns of caregivers particularly side effects and strengthening the Expanded Programme on Immunization services in rural areas.

**Keywords:** Expanded programme on immunization, routine immunization, vaccination coverage

## INTRODUCTION

The Expanded Programme on Immunization (EPI) was launched in Sudan in 1976. The first 5-year plan for the EPI was formulated in 1985. The programme has introduced the six classical EPI antigens (BCG, polio, DTP (Diphtheria-Tetanus-Pertussis) and measles vaccines) (FMH, 2004) and recently in 2009, Pentavalent was introduced. In 1990, vaccination coverage of children under 1 year of age reached 62% for DTP3 as a national estimate (FMH, 2005). During the period 1995 to 2001 coverage was not sustained and ranged between 50 and 79%. Sudan since then has strengthened its routine EPI activities with significant success; increased coverage rates, successful National Immunization Days (NIDs), strengthened disease surveillance with emphasis on Acute Flaccid Paralysis (AFP) surveillance and improvement of the cold chain capacity and quality (WHO/UNICEF, 2008).

The EPI program has shown a significant qualitative and quantitative improvement in providing

immunization services in Sudan for the last 6 years. However, the routine immunization continued to show low coverage in many of the localities of South Darfur state with a resultant of direct impact on the total coverage of the country (WHO, 2008, 2006; FMH, 2010).

With a funding from the Global Alliance for Vaccines and Immunization (GAVI) in 2005, the EPI has introduced Hepatitis B vaccine in 3 states of Sudan. Later in 2006 the vaccine was introduced nationally to all of the 15 Northern states (FMH, 2010). Polio, measles and MNT (Maternal and Neonatal Tetanus) campaigns supplement the routine programmed. In July, 2009, Sudan, including South Darfur state became the first GAVI-eligible country in Africa to introduce a new vaccine to protect children from rotavirus, the leading cause of severe infant diarrhea. Currently the Pentavalent which is a five-in-one vaccine that combines 5 antigens, namely: Diphtheria; Pertussis; Tetanus; Hepatitis B (HB) and Haemophilus influenzae type b (Hib), into one single shot that now immunizes

the child against five childhood diseases is implemented in the country. Under this service a fully immunized child is a child who had received the full standard doses of recommended antigens (BCG, Pentavalent, polio and measles vaccines) within the recommended time of less than 1 year of age (Keja *et al.*, 1988).

The EPI programme in Sudan is still almost completely dependent upon external aid while the government contribution is limited in share for operational costs. This was due to the difficulty to access some areas, rural-urban migration, natural disasters and above all, the long-standing civil war in the country. There are wide variations within the country in delivery of services, vaccination coverage and disease incidences. It was estimated that only 33% of the population have access to fixed immunization services in 2006. Mobile teams conduct immunization activities in remote areas in an irregular manner, whenever transport is available. In some remote and conflict prone areas, the population is entirely dependent on National and International Non Governmental Organizations (NGOs) services for immunization. The Sudan Federal Ministry of Health plans to provide additional health centers, dispensaries, dressing stations and Primary Health Care (PHC) units for all underserved areas (MHSD, 2009).

The total target of less than 1 year children for 2009 in South Darfur state was around 150,000. The state has been struggling to maintain the routine EPI coverage above 80% for DTP3/Pentavalent3 for the last couple of years. The annual coverage through routine EPI sessions in 2009 was 35% for Penta3 and the state EPI had to depend on six rounds of acceleration campaigns to raise the coverage to above 80% annually since 2006. Accelerations campaign is referring to Periodic Intensification of Routine Immunizations (PIRIs) recommended by World Health Organization (WHO) in reaching more children in some hard areas to improve routine coverage which is similar to Vaccination Week in the America and Immunization Week European countries (World Health Organization, 2009).

The target set for the year 2009 by South Darfur EPI program was to vaccinate 92% of children in the state but the state could hardly reach 83% by end of the year (Federal Ministry of Health, 2010). The state has many valid reasons for not reaching the targets sets for the routine EPI. It has deficit human resources and financial constraints in addition to the insecurity, as it is the biggest state of this conflict affected region. These confounding factors in the state lead to high dependency on acceleration campaigns. The acceleration campaigns are known to contribute to around 50% or more to the total coverage of <1 year children. The international community is present in Darfur through NGOs, UN agencies and the African

Union-United Nations hybrid Mission in Darfur (UNAMID), whose humanitarian mandate centers on facilitation of aid delivery and access to people in need. Attacks and banditry on peacekeepers and humanitarian workers destabilize the operating environment, in some cases leading to suspension of assistance (World Bank, 2009).

While reasons for not reaching the targets sets for the routine EPI in South Darfur include deficit human resources, financial constraints and insecurity, the exact reasons behind incomplete routine vaccination remain unknown and have to be explored. To date, no systemic analysis of the routine immunization coverage has been performed in south Darfur state to the best of our knowledge. Thus, the objective of this community based coverage survey was to assess the routine immunization coverage in Nyala locality in order to reveal the reasons behind incomplete routine vaccination and to identify areas for focused interventions. This in turn will support the state EPI program in strengthening its plans for routine EPI activities with optimal use of available resources to reduce dependency on acceleration campaigns in a phase-wise manner.

## **MATERIALS AND METHODS**

This is a descriptive cross-sectional study planned to assess routine immunization coverage and the factors behind incomplete immunization in Nyala locality. WHO guideline of coverage survey method were used in this study (30 by 7 cluster sample), with estimated expected immunization coverage of 35%. The goal of this sampling design was to estimate immunization coverage within  $\pm 10\%$  points of the true proportion, with 95% confidence interval (WHO (World Health Organization), 2005a). A sample of 213 children aged 12 to 23 months was obtained. Nyala locality was divided in to 3 strata (Urban, Rural and IDPs camps); from these strata, 30 clusters were selected randomly and proportionally to the population figures. The list of Nyala locality EPI catchments areas for routine immunization was used as sampling frame. There were 87 EPI sectors in all Nyala locality (61 urban, 19 rural communities and 7 IDPs camps). Within these 30 clusters (22 Urban, 5 Rural and 3 IDPs camps) were selected. From the 30 clusters 210 households (HHS) were selected randomly as proportional to the population size of the 3 stratum and the 30 clusters in Nyala locality. Within these 30 sub clusters, systematic random sampling was used to select households. Two data collection forms (questionnaires) were used for a cluster survey of routine Immunization of children aged 12-23 months. These were: The infant immunization status cluster questionnaire, which was adapted from standard questionnaire. The reason for incomplete

immunization (not immunized or partially immunized cluster questionnaire also was adapted from standard questionnaire. The data were collected in one week duration (from 22/3/2010-28/03/2010). During the data collection access to the locations was possible; hence the impact of insecurity was minimal. The effect of the periodic insecurity is manifested in the routine immunization. After securing informed consent of the caregivers, structured interview were conducted with the caregivers. Collection of data was preceded by 2 days training for data collectors and supervisors. The structured questionnaire used for data collection was then piloted and adopted to include status of vaccination by asking for immunizations cards, recall by caregivers and reasons for not vaccinations and or partially vaccination, knowledge, attitudes, practices of caregivers and access to the EPI services were included. Interviewers filled the questionnaires depending on the answers of the caregivers and information from the immunization cards, if they were available.

Descriptive statistics such as frequency distributions of all the variables, simple cross-tabulations and calculation of confidence intervals for the proportion were done. The presence of the association between completion of vaccination and socio demographic and caregivers' reproductive history was assessed using chi-square test. The data was analyzed using SPSS (CSPlan).

## RESULTS

Most (53.5%) of the children were girls. The immunization status of the 213 children under study, the complete vaccination coverage as revealed by vaccination card alone was 63% (n = 135) fully immunized, 31% (n = 66) were partially immunized and 5.6% (n = 12) of children were not vaccinated at all in comparison to the vaccination coverage by card and caregiver's recall, remarkable increased in coverage by all antigens were found (Penta1 increased to 95%, penta3 increased to 82%, BCG increased to 77% and Measles increased to 72%).

When the vaccination status of children under study was assessed by the presence of immunization for various antigens, high percentage (72%) of children have received pentavalent1 antigens, followed by BCG (69%), pentavalent2 (66%), pentavalent3 (63%) and measles (52%). In contrast to the state EPI report for 2009 which was based on 24,758 Children revealed that 105% of children have received penta1 followed by penta2 (101%), penta3 (87%), BCG (79%) and measles (74%) (Table 1).

Out of the 157 children under study that reside in urban areas 72, 22.3 and 5.7% were found to be fully immunized, partially immunized and non-immunized respectively. On the other hand out of the 35 children that reside in rural areas 34.4, 60 and 5.7% were found to be fully immunized, partially immunized and non-immunized respectively. Moreover, in the IDPs camps 47.6, 47.6 and 4.8% of children assessed were found to be fully immunized, partially immunized and non-immunized respectively (Table 2). When compared to the 2009/EPI state report, 82, 53, 75%, respectively of children in urban areas were found to be fully immunized, partially immunized and non-immunized respectively. In rural areas 10, 32 and 16%, respectively of children were found to be fully immunized, partially immunized or non-immunized respectively. In the IDP camps, 7, 8 and 15%, respectively of children were found to be fully immunized, partially immunized respectively or non-immunized (Table 2).

The drop-out rates observed here was 8.4%, between Penta1 and penta3.

### Reasons for non-immunization and incomplete immunization, according to the mothers history:

According to mothers history of the 78 non-immunized and partially immunized children, obstacles that include (Place of immunization too far n = 2, Time of immunization inconvenient n = 1, Vaccinator absent n = 4, Vaccine not available n = 10, Mother too busy n = 31, Family problem including illness of mother n = 1 and Child ill-not brought n = 1) were found to be

Table 1: Proportion of immunization coverage according to EPI annual report, 2009 compared with the immunization coverage according to mother's history (recall only), card only and (card and recall), (n = 213), Nyala locality, South Darfur state, 2009

Antigens	2009 EPI reported coverage of Nyala locality (%)	Study result recall only (%)	Study result card only (%)	Study result (recall and card) (%)	Confidence Interval (CI) card only
BCG	79	8	69	77	62-74
Measles	74	21	52	73	47-61
Penta1	105	23	72	95	65-77
Penta2	101	21	66	87	60-73
Penta3	87	19	63	82	57-70

Table 2: Frequency and percentage of immunization status of children's under study by immunization cards and care giver's recall and by place of residence, (n = 213) Nyala locality, South Darfur state, 2009

Place or residence	Number of children	Fully immunized number (%)	Partially-immunized number (%)	Non-immunized number (%)
Urban	157	113 (72%)	32 (22.3%)	9 (5.7%)
Rural	35	12 (34.3%)	21 (60%)	2 (5.7%)
IDPs camp	21	10 (47.6%)	10 (47.6%)	1 (4.8%)
Total	213	135 (63%)	66 (31.0%)	12 (5.6%)

Table 3: Reasons for partial immunization and non-immunization, according to the mothers history (n = 78) Nyala locality, South Darfur state, 2009

Reason	Number of children	(%)
Lack of information		28.2
Unaware of need immunization	5	
Unaware of need to return for 2 <sup>nd</sup> or 3 <sup>rd</sup> dose	3	
Fear of side reactions	10	
Wrong ideas about contraindications	2	
Others	2	
Lack of motivation		7.7
Postponed until another time	5	
Rumors	1	
Obstacles		64.1
Place of immunization too far	2	
Time of immunization inconvenient	1	
Vaccinator absent	4	
Vaccine not available	10	
Mother too busy	31	
Family problem, including illness of mother	1	
Child ill-not brought	1	
Total	78	100

the highest (64%) significant reasons behind non-immunization and incomplete immunization, followed by lack of information (28%) which includes (Unaware of need immunization  $n = 5$ , Unaware of need to return for 2<sup>nd</sup> or 3<sup>rd</sup> dose  $n = 3$ , Fear of side reactions  $n = 10$ , Wrong ideas about contraindications  $n = 2$  and other  $n = 2$ ) and lack of motivation (7.7%) which includes (Postponed until another time  $n = 5$  and Rumors  $n = 1$ ) (Table 3).

According to vaccination strategy 30% of children in urban areas were covered by outreach/mobile strategy whereas, 60% were covered by fixed strategy. In the IDPs camps 95% of children were covered by outreach/mobile strategy whereas, 5% were covered by fixed strategy. In rural areas 70% of children were covered by outreach/mobile strategy whereas, 30% were covered by fixed strategy (Fig. 1a). The percentage of coverage from acceleration campaign in the study population where access and utilization to the EPI services problems not existed contributed to (11.7%) in pental out of the total 72% coverage. The third dose of pentavalent3 (penta3) that reported from acceleration was 7.5% out of the total 63% coverage (Fig. 1b), In contrast to the total target of less than 1 year children for South state, which was around 150,000. The target set for the year 2009 to covered by EPI was 92% but the state could hardly reach 82%, the acceleration campaigns are known contributed to around 50% or more to the total state achieved coverage of <1 year children (Federal Ministry of Health, 2010), It added 54% to the total of 96% coverage by Pentavalent1 while its contribution to the 82% coverage was 47%. The measles showed the highest addition of 45% to the total of 78% coverage by end of 2009. The accessible Nyala locality were the study conducted, the EPI for routine immunization

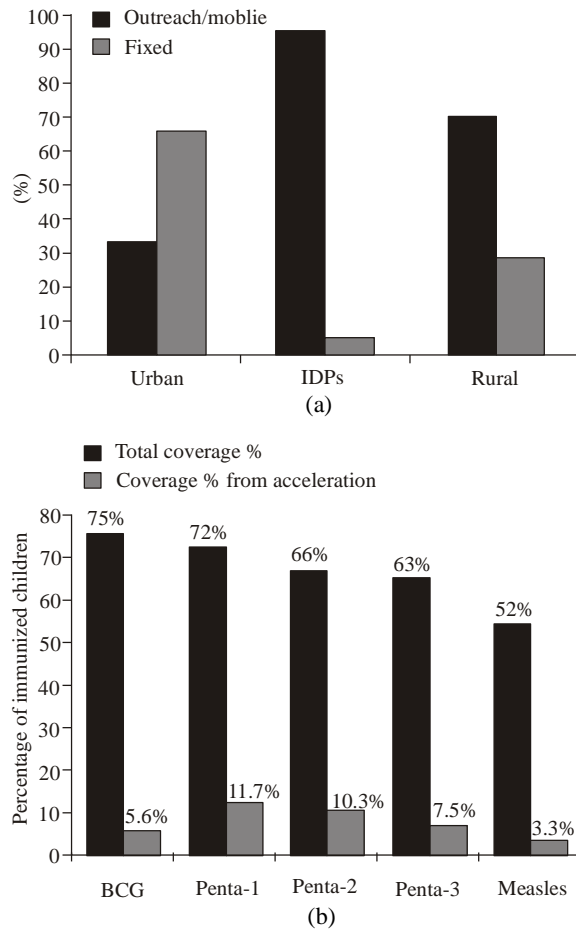


Fig. 1: (a) Frequency of immunization coverage by strategies from mother’s history and immunization cards by residence (b) percentage of contribution of acceleration campaign to the total routine coverage by strategies for the various antigens

target is 24,758 Children (16.5% of the total state target). It can easily be concluded that the state has to continue with the acceleration campaigns particularly for rural remote areas, till it finds a permanent solution to reduce this dependency in a phase-wise manner (Fig. 2). It has been anticipated that many other factors in addition to the ones stated above could contribute to the low routine EPI coverage in the state. The state has been facing the problems of access and utilization of EPI services. It was not only the final coverage by third dose which was low but also there has been a high dropout rates for the last couple of years particularly in the remote rural inaccessible areas. Two factors were found to be associated with completion of vaccination schedule. Children whose mother attended antenatal care were 1.8 times more likely to complete their immunization schedule compared to their counterparts (OR = 1.84; 95% CI: 1.01-3.36). Children from urban areas were 3.72 more likely complete their

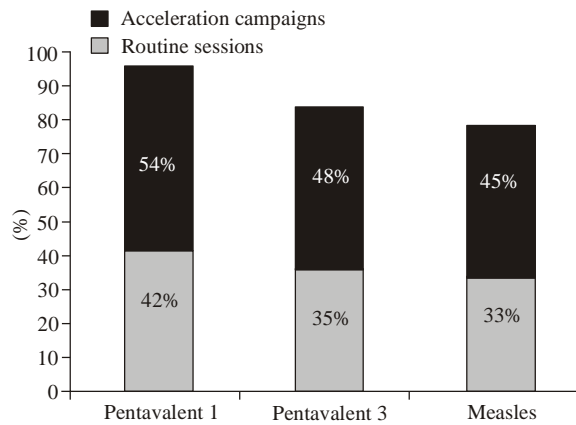


Fig. 2: Percentage of annual routine EPI coverage through routine immunization activities compared to percentage of acceleration campaign EPI coverage, South Darfur, 2009, Sudan  
 2009 EPI annual report, ministry of health-EPI department, South Darfur, Nyala March 2010. The graph above shows that the contribution of acceleration campaigns was 50% to the total coverage. It added 54% to the total of 96% coverage by Pentavalent1 while its contribution to the 83% coverage was 48%. The measles showed the highest addition of 45% to the total of 78% coverage by end of the year. It can easily be concluded that the state has to continue with the acceleration campaigns till it finds a permanent solution to reduce this dependency in a phase-wise manner

Table 4: Potential variables associated with completion of vaccination, South Darfur, Sudan

Variables	Fully immunized		p-value
	Yes	No	
Sex			0.1010
Male	69 (69.7)	30 (30.3)	
Female	66 (57.9)	48 (42.1)	
Antenatal care			0.0120
Yes	94 (70.1)	40 (29.9)	
No	41 (51.9)	38 (48.1)	
Mother received TT vaccine			0.8160
Yes	56 (70.9)	23 (29.1)	
No	44 (67.7)	21 (32.2)	
Immunization card			0.0940
Yes	110 (66.7)	55 (33.3)	
No	25 (52.1)	23 (47.9)	
Location			0.0001
Urban	111 (71.6)	44 (28.4)	
Camp	10 (47.6)	11 (52.4)	
Rural	14 (37.8)	23 (62.2)	
Place of delivery			0.7510
Health institution	19 (67.9)	9 (32.1)	
Other	116 (62.7)	69 (37.3)	
Birth attendant			0.1530
Skilled	14 (82.4)	3 (17.6)	
Not skilled	121 (61.7)	75 (38.3)	

immunization schedule compared to those who live in rural areas (OR = 3.72; 95 CI:1.7-2.97) (Table 4 and 5).

When these results are compared to those before Darfur conflict in 2003, the current reasons for partial immunization and non-immunization and included

limited access to the health services; particularly to those vulnerable rural population and limited accesses to outreach health services. The reported DPT3 (before introduction of Pentavalent vaccine) routine coverage in Sudan, including Darfur at the beginning of 2003 was 30% (World Health Organization, 2003). The coverage in 2009 was 64% conducted by outreach and mobile strategies and 36% through fixed sites within health facilities. The establishment of an Early Warning and Response Network (EWARN), in 2004 in Darfur, implemented by a network of health care groups throughout the three Darfur states has resulted that, twelve communicable diseases(including vaccine preventable diseases) and health events are being monitored weekly which was not present before 2004. These monitoring activities usually trigger vaccination services in response to excess occurrence of vaccine preventable diseases, which increases vaccination coverage. In general the EPI indicators are in progress and overall better than the pre-conflict period. This could be attributed to the global mobilization of resources and huge presents of International NGOs, subsidizing efficiently in improving the access and utilization to the health services (World Health Organization, 2004).

## DISCUSSION

The routine immunization showed low coverage in South Darfur state, despite the considerable financial and logistic support to the program. Therefore, this study was intended to assess the coverage through a cluster survey and to identify the reasons behind partial immunization and non-immunization coverage in Nyala locality, in complex emergency, where the health system is shattered.

In this study the complete vaccination coverage as revealed by vaccination card alone was 63.4% while it increased to 82.2% when both history and cards were used for Penta3. The difference between the coverage percentage from card only and cards plus history for Penta3 was 19% which indicates that children with cards are those children that have access to services and are those that are most likely to obtain all required vaccinations whereas those without cards are more likely to be children without access to services; it is also shed a light on the importance of issuing the card to the child at the first vaccination session.

Comparing the vaccination coverage of this study (63.4% by card) with that of the official vaccination coverage report of 2009 in Nyala locality (87%) revealed differences in the coverage. Such differences may reflect that administrative data on immunization coverage seems to be having some problems over-reporting or weakness in the data quality audit or it may be due to difference in data adopted in each report (Ronveaux *et al.*, 2005; UNICEF, [http://www.childinfo.org/immunization\\_countryreports.html](http://www.childinfo.org/immunization_countryreports.html)).

Table 5: Factors independently associated with immunization schedule completion

Variables	Fully immunized		Unadjusted or	Adjusted or
	Yes	No		
Mother attended antenatal care				
Yes	94 (70.1)	40 (29.9)	2.18 (1.22-3.87)	1.84 (1.01-3.36)
No	41 (51.9)	38 (48.1)	1.00	1.00
Location				
Urban	111 (71.6)	44 (28.4)	4.14 (1.96-8.78)	3.72 (1.7-2.97)
Camp	10 (47.6)	11 (52.4)	1.49 (0.50-4.41)	1.45 (0.48-4.33)
Rural	14 (37.8)	23 (62.2)	1.00	

Taking into consideration the World Health Organization (WHO) suggests that complete vaccination coverage should reach at least 90% of children at the country level and 80% in sub-areas by the year 2010. Such an ambitious objective is far beyond the actual reach of most developing countries for several reasons (World Health Organization (WHO), 2005b). In contrast to the state EPI report for 2009 that based on 24,758 Children in South Darfur locality revealed that 105% of children have received penta1 followed by penta2 (101%), penta3 (87%), BCG (79%) and measles (74%).

The Study showed a significant association between availability of immunization card and the residences of the children where the availability of the card was documented to be more preserved in IDPs camps (90.5%) followed by urban areas (81.3%) and then rural areas (54.1%) (p = 0.001). Percentage of children vaccinated as documented by cards was 68% for the BCG, moreover those with visible BCG scar were found to be 74% despite the fact that, the most of mothers may lost their children's immunization cards, this indicates that the validity, potency of the vaccine and the injection technique were satisfactory. Such observation of the absence's or not showing of the immunization cards is in accordance with other studies reported from other countries such as studies from parts of Turkey report that availability of the vaccination cards may be as low as 20% (Şener, 1997). Absence of vaccination cards is a problem in developed countries also. Even in USA, study reports, that only one-third of the children had vaccination cards in the country (Stokley *et al.*, 2001).

In this vaccination coverage assessment there was no significant association between the gender and the immunization status of children. In some societies with cultural discrimination against female children, boys have a greater chance to be vaccinated (Danni *et al.*, 2001). There was no evidence to support that child gender had any impact on vaccine uptake or in defining missed opportunities for vaccination in our study area indicating that there was no gender related barriers for immunization within the study population.

Twelve (5.6%) children out of the 213 under the study didn't receive any immunization antigen (zero doses); two were from rural areas, one was from IDPs camp and 9 were from urban areas. The reasons in our results showed that 28.2% of the respondent, whom their children were partially immunized or not

immunized, have some sort of lack of information that affected the immunization status of their children. The majority of those respondents (64.1%) claimed obstacles and the minority (7.7%) claimed lack of motivation is factors behind the immunization status of their children. The level of awareness may be attributable to the quality of information provided to mothers at the health facilities. The level of awareness in this community contrasts with a low rate (4%) of knowledge about OPV reported from Niger (Kobayashi *et al.*, 2003) and an equally low rate of awareness (1%) that measles was preventable by immunization from Nigeria (Akesode, 1982), but comparable to the 97% of survey participants who were able to define immunization in Nairobi, Kenya. However, in Niger, the vaccination coverage against polio was higher than in our survey area despite the low level of awareness by the mothers in that country due to more frequent use of "National Polio Immunization Days (Ambe *et al.*, 2001).

In this study it was clear that, obstacles, lack of information concerns followed by lack of motivation as problem were important factors which had affected the immunization coverage. It is worth here to indicate that information alone is not enough to deal with such behavioral concerns. The EPI program and SMOH have paid attention to the issue of social mobilization and community awareness, but it seems that from the results of this study that, intensive and different approaches are needed to positively affect the behavioral concerns among the local communities in south Darfur. EPI program and SMOH should have to pay attention to the issue of social mobilization and community awareness, but it seems that from the results of this study that, intensive and different approaches are needed to positively affect the behavioral concerns among the local communities in south Darfur.

Accessibility and continuity of mobile EPI services remain major challenge facing EPI coverage in rural area as showed in this study, 71% of the immunization coverage in rural areas was achieved by outreach and Mobile strategies. Accessibility as a function of distance and need for using transport were identified as confounder variables for immunization non-uptake. However, spending longer than 60 min to reach the nearest health facility was demonstrated to have a strong negative influence in immunization uptake (Hutchins *et al.*, 1993). A friendly organization of the health facility and a good coordination between fixed

and outreach activities, including a strong involvement of the local community, could help to decrease the mothers' expenses on transportation and the time spent for obtaining vaccination services (De Sousa, 2006).

The existing and ongoing armed conflict has limited the movements and access to the health services and the timely responses to emergencies, this basically appear clear after expulsion of the NGOs in April 2009. For example East Jebel Marra area in South Darfur state was not accessed by the health services including the EPI and remained the high concern area for health sector to be accessed by Health services (MHSD, 2009). Thus, it could be concluded that, in case of expulsion of NGOs health partners and their resources from South Darfur for any reason, the immunization services provided by such international community could be collapses.

It is worth to mention that, the shortage of the human resources may turn out as another challenge that faces routine immunization activities in rural areas. Although the IDPs were covered by international and national NGOs which provide comprehensive PHC services (Federal Ministry of Health, 2010); it was clear that partially immunization and non-immunized children was 52.4% which may indicate poor utilization of the provided services due to knowledge, attitudes and practices of IDPs; also social mobilization may be of great concern towards this situation. Moreover, vaccinators and health workers knowledge, skills and attitude could play crucial roles in the vaccination coverage in all rural, urban and IDPs camps.

The contribution of acceleration campaigns for routine immunization activities to the total vaccination converges by antigens, as reported here in Nyala locality, was not that much; for example Penta3 coverage in the locality showed 7% only. In rural areas, the contribution of the acceleration campaign was more evident comparing it to the urban areas. This indicate that the acceleration campaign is more effective and productive in rural areas rather than in urban and IDPs communities.

Children from urban areas and were more likely to finish their immunization schedule. This could be due to that most children were vaccinated from outreach sites, where access and logistical factors often results in disruption of the services compared to those services from fixed sites which has regular supply. Children whose mothers received TT doses are more likely to complete their schedule this could be due to the access to the information from such visits.

This study is not without limitation, it was not our original intention to compare urban and rural areas determining the number of children proportionally resulted in having a relatively fewer number of children in the urban area which might not reflect the true distribution of South Darfur state population. The recall bias and information bias when using only vaccination cards are also other limitations, in our study we have

combined both. In addition, studies show that mothers' responses are accurate and provide generally adequate information even if they are said to underreport immunization uptakes (Aday and Andersen, 1974). The rate for immunization coverage we obtained in this study is lower compared to results of the State-EPI Nyala Locality of the previous year. What this study cannot rule out is the possibility of over reporting due to poor recall. We show, however, a strong association between complete immunization and the presence of immunization card at the time of interview. This study cannot, provide an explanation for the increased partially immunization coverage rate nor can it completely account for the role of the vaccination card in these results. To overcome the under reporting for BCG coverage, presence of scar were applied which had a special focus on the immunization record cards provides a fuller description to that end.

## CONCLUSION

This study indicated that only 63.4% of children under study were fully vaccinated within the recommended time and were much lower (by showed vaccination cards) than the official vaccination coverage report (87%). Information and health system factors were found to be barriers for immunization. Accessibility and continuity of mobile EPI services remain major challenge facing EPI coverage in rural area. To increase the vaccination coverage in the area, community mobilization, health education which addresses concerns of caregivers regarding side effects should be addressed. In addition ensuring vaccine supplies and monitoring the service provided is curtail for continuity of the services. Finally involving caregivers in choosing the appropriate time for vaccination would help in increasing the uptake of the services.

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## REFERENCES

- Aday, L.A. and R. Andersen, 1974. A framework for the study of access to medical care. *Health Serv. Res.*, 9(3): 208-220.
- Akesode, F.A., 1982. Factors affecting the use of primary health care clinics for children. *J. Epidemiol. Commun. Health*, 36(4): 310-314.

- Ambe, J.P., B.A. Omotara and B.M. Mandu, 2001. Perceptions, beliefs and practices of mothers in sub-urban and rural areas towards measles and measles vaccination in Northern Nigeria. *Trop. Doct.*, 31: 89-90.
- Danni, D., R.B. R.M. Klevens and G.A. Herrera, 2001. Under vaccinated African-American preschoolers: A case of missed opportunities. *Am. J. Prev. Med.*, 20(4Suppl): 61-8.
- De Sousa, C.A.D.P., 2006. Health and development in a border district of Mozambique: Challenges in post-war magude district to inter-sectorial integration and community participation. Ph.D. Thesis, University of Oslo, International Health Community, pp: 220.
- FMH (Federal Ministry of Health), 2004. Expanded programme on immunization: Annual report. Federal Ministry of Health, Khartoum, Republic of Sudan.
- FMH (Federal Ministry of Health), 2005. Expanded programme on immunization: GAVI progress report 2004. Khartoum, Republic of Sudan.
- FMH (Federal Ministry of Health), 2010. Expand programme on immunization: Comprehensive multi-year plan (2006-2010). Federal Ministry of Health, Khartoum, Sudan.
- Hutchins, S.S., H.A. Jansen, S.E. Robertson, P. Evans and R.J. Kim-Farley, 1993. Studies of missed opportunities for immunization in developing and industrialized countries. *Bull. World Health Organ.*, 71(5): 549-556.
- Keja, K., C. Chan, G. Hayden and R.H. Henderson, 1988. Expanded programme on immunization. *World Health Stat. Q.*, 41: 59-63.
- Kobayashi, M., K. Hirakawa, M. Sawada, C. Suzuki, S. Saikawa, H. Ando, M. Nakame and T. Nakano, 2003. Vaccination coverage of poliomyelitis among less than 5-year old children in the markets of Niger. *Jpn. J. Infect. Dis.*, 56: 175-77.
- MHSD, 2009. Expanded programme on immunization: Annual report of 2009. Ministry of Health, South Darfur State, Nyala, Sudan.
- Ronveaux, O., D. Rickert, S. Hadler, H. Groom, J. Lloyd *et al.*, 2005. The immunization data quality audit: Verifying the quality and consistency of immunization monitoring systems. *Bull. World Health Organ.*, 83: 503-510.
- Şener, S., 1997. Evaluation of expanded immunization programme in Kahramanmaraş, and Kars with lot quality technique. Ph.D. Thesis, Department of Public Health, Ankara, (In Turkish).
- Stokley, S., P.J. Smith, R.M. Klevens and M.P. Battaglia, 2001. Vaccination status of children living in rural areas in the United States: Are they protected? *Am. J. Prev. Med.*, 20: 55-60.
- WHO, 2005a. UNICEF: Global polio eradication initiative. 2005 Annual Report, CDC, Geneva, Rotary International. Retrieved from: WHO/Polio/06.02.
- WHO, 2006. Challenges in Global Immunization and the Global Immunization Vision and Strategy 2006-2015. Retrieved from: <http://www.who.int/wer/2006/wer8119>.
- WHO/UNICEF, 2008. Review of National Immunization Coverage, 1980-2007. Retrieved from: [http://www.who.int/immunization\\_monitoring/data/tch.pdf](http://www.who.int/immunization_monitoring/data/tch.pdf), (Accessed from: Dec. 16, 2008).
- World Bank, 2009. Darfur beyond emergency relief. Worldwide governance indicators (2009). Annual Report 2009.
- World Health Organization, 2003. In the Eastern Mediterranean Region. Annual Report of the Regional Director. Retrieved from: <http://www.emro.who.int/stb/media>, (Accessed from: December 2003).
- World Health Organization, 2004. Darfur crisis. Progress Report, Sudan. Retrieved from: [http://www.who.int/hac/about/ann\\_rep\\_2004\\_layout.pdf](http://www.who.int/hac/about/ann_rep_2004_layout.pdf), (Accessed from: September 12, 2004).
- World Health Organization, 2009. Periodic Intensification of Routine Immunization Lessons Learned and Impact for Action. Retrieved from: [www.who.int/vaccines-documents](http://www.who.int/vaccines-documents), WHO/IBV/2009.
- World Health Organization (WHO), 2005b. Immunization Coverage Cluster Survey-reference Manual. Retrieved from: [www.who.int/vaccines-documents/WHO/IVB/04](http://www.who.int/vaccines-documents/WHO/IVB/04), (Accessed from: June, 23, 2005).