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An Analysis of the Costs and Consequences of Routine Immunization for Measles in Anambra State, Southeast Nigeria

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Abstract: Background: Funding measles immunization in a resource constraint setting like Nigeria has been challenging. Nigeria needs a domestic cost data on measles routine immunization to inform measles routine immunization planning. This study assessed the costs and consequences of a dose of measles vaccine to children through routine immunization. Methods: A cross sectional retrospective costing study at twelve Primary health facilities was conducted. Ingredient approach to costing was used to collect data on routine immunization based on providers' perspective. Costs attributable to measles vaccination were extracted from the data pool considering the fraction of a dose of measles vaccine to a total of ten doses of routine vaccines for a child. Microsoft excel was used for data analysis. Unit costs were calculated and compared between types of health facility. State estimates was computed using volume weighted mean method. Results: Cost per child immunized considering total and operational costs were $1.41 and $1.01 respectively. Personnel time and vaccine contributed 62%and 23% of the total cost respectively. Cost per child immunized and vaccine doses used were higher at the Health Post than Primary health facility. The percentage coverage was 39% and the wastage rate was 14%. Conclusion: The findings will guide the policy makers in planning for efficient and sustainable measles immunization financing.

Keywords: Anambra State, Children, Cost Analysis, Measles Containing Vaccine, Routine Immunization, Nigeria

1. Introduction

Measles vaccine has proved to be cost-effective as it drastically reduced measles deaths globally. The Global Vaccine Action Plan launched in 2001 resulted in accelerated measles vaccination that led to 73% drop in measles deaths between 2000 and 2018 worldwide [1]. However, in recent times there has been an upward global trend in the number of measles deaths. For instance, in 2017 and 2018, global measles deaths were approximately 124,000 and 140,000 respectively and most deaths occurred in under five year old children [1, 2].

In 2015, Nigeria ranked second out of six countries that harbor 53% of 20.8million infants who did not receive first dose of measles containing vaccine in the world [3]. More recently, in 2018, estimates show that 19.2 million infants were not vaccinated with at least one dose of measles vaccine through routine immunization and approximately 6.1 million were in 3 countries including Nigeria [4]. The latest Nigeria Demographic health survey (NDHS) 2018, shows that the percentage coverage for first dose of the measles containing vaccine (MCV1) is 54% which is still low [5]. In 2019, between January to May, a total of 28,796 suspected cases have been recorded in Nigeria which was higher the same time the previous year [6].

It is well known that only unvaccinated children and those

that were vaccinated with only the first dose of measles containing vaccine (MCV1) but did not develop immunity are at risk of contracting measles [1, 7]. In Nigeria, evidence shows that absence of immunization delivery services and unavailability of vaccines at scheduled time contributed to low utilization of routine immunization. [8]. Measles elimination progress report pointed out that resource commitment by countries is one of the major factors to ensure measles elimination [9, 10]. Funding has also been reported in a Nigeria study as one of the factors negatively affecting measles immunization [11]. This study was conducted when Nigeria was offering only one dose of measles vaccine through routine immunization. However, there was a window of opportunity to join the league of countries that provide two doses of measles through routine immunization in 2016 which created more funding challenge [12]. Obviously, current and future measles routing immunization planning requires quality cost data that can inform efficient allocation of resources.

There is no available recent cost data on MCV routine immunization that can help in budgeting and planning to scale up measles routine immunization. The only immunization costing study in Nigeria was done in almost a decade ago and focused on routine immunization generally of which the finding is not appropriate for measles routine immunization budgeting and planning [13]. It is therefore important to understand the costs, cost structure and consequences of a dose of MCV through RI in Nigeria context for planning of measles routine immunization. The information is important so that programming will be more efficient, especially in the face of dwindling donor and national government financial support for immunization.

The objective of the study was to compute the unit cost of immunizing a child with one dose of MCV through routine immunization and to understand the drivers of the costs. Hence, the paper provides new knowledge that can be used to inform decisions for planning and budgeting for routine immunization especially measles routine immunization. The information will also be useful to correct inefficiencies at facility levels to achieve more with available resources.

2. Methods

2.1. Study Design

This is a part of an economic evaluation study aimed to determine the most cost-effective strategy for the delivery of measles vaccine to children. The study adopted a cross sectional retrospective study design. The study took place in Anambra state which is made up of twenty one Local government areas (LGAs) divided in three senatorial districts. Each LGA has public primary health care facilities basically comprising of Health posts (HP) and Primary health centres (PHC).

The study sites were selected through multistage sampling technique. The first stage involved clustering each of the 3 senatorial zones in the state into seven Local Government Areas (LGAs) which was used as a sample frame. The second stage involved stratifying the seven LGAs that make up each zone into two groups considering routine immunization performance typology Diphtheria-Pertussis-Tetanus 3 (DPT3) coverage <80%; >80%) for the first five months of 2016. The third stage involved randomly selecting one LGA from each group by lottery method. The fourth stage involved stratifying the public primary health facilities in each selected LGA into Primary Health Center (PHC) and Health Post (HP). At the fifth stage, one PHC and one HP were selected from each group by lottery method for data collection. A total of twelve Primary Health Care Facilities was selected (six PHCs and six HPs) from the selected six LGAs. The public primary health care facility was the primary sampling unit.

2.2. Data Collection

The data were collected using a pretested immunization costing questionnaire developed for the study. The questionnaire was designed to accommodate both primary and secondary data. It has six sections including health facility basic information; Personnel time; equipment and furniture; Building; immunization activities; immunization output. The questionnaire was used to collect annual cost data for routine immunization generally and only measles output data. Face to face interviews, observations and review of relevant documents were used for data collection. Data were collected from Officers in Charge (OIC) of the selected health facilities or their representative in their absence. Ingredient approach to costing was employed. Data were collected on both economic and financial costs based on a providers' perspective.

Documents such as immunization summary sheet, immunization tally sheet and the inventory register were reviewed to either confirm some responses or extract some relevant data. Observation was used to collect data on some capital items such as the building for proper description and valuation. The lead author conducted the interviews and collected all data for the study. Data collection was from September to November, 2016.

2.3. Statistical Analysis

Data were analyzed using windows Microsoft excel 2007 version. Cost data from each health facility was independently analyzed before the sample cost was aggregated. The costs were grouped in different components as Equipment and Furniture, Building, Personnel time, vaccine vial, reconstitution syringe, auto-disabled syringe, cotton wool, injection safety box, transportation, Monitoring and Supervision, Short training, advocacy/Social mobilization and Cold Chain management. The cost of equipment and Furniture, Building, Personnel time, Transportation, Monitoring and Supervision, Short training, advocacy/Social mobilization and Cold Chain were weighted by the fraction of one dose of measles vaccine in ten doses of vaccines in routine immunization which is one tenth of the

cost. The routine immunization offered 10 doses of vaccines to children in the period of study as follows: 3 doses of pentavalent vaccine, 1 dose of BCG, 4 doses of Oral polio vaccine, 1 dose of Measles, 1 dose of yellow fever. Based on this, the shared costs were in a fraction of 10 and MCV1 activities incurred $1/10^{th}$ of any shared cost. The cost of each components from different facilities were summed up to get the total cost of each component for the sample.

Operational costs which are the routine costs of running a programme was considered. The operational cost was estimated by excluding the costs of vaccine and vaccine supplies from the total cost. The MCV costs were extrapolated to get the state estimates by employing a volume weighted mean method as reported in our previous paper [14]. The total delivery volume for Anambra state, which is the additional data required for state estimates was extracted from the state routine immunization report [15].

The outcome indicators were number of children vaccinated, vaccine doses administered and vaccine doses used. Vaccine doses administered and number of children immunized were extracted from the tally sheet and immunizations registers then summed up to get the total for the sample. The vaccine doses used was estimated from the number of vaccine vials used as recorded in the health facility vaccine order register. The percentage coverage was calculated by dividing the number of children vaccinated by the target population then multiplied by 100. The percentage wastage was calculated by first subtracting the vaccine doses administered from the vaccine doses used to get the number of vaccine wastage. The vaccine wastage was divided by the vaccine doses used multiplied by 100 to get the percentage wastage. The cost per dose used was calculated by dividing the total cost by the number of doses used.

Two-way sensitivity analysis was done to test for the robustness of the initial cost per child immunized. Cost components varied were personnel cost, advocacy and social mobilization cost, capital cost, monitoring and supervision cost and Short training cost. A percentage of total measles immunization costs for monitoring and supervision (2.87%) and short training (2.24%) found in a similar study [16] were assumed for the same components in this study. Percentage coverage which shows the effectiveness of each delivery strategy was varied from 50% to 95%. The capital cost ($7,390.02) was excluded.

2.4. Data Management

The immunization costing questionnaires were coded to avert misplacement of data during data entry. The data was collected by the first author who invariably ensured quality data collection. A comprehensive data base was created in two computers for data entry. Data from one completed questionnaire were entered in the data base in the two computers and the Micro soft excel software was tested to ensure reliability of the result. The data set was created after data collection. Summations and averages were used to analyze data.

3. Results

3.1. Descriptive Statistics of Key Variables by Health Facility Type

The target population for measles routine immunization (RI) was14, 494 children from the 12 health facilities. The health facilities conducted 264 and 288 routine immunization sessions at the facilities and outreach stations respectively. A total of 6600 vaccines were used to vaccinate 5686 children for the year. The Primary Health Centres (PHC) contributed higher percentage of the total number of days RI session was held at the health facility (59%) and outreach stations (63%) respectively. The PHCs also had higher numbers of RI personnel (43) and children vaccinated (3,077) although Health Post (HP) had higher percentage (40%) coverage (Table 1).

Table 1. *Descriptive statistics of key variables by health facility type.*

	HP n (% of total)	PHC n (% of total)	Total
Target population	6,593 (45)	7,901 (55)	14,494
Number of RI sessions per year at health facility	108 (41)	156 (59)	264
Average Hours for RI per day	7	6	7
RI outreach sessions per year	108 (38)	180 (63)	288
Number of RI personnel	25 (37)	43 (63)	68
Vaccine vials used	308 (47)	352 (53)	660
Vaccine doses used	3,080 (47)	3,520 (53)	6,600
Vaccine doses administered	2,609 (46)	3,077 (54)	5,686
Number of children vaccinated	2,609 (46)	3,077 (54)	5,686
% coverage	40	39	39
% wastage	15	13	14

Table 2. *Cost of measles routine immunization by type of health facility.*

Cost items	HP $ (% of HP total total)	PHC $ (% of PHC total)	Total $ (% of total)
Equipment& Furniture	110.12 (2.50)	396.20 (1.01)	506.32 (6.32)
Building	47.36 (1.07)	61.46 (1.71)	108.83 (1.36)
Personnel time	3,112.39 (70.56)	1,850.36 (51.42)	4,962.75 (61.96)
Vaccine vials	877.03 (19.88)	1,002.32 (27.85)	1,879.35 (23.46)
Reconstitution syringe	14.04 (0.32)	16.18 (0.45)	30.21 (0.38)

Cost items	HP $ (% of HP total total)	PHC $ (% of PHC total)	Total $ (% of total)
Auto disable syringe	118.90 (2.70)	140.23 (3.90)	259.13 (3.24)
Cotton wool	18.39 (0.42)	11.24 (0.31)	29.63 (0.37)
Injection safety box	21.02 (0.48)	27.66 (0.77)	48.68 (0.61)
Transportation	69.89 (1.58)	68.05 (1.89)	137.95 (1.72)
Supervision & Monitoring.	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Short Training	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Advocacy& Social mobilization	21.72 (0.49)	24.88 (0.69)	46.59 (0.58)
Cold Chain management	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	4,410.86 (55.07)	3,598.58 (44.93)	8,009.44

Cost of measles routine immunization by type of health facility

The total cost of delivering MCV1 was $8009.44. Personnel constituted the highest percentage (61.96%) of the total cost followed by vaccine cost (23.46%) but there were zero costs for monitoring and supervision, short training and cold chain management (Table 2). The total cost of measles RI was higher at HP ($4,410.86) compared to PHC ($3,598.58). Personnel time consumed 70.56% and 51.42% of total costs for HP and PHC respectively. The percentage of total cost that was attributed to vaccine was higher in PHC (27.85%) than HP (19.88%). The PHCs used higher percentage of their total cost for advocacy and social mobilization than HP (Table 2).

3.2. Unit Cost of Measles Routine Immunization by Type of Health Facility

The number of vaccine doses used and children vaccinated were 6600 and 5686 respectively. The cost per child vaccinated with MCV1 and cost per vaccine dose used for the sample were $1.41 and $1.21 respectively. However, the cost per child vaccinated with measles containing vaccine through routine immunization was higher at Health Posts ($1.65) compared to Primary Health Centre ($1.17) (Table 3).

Table 3. *Unit cost of measles routine immunization by type of health facility.*

	HP	PHC	TOTAL
Number of vaccine doses used	3,080	3,520	6,600
Number of Children immunized	2,669	3,077	5,686
Total cost	$4,410.86	$3,598.58	$8,009.44
Cost per child immunized	$1.65	$1.17	$1.41
Cost per doses used	$1.43	$1.02	$1.21

3.3. Operational Cost of Measles Routine Immunization by Type of Health Facility

The total operational cost for the sample was $5,762.43 and HP contributed higher amount $3,361.48 than PHC $2,400.95 (Table 4). Personnel time constituted the highest percentage (86.12%) of the total cost, followed by equipment and furniture (8.79%) then transportation (2.39%) in the sample. Advocacy and social mobilization contributed the lowest percentage of total cost (0.81%). The table also shows that personnel cost took a higher percentage of the total cost at HP (92.59%) than PHC (77.07%). On the other hand, advocacy and social mobilization took a higher percentage of the total cost at PHC (1.04%) than HP (0.65%) in the sample (Table 4).

Table 4. *Operational cost of measles routine immunization by type of health facility.*

Cost items	HP $ (% of HP total)	PHC $ (% of PHC total)	Total $
Equipment& Furniture	110.12 (3.28)	396.20 (16.50)	506.32 (8.79)
Building	47.36 (1.41)	61.46 (2.56)	108.83 (1.89)
Personnel time	3,112.39 (92.59)	1,850.36 (77.07)	4,962.75 (86.12)
Transportation	69.89 (2.08)	68.05 (2.83)	137.95 (2.39)
Supervision & Monitoring	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Short Training	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Advocacy & Social mobilization	21.72 (0.65)	24.88 (1.04)	46.59 (0.81)
Cold Chain management	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Total	3,361.48	2,400.95	5,762.43

3.4. Operational Unit Cost by Type of Health Facility

The cost per child vaccinated and cost per dose used considering operational cost for the sample was $1.01 and $0.87 respectively (Table 5). The cost per child vaccinated with MCV1 was higher at HPs ($1.26) compared to PHCs ($0.78).

Table 5. *Unit cost by type of health facility (Only Operational costs).*

	HP	PHC	TOTAL
Children immunized	2,669	3,077	5,686
Number of vaccine doses used	3,080	3,520	6,600
Cost per child vaccinated	$1.26	$0.78	$1.01
Cost per dose used	$1.09	$0.68	$0.87

3.5. Anambra State Unit and Total Cost Estimates

The state total cost and unit cost were estimated using the volume weighted method. The total delivery volume for the state was 123,110 vaccinated children for the year [15]. The estimated total cost and unit cost for Anambra state was $173,415.83 and $1.41 respectively. The estimated total operational cost for the state was $124,764.60. The unit cost for the state was $1.01 per child vaccinated considering operational cost.

3.6. Two-way Sensitivity Analysis of the Initial Results

Sensitivity analysis revealed that when the percentage coverage

increased to 95% the cost per child vaccinated will decrease to $0.58 per child vaccinated. Fifty percent (50%) increase of personnel cost increased the cost per child vaccinated to $1.85 while fifty percent (50%) increase of cost of social advocacy and mobilization did not change the initial cost per child vaccinated ($1.14). Inclusion of cost for monitoring and evaluation and training did not affect the initial cost per child vaccinated as they resulted in $1.44 and $1.45 respectively (Table 6).

Table 6. *Two-way sensitivity analysis of the initial results.*

Variable	Total Cost $	Children immunized	Cost per child ($)
Base Case	8,009.44	5,686	1.41
% coverage			
50%	8,009.44	7,247	1.11
60%	8,009.44	8,696	0.92
70%	8,009.44	10,146	0.79
80%	8,009.44	11,595	0.69
90%	8,009.44	13,045	0.61
95%	8,009.44	13,769	0.58
Personnel cost			
Increased by 20% of initial personnel cost	9,001.99	5,686	1.58
Increased by 50% of initial personnel cost	10,490.81	5,686	1.85
Adv.& Social Mob.			
20% increase of initial cost	8,018.76	5,686	1.41
50% increase of initial cost	8,032.74	5,686	1.41
80% increase of initial cost	8.046.71	5,686	1.42
100% increase of initial cost	8.056.03	5,686	1.42
Monitoring. & Supervision			
Included 2.24% of total cost	8,188.85	5,686	1.44
Short training			
Included 2.84% of total cost	8,236.91	5,686	1.45
Capital cost			
Excluded capital cost	7,394.29	5,686	1.30

4. Discussion

This study found that annual cost per child vaccinated with one dose of measles containing vaccine through routine immunization was $1.41, which is lower than finding from a related study that reported $2.59 per child vaccinated [16]. The difference may be because of the scope of the cost components in each case. In our study we identified that no provision was made for activities such as monitoring and supervision, short training and cold chain management for routine immunization. However, our finding is higher than the estimated cost per child immunized of one dose of measles vaccine as estimated by World Health Organization (WHO) [1]. This calls for the attention of all stakeholders that are involved in funding of routine immunization because underestimation of measles vaccination cost will obviously affect planning and resource mobilization. Contextualizing planning of routine immunization programme in a resource constrained country such as Nigeria is important for the RI effectiveness and sustainability.

This study also showed that there is variation in the costs of measles immunization across different type of primary health facilities. We found that the cost per child immunized with MCV1 through routine immunization is higher in Health Posts (HP) than at Primary Health Centres (PHC). This is surprising as the HP is a mini health centre that refers clients to the PHC. This possibly implies that the infrastructure and level of specialization of health personnel at HP level is assumed to be lower than that of PHC, implying that the HP costs should be lower than PHC costs [17]. The higher cost per child seen in HP may not be unconnected to higher total cost and lower number of children vaccinated seen in HP than PHC, which is not ideal because HP is the lowest level of primary health care that is closest to the grass root for easy access to Primary health care services including routine immunization. In most instances, routine immunization service is the major service provided at the HP, services like Ante-natal services and deliveries are provided at the PHC. It is therefore expected that the unit cost of routine immunization at the HP will be lower. This finding buttressed findings from related studies that also reported variations of unit cost of routine immunization across health facilities [18], states [19] and regions [20].

It was found that the total cost of MCV1 immunization was higher at the health posts than the primary health centers. The higher total cost may be because of high cost of personnel time seen at the health post. The percentage of total cost attributed to personnel time at health post was higher (70.56%) than at primary health centre (51.42%). The finding brings to question the caliber of personnel deployed at Health Posts and Primary Health Centers respectively. It is important to apply strategic deployment of personnel at primary health facilities to ensure human resources are efficiently utilized. In the context of shrinking economy, having a fit-for-purpose health workforce, who have adequate knowledge suitable for the level of care required at the Primary Health Care level should be a priority. More worrisome is that the number of personnel seen at PHC is more than the number seen at HP yet the personnel cost was higher at HP. The policy markers especially at the state level needs to conduct a kind of profiling of health workers at

different primary health care facilities for efficient use of available human resources.

The findings revealed that the total cost of measles routine immunization for the sample was $8009.44, with personnel time and vaccine cost as the top two major cost centers. Surprisingly, HPs contributed a higher cost ($4,410.86) than the PHC ($3,598.58). Although the cost of vaccine contributed by the HP was lower ($877.03) than cost of vaccine from PHC ($1,002.32), the costs of personnel time was higher ($3,112.39) in HP than PHC ($1,850.36). The cost structure found in our study is not in line with the findings in a similar study by Kaucley and Levi (2015) [16] where although they found personnel cost to have the highest percentage of the total cost, vaccine cost was fifth in the rank. Moreover, the personnel cost in our study contributed more than half of the total cost (61.96%), which also significantly differ from findings by Kaucley and Levi (2015) [16] where personnel cost was just 36.54% of the total cost. Other related studies in Nigeria [13] and India [21] also found personnel cost as taking the biggest chunk of the total cost of routine immunization. In our study, transportation was the fifth highest cost component and took 1.72% of the total cost while a similar study [16] found that transportation used 0.97% of the total cost. The cost structure seen in our study widely differs from the cost structure reported from the study done in the Republic of Benin [16]. This has thrown more light on the level of disparity in measles immunization cost structure across different contexts.

In this study, short training, monitoring and supervision and cold chain management were neither carried out nor fund allocated to them. It is well documented that short training has a positive effect on knowledge of existing guidelines for proper implementation of plans for effective outcome [22, 23]. The absence of short training maybe the reason for poor knowledge of current routine immunization policies on service provision which was evident in the number of days routine immunization was provided at primary health facilities. Our study revealed that routine immunization services were not offered on every working day showing that immunization staff maybe ignorant of the current immunization guideline. Current immunization guideline stipulates that routine immunization services should be conducted every day to improve coverage and prevent missed opportunity [24].

The inference from the high level of vaccine wastage rate that was found in this study (14%) reflected the fact that most likely, vials were opened only when there were enough children invariably to control vaccine wastage. The wastage rate seen in our study is far below the recommended maximum wastage rate of 50% for multi-dose vaccines including measles containing vaccine [25, 26].

The zero cost for cold chain managements seen in this study is due to lack of standard cold chain equipment for vaccine storage more than 24 hours at the facility level. The implication is that for vaccines including MCV to be available at health facilities every day, health facility staff must make a trip to the Local Government Area (LGA) immunization office daily where LGA cold chain office is located. Non-availability of vaccines at the time mothers visit the health facility for routine immunization will lead to long waiting time which has been reported as one of the major factors that is negatively affecting routine immunization uptake [27]. Generally, these neglected routine immunization activities created some forms of barrier to MCV immunization access thereby negatively affected the coverage.

This study also revealed that the percentage coverage of measles routine immunization was 39% for the sample. The finding may be connected to the level of social mobilization and advocacy activities seen in the sample. Social mobilization and advocacy activity comprised just 0.58% of the total cost of measles routine immunization. It is well documented that demand creation activities like social mobilization and advocacy is a tool for promoting access to routine immunization [28-30]. Our finding buttressed an earlier finding from a Nigeria study that revealed that funding is a barrier to demand creation activities for routine immunization [11].

Our study also revealed similar percentage coverage at the HP and PHC. We expected that HP will have a higher percentage coverage considering its position and scope in the health system. However, the finding could be linked to the percentage of the total cost for advocacy and social mobilization at the facilities especially at the HP. Aside from funding, it is also important to critically assess the duties of the primary health care workers to ensure that personnel carry out the duties for which they were employed for. Negligent of duty at the primary health care level has been reported in a Nigeria study that 95% of community health extension workers (CHEW) were fully engaged with the activities at the health facility instead of working in the communities where they were supposed to work [31]. Although the percentage coverage was similar at HP and PHC, the volume of children vaccinated was higher at PHC than HP. This may be because; the PHCs had more immunization sessions both at the facility and outreach stations. The practice created more opportunities for care givers to access measles routine immunization at PHCs than HP. Outreach immunization sessions have been identified as a means of reducing inequities in routine immunization delivery and improving access. It creates opportunities for poor socio-economic groups and those residing in an environment with limited access to routine immunization hence improving coverage [32].

The coverage found in our study may be in variance with an administrative report [5]. In our study, the number of children vaccinated was counted from the vaccination tally sheet at the health facility which is different from administrative reports. A study done in Anambra state earlier found inaccuracy and variations in routine immunization data reports at Local Government Area level and health facility level [33]. Evidence abound on the disparities in immunization survey data and administrative data which is also a challenge for adequate immunization planning in Nigeria and other countries [34-36].

Our study further revealed that the total operational cost for the sample was $5,762.43. The finding revealed that the operational cost is approximately 72% of the total cost of measles routine immunization. The knowledge of operational cost of measles routine immunization is critical in planning and resource mobilization to ensure available vaccines are delivered to children that need them. Expectedly, personnel cost had the highest percentage of the total cost for both type of facility. However, approximately 93% of the total cost attributed to personnel at HP was somehow striking, may need further evaluation in subsequent studies. The operational cost per child vaccinated with MCV1 was $0.87. The cost per child vaccinated was higher at HP ($1.09) than PHC ($0.68). The gap further questions the level of efficiency at the HP. There is a dare need to review the operations of the primary health care facilities in Nigeria generally to improve efficiency and possibly curb corruption as reported in a related study [37].

The finding from the sensitivity analysis underscores the importance of high immunization coverage as it has a multiplier effect on the overall measles routine immunization program. Interestingly, the sensitivity analysis also revealed that there is no significant change in the cost per child immunized when the cost allocated to advocacy and social mobilization was doubled. This implies that scaling up routine immunization demand creation activities like advocacy and social mobilization will only improve coverage without significantly increasing the cost of measles routine immunization. Similarly, when costs of monitoring and supervision and short training were included at different times, the cost per child immunized was almost the same. The findings will encourage the policy makers to consider allocation of funds to some neglected routine immunization activities like short training and monitoring and supervision. These activities were not given required attention in routine immunization programme but they are significant in effective delivery and uptake of routine immunization including measles immunization. There is a need to review activities of measles routine immunization and adopt strategic allocation of funds within routine immunization activities to achieve more with available resources.

A study limitation was that we did not consider cost of waste management and administrative cost beyond the health facilities. Also, although, measles routine immunization was also delivered at the health facilities and outreach sessions, we did not separate the costs by the delivery strategies.

5. Conclusions

Overall, the cost per child vaccinated with MCV through routine immunization is reasonable despite low coverage. However, the higher total cost and unit costs found at HP is worrisome. Different cost structures seen and their resultant unit costs will help to address inefficiencies at health facility level for more efficient routine immunization service delivery across different health facilities. There is a need to review the health personnel mix at the Primary Health care facilities to ensure efficient use of available human resource for health. Policy makers should consider an upward review of fund allocations to social mobilization activities to improve routine immunization coverage including MCV coverage. Increased coverage will drastically reduce the unit cost to ensure effective implementation of measles routine immunization programme and sustainability. We also recommend periodic cost analysis of routine immunization generally to gain insight on how resources are allocated within routine immunization system and improve efficiency.

List of Abbreviations

BCG: Bacille Calmette-Guerine
DPT3: Diphtheria, Pertussis, Tetanus vaccine third dose
HP: Health Post
LGA: Local Government Area
MCV1: Measles containing vaccine first dose
MCV2: Measles Containing vaccine second dose
NAUTH: Nnamdi Azikiwe University Teaching Hospital
NDHS: Nigeria Demographic Health Survey
PHC: Primary Health Centre
RI: Routine Immunization
WHO: World Health Organization

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