

Factors Influencing Childhood Immunization Uptake in Africa: A Systematic Review

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Abstract

Background: Vaccine Preventable Diseases are still the most common cause of childhood mortality with an estimated of approximately 3 million death every year mainly in Africa and Asia and about 29% of deaths among children aged 1–59 months were as a result of vaccine preventable. Despite the benefit of childhood immunization uptake, routine vaccination coverage for all recommended Expand Program on Immunization vaccines has remained poor in some African countries such as Nigeria (31%), Ethiopia (43%), Uganda (55%) and Ghana (57%). The aim of this study is to collate evidence on the factors that influences childhood immunization uptake in Africa and also provide evidence for future researchers in developing, implementing and evaluating intervention among African populations that will improve childhood immunization uptake.

Methods: We conducted a systematic review of articles on the factors influencing under-five childhood immunization uptake in Africa through using various keywords and we searched multiple databases (Medline, PubMed, CINAHL and Psychology and behavioural data collection) dated from inception to 2019.

Results: Of 17,208 records citations retrieved, 240 abstracts were screened leading to 46 included studies: The factors that were found to influence the childhood immunization uptake were classified into modifiable and non-modifiable factors and were further classified into different groups based on its relevance. The modifiable factors include: obstetric factors, maternal knowledge, maternal attitude and self-efficacy and maternal outcome expectation. Whereas non-modifiable factors were sociodemographic factors of parent and child, logistic factors and administration factors.

Conclusion: There were different factors found to be influencing under-five childhood immunization uptake among parents in Africa. Immunization health education intervention should be designed among pregnant women using social cognitive theory SCT which will enable researchers to tackle cognitive factors as well as some environmental factors that could be modifiable which may hopefully improve childhood immunization uptake in a country with poor coverage like Nigeria.

Background

Vaccine Preventable Diseases (VPDs) are still the most common cause of childhood mortality with an estimated of approximately 3 million death every year mainly in Africa and Asia [1]. From report done by World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) it was found that about 29% of deaths among children aged 1–59 months were as a result of vaccine preventable [2]. In the year 2014, there were 24.1 million reported cases of pertussis with the African region accounting for the highest proportions 7.8 million (33%) cases [3]. Nigeria was found to be one of the countries included among the 30 high burden countries with cases related to tuberculosis (TB), Human Immunodeficiency Virus (HIV) and Drugs resistant tuberculosis (DR-TB). According to the WHO report, Nigeria was estimated to have an incidence of TB 322 per 100,000 population [4].

Immunization is considered as one of the most successful and cost-effective public health interventions sustained effort of human beings against diseases that affect our health [5]. Routine immunization plays an important key role to significant reduction in child mortality, resulting from vaccine preventable diseases. World Health Organisation revealed that, immunization has been estimated to avert between 2 to 3 million deaths

every year globally. Reduction was recorded in measles mortality worldwide, between 2000 and 2016 by 84% due to measles vaccination [6]. Likewise, reduction in pertussis mortality was also recorded globally from 390,000 death in the year 1999 among children younger than 5 years of age to 160,700 death in 2014 as a result of vaccine effectiveness against pertussis [7, 6].

According to Expand Program on Immunization (EPI) every child in Africa must receive one dose of Bacillus Calmette Guerin (BCG), Oral Polio Vaccine (OPV0) and Hepatitis B Vaccine (HBV1) at birth, Penta1 & OPV1 at 6 weeks of age, Penta2 & OPV2 at 10 weeks of age, Penta3 & OPV3 at 14 weeks of age, measles and yellow fever at 9 months of age. Despite the benefit of childhood immunization uptake, routine vaccination coverage for all recommended EPI vaccines has remained poor in some African countries such as Nigeria (31%), Ethiopia (43%), Uganda (55%), Ghana (57%) the coverages are higher in some of the African countries like Tanzania and Kenya (75% and 78%) [8, 9, 10, 11, 12, 13]. Among all states in Nigeria, Anambra was reported to have highest percentage of fully child vaccination coverage 75.8% whereas Sokoto was having the lowest percentage 4.5% and for Zamfara 7.4%. [8]. Diphtheria Pertussis and Tetanus (DPT3) coverage is low in Nigeria (50%) compared to other African countries such as Ethiopia (61%), Kenya (72%) and Uganda (78%) [8, 9, 13, 10]. These coverages are still below the targets endorsed by WHO in 2012 Global Vaccine Action Plan, which aimed of ensuring delivery of universal access to immunization with associated targets of reaching 90% national vaccination coverage and at least 80% vaccination coverage in every district [14].

Previous observational studies conducted among African countries and other parts of the world have reported some factors that are influencing childhood immunization uptake. These factors include: socio-demographic factors [15, 16, 17, 18] obstetric factors [18, 19, 20, 21]. Despite the poor childhood immunization uptake in African countries, there is no current systematic review conducted that focused on describing the detail factors influencing childhood immunization uptake in Africa. Therefore, the aim of this study is to collate evidence on the factors that influences childhood immunization uptake in Africa and also provide evidence for future researchers in developing, implementing and evaluating intervention among African populations that will improve childhood immunization uptake.

Methods

This systematic review was conducted using a pre-specified protocol and reported in accordance to published Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) [22].

Electronic Database Search

We designed and implemented a comprehensive systematic literature search with assistance of an experienced librarian using a well-developed search strategy. The following databases were searched from date of inception to 9th of September 2019: Medline, PubMed, CINAHL and Psychology and behavioural data collection. The search strategy comprised a combination of medical subheading (MeSH) terms and key words "Childhood immunization uptake", factors, influencing or affecting, child or newborn or infant or baby, immunization or vaccines or vaccination or pentavalent vaccine or Penta vaccine or Bacillus Calmette Guerin vaccine or BCG or Diphtheria Tetanus and Pertussis or DTP Or Oral Polio vaccine or OPV or Measles vaccine or Yellow fever vaccine or Pneumococcal Conjugate vaccine or PCV or Hepatitis B vaccine or Hep B vaccine, uptake or adherence or compliance or coverage.

The search strategy was developed in Medline and adapted for the other databases in order to account for differences in indexing. We imposed English language limitations and also restricted to human in the search process. Reference lists of included studies were also searched.

Eligibility criteria

We included any quantitative (cross-sectional and case-control) or qualitative study design conducted in Africa which is published in English language with findings related to childhood immunization uptake, having caregivers as study participants with children less than 5 years of age and reported data on association between possible predictors and childhood immunization or gave reason any for non-compliance. We also included peer-reviewed full text publications reporting an association between at least one individual factor and uptake of childhood immunization. Moreover, no restrictions were imposed with regard to year of publication.

We excluded articles without any description of study design, intervention studies, review articles or systematic review and studies that did not mention any of the Expand Program on Immunization target vaccines according to National Program on Immunization (NPI).

Selection of studies

All searched articles were evaluated for their eligibility to be included in the review. The main researcher firstly removed all duplicates and screened the titles using Microsoft Excel. Abstract screening was then conducted independently by two reviewers. The full text for any article considered potentially relevant was also retrieved independently by the two reviewers. Consensus was reached by discussion or involvement of third reviewer when there were differences of opinion.

Data extraction

A data extraction form was designed and piloted for this review. The form was used to extract the following data: study characteristics such as authors name and year of publication, study location, method, study design, sample size, results and factors. Data was extracted independently by the two reviewers to ensure accuracy. Any disagreement was resolved by discussion or involvement of third reviewer when there were differences of opinion.

Assessment of methodological quality

The main researcher assessed the methodological quality for each of the included study using criteria outlined in the Joanna Briggs Institute (JBI) for both quantitative and qualitative studies [23], which includes 8 items for cross-sectional study design and 10 items for both case-control and qualitative study designs respectively. The checklist for cross-sectional studies includes the following items: 1. Clarity for inclusion criteria. 2. Details description of subject settings. 3. Validity and reliability of exposure assessment. 4. Used of standard criteria for measuring condition. 5. Identification of confounding variables. 6. Strategies for dealing with confounding variables. 7. Validity and reliability of outcome assessment. 8. Used of appropriate statistical analysis. The

checklist for case-control studies includes the following items: 1. Comparability of groups between the cases and controls. 2. Appropriateness matching for cases and controls. 3. Used of the same criteria for identification of cases and controls. 4. Standardization, validity and reliability of exposure assessment. 5. Similarity for exposure assessment between cases and control. 6. Identification of confounding variables. 7. Strategies for dealing with confounding variables. 8. Standardization, validity and reliability for outcome assessment. 9. Adequacy period for exposure assessment. 10. Used of appropriate statistical analysis. The checklist for qualitative studies includes the following items: 1. Congruity between the stated philosophical perspective and the research methodology. 2. Congruity between the research methodology and the research question or objective. 3. Congruity between the research methodology and the methods used for data collection process. 4. Congruity between the research methodology and the representation and data analysis. 5. Congruence between the research methodology and the interpretation of results. 6. Locating the researcher culturally or traditionally. 7. Addressing the influence of the researcher on the research or vice-versa. 8. Representation of participants and their voices. 9. Ethical approval through appropriate body. 10. Relationship of conclusions to analysis or data interpretation. In order to avoid error, the second reviewer cross checked the quality assessment. Any disagreement was resolved by discussion. Most of our studies achieved at least 70 % scores for their methodological qualities using the JBI critical appraisal tools and in this review, studies scoring ≥ 60 % were considered to be high quality.

Data synthesis

No meta-analysis was conducted, however, the results obtained from the systematic review were synthesized and placed in a logic frame work. The various results obtained from the systematic review were shown in the logic frame work and discussed in a narrative synthesis manner.

Results

Of 17,208 records citations retrieved, 7290 duplicates were removed. After screening 9918 titles, 240 records remained and their abstracts were screened. Fifty-six records remained after abstracts screen and their full text were assessed for eligibility. We excluded 25 studies in total of which 10 studies were not conducted in Africa, 6 studies did not mention any of EPI vaccine 5 were review studies and 4 were intervention studies. In total, 46 studies were included of which 31 are from the main database search, 8 from forward citation tracking and 7 from reference tracking. All the included studies looked into factors influencing childhood immunization uptake in one of the African countries (figure 1). The Table 1 contained the summary of the factors that influences under-five childhood immunization uptake among mothers/care-givers. The studies used different study designs to portray the factors that influences under-five childhood immunization uptake among parents.

Study locations

The studies were conducted in various countries within Africa with Angola, Cameroon, Congo and Mozambique with one study respectively. Burkina Faso, Gambia, Ghana and Tanzania contributed two studies respectively. Kenya and Uganda contributed three studies respectively with Ethiopia ten studies. Most of the studies were conducted in Nigeria with a total number of 18 studies. The most of the study respondents were parents of

children who were within the childhood immunization schedule range. The studies focussed on the factors that influences or determine childhood immunization uptake. The majority of the studies were mainly carried-out in west Africa (Nigeria) due to poor childhood immunization uptake in the respective nation. This demonstrated that the most of researches were still attempting to determine the main factors that play a role on influencing childhood immunization uptake which will enable researchers to address the issues for the development of future health education intervention program.

Study type and respondents

The majority of the studies were cross-sectional study design with total number of 38 studies, 3 qualitative study design [33, 46, 64], 3 mixed method [30, 32, 36] and 2 case-control [27, 59]. The number of study respondents varied across the studies with 14 being the smallest and 7815 the largest.

Factors associated with immunization coverage

The qualitative synthesis for the factors influencing childhood immunization uptake among parents of children under-five years of age identified from the 46 studies are categorized into 7 groups: parental socio-demographic factors; child socio-demographic factors; obstetric history; maternal knowledge, maternal attitude; maternal outcome expectation; maternal self-efficacy and environmental factors. This classification would enable researchers to plan an appropriate health education intervention with the use of appropriate health behavioural theory.

Modifiable factors

The factors that are considered as modifiable in this review are: obstetric factors, maternal knowledge, maternal outcome expectation, maternal attitude, maternal self-efficacy and environmental factors. These factors were found to statistically influence childhood immunization uptake in Africa. For obstetric factors, place of delivery was reported in three studies [40, 53, 63], three studies also reported postnatal care follow-up [20, 59, 63]. Two studies revealed antenatal care follow-up [16, 19], likewise maternal tetanus toxoid was reported in two studies [31, 47].

Many studies reported factors related to maternal knowledge for instance, knowledge on child immunization [27], knowledge on preventive objective of immunization [24], knowledge on vaccines [57], knowledge on child vaccination schedule which was reported in three studies [29, 53, 59]. Likewise, awareness on immunization and immunization program was also revealed in three studies [20, 32, 56]. Two studies reported the impact of knowledge of VPDs [16, 61]. For maternal attitude and self-efficacy, three studies reported availability of child immunization record [20, 24, 43]. Likewise, four studies revealed fear of vaccine side effects [30, 57, 60, 62], wrong beliefs towards childhood immunization uptake [42], good perception of immunization [45] and confidence towards vaccine safety [42].

With regards to maternal outcome expectation, three studies reported knowledge on benefit of childhood immunization uptake [29, 30, 52] and one study revealed severity of VPDs [41]. For environmental factors, two

studies reported religious belief [40, 64]. Likewise, two studies also revealed cultural belief [55, 60].

Non-modifiable factors

In this review, parental socio-demographic factors including maternal age, maternal education, paternal education, maternal marital status, area of residence, wealth index, number of siblings, religion, ethnicity and family income; child socio-demographic factors including gender and age and environmental factors including distance to health facility, mode of transportation, accessibility of vaccination site, satisfaction with vaccine services, quality of vaccine provider clients relationship and availability of vaccine are considered as non-modifiable factors. These factors were found to statistically influence childhood immunization uptake in Africa.

For parental socio-demographic factors, three studies reported maternal age [30, 31, 33], five studies reported maternal educational status [15, 18, 53, 54, 18], three studies reported paternal education [16, 44, 59], one study reported maternal occupation [16], two studies reported mothers marital status [37, 58], two studies reported area of residence [18, 53], one study reported wealth index [20], three studies reported family income [16, 24, 59], one study reported number of siblings [56], two studies reported religion [19, 40], two studies reported nomadic life style [39, 53] and ethnicity was also reported by two studies [48, 53]. For child socio-demographic factors, child age was reported in two studies [55, 56], whilst one study reported gender [42]. Regarding environmental factors, distance to health facility was revealed in three studies [16, 40, 53], one study reported mode of transportation [35], accessibility of vaccination site was also revealed in one study [28], four studies reported satisfaction with vaccine services [50, 55, 60, 64], quality of vaccine provider clients relationship was recorded in one study [50] and vaccine availability in two studies [55, 60].

Discussion

The main reason for conducting this systematic review was to identify the factors that influences under-five childhood immunization uptake among parents. In this review, many factors have been found to be influencing childhood immunization uptake and they are categorized and discussed below.

Parental socio-demographic factors

Maternal age was revealed to be a factor influencing childhood immunization uptake in a case-control study conducted in Ethiopia that involved 548 children aged (12 to 23 months) in which mothers who are above 19 years of age are about 10 times more likely to have their children fully immunized compared with mothers below 19 years of age [30]. This finding is supported with two studies conducted in Ethiopia [31, 32].

In this review, maternal education was the most frequent reported parental sociodemographic factors found to be influencing childhood immunization. Those mothers with at least primary or secondary school education were found to be about eight times more likely to have their children fully immunized compared with mothers with no formal education [55]. Many studies reported similar findings [53, 15, 54, 18]. This is more likely be due to the fact that as educational status of mothers is improving, the seeking behavior of children may perhaps increase which in turn may have positive impacts towards childhood immunization uptake. Moreover, this could

also be due to changes that accompany maternal education, such as changes in attitudes, traditions and beliefs, increased autonomy and control over household resources, which enhance healthcare seeking [55]

From a cross-sectional study conducted in Sinana district of Ethiopia consisting of 591 children aged 12-23 months, paternal education was also found to be statistically associated with child immunization status where children whose fathers has secondary and above educational level were three times more likely to be fully vaccinated compared with children whose fathers has no formal education [16, 44, 59].

Results from a cross-sectional study conducted in Sinana district of Ethiopia consisting of 591 children aged (12-23 months) has found maternal occupation to be statistically associated with child immunization uptake where mothers whose occupation is farming were almost twice more likely to complete the immunization of their children compared with mothers who were housewives; the proportion of children who were not fully vaccinated was found to be higher among mothers who are housewives [16].

Mothers marital status was reported to have influence towards childhood immunization in a descriptive cross-sectional study conducted in Ghana, that involved 280 mothers, where divorced mothers were 3 times less likely to complete immunization schedules of their children compared with mothers who were married [37]. In a cross-sectional study conducted in Nigeria involving 232 mothers (children aged 12-23 months), married women were observed to have a significantly adequate knowledge of immunization which may increase the likelihood of having higher rate of immunized children compared with mothers who were either single/divorced/widowed or separated counterparts [58].

One cross-sectional study from this review that was conducted in Kenya which consisted of 298 mothers (children aged 12-23 months) showed area of residence to be statistically influencing childhood immunization uptake where children whose area of residence were located in urban were 12 times more like to be vaccinated compared to children living in rural community [53]. In Nigeria, results obtained using NDHS data, that involved 5,754 children aged (12-23 months) has also revealed a statistical association between area of residence and child immunization status where children located in urban more like to be vaccinated compared to children leaving in rural community. This may probably be attributed to the fact that parent living in urban were more likely to be educated which may increases their knowledge towards the benefit of childhood immunization uptake compared to parent living in the rural areas [18].

Only one cross-sectional study which was conducted in Ethiopia consisting of 1,927 mothers (children aged 12-23 months) has found wealth index to be a factor influencing childhood immunization uptake where children born to mothers of rich index group were found to be as twice as likely to be fully vaccinated compared with children from mothers of poor wealth index group [20].

Family income was found to be a factor influencing childhood immunization uptake in a cross-sectional study conducted in Burkina Faso consisting of 591 children (aged 12-23 months) where the study found that if income of family is high for instance greater than 1000 ETB or 52 USD it increases the tendency of having children fully vaccinated in that family about three times compared with poorest family with less income [16]. This finding was also supported by [24, 59].

Number of siblings was found to be a factors affecting childhood immunization uptake in a cross-sectional study conducted in Angola involving 1,209 children that are below 5 years of age where family that comprised of

2 to 3 siblings were more likely to vaccinate their children compared with family with less than 2 siblings [56]. This may be due to experience accumulated over time on the importance of immunization and also on the facilities that have occurred to children due to lack of immunization.

Religion has been revealed by studies to be a factor influencing childhood immunization uptake. From a cross-sectional study conducted in Uganda using Uganda Demographic Health Survey data child immunization uptake was affected by religion status where children from Muslim were having lower chances of been fully vaccinated compared with children from Catholic families [19]. Likewise, in Mozambique parent with no religious belief were found to be as twice as likely to not complete their childhood immunization uptake [40].

Nomadic life style was found to be associated with child immunization uptake in Kenya where children born to a family who practices nomadic lifestyle were found to be 11 times more likely not to be fully vaccinated compared with children born to a family that does not practice nomadic [39,53]. The family who practices nomadic lifestyle may constantly change their locations, switching from one place to another where immunization services may not be accessible [53].

Ethnicity was found to be factor affecting childhood immunization uptake in Nigeria in which children whose belong to Igbo ethnic group were about three times as more likely to be fully vaccinated compared to children that belongs to ethnic group like Hausa, Yoruba and others [48]. This was also supported by another community based cross-sectional study conducted in Imo state, Nigeria [55].

Child socio-demographic factors

Child gender was found to be associated with child immunization uptake Ibadan, Nigeria where male child are about three times as more likely to be immunized compared with female child [42]. This may be attributed to the beliefs of parents that immunization will have negative impacts to their daughters at their child bearing age.

A contradicted finding was revealed with regards to influence of child age on immunization uptake. In Nigeria, higher immunization uptake was observed in children above 1 year of age (84.4%) compared with children below 1 year (63.6%) and this could be due to the fact that some mothers are delaying the child immunization uptake until their children reach some certain age, having negative beliefs that their children are too young to be immunized [55]. In Angola, higher immunization uptake was seeing in children who were one year of age or less than one year compared with children that were above one year of age and this could be attributed to the lectures received by mothers towards benefits of timely childhood immunization uptake during their antenatal and postnatal care, probably the content for the health education delivered to the mothers have now changed focus more on emphasizing the benefit of childhood immunization uptake [56].

Obstetric factors

Antenatal care follow-up (ANC) was found to be a factor influencing childhood immunization uptake in a cross-sectional study conducted in Ethiopia that involved 591 children (aged 12-23 months) in which mothers who frequently attend ANC during their pregnancy were about four times as likely to have their children fully vaccinated compared with mothers who did not attend ANC regularly [16]. This finding is supported with the

findings of study conducted in Uganda [19]. Mothers who went to health facilities during pregnancy may receive counselling on childhood immunization where the importance of timely childhood immunization uptake may be prioritized regularly [16].

The postnatal check-up was also found to be an influencing factor towards childhood uptake where children who received check-up within two months after birth were twice as more likely to be fully vaccinated compared to those who did not receive check-up after delivery [20, 59, 63]. This can be attributed to learning sessions that mothers were exposed to during postnatal visit where importance of timely immunization of the baby may be emphasized [20].

The maternal tetanus toxoid (MTT) vaccine was also noted to be a factor influencing childhood immunization uptake, in which mothers who received at least one dose of TT vaccine were three times more likely to have their children fully immunized compared with mothers who did not receive any dose of TT vaccine [31, 47]. This could be attributed to the knowledge that mothers may obtain with regards to the benefit of childhood immunization uptake during the TT vaccination in their health center [47].

The children who were delivered in hospital were more likely to have complete vaccination status compared with children delivered at home [40, 53, 63]. Mothers who delivered at hospital may receive advice after delivery where importance of timely immunization of the baby may be emphasized and children delivered at hospitals are more likely to receive vaccine [40].

Maternal Knowledge

Having a good maternal knowledge on child immunization was revealed to be a predictor for child immunization uptake in a case-control study conducted in Northern Ethiopia, where children of mothers with good knowledge on child immunization were found to be three times more likely to be completely immunized compared with children whose mothers are having poor knowledge on child immunization [27].

In Burkina Faso, mothers with knowledge on preventive objectives of immunization were more likely to have their children compared with mothers without the knowledge [24]. In a household-level cluster survey consisting of 7,815 children, conducted in Nigeria that involved 40 polio high risk districts of Nigeria, lack of maternal knowledge about vaccines was found to be the highest reasons contributing to poor childhood immunization uptake which accounted for 50% reasons for non-vaccination [57].

Maternal knowledge on vaccine and VPDs was also revealed to influence childhood immunization uptake in Southeast Ethiopia where children whose mothers had good knowledge on vaccine and VPDs were found to be three times as likely to be fully vaccinated compared with children that belongs to mothers who had poor knowledge on vaccine and VPDs [16]. Similar finding was also found in Nigeria [61]. Maternal knowledge on child vaccine schedule was revealed to be statistically influencing child immunization uptake where mothers who had knowledge on schedules of vaccine were found to be four times as likely to fully immunize their children compared with mother who has no knowledge on vaccine schedule [29, 53, 59]. Mothers with knowledge of immunization schedule may know the exact time for each childhood immunization uptake and they might also know the benefit of timely immunization uptake for their children. In parents who have awareness on immunization and immunization program, they were three times more likely to have their children immunized

compared with their counterpart [20, 32, 56]. Childhood immunization uptake is negatively affected by the knowledge of mothers, the more knowledge they acquired the more tendency of increasing their practice confidence towards childhood immunization uptake.

Maternal attitude and self efficacy

Studies showed that mothers who has their child immunization record were more likely to have their children fully immunized compared with mothers without child immunization records [20, 24, 43]. In Nigeria, poor attitude of mothers accounted for (16%) among the reasons for poor childhood immunization uptake [57]. Among 248 defaulting mothers in Ibadan, Nigeria more than half of the defaulting mothers reported reason for defaulting to be their belief towards childhood immunization where they considered it as waste of time [42]. The children whose mothers has positive perception towards vaccine side effects were twice as likely to be fully immunized compared with children whose mothers are having negative perception towards vaccine side effects [30]. Many studies also reported fear of vaccine side effects to influence immunization uptake [57, 60, 62]. Mothers who were lacking confidence towards vaccine safety were less likely to have their children immunized [42]. Mothers with good perception on immunization were three times as likely to have their children fully immunized compared with mothers with poor perception on immunization [45]. The attitudes of mothers towards child childhood immunization uptake is influenced by their perception which decrease their confidence towards childhood immunization uptake.

Maternal outcome expectations

Mothers who knew the benefits of childhood immunization were six times as likely to have their children fully immunized compared with their counterpart [29, 30]. Having expectation towards the protection that follows childhood immunization significantly influence childhood immunization [52]. Likewise, Knowing the seriousness of VPDs was also found to be a predictor for non-compliance [41]. The more knowledge mothers acquired with regards to benefit of child immunization and consequences of not immunizing a child the more tendency of increasing their practice confidence towards childhood immunization uptake.

Environmental factors

The environmental factors are classified as: social factors and health care system or logistic factors. Religious belief was revealed to be one of the social factors influencing childhood immunization uptake in Mozambique where mothers who considered immunization as unacceptable in their religion were less likely to have their children fully immunized compared with mothers who did not considered immunization as unacceptable in their religion [40]. Lack of adequate involvement of religious and traditional leaders in immunization activities was found to be among reason for immunization failure Borno state, Nigeria [64].

In Nigeria, cultural beliefs against immunization are found to be destructive towards childhood immunization uptake [55, 60]. This could probably be due to circulation of false information via the used of either family or religious networks. For instance, this false information might be related to negative beliefs towards vaccines, for-example believes that vaccines composed of anti-fertility drugs therefore, destroying the egg of females and damaging her reproductive system [65]. Traditional and religion leaders are highly respected and generally, they are regarded and accepted as the custodians and traditions entrusted to them to provide traditional guidance to their respective communities, therefore their involvement on immunization activities will help and increase immunization acceptance and uptake since their community have trust on them [64].

In Kenya, distance to health facility was found to affect childhood immunization uptake among 298 respondents where children belonging to mothers or caregivers who travelled with-in short distance to health facility for immunization were 18 times more likely to be fully vaccinated compared with children whose mothers or caregivers travelled far away to health facility for their children immunization [53]. This was supported with two studies conducted in Mozambique [40] and Ethiopia [16]. The mode of transportation for immunization was also revealed to be an influencing factor where mothers who are using public transports were as twice as likely to have their children fully immunized compared to mothers who walked [35].

Accessibility of vaccination site was found to be a predictor for childhood immunization uptake in Southern Ethiopia where mothers who considered immunization site to be accessible were 5 times as likely to have their children fully immunized compared to mothers who does not considered it accessible [28].

Satisfaction with vaccine services was found to influence childhood immunization uptake in Tanzania, among 380 mothers of children aged 12-23 months where mothers who are satisfied with vaccine services were about three times more likely to have their children vaccinated compared with mothers who were unsatisfied with vaccine services [50]. Similar finding was also reported in Nigeria [55, 60, 64].

The quality of vaccine provider clients' relationship was also revealed to be a predictor for childhood immunization uptake in Tanzania among 380 participants where mothers who has positive perception towards quality of vaccine provider clients' relationship were twice as likely to have their children fully immunized compared to mothers who has negative perception towards quality of vaccine provider clients' relationship [50]. This could probably be due to the way vaccine providers behave which may enhance or discourage mothers from taking children for vaccination [50].

In Nigeria, unavailability of vaccine when required was also found to be a reason for defaulting from childhood immunization uptake [55, 60]. Mothers may have been spending a lot of money with regards to having access to the health care for several times but still the service was not available and they later on got discouragement, therefore failed to complete the immunization uptake of their children [55].

Conclusions

In conclusion, various factors influencing childhood immunization uptake in Africa were identified from this systematic review. The factors were categorized into two main groups, modifiable and non-modifiable factors which were later divided further into groups. The Modifiable factors (obstetric history, maternal knowledge, maternal attitude and self-efficacy and maternal outcome expectation) were revealed as having a direct relationship with the childhood immunization uptake. Many factors and results attained from this review could

enable the researchers to further understand and develop necessary intervention in order to address the issue towards the factors influencing childhood immunization uptake. Finally, we are recommending for an immunization health education intervention among pregnant women using social cognitive theory SCT which will enable researchers to tackle cognitive factors as well as some environmental factors that could be modifiable which may hopefully improve childhood immunization uptake in a country with poor coverage like Nigeria.

Abbreviations

VPDs: vaccine preventable diseases

AOR: adjusted odd ratio

OR: odd ratio

APR: adjusted prevalence ratio

CI: confidence interval

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable.

Availability of data and materials

All data generated during this study are included in this article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ANG conceived the study with NZ, and SS advised on the methods. ANG undertook the searches and titles for screening. ANG and NZ and SS agreed final inclusions and undertook data extraction. ANG, NZ, SS and NA

contributed to write-up and editing of the final paper. All authors have read and approved the final version of this manuscript.

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Tables

Table1: Summary of systematic review of factors influencing childhood immunization uptake in Africa

| Authors/year/Location | Method | Study design | Sample size | Results | Factors |
|--|--|-----------------|-------------|---|--|
| Sanou,2009 (Nouna District, Burkina Faso) [24] | Nouna Health Research Centres Demographic Surveillance System (DSS). | Cross-sectional | n=476 | Knowledge of the preventive objectives of immunization: Illiterate parent vs literate parents 7.8% Vs 90%, p= 0.030 completely immunized; Availability of a vaccination record document: Yes vs no: OR=2.381; 95% CI: 1.436-3.948, p=0.001; Religion: Muslims Vs Others OR=1.813; 95% CI: 1.102-2.985, p=0.019; Marital status: Monogamous parent's vs polygamous parents; 61.4% vs 34.2%, p<0.05; Economic status: 4 th quartile vs 1 st , 2 nd and 3 rd : OR= 2.100; 95% CI: 1.242-3.554, p=0.006 | 1. Knowledge 2. Availability of child immunization record 3. Religion 4. Marital status 5. Economic status |
| Chiabi,2017 (Yaounde, Cameroon) [25] | Pre-tested questionnaire and children's vaccination booklets | Cross-sectional | n=400 | Maternal educational status: Higher education vs primary and secondary (AOR= 7.0; 95% CI: 2.16-22.68, p= 0.001). Paternal occupational status: Employed vs unemployed (AOR= 12.39; 95% CI: 2.21-69.26, p=0.004) | 1. Maternal education 2. Paternal occupation |
| Mwamba, 2017 (Kinshasa, Democratic Republic of Congo) [26] | Structured interview | Cross-sectional | n=1224 | Distance to health facility: < 30 minutes vs >30 minutes p=0.04; Mothers thought child vaccine is up-to date: Yes vs No <0.001. | 1. Distance to health facility 2. Mothers thought |
| Aregawi , 2017 (LaelayAdiabo District, Northern Ethiopia) [27] | Structured questionnaire | Case-control | n=270 | Maternal knowledge on Immunization: Good vs poor (AOR | 1. Maternal knowledge on immunization |

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|---|---|-----------------|-------|--|---|
| | | | | <p>= 3.3,95% CI:1.87–7.43). Post-natal care follow-up: Yes vs no (AOR = 5.2,95%CI:2.36–11.46). participation in women’s developmental groups: Good vs poor (AOR = 3.3,95%CI 1.54–7.08). Health extension worker visit: Yes vs no (AOR = 2.68,95%CI:1.30–5.51). Distance to health facility: <30 minutes vs > 30 minutes (AOR =3.56,95%CI:1.58–8.01). Other reasons for defaulting: Child illness 21.1%; Forgetfulness 17.80%; Inconvenience time 8.9%; Lack awareness about vaccine 7.80%; Not knowing return for 2nd and 3rd dose 7.80%; Vaccine not available 5.60% and Fear of side effect 4.40%.</p> | <ol style="list-style-type: none"> 2. Post-natal care 3. Participation in women’s developmental groups 4. Health extension worker visit 5. Attitude 6. Lack of awareness 7. Lack of knowledge on EPI schedule 8. Availability of vaccine |
| Animaw, 2014 (Arba Minch town and Zuria District, Southern Ethiopia) [28] | Semi structured questionnaire and child immunization record | Cross-sectional | n=630 | <p>Maternal educational status: Primary or above vs no education (AOR=2.22; 95% CI 1.31,3.76). Accessible vaccination site: Yes vs no (AOR=4.54; 95%CI:2.34,8.77). Nearest vaccine site: Health post vs outreach (AOR=1.89; 95% CI: 1.07,3.33).</p> | <ol style="list-style-type: none"> 1. Maternal education 2. Accessible vaccine site 3. Nearest vaccine site |
| Etana, 2012 (Ambo Woreda, Central Ethiopia) [29] | Structured questionnaire and child immunization record | Cross-sectional | n=536 | <p>Maternal Knowledge on benefit of immunization: Yes vs no (OR=4.5; 95% CI: 2.5,7.9). Maternal Knowledge on age to start immunization: Yes vs no (AOR=2.9, 95% CI: 1.9,4.6). Maternal knowledge on age to complete child</p> | <ol style="list-style-type: none"> 1. Maternal knowledge on benefit of vaccine 2. Knowledge on age to start child immunization |

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|--|---|------------------------|---------------|--|--|
| | | | | <p>immunization: Yes vs no (AOR=4.3; 95%CI:2.3,8.0). ANC follow-up: Yes vs no (AOR=2.4; 95% CI:1.2,4.9). Maternal knowledge on total immunization session: Yes vs no (OR=1.7; 95%CI:1.1,2.5). Place of delivery: Hospital vs home (AOR=2.1; 95% CI: 1.3,3.4).</p> | <p>3. Knowledge on age to complete child immunization</p> <p>4. ANC follow-up</p> <p>5. Maternal knowledge on total immunization session</p> <p>6. Place of delivery</p> |
| <p>Negussie, 2016(Arbegona district, southern Ethiopia) [30]</p> | <p>Structured questionnaire and focused group discussion</p> | <p>Mixed method</p> | <p>n=548</p> | <p>Case-control findings</p> <p>Maternal Age: >19 years vs < 19 years (AOR=9.54; 95% CI: 5.03, 18.09, p=0.001). Knew the benefits of immunization: Yes vs no (AOR=5.51; 95% CI:1.52, 19.94. p=0.009). Perception about vaccine side effects: Positive vs negative (AOR=1.92; 95% CI:1.01, 3.70). Birth order: 1 vs 2 – 4 (AOR=3.64; 95% CI:1.63, 8.14, p <0.001); 1 vs ≥ 5 (AOR=5.27; 95% CI:2.20, 12.64, p=0.002).</p> <p>Qualitative findings</p> <p>Maternal migration, fear of vaccine side effect, unavailability of vaccine, knowledge on EPI schedule.</p> | <p>1. Maternal age</p> <p>2. Knowledge on benefit of immunization</p> <p>3. Perception about vaccine side effect</p> <p>4. Birth order</p> <p>5. Maternal migration</p> <p>6. Availability of vaccine</p> <p>7. knowledge on EPI</p> |
| <p>Lakew,2015(Ethiopia) [20]</p> | <p>Ethiopian Demographic and Health Survey (EDHS) women questionnaire</p> | <p>Cross-sectional</p> | <p>n=1927</p> | <p>Source of immunization information: Immunization record vs mothers self-report (AOR=7.7; 95% CI: 5.95-10.06). postnatal check-up:</p> | <p>1. Source of information</p> <p>2. PNC check-up</p> |

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|--|---|-----------------|-------|---|---|
| | | | | Yes vs no (AOR= 1.8; 95% CI: 1.28-2.56). women's awareness of community conversation program: Yes vs no (AOR= 1.9; 95% CI: 1.44-2.49). wealth index: Rich vs poor (AOR= 1.4, 95% CI:1.06-1.94). | 3. Awareness 4. Wealth index |
| Mohamud, 2014(Jigjiga District, Somali National Regional State, Ethiopia) [31] | Structured questionnaire | Cross-sectional | n=582 | Maternal age: ≥ 20 years vs ≤ 19 years (AOR= 2.19; 95% CI:1.26,3.83). Maternal literacy: Literate vs illiterate (AOR= 3.06; 95% CI:1.64,5.71). Place of residence: Urban vs rural (AOR=2.04; 95% CI:1.33,3.13). Maternal TT vaccine: Yes vs no (AOR=2.43; 95% CI: 1.56,3.77). Place of delivery: Hospital vs home (AOR= 2.02; 95% CI:1.24,3.28). Household visit by health workers: Yes vs no (AOR= 1.92; 95% 1.17,3.16). | 1. Maternal age 2. Maternal literacy 3. Place of residence 4. Maternal TT vaccine 5. Place of delivery 6. House hold visit by health workers |
| Abebe, 2019 (BassonaWorena Woreda, Amhara Region, Ethiopia) [32] | Structured questionnaire and focused group discussion | Mixed method | n=575 | Cross-sectional findings Maternal age: ≥ 40 years versus ≤ 40 years (AOR = 1.9; 95% CI 1.12, 5.83). Awareness about immunization: Yes vs no (AOR = 2.8; 95% CI 1.67, 9.34). ANC follow-up: Yes vs no (AOR = 3.67; 95% CI 1.96, 6.78). Availability of health facility: Yes vs no (AOR = 1.49; 95% CI 1.06, 8.12). | 1. Maternal age 2. Awareness 3. ANC follow-up 4. Availability of health facility 5. Lack of faith |
| | | | | Qualitative findings Lack of awareness on immunization; no | |

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|---|---|-----------------|--------|--|--|
| | | | | faith on immunization; ANC follow-up; availability of health facility | |
| Zewdie et al, 2016 (Hadiya zone, Southern Ethiopia) [33] | Focused group discussion | Qualitative | n=14 | Lack of awareness on immunization; no faith on immunization; ANC follow-up; availability of health facility; knowledge of benefits of immunization; knowledge of vaccination schedules and service arrangements; lack of social support from family; loss of vaccination card; problems with vaccine supply and service arrangement; health systems and health care provider factors; poor counselling and client-provider relationships are influencing childhood immunization uptake. | |
| Payne, 2013 (Gambia) [34] | Farafenni Health and Demographic Surveillance System (FHDSS). | Cross-sectional | n=7363 | Ethnic group: Wolof vs Mandika (AOR=1.52; 95% CI:1.28–1.81, p <0.001). Wealth index: Quintile 5 vs Quintile 1 (AOR= 1.49; 95% CI: 1.09–2.04, p= 0.011). | 1. Ethnic group 2. Wealth index |
| Odutola, 2015 (Western region of Gambia) [35] | Structured questionnaire | Cross-sectional | n=1154 | Place of birth: Hospital vs home (AOR=1.47; 95% CI: 1.05–2.07, p=0.001). Mode of transportation: Public transport vs walking (AOR=1.54; 95% CI:1.20–1.97, p=0.02). Birth order: ≥ 2 vs ≤ 2 (AOR:1.37; 95% CI: 1.04–1.79). | 1. Place of birth 2. Mode of transportation 3. Birth order |

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|--|---|-----------------|--------|--|--|
| Bosu, 1997 (Komenda-Edina-Eguafo-Abrem District of Ghana) [36] | Structured questionnaire and focused group discussion | Mixed method | n=469 | <p>Cross-sectional findings</p> <p>Knowledge of EPI diseases: Inadequate Vs adequate: 30.35% vs 17.58% children not fully immunized.</p> <p>Mothers who never attend child immunization (n=74): financial difficulties (37.8%); baby too young (14.9%); mothers travelled out of community (13.5%); mothers too busy (4.1%)</p> | <ol style="list-style-type: none"> 1. Knowledge on EPI diseases 2. Financial difficulties 3. Mothers attitude |
| Anokye, 2018 (Koforidua, Ghana) [37] | Structured questionnaire | Cross-sectional | n=280 | <p>Marital status: Married vs divorced (AOR=3.01; 95% CI: 1.59–58.2, p=0.048); Employment status: Working part-time vs unemployed (AOR=2.28; 95% CI:1.031–9.11, p=0.049); Maternal income: >100 cedes vs <100 cedes (AOR=2.41; 95% CI:1.56–2.01).</p> | <ol style="list-style-type: none"> 1. Marital status 2. Employment status 3. Income |
| Mutua, 2011 (Korogocho and Viwandani slums of Nairobi, Kenya) [38] | Nairobi Urban Health and Demographic Surveillance System (NUHDSS) | Cross-sectional | n=1848 | <p>Place of delivery: Hospital vs home (OR=1.27; 95% CI: 1.002,1.619). Maternal education: Complete primary school vs not complete (OR=1.3024; 95% CI: 1.011,1.676). Maternal age: > 20 years vs < 20 years (OR=1.48; 95% CI: 1.057,2.079).</p> | <ol style="list-style-type: none"> 1. Place of delivery 2. Maternal education 3. Maternal age |
| Pertet, 2018 (pastoralist community of Kenya) [39] | An interviewer-administered questionnaire | Cross-sectional | n=515 | <p>lack of vaccines, p=0.002; location of health facility, p=<.001; nomadic lifestyle: OR=9.0; 95% CI: 1.11, 72.66, p=0.006</p> | <ol style="list-style-type: none"> 1. Availability of vaccine 2. Location of health facility |

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|---------------------------------------|-------------------------|-----------------|-------|--|--|
| | | | | | 3. Nomadic lifestyle |
| Jani, 2008 (Southern Mozambique)[40] | Face to face Interview | Cross-sectional | n=668 | Distance to health facility: Near vs far away (OR=3.64; 95% CI: 1.71,7.74, p=0.001). Maternal schooling: Yes vs no (OR=2.24; 95% CI: 1.41,3.56, p=0.001). Knowledge on EPI: Yes vs no (OR=2.02; 95% CI: 1.19,3.42, p=0.009). Religious beliefs: Yes vs no (OR=1.65; 95% CI: 1.15,2.36, p=0.004). Child born: Inside Mozambique vs outside (OR=5.20; 95% CI: 3.35,11.51, p<0.001). Place of delivery: Hospital vs home (OR=1.78; 95% CI: 1.28,3.36, p=0.03). Marital status: Married vs divorced or widowed (OR=1.68; 95% CI: 1.07,2.64, p=0.02). | 1. Distance to HF 2. Maternal schooling 3. Knowledge on EPI 4. Religious beliefs 5. Child born location 6. Place of delivery 7. Marital status |
| Umeh, 2018 Northern Nigeria [41] | Face to face interview | Cross-sectional | n=396 | Compliant vs non-compliant Satisfaction with immunization p=0.001; refusal to vaccination p=0.001; doubt about Immunization p=0.001; worries about Vaccination Safety p=0.001; knowledge on importance of vaccination p=0.001; seriousness of VPDs p=0.045. | 1. Immunization satisfaction 2. Attitudes 3. Knowledge on important of vaccination 4. Seriousness of VPDs |
| Oladokun, 2010 (Ibadan, Nigeria) [42] | Face to face interviewe | Cross-sectional | n=248 | Maternal education: Primary vs none: OR=5.90; 95% CI: 1.87,17.92, p=0.002. Religion: Christianity vs Islam: OR=3.05; 95%: 1.20,7.81, p=0.019. Gender of child: Male vs | 1. Maternal education 2. Religion 3. Child gender |

| | | | | | |
|--|--|-----------------|--------|---|--|
| | | | | female: OR= 2.98; 95% CI: 1.21, 7.35, p=0.017. Mothers Beliefs and attitudes on Immunization: 248 defaulters: availability of vaccines 65 (26.2%); lack of knowledge on EPI 41 (16.5%); inconvenient time 34 (13.7%); lack of knowledge on benefit of immunization 24 (9.7%); child ill 25 (10.1%); Immunization is waste of time 129 (52%); immunization is harmful to children 81 (32.7%) | 4. Mothers beliefs and attitude |
| Babalola, 2008 South and Northern Nigeria [43] | Face to face interview | Cross-sectional | n=1472 | Place of delivery: Hospital vs home (OR=2.54). child immunization record: Yes vs no (OR=2.10). Immunization ideation: High vs low (OR=6.04). | 1. Place of delivery 2. Child immunization record 3. Immunization ideation |
| Odusanya, 2008 Edo State, Nigeria [44] | Interviewer administer questionnaire | Cross-sectional | n=339 | Child immunization record: Yes vs no (p=0.002) | 1. Child immunization record |
| Taiwo, 2017 Kaduna State, Nigeria [45] | Semi-structured interviewer-administered questionnaire | Cross-sectional | n=379 | Maternal education: educated vs uneducated (AOR= 1.90; 95% CI: 1.11,3.28). Maternal perception on immunization: Good vs poor (AOR= 2.60; 95% CI: 1.50,4.51). Maternal knowledge on immunization: Satisfactory vs unsatisfactory(135 (35.6%) vs 244 (64.4%)). | 1. Maternal education 2. Maternal perception 3. Maternal knowledge on immunization |
| Oku, 2017 Northern and Southern Nigeria [46] | In-depth interview | Qualitative | n=15 | health workers shortages; training deficiencies; poor attitudes of health workers; long waiting times; attitudes among | |

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|---|--|-----------------|---------|--|---|
| | | | | community members; engagement of traditional and religious institutions | |
| Adedire, 2016 Ogun State, Nigeria [47] | Semi-structured questionnaire | Cross-sectional | n=750 | ANC follow-up: Yes vs no (AOR=3.3; 95% CI:1.2 , 8.3, p=0.03). Maternal tetanus toxoid: At least a dose vs none (AOR= 3.2; 95% CI: 1.1,10.0, p=0.04). Maternal knowledge on RI: Good vs poor (AOR=2.4; 95% CI: 1.6,3.8, p<0.001). Access to immunisation information in last 12 months: Yes vs no (AOR=2.5, 95% CI:1.1, 2.5, p=0.02). | 1. ANC follow-up 2. Maternal TT 3. Maternal knowledge on RI 4. Accessibility |
| Adedokun, 2017 Nigeria [18] | Secondary analyses from the 2013 Nigeria Demographic and Health Survey (DHS) | Cross-sectional | n= 5754 | Maternal education: secondary or higher vs none (AOR=2.14; 95% CI:1.59,2.86 secondary or higher vs primary: AOR=1.42; 95% CI:1.14,1.76). Birth order 1st -3rd order vs 4th -6th order (AOR= 1.53; 95% CI:1.24,1.86). Access to health facility: Not a problem vs problem (AOR: 1.28;1.02,1.57). | 1. Maternal education 2. Birth order 3. Accessibility |
| Antai, 2009 Nigeria [48] | Secondary analyses from the 2003 Nigeria Demographic and Health Survey (DHS) | Cross-sectional | n= 3725 | Ethnicity: Hausa/Fulani vs Igbo (AOR= 2.47; 95% CI:1.28,4.76). | 1. Ethnicity |
| Ijarotimi, 2018 Oyo State, Nigeria [49] | interviewer administered questionnaires | Cross-sectional | n=449 | Maternal educational status: ≥ Primary vs none (AOR=6.4; 95% CI:2.9,14.0). Maternal religion: Christian vs Muslims (AOR= 2.2; 95% CI: 1.3–3.7). Wealth index: Richest vs poorest (AOR= 14.5; 95% CI:8.2–20.5). | 1. Maternal education 2. Religion 3. Wealth index |

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| Chambongo, 2016 Illeje District, Tanzania [50] | Structured questionnaire | Cross-sectional | n=380 | Place of birth: Health facility vs home (AOR=14.4; 95% CI:8.04-25.8). Perceived quality of vaccine provider client's relationship: Positive vs negative (AOR=1.86; 95% CI: 1.03-3.5). Satisfaction with vaccine services: Satisfied vs unsatisfied (AOR=2.63; 95% CI:1.1-6.3). | 1. Place of birth 2. Perceived quality of vaccine provider client's relationship 3. Satisfaction with vaccine services: |
| Semali, 2010 Tanzania [51] | Secondary analyses from the 1990, 1996 and 2004 Tanzania DHS | Cross-sectional | n=4471 | Residence: Urban vs rural (AOR= 1.4; 95% CI: 1.0-1.9). Number of children under five years: <2 vs >2 (AOR=1.4; 95% CI: 1.0-1.8). Wealth index: Least poor vs most poor (AOR=1.9; 95% CI: 1.1-3.7). | 1. Residence 2. Number of children under five years 3. Wealth index |
| Vonasek, 2016 Rural Sheema District Southwest Uganda [52] | Face-to-face interviews | Cross-sectional | n=476 | Stated reasons to immunize children Protect children from disease: Yes vs no (PR= 1.35; 95% CI: 1.01, 1.80). | 1. Knowledge |
| Kiptoo, 2015 East Pokot, Baringo, Kenya [53] | Structured questionnaire | Cross-sectional | n=298 | Maternal level of education: primary vs none (OR=3.55; 95% CI: 1.49-8.47; p=0.0049). knowledge on immunization schedule: yes vs no (OR=9.04; 95% CI:1.37-7.87; p<0.0001). Nomadic lifestyle: yes vs no (OR=11.06; 95% CI: 4.29-28.54; p<0.0001). Distance to health facility: <1-hour vs >1 hour (OR=18.24; 95% CI: 5.56-59.80; p<0.0001). Area of residence: urban vs rural (OR=12.3; 95% CI: 4.77-31.73; p<0.0001). Place of birth: hospital vs home (OR= 4.5; 95% CI: 1.7-11.61; p<0.0001). | 1. Maternal level of education 2. Knowledge on immunization schedule 3. Nomadic lifestyle 4. Distance to health facility 5. Area of residence 6. Place of birth |

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| Kagone, 2017 Nouna, North West Burkina Faso [54] | Nouna Health and Demographic Surveillance System (HDSS) | Cross-sectional | n=6579 | Maternal educational status: educated vs non educated (AOR=1.08; 95% CI: 1.02-1.13; p=0.02) | 1. Educational status |
| Gidado, 2014 Zamfara state, Nigeria [15] | Structured interviewer-administered questionnaire | Cross-sectional | n=450 | Satisfactory knowledge on routine immunization: yes vs no (AOR=18.4; 95% CI=3.6-94.7). Level of education: secondary education vs none (AOR=3.6; 95% CI=1.2-10.6) | 1. Satisfactory knowledge on routine immunization 2. Level of education |
| Duru, 2016 Imo state, Nigeria [55] | Semi structured, interviewer administered questionnaire | Cross-sectional | n= 743 | Maternal age (year): 25-29 vs <25 (OR= 2.1; 95% CI: 1.12-4.05; p < 0.01). Maternal level of education: primary vs none (OR= 7.5; 95% CI: 1.27 - 44.08, p < 0.05). Knowledge about immunization: good vs poor (OR= 37.71; 95% CI: 4.74 - 299.62; p < 0.0001). | 1. Maternal age 2. Maternal level of education 3. Knowledge about immunization |
| Legesse, 2015 Southeast Ethiopia [16] | Pre-tested, interviewer administered questionnaire | Cross-sectional | n=591 | Antenatal care follow-up: yes vs no (AOR = 3.7; 95% CI: 2.3-5.9). Maternal occupation: farmer vs housewife (AOR = 1.9; 95% CI: 1.1-3.1). Paternal level of education: >secondary vs illiterate (AOR = 3.1; 95% CI: 1.3-7.4). Family income: >1000 52 USD vs < 52 USD (AOR = 3.2; 95% CI: 1.4-7.4). Distance to health facilities: <an hour vs > an hour (AOR = 3.1; 95% CI: 1.5-6.3). Ever discussed about immunization with HEWs: yes vs no (AOR = 2.4, 95% CI: 1.3-4.2). Maternal knowledge on immunization: good | 1. Antenatal care follow-up 2. Maternal occupation 3. Paternal level of education 4. Family income 5. Distance to health facilities 6. Ever discussed about immunization with HEWs 7. Maternal knowledge on immunization |

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| | | | | vs poor (AOR = 2.5; 95% CI: 1.5-4.2). | |
| Oliveira, 2014 Angola [56] | interviewer administered questionnaire | Cross-sectional | n=1209 | Child age (years): > 1 vs < 1 (APR=1.78; 95% CI: 1.53-2.07). Family size: 2-3 vs > 6 (APR= 1.34; 95% CI: 1.05-1.71). Knowledge of immunization programs: yes vs no (APR=1.32; 95% CI: 1.07-1.63). Appliances: radio vs television or none (APR=1.45; 95% CI: 1.05-1.99). | 1. Child age 2. Family size 3. Knowledge of immunization programs 4. Appliances |
| Bbale, 2013 Uganda [19] | Uganda Demographic Health Survey (UDHS) | Cross-sectional | n= 7591 | Maternal educational status: primary education vs no education (increase probability of fully immunized child 8-14%; p< 0.05); secondary education vs no education (increase probability of child receiving three doses of DPT and oral polio vaccines: 6-7%; p< 0.05); primary education vs no education (increase probability of child receiving three doses of oral polio vaccines: 7-11%; p< 0.01). Wealth index: rich vs poor (increase probability of child being vaccinated against polio and measles by 7%; p< 0.05). | 1. Maternal educational status 2. Wealth index |
| Gunnala, 2016 Nigeria [57] | Pre-tested, interviewer administered questionnaire | Cross-sectional | n=7815 | Common reported reason for non-vaccination: lack of maternal knowledge on vaccines and vaccination services (50%), poor maternal attitude towards immunization (16%), lack of access to routine | 1. Lack of maternal knowledge on vaccines 2. Poor maternal attitude towards immunization |

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| | | | | immunization services (15%) and fear of side effects (9%). | <ol style="list-style-type: none"> 3. Lack of access 4. Fear of side effects |
| Chris-Otubor 2016 Nigeria [58] | semi-structured questionnaire | Cross-sectional | n=232 | Maternal education: primary or secondary vs none; marital status: married vs single or separated or divorced; religion: Islam vs Christian, geopolitical zone: and the mother or the father of the child been immunized as children significantly influenced maternal knowledge on childhood immunization ($p < 0.05$). | <ol style="list-style-type: none"> 1. Maternal education 2. Marital status 3. Religion 4. Geopolitical zone 5. Mother or father being immunized as children |
| Tadesse, 2009 Ethiopia [59] | structured questionnaire | Case-control | n=264 | Current postnatal care visit: yes vs no (AOR= 19.52; 95% CI: 1.68-226.29). Perceived health institution support: positive attitude vs negative attitude (AOR= 2.71; 95% CI 1.39-5.26). knowledge of immunization schedule: yes vs no (AOR= 3.01; 95% CI: 1.42-6.35). knowledge on OPV schedule: yes vs no (AOR= 6.52; 95% CI: 1.35-31.39). knowledge on measles: yes vs no (AOR= 34.72; 95% CI: 12.74-94.64). knowledge on benefit of vaccines: yes vs no (AOR= 6.36; 95% CI: 1.24-9.53). | <ol style="list-style-type: none"> 1. Postnatal care visit 2. Perceived health institution support 3. Knowledge on immunization schedule 4. Knowledge on OPV schedule 5. Knowledge on measles 6. Knowledge on benefit of vaccines |
| Kio, 2016 Ogun state, Nigeria [60] | Structured pre-tested questionnaire | Cross-sectional | n=120 | Reason for defaulting: 52% or respondents are lacking knowledge on child immunization schedule, 47.5% reported lack of awareness on | <ol style="list-style-type: none"> 1. Lack of maternal knowledge on child immunization schedule 2. Lack of awareness on |

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| | | | | immunization in their areas, 54.2 reported negative cultural belief on immunization in their areas, 43.8% believes immunization to has adverse effects, 54.2% reported communicable diseases has to do nothing with routine immunization and 51% reported their children to be available for immunization only if the schedule is convenient for them | immunization 3. Cultural beliefs 4. Adverse effects 5. Lack of knowledge routine immunization 6. Convenient time |
| Awosan, 2018 Sokoto state, Nigeria [61] | standardized, structured, interviewer-administered questionnaire | Cross-sectional | n=220 | 55.5 % of the respondents are having poor knowledge of the child that requires immunization and its benefits. 50.9% of the respondents are having poor knowledge on vaccine preventable diseases (VPDs). Knowledge on VPDs: good vs poor (85.2% vs 46.4% p<0.05 children fully immunized). | 1. Knowledge on immunization 2. Knowledge on VPDs |
| Ekure, 2013 Southwest, Nigeria [62] | interviewer-administered questionnaire | Cross-sectional | n=36 | >30 % of the respondents reported not to take their children back to complete RI if they develop any adverse effect and >40 % of the respondents reported not to allow their children to receive polio vaccine. | 1. Fear of adverse effects 2. Poor attitude |
| Canavan, 2014 Uganda [63] | Uganda demographic Health Survey (UDHS) | Cross-sectional | n=474 | Maternal educational status: secondary school or higher vs no formal education (AOR=3.39; 95% CI:1.20-9.51). Place of delivery: public hospital vs home (AOR=3.94; 95% CI: 2.12-7.33). | 1. Maternal educational status 2. Place of delivery |

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| Omotora, 2012 Borno state, Nigeria [64] | Focus group discussion | Qualitative | n=120 | The main reasons for not fully supporting immunization program in some areas includes: inadequate adequate information about logistics and time of immunization programme, lack of adequate involvement of traditional and religious leaders and poor attitude of health workers. Mothers need incentives in order for them to take their children for immunization in forms of soap and complimentary health care services. | <ol style="list-style-type: none"> 1. Inadequate adequate information about logistics and time of immunization programme 2. Lack of adequate involvement of traditional and religious leaders 3. Poor attitude of health workers. 4. Incentives |
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Figures

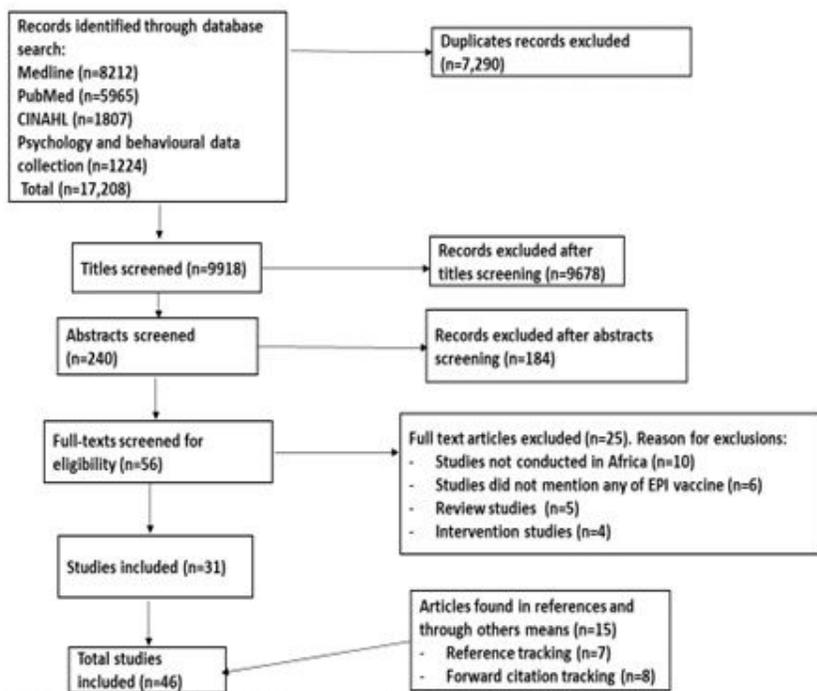


Fig 1: PRISMA flow diagram for the identification, screening, eligibility, and inclusion of studies.

Figure 1

PRISMA flow diagram for the identification, screening, eligibility, and inclusion of studies

Supplementary Files

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