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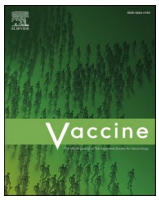

Review

Paternal factors affecting under-five immunization status in Sub-Saharan Africa: A systematic review and meta-analysis

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ABSTRACT

While maternal influences on childhood immunization have been extensively studied in sub-Saharan Africa (SSA), paternal socioeconomic factors remain underexplored despite their potential impact on vaccination outcomes. This systematic review and meta-analysis aimed to synthesize current evidence on the influence of paternal characteristics on full childhood immunization status in SSA.

A comprehensive literature search was conducted in PubMed, Google Scholar, Embase, and Scopus for studies published between January 2014 and March 2025. Studies were included if they examined paternal factors, such as education, employment, and decision-making power, in relation to childhood immunization among children under five in SSA. Data were extracted from 16 eligible studies, and a meta-analysis was conducted using MetaXL and IBM SPSS to calculate pooled prevalence and effect sizes. The Downs and Black checklist was used for risk of bias assessment.

Of the 16 studies included, seven contributed data to the meta-analysis on full immunization. The pooled prevalence of full immunization was 60 % (95 % CI: 37–81 %) across SSA. Children of fathers with primary education or higher were nearly three times more likely to be fully immunized than those whose fathers had no formal education (OR = 2.72, 95 % CI: 1.22–6.03, I^2 = 98 %). While the association between paternal employment status and child immunization was statistically non-significant (OR = 1.74, 95 % CI: 0.10–29.20, I^2 = 91 %), qualitative findings suggest employment influences health-seeking behavior. Decision-making power within households also emerged as an important factor, with joint parental decision-making linked to higher immunization coverage.

Interventions aiming to improve immunization outcomes should consider strategies to engage fathers, promote joint decision-making, and address underlying gender norms. Further research is needed to understand better the mechanisms through which paternal factors influence vaccine uptake in diverse SSA settings.

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1. Introduction

Immunization plays a critical role in the prevention of infectious diseases, safeguarding both individual and public health. In sub -Saharan Africa (SSA), where child mortality rates remain high, vaccination against preventable diseases such as measles, polio, and hepatitis remains a significant public health priorities [1]. Full vaccination against vaccine preventable diseases such as measles, polio and hepatitis is critical because not only this protect individual health, but also contributes to herd immunity and the general reduction of disease transmission in communities [2].

As caregivers, parents play an instrumental role in health decision-making processes for their children in families. Traditionally, mothers are seen as the primary decision-makers when it comes to child health, including immunization. However, the importance of involving both parents in health decision-making is increasingly recognized [3–5]. Fathers, as key stakeholders in the household, contribute not only financially but also in terms of logistical and decision-making support, which can significantly influence vaccination rates. Studies suggest that paternal involvement is associated with higher immunization rates among children, highlighting the need for strategies that encourage fathers to take an active role in their children's health [6]. This relationship underscores the importance of recognizing paternal characteristics as key factors in shaping health-seeking behaviors and vaccination adherence within families, especially in SSA, where traditional gender roles often assign health responsibilities predominantly to mothers.

Despite this recognition, much of the research on immunization in SSA has focused predominantly on the role of maternal characteristics as key determinants of vaccination outcomes. Despite this recognition, much of the research on immunization in SSA has focused predominantly on the role of maternal characteristics as key determinants of vaccination outcomes. This bias has resulted in resulted in paternal characteristics remaining underexplored in the context of childhood immunization health-seeking behavior. Ignoring the role of fathers also contributes to widening gender inequalities, as fathers should also be supported to be further involved in their children's health decision-making. While maternal factors undoubtedly play a significant role, understanding the influence of fathers, particularly their socioeconomic status, education, and involvement in health decisions, can provide a more comprehensive view of the dynamics that affect immunization rates [7]. The necessity of this research lies in addressing a critical evidence gap.

Research has shown that paternal characteristics such as income, education, and employment status have a direct impact on health behaviors within families [8–10]. Fathers often hold significant authority in financial and logistical decisions, which can affect access to healthcare services, including immunization. Furthermore, education levels among fathers have been linked to greater health literacy, which can lead to more informed decisions regarding their children's health [8]. This study, therefore, aims to address these gaps by synthesizing evidence of paternal factors affecting full childhood immunization in under-fives in SSA. In doing so, the study will also explore the challenges, strategies, and lessons learned from past interventions. Specifically, the review addresses two research questions:

1. What paternal factors are associated with the uptake of routine childhood vaccines in sub-Saharan Africa?
2. Which paternal factors act as risk or protective factors for full childhood immunization status in sub-Saharan Africa?

2. Methods

2.1. Study design, literature search and screening

This systematic review and meta-analysis conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [11]. The protocol was registered on PROSPERO (ref: CRD420251036825). A comprehensive search was performed across the following electronic databases: PubMed, Google Scholar, Embase, and Scopus. The search covered studies published from January 1, 2014, to the date of the final search (March 2nd, 2025). We chose the time frame from January 1, 2014, to March 2, 2025, to ensure the review reflects the most recent and relevant evidence regarding paternal factors affecting under-five immunization in Sub-Saharan Africa. Studies prior to 2014 were excluded to focus on data that align with recent global and regional immunization strategies, policy changes, and shifts in paternal involvement in child health over the past decade. This period also captures the post-MDG (Millennium Development Goals) era, transitioning into the Sustainable Development Goals (SDGs), during which child health interventions and data reporting significantly evolved.

Search terms included combinations of keywords and Boolean operators. Key search terms included father OR paternal; immunization OR vaccination; child OR infant OR under-five; coverage OR uptake. Medical Subject Headings (MeSH) and equivalent controlled vocabulary were used where applicable to enhance the search sensitivity. The search was restricted to human studies and studies published in English. Reference lists of included articles and relevant reviews were also handsearched to identify additional studies. All retrieved articles were screened by title and abstract, followed by full-text screening based on pre-defined inclusion criteria. Two researchers conducted article screening. Discrepancies were resolved by engaging a third, more senior, reviewer.

2.2. Inclusion criteria

Participants: Studies were included if they examined children aged five years or younger, residing in sub-Saharan Africa. Studies focusing on children selected due to pre-existing illness or conditions unrelated to routine immunization were excluded.

Predictors/Exposures: Studies were included if they assessed paternal factors, such as education, income, employment status, health decision-making involvement, or other paternal characteristics, and their association with full childhood immunization status. Studies that focused solely on maternal characteristics or factors unrelated to paternal influence (such as community-level interventions, maternal education only, or health system factors) were excluded.

Outcomes: This review addressed two research questions, each with specific outcome criteria. For Research Question 1, which examined the range of paternal factors associated with childhood immunization, studies were included if they reported an association between paternal characteristics and the uptake of any routine childhood vaccine. Studies were eligible even if they focused on a single vaccine, rather than full immunization, provided the paternal factor and immunization outcome were clearly linked. For Research Question 2, which investigated the influence of paternal factors on full immunization status, studies were included only if they reported data on complete or full childhood immunization—defined as the receipt of all vaccines recommended for a child's age according to the national immunization schedule of the respective sub-Saharan African country. Studies that only reported partial immunization or the uptake of individual vaccines without assessing full immunization coverage were excluded from this part of the analysis.

Study Reporting and Design: We included studies using quantitative methodologies, noting the specific methodology such as cross-sectional, cohort, or case-control designs. Only studies conducted in countries within the sub-Saharan African region were eligible. For feasibility, only studies published in English were included

2.3. Data extraction

For each included study, we extracted detailed information using a

standardized data extraction form. The extracted data included the country in which the study was conducted, the study design (such as cross-sectional, cohort, or case-control), and the sample size, along with relevant population characteristics, including the age range of children and demographics of fathers. We also recorded the type of vaccine or vaccines assessed, noting whether the study focused on specific vaccines or reported on full immunization based on the national immunization schedule. Particular attention was given to the paternal factors evaluated in each study. The immunization outcomes were categorized based on whether the study reported on the uptake of a single vaccine or full immunization status. Additionally, we extracted the statistical measures used to describe the associations, including odds ratios, confidence intervals, and *p*-values, as well as the key findings relevant to the influence of paternal characteristics on childhood immunization outcomes. Data extraction was carried out independently by two reviewers. Any discrepancies between reviewers were resolved through discussion, and if necessary, by consulting a third reviewer.

2.4. Risk of bias assessment

The risk of bias for each included study was assessed using an adapted version of the Downs and Black Checklist [12], a validated tool commonly used for evaluating the methodological quality of quantitative studies in systematic reviews [13]. This checklist examines five key domains: study quality, external validity, study bias, confounding and selection bias, and the study's power. Given the observational nature of the included studies, items related explicitly to interventions were excluded from the assessment, as they were not applicable.

Each study was scored out of a maximum of 19 points. Based on the total score, studies were classified as follows: those scoring 16 or above were considered good quality, scores of 11–15 indicated moderate quality, and studies scoring 10 or less were of poor quality [12]. Risk of bias was defined as the potential for systematic error in study design, conduct, or reporting that could distort the true effect of paternal factors on childhood immunization outcomes. The assessment was conducted independently by two reviewers, with any discrepancies resolved through discussion or consultation with a third reviewer when necessary. This approach ensured a consistent and objective appraisal of the methodological rigor of each study included in the review, helping to contextualize the strength of the evidence on paternal influences on childhood immunization in sub-Saharan Africa.

2.5. Meta- analysis

Data were exported to MetaXL for analysis to quantify the pooled prevalence of full childhood immunization in SSA. A random effects meta-analysis model was utilized to address potential heterogeneity among studies. The Q and I^2 tests were employed to assess the statistical heterogeneity of the studies. I2 cut-off points of 25 %, 50 %, and 75 % indicate low, medium, and high heterogeneity, respectively [14]. While the original protocol proposed performing subgroup analyses to investigate potential differences in the prevalence of full childhood immunization based on the year of publication, sample size, and the region, this was not conducted due to limited number of studies retrieved. Funnel plots were utilized to assess publication bias. Sensitivity analysis was performed to determine the impact of individual studies on the overall prevalence of full childhood immunization. Data was exported to IBM SPSS Statistical Package for Windows version 29 to ascertain the pooled effect size of the determinants of full childhood immunization and the effect size of each determinant in individual studies. Odds ratios were utilized to estimate the pooled effect sizes. Only variables that demonstrated statistical significance in at least two of the included studies were incorporated into the meta-analysis. Non-dichotomous variables were converted into dichotomous variables before the computation of odds ratios. Forest plots were used to represent pooled estimates and their 95 % confidence intervals visually. A *p*-value below 0.05 was deemed statistically significant for all statistical analyses.

3. Results

3.1. Screening results

Our database keywords search found 824 potentially eligible articles. Following the title screening, 64 articles were eligible for inclusion in the abstract screening. Furthermore, 11 duplicates were removed, resulting in 53 articles being included. Following abstract screening, 35 studies were excluded, leaving 18 articles for full article screening. Two articles were excluded after full article screening, and 16 articles were included in data extraction. [15–30]. Notably, only seven of these [15,17,20,24,25,27,29] reported full immunization status and were included in the meta-analysis. Fig. 1 shows a flow diagram of the screening results.

3.2. Characteristics of included articles

3.2.1. Research question 1

All 16 studies reported evidence of paternal factors associated with immunization status in SSA. Of these, six were conducted in Nigeria [15,16,18,21,22,26], one from Benin [17], one from Cameroon [24], one from Ethiopia [20,25], one from Gambia [30], two multi-country [19,27,29], one from Somalia [28], and one from Zambia [23]. All the studies included were published between 2014 and 2025. Of the included studies, eight cross-sectional surveys [18,20–22,24,26,28,30] and eight articles were secondary data analysis [15–17,19,23,25,27,29]. The sample sizes varied across the studies, with 400 being the smallest and 27,571 the largest. More details are presented in Table 1.

3.2.2. Research question 2

All 16 studies reported evidence of paternal factors associated with child full immunization status in SSA [15,17,20,24,25,27,29]. Of these, five assessed the association of father's education on child full immunization status. [15,17,20,27,29], one assessed father's occupation type [15], while assessing father's employment status [24,25] association with child full immunization. More details are presented in Table 2. (See Table 3.)

3.3. Paternal socioeconomic factors associated with child routine vaccination status

Paternal socioeconomic factors, particularly level of education and occupation, play a crucial role in influencing child immunization across SSA. The included studies demonstrated a positive correlation between higher paternal education levels and increased rates of complete childhood vaccination. This trend is observed across the following countries; Nigeria [15,16,18,21,26], Benin [17], Ethiopia [20], Gambia [30], Somalia [28] and Zambia [23]. Specifically, children of fathers with secondary or tertiary education are significantly more likely to be fully immunized compared to those whose fathers have lower or no education.

Paternal occupation also emerged as a significant factor in child immunization. Studies indicate that fathers' employment status influences immunization coverage, with children of employed fathers having a higher chance of being fully immunized. For instance, research in Cameroon [24] and Ethiopia [25] found that children were more likely to be fully immunized if their fathers were employed. Conversely, certain occupations or employment conditions can present challenges; for example, in Zambia, paternal employment in business or piecework was associated with a reduced likelihood of children being vaccinated [23].

In addition to education and occupation, other paternal factors such as decision-making power also play a role. In Nigeria, joint decision-making between parents was associated with higher rates of full child

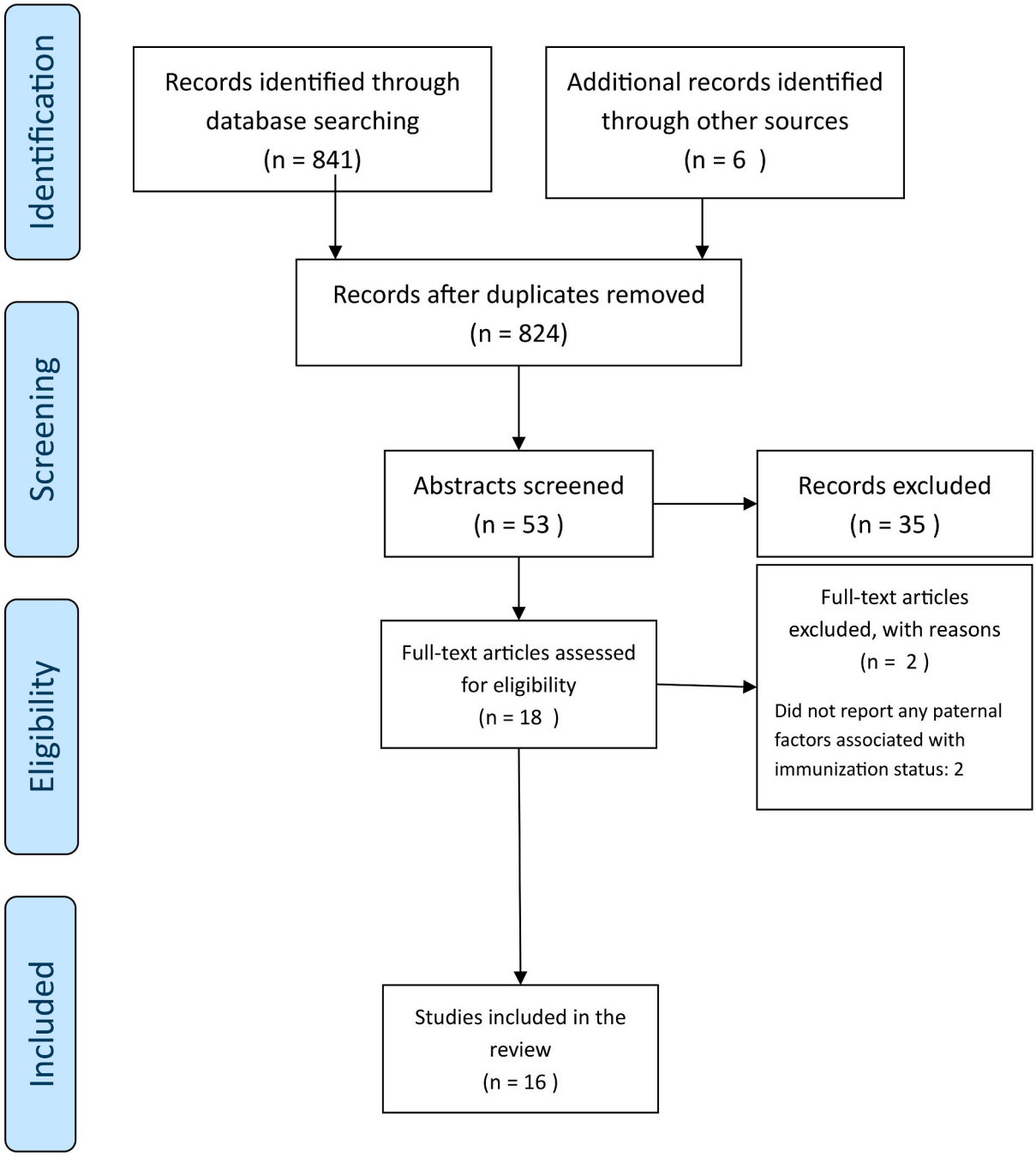

Fig. 1. PRISMA flow chart.

vaccination, while fathers making health decisions alone was linked to lower vaccination rates [15]. In the same study, when fathers alone made health decisions, their children were 47 % less likely to be fully vaccinated than to be unvaccinated compared to when couples together made health decisions [15]. Two studies reported paternal age as significantly associated with a child's full immunization status [16,23]. More details are presented in Table 2.

3.4. Meta analysis on child full immunization status and paternal factors associated with child full immunization status

3.4.1. Pooled prevalence of child full vaccination

The analysis included seven studies and revealed a pooled prevalence of full child immunization status of 60 % (95 % CI: 37 % - 81 %). The analysis also identified significant heterogeneity among the studies (I-squared = 99.3 %, $p < 0.001$). Heterogeneity was anticipated due to the differences in study settings, study population, design, and methodology. More details are presented in Fig. 2.

3.4.2. Association of father's education status and a child's full immunization

This review revealed statistically significant associations between the father's educational status and child full immunization status in four studies [15,17,20,27]. This study included 28,293 participants to determine the association between the father's educational status and a child's full immunization status (Refer to Table 2). The meta-analysis revealed that children with fathers who had primary education, or more, were about three times more likely to be fully immunized than

Table 1
Characteristics of included studies.

First Author, Year	Country	Aim	Sample Size	Key Findings
Azubuike, 2025	Nigeria	Using the 2018 Nigeria Demographic Health Survey, a multinomial logistic regression analysis was conducted to examine the influence of paternal factors on full childhood vaccination	2098	Achieving full vaccination was significantly predicted by a higher paternal education level and joint decision-making. Children of fathers with no education were 77 % less likely to be fully vaccinated than to be unvaccinated compared to fathers with secondary education, and when fathers alone made health decisions, their children were 47 % less likely to be fully vaccinated than to be unvaccinated compared to when couples together made health decisions ($p <$ 0.05)
Oleribe, 2017	Nigeria	A quantitative analysis of the 2013 NDHS dataset was performed	27,571	Of 27,571 children aged 0 to 59 months, 22.1 % had full vaccination, and 29 % never received any vaccination. Immunization coverage was significantly associated with paternal education, occupation, and age were significantly associated with immunization coverage. Paternal education was identified as a significant determinant of full child vaccination, with higher paternal education associated with the likelihood of full vaccination
Budu, 2021	Benin	Authors analysed data from the 2018 Benin Demographic and Health Survey (BDHS)	4156	
Raji, 2019	Nigeria	To assess the knowledge of fathers, uptake of routine immunization, and its associated factors in a rural community of North West Nigeria.	276	Majority of the respondents that had poor knowledge of routine immunization had no formal education ($P =$ 0.043).
Tesema, 2020	Muti-country	Authors analysed data from the	18,811	Husband primary education (AOR =

Table 1 (*continued*)

First Author, Year	Country	Aim	Sample Size	Key Findings
		Demographic and Health Surveys (DHSs) of 12 African countries (Burundi, Ethiopia, Comoros, Uganda, Rwanda, Tanzania, Mozambique, Madagascar, Zimbabwe, Kenya, Zambia, and Malawi)		1.25, 95 % CI: 1.13, 1.39), husband secondary education and above (AOR = 1.24, 95 % CI: 1.11, 1.40) were significantly associated with complete childhood vaccination.
Legesse, 2015	Ethiopia	To assess complete immunization coverage and its associated factors among children aged 12 to 23 months in Sinana district, Bale Zone, Southeast Ethiopia.	591	Factors significantly associated with full immunization included being father with secondary and above educational level (AOR = 3.1; 95 % CI: 1.3, 7.4) On bivariate analysis, children of fathers that completed no education (OR 24.1; 95 % CI 18.8–36.0), primary education (OR 13.0; 95 % CI 4.4–18.8) or secondary education (OR 3.6; 95 % CI 1.2–10.34) were all more likely to be partially or un-immunized compared to children of fathers that completed tertiary education.
Ijarotimi, 2018	Nigeria	To determine the immunization status and its associated demo-graphic factors among children 12–59 months old in Akinyele Local Government area (LGA), Oyo State, Nigeria	449	
Okoro, 2015	Nigeria	To assess factors associated with immunization of children with chronic neurological disorders in Enugu, Nigeria	168	Father's occupation was significantly associated with immunization of children with chronic neurological disorders
Marufu, 2019	Zambia	To assess Factors associated with being vaccinated in the measles-rubella vaccination campaign applied to children aged 9–179 months in the eastern province of Zambia in 2016 assessing vaccination completeness and timeliness in children aged 0 to 11 months attending the vaccination clinic of the Yaounde	594	Paternal education of grade 1–12, paternal employment of business/ piecework, paternal age group 30–39 years were all associated with a reduced likelihood of children being vaccinated On both bivariate and multivariate analysis, the father's profession increased the infant's chances of immunization completeness.
Chiabi, 2017	Cameroon		400	Employed vs

(*continued on next page*)

Table 1 (*continued*)

First Author, Year	Country	Aim	Sample Size	Key Findings
		Gynaeco-Obstetric and Pediatric Hospital.		unemployed (AOR = 12.39; 95 % CI: 2.21–69.26, p = 0.004)
Kinfe, 2019	Ethiopia	To assess individual and community level factors associated with full immunization among children 12–23 months of age in Ethiopia.	1929	Paternal employment status: Employed vs unemployed (AOR = 2.1, 95 % CI: 1.32, 3.35). In one of the regions, Bauchi, father's education was significantly associated with measles vaccination status among children aged 12–23 months
Cockcroft, 2014	Nigeria	To assess the coverage of measles vaccination and reasons for not vaccinating children in two states in Nigeria	2421	OR 1.73 (CI: 1.26–2.20)
Fenta, 2021	Muti-country	To identify the determinant factors of full childhood immunization among children aged 12–23 months in sub-Saharan Africa using DHS data from nine SSA countries	21,448	Fathers secondary education and above (AOR = 1.28, 95 % CI: 1.11, 1.48) was significantly correlated with full childhood immunization
Hayir, 2020	Somalia	To assess barriers for complete vaccination coverage among under five years children in Mogadishu, Somalia.	741	Immunization was found to be increased by having a father with secondary and above education (AOR = 1.755, 95 % CI = 1.161–2.655, P-Value = 0.008)
Barrow, 2023	Muti-country	Investigate the uptake and determinants of childhood vaccination status among children under the age of one year, for Gambia, Sierra Leon, and Liberia	5368	Children whose father had primary education had lower odds (aOR = 0.67, 95 % CI = 0.48–0.96) of being fully vaccinated compared to those who had no education
Odutola, 2015	Gambia	Assess risk factors for delay in age-appropriate vaccinations among Gambian children	1154	Having an illiterate father was independently associated with delays in receipt of DPT1 and DPT3 vaccine. Children of illiterate fathers were twice more likely to have had delay in receipt of measles vaccine compared to children whose fathers had at least primary school education (OR 0.54; 95 % CI 0.35–0.82).

Table 2
Paternal factors associated with full vaccination from the included primary studies.

First author, Publication year	Variables	Full vaccination		Crude Odds Ratio (95 % Confidence Interval)
		Yes	No	
Azubuike, et al., 2025	**Education of father**			
	No education	40	489	1
	Primary	84	250	**4.11 (2.74–6.17)**
	Secondary	307	590	**6.36 (4.48–9.03)**
	Higher	162	176	**11.25 (7.64–16.56)**
	Occupation of father			
	Professionals	129	186	1
	Sales/services	185	357	**0.75 (0.56–0.99)**
	Agriculture/self-employed	107	677	**0.23 (0.17–0.31)**
	Blue collar	172	285	0.87 (0.65–1.17)
	Religion of father			
	Christianity	393	629	1
	Islam	200	876	**0.37 (0.30–0.45)**
	Health decision			
	Father alone	276	909	1
	Father and mother	206	348	**1.95 (1.57–2.43)**
	Mother and other	111	248	**1.47 (1.14–1.91)**
	Education difference			
	Father's education less	84	135	1
	Same education	357	929	**0.62 (0.46–0.83)**
	Father's education higher	152	441	**0.55 (0.40–0.77)**
Budu et al., 2021	**Father's education**			
	No education	1758	487	1
	Primary	789	75	**2.91 (2.25–3.77)**
	Secondary/ tertiary	1000	47	**5.89 (4.33–8.03)**
Legesse et al., 2015	**Father's education**			
	No formal education	117	55	1
	Primary	240	69	**1.64 (1.08–2.48)**
	Secondary and above	97	13	**3.51 (1.81–6.80)**
Chiabi et al., 2017	**Father's employment status**			
	Employed	378	13	1
	Not employed	7	2	**0.12 (0.02–0.64)**
Kinfe et al., 2019	**Father's employment status**			
	Not employed	40	126	1
	Employed	675	985	**2.16 (1.49–3.12)**
Fenta et al., 2021	**Father's education**			
	No education	3597	2579	1
	Primary	4847	3666	0.95 (0.89–1.01)
	Secondary or higher	4287	2472	**1.24 (1.16–1.33)**
Barrow et al., 2023	**Father's education**			
	No education	310	1771	1
	Primary	40	323	0.71 (0.50–1.00)
	Secondary	221	1179	1.07 (0.89–1.29)
	Tertiary	68	289	**1.34 (1.01–1.80)**

those with fathers who had no formal education, crude odds ratio (OR) = 2.72, 95 % CI (1.22–6.03), I^2 = 98 %, $p < 0.01$. Fig. 3 shows the forest plot of the pooled odds ratio of the association between a child's full immunization status and the father's educational status.

3.4.3. Association of father's employment status and a child's full immunization

This review revealed statistically significant associations between the father's employment status and child full immunization status in two studies [24,25]. This study included 1048 participants to determine the association between the father's employment status and a child's full immunization status (Refer to Table 2). The meta-analysis revealed that there was no statistical difference in childhood full immunization between children with fathers who were employed and those whose fathers were unemployed, crude odds ratio (OR) = 1.74, 95 % CI

Table 3
Recommendations.

Domain	Recommendation	Rationale
Education and Awareness	Implement father-targeted health education campaigns through community radio, SMS, and local events	Enhances fathers' knowledge and awareness of immunization schedules and benefits; bridges knowledge gap caused by lower educational levels
	Integrate formal and informal education through health seminars, workplace outreach, and local cultural events	Makes immunization education accessible across different literacy levels and cultural settings
	Include critical decision-making skills in educational programs	Empowers fathers to evaluate health information and make informed decisions independently or jointly with partners
Community Engagement	Engage community and religious leaders to promote immunization as a shared parental responsibility	Shifts community norms that place childcare solely on mothers; enhances credibility and acceptance
	Establish men's health clubs and peer support groups	Encourages positive paternal role modeling and collective reinforcement of child health responsibilities
	Collaborate with local health organizations to offer culturally sensitive immunization outreach	Increases service accessibility and relevance to local customs, reducing resistance or apathy
Policy and Structural Solutions	Introduce mobile and subsidized immunization services for low-income and rural fathers	Addresses transport and financial barriers preventing access to vaccination services
	Integrate fathers into maternal-child health programs (e.g., prenatal classes, postnatal check-ups)	Fosters shared decision-making and enhances paternal commitment from early stages
	Recruit and train male healthcare workers to lead father-targeted immunization campaigns	Encourages male engagement by breaking gender stereotypes and building comfort in discussing child health
Research and Monitoring	Conduct qualitative studies exploring paternal attitudes and barriers to immunization	Fills current research gaps and uncovers nuanced cultural and socioeconomic barriers
	Develop national and regional immunization databases with disaggregated data on paternal involvement	Facilitates targeted interventions and policy evaluation
Media and Communication	Utilize social media, radio jingles, and visual campaigns to target fathers with positive vaccine messaging	Leverages contemporary media as a tool to shape paternal health-seeking behavior
	Counter vaccine misinformation through father-specific trusted media outlets	Helps combat growing vaccine hesitancy and misinformation, especially among male caregivers

(0.10–29.20), $I^2 = 91$ %, $p < 0.01$. Fig. 4 shows the forest plot of the pooled odds ratio of the association between a child's full immunization status and the father's educational status.

4. Discussion

4.1. Findings in the context of existing literature

This systematic review and meta-analysis aimed to synthesize available evidence on the role of paternal factors in influencing childhood full immunization status in SSA. The findings confirm that paternal factors are significantly associated with child vaccination outcomes and suggest that strengthening paternal involvement could enhance immunization uptake in the region. In many SSA settings, socio-economic structures are shaped by patriarchal norms, where men often serve as the primary decision-makers in household financial and health-related matters. From a gender perspective, this underscores the importance of recognizing fathers not only as economic providers but also as gatekeepers to healthcare access for their children. Interventions that aim to improve childhood immunization coverage may need to engage fathers more deliberately, while also addressing structural gender inequalities that limit maternal autonomy in child health decision-making.

A major finding of this review is the consistent association between higher paternal education levels and increased likelihood of full child immunization. Across multiple countries, including Nigeria, Benin, Ethiopia, and Somalia, children of fathers with primary, secondary, or tertiary education were significantly more likely to be fully immunized compared to those whose fathers had no formal education. This pattern was further supported by the meta-analysis, which found that children of educated fathers were nearly three times more likely to receive complete immunization. These findings align with broader literature indicating that parental education, especially health literacy, is a crucial determinant of proactive health-seeking behavior and service utilization [5,31].

Parental employment status usually translates into economic security, which influences not only the ability to access health services but also the prioritization of vaccination in economic planning. Families with higher incomes probably have more access to health facilities, reliable transportation, and educational resources that increase the knowledge and importance of vaccines. In addition, varied levels of education among parents can affect their health literacy, further affecting immunization results for their children. Previous research has shown that educated parents may be more aware of the need for vaccines and the potential long -term benefits of child health immunization [32]. Despite the growing body of research in this domain, they remain significant gaps. Existing literature usually fails to address cultural dynamics at stake in paternal involvement and decision-making in child health [33]. In addition, limited qualitative studies that exploit the paternal perspectives on immunization highlight an urgent need to evaluate parents' attitudes and beliefs regarding vaccines qualitatively. This investigation could reveal barriers and richer and more nuanced insights on facilitators that are currently obscured by quantitative data only. Moreover, given the substantial role that paternal socioeconomic status plays, understanding its interaction with maternal characteristics and broader social factors can offer a broader image of vaccine capture in sub -Saharan Africa.

While this review focused on paternal socioeconomic factors, it is essential to emphasize the significance of inclusive decision-making in families. In many households across SSA, gendered power dynamics can marginalize maternal input, even though mothers are often the primary caregivers and directly responsible for taking children to health facilities. Promoting collaborative decision-making between mothers and fathers is crucial to overcoming barriers to immunization. Evidence suggests that when women are empowered to participate equally in household decisions, especially those related to health and child welfare, immunization rates tend to improve. At the same time, encouraging greater involvement of fathers in child health matters, including immunization, can complement maternal efforts and improve uptake. Therefore, shifting toward gender-transformative strategies that promote equitable parental involvement can help bridge access gaps and foster a more sustainable immunization environment.

The review also identified paternal occupation and employment status as influential, though more complex, determinants of child immunization. Evidence from Cameroon and Ethiopia revealed that children of employed fathers had higher odds of being fully immunized [23,24]. However, nuances emerged when the type of employment was taken into consideration. In Zambia, for example, paternal involvement in informal work such as piecework or business was linked to lower immunization rates [23]. These results may reflect not only income disparities but also time constraints, job flexibility, and access to

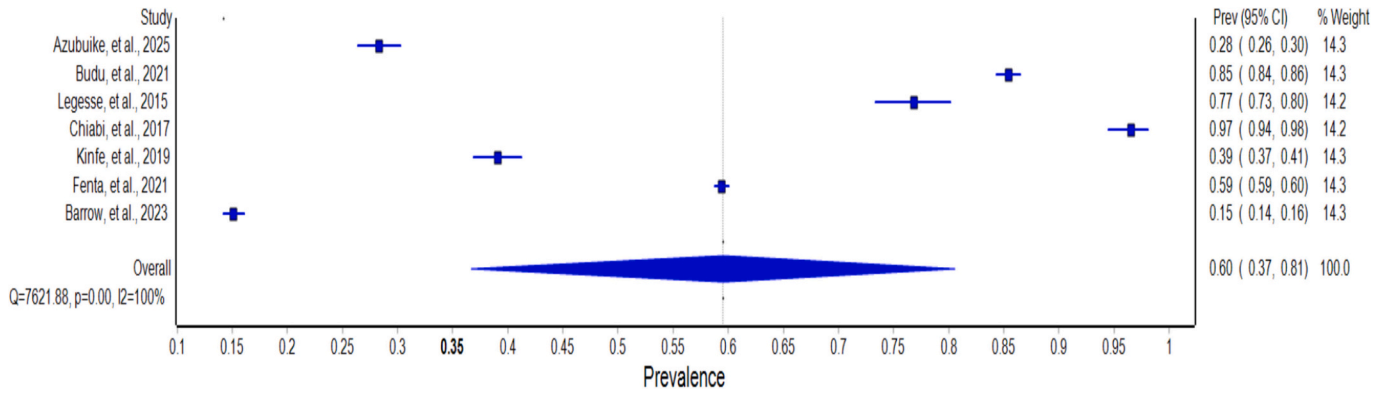

Fig. 2. Forest plot of the pooled prevalence of child full immunization from included studies.

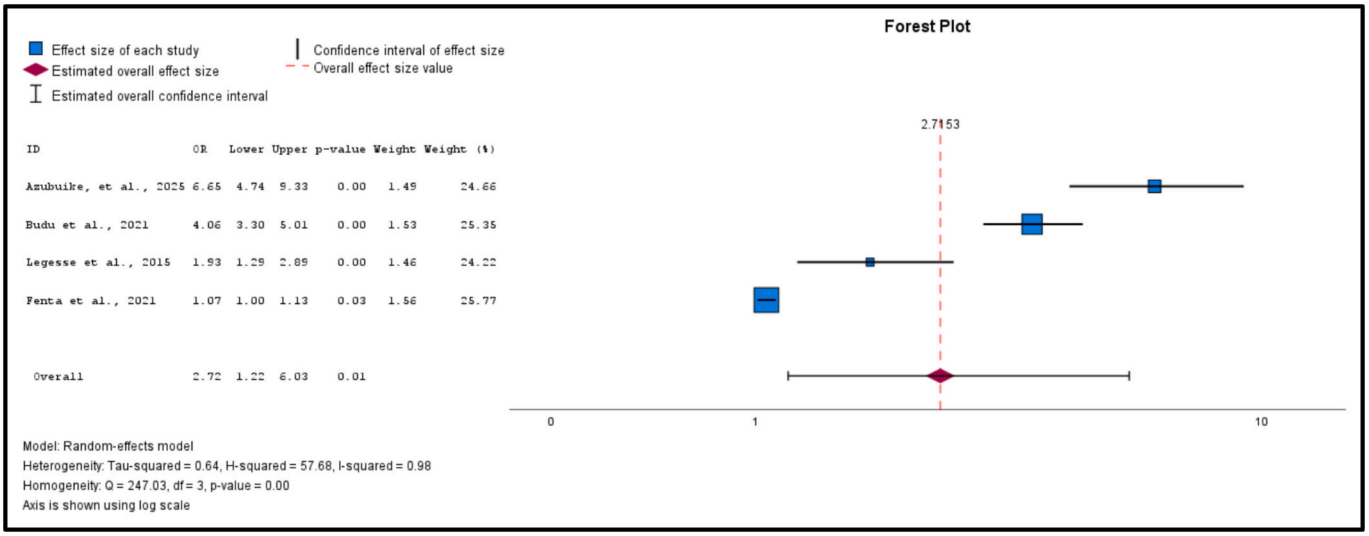

Fig. 3. The pooled odds ratio of the association between a child's immunization status and the father's educational status.

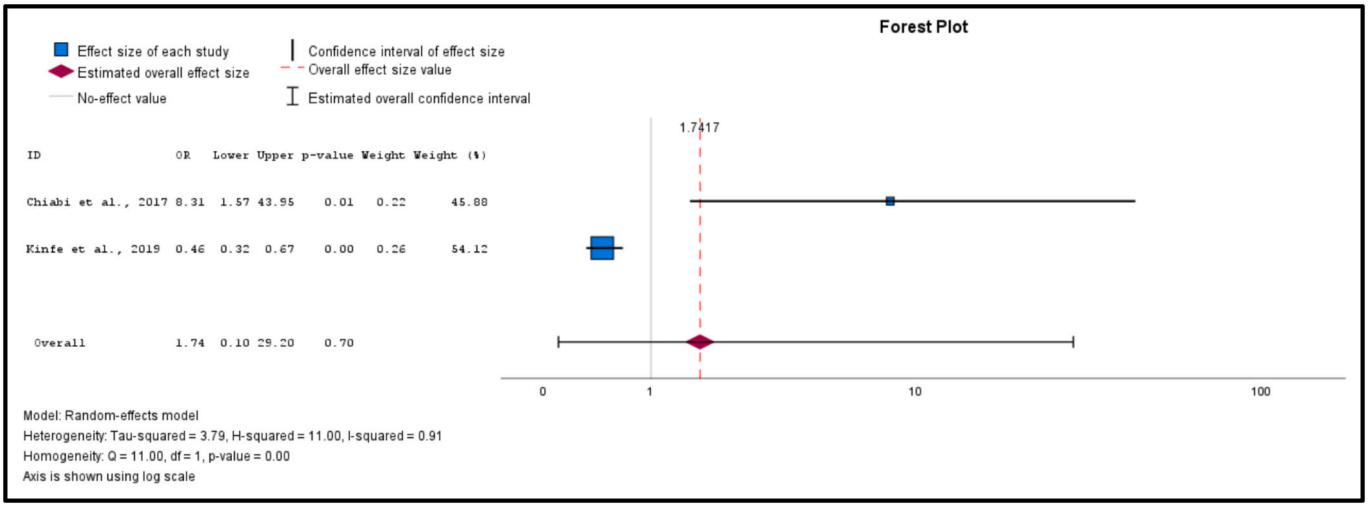

Fig. 4. The pooled odds ratio of the association between a child's immunization status and the father's employment status.

healthcare. Fathers employed in irregular or time-intensive jobs may have limited opportunities to accompany their children to health facilities or to prioritize preventive health services like vaccination.

Interestingly, the meta-analysis found no statistically significant difference in childhood immunization rates between employed and unemployed fathers, with a crude OR of 1.74 (95 % CI: 0.10–29.20). However, the high heterogeneity (I^2 = 91 %) and wide confidence interval suggest variability in how employment interacts with other contextual factors. These findings imply that while employment can offer financial security and access to services, it is not universally

beneficial without considering quality of jobs, working conditions, and how these factors shape the father's ability to engage in childcare. Future studies may benefit from distinguishing between types of employment and exploring how job flexibility or employer-supported family health initiatives influence immunization behaviors.

Beyond socioeconomic indicators, the review also revealed the critical role of paternal decision-making dynamics in vaccination uptake. In particular, joint decision-making between mothers and fathers was significantly associated with improved immunization coverage [15]. In contrast, when fathers were the sole decision-makers regarding healthcare, their children were significantly less likely to be fully vaccinated. This aligns with prior research emphasizing the importance of collaborative parenting and suggests that empowering both parents to make informed health decisions can significantly improve child health outcomes [34,35]. This finding is significant in the context of SSA, where patriarchal norms often position men as dominant household decision-makers, including in matters of healthcare. Encouraging joint decision-making can therefore serve as a culturally sensitive intervention to promote shared responsibility and reduce barriers to immunization. Health education programs that target couples together, such as through community-based seminars or couple-focused antenatal care sessions, may foster dialogue and mutual understanding around child health responsibilities.

4.2. Recommendations

This review revealed education as a key driver of behavior change and one of the most influential factors affecting fathers' participation in child immunization. Supporting these insights, Parsekar (2024) reviewed strategies across LMICs and noted that sensitization and educational campaigns directed at caregivers have been commonly used to overcome attitudinal and knowledge-based barriers to immunization [36]. These campaigns ranged from community meetings to media outreach initiatives, indicating that a multi-channel approach can be effective in reaching fathers with diverse educational and socioeconomic backgrounds. The review also highlighted the use of automated voice messages and written or pictorial materials to improve awareness of vaccination schedules, timeframes, and locations. These tools have been used either as standalone strategies or as part of broader interventions to inform caregivers, including fathers, and motivate them to follow through with immunization appointments.

In alignment with this, educational interventions specifically designed to increase paternal involvement have emerged as particularly effective. These include targeted campaigns that not only disseminate vaccine information but also actively challenge the gendered perception that child health is a maternal responsibility. Such campaigns can empower fathers to make informed decisions and share responsibility for child health more equitably [37]. Additionally, integrating both formal education, like workshops and health seminars, and informal community-based sessions during local events has been shown to engage fathers more effectively. These platforms can enhance fathers' understanding of their roles and build trust in immunization systems. Furthermore, interventions that teach fathers critical decision-making skills, such as recognizing disease symptoms and evaluating vaccine benefits, have shown promise in improving their proactive health behaviors. Notably, the mode of delivery may significantly influence uptake; for instance, in-person workshops may be practical for literate and urban populations, while distance learning tools such as mobile voice messages, SMS, or radio programs could better reach fathers in rural or low-literacy settings. Tailoring educational approaches to the sociocultural and logistical realities of specific populations is therefore essential for overcoming barriers and maximizing the impact of paternal engagement interventions.

Technology has also emerged as a viable tool for enhancing paternal engagement. In Iran, a study assessing the impact of virtual education on fathers' involvement in infant care showed that the mean involvement scores at two, four, and six months postpartum were significantly higher in the intervention group than in the control group [38]. This study indicated that digital education tools can substantially increase paternal involvement, including participation in immunization-related activities. This approach is particularly valuable in settings where fathers may not be available during traditional clinic hours due to work or other obligations. Similarly, a previous study revealed that mobile and digital communication tools can enhance fathers' awareness of their children's vaccination needs, thereby increasing the likelihood of timely immunization [36].

Community-based engagement also plays a critical role in improving immunization uptake. Although most studies in this domain do not focus specifically on fathers, their findings offer valuable insights. For example, Oyo Ita [39] and Jain [40] emphasised the effectiveness of community mobilization efforts and the involvement of local leaders in driving immunization initiatives. These interventions help foster community-wide acceptance of immunization and could be tailored to address male caregivers more explicitly [41]. Furthermore, leveraging trusted community figures, such as religious leaders, elders, and local influencers, has proven beneficial in shifting public perceptions and increasing male involvement. The establishment of peer support systems, such as men's health clubs or paternity workshops, offers a platform for fathers to share experiences and motivate each other. These initiatives not only reduce isolation but normalize fathers' active roles in child health. Collaborating with local health organizations to address logistical and financial barriers through mobile clinics, health fairs, or subsidized transportation also helps make immunization more accessible and father-friendly [42,43].

Health facility visits offer another opportunity for engaging fathers in conversations about immunization. A study conducted in Nigeria compared fathers who accompanied their children for circumcision with those who did so for immunization. The findings revealed that fathers attending circumcision appointments were more educated and more knowledgeable about vaccine names and potential side effects. [44]. Interestingly, those who brought their children for immunization were more aware of the correct ages for starting and completing the vaccine schedule. Despite these insights, both groups exhibited knowledge gaps, underlining the importance of leveraging every healthcare contact as an educational moment. The study concluded that all healthcare interactions involving fathers, regardless of the reason for the visit, should be utilized to provide information on the importance and logistics of childhood immunization.

One promising policy strategy involves actively integrating fathers into maternal and child health systems. For instance, couples-based prenatal and postnatal education sessions promote a shared understanding and responsibility for childhood health. These shifts can alter cultural narratives and normalize paternal participation. Additionally, increasing male representation in the health workforce may serve as a visible signal that fathers are welcome and needed in these spaces. Male healthcare professionals can act as role models, reducing stigma and encouraging more men to engage with child health services.

Another significant challenge is the general scarcity of targeted interventions for fathers. Many of the studies focus primarily on general caregiver engagement or community-wide strategies, limiting the ability to assess the effectiveness of father-specific programs [39,40]. The lack of disaggregated data on paternal involvement makes it challenging to design and implement evidence-based interventions that effectively target fathers and measure their outcomes.

Access to and availability to visit healthcare facilities also pose notable barriers. Fathers, especially those employed in informal sectors or working long hours, may find it difficult to attend clinic sessions or community meetings. Digital interventions offer an alternative, but their success depends on adequate access to mobile devices, digital literacy, and internet connectivity [38].

From the interventions and studies reviewed, several important lessons emerge. First, education remains foundational. Second, the

dynamics of household decision-making are crucial. Encouraging joint parental decisions can significantly improve immunization uptake. Third, technology provides scalable and accessible solutions, particularly in contexts where face-to-face engagement is impractical. Fourth, healthcare settings should be leveraged more effectively to reach fathers with tailored messages during any visit. Fifth, community-wide interventions, while not father-specific, can shift broader social norms that influence paternal behavior, creating more supportive environments for male involvement. Finally, structural and policy reforms that address socioeconomic and logistical constraints are essential to remove access barriers and promote equitable health-seeking behavior.

Overall, while direct interventions targeting fathers remain sparse, existing strategies involving education, digital outreach, community mobilization, and opportunistic engagement during healthcare visits demonstrate potential. Overcoming barriers such as cultural expectations, access limitations, and data shortages will be critical in designing more effective and inclusive programs. Policymakers and health practitioners can leverage an often-overlooked resource to boost vaccine coverage and improve child health outcomes across LMICs by recognizing and enhancing the role of fathers in immunization decisions.

4.3. Limitations of the review

While the findings from this review are compelling, they must be interpreted in light of several limitations. First, the studies included in the meta-analyses exhibited high heterogeneity, particularly in the pooled prevalence of full immunization ($I^2 = 99.3$ %). This variability likely stems from differences in study settings, populations, and measurement tools. Despite using standard meta-analytic techniques, this heterogeneity suggests that localized factors, such as health infrastructure or cultural attitudes, play a significant role in shaping outcomes.

Second, the review is limited by the relatively small number of studies focusing exclusively on paternal factors. Most research in this domain continues to emphasize maternal characteristics, reflecting a broader gap in the literature. This imbalance underscores the need for more primary studies that disaggregate parental roles and explore father-specific barriers and facilitators to vaccination.

Furthermore, only seven studies reported full immunization status and were eligible for meta-analysis, limiting the generalizability of the quantitative findings. Many of the remaining studies were cross-sectional or based on secondary data analyses, which constrain the ability to infer causality. Longitudinal studies that follow families over time and assess changing paternal involvement would offer stronger evidence on how fathers' roles evolve and influence child health outcomes.

Despite these limitations, this review provides several actionable insights. First, interventions aimed at increasing vaccination rates in SSA should actively involve fathers through education and targeted outreach. Programs must go beyond general awareness campaigns and provide tailored content that addresses fathers' roles and challenges. Second, policymakers and healthcare providers should integrate father-friendly strategies into routine child health services, such as flexible clinic hours, male health workers, and father-child days at health centers. Third, more inclusive health policies that promote gender-equitable parenting and joint decision-making are needed to shift cultural narratives and institutional practices that marginalize paternal participation. As fathers' input into children's immunization have shown to have a positive effect, it can be a cost-effective exercise to invest to support this practice further.

Finally, there is a critical need for improved data collection and reporting on paternal characteristics in immunization and child health surveys. This would not only address critical research gaps but also balance what is known with regard to both mothers and fathers with regard to the impact of different characteristics on children's immunization and overall health. Disaggregated data would enable researchers and practitioners to design more precise, evidence-based interventions and track progress over time.

5. Conclusion

This systematic review and meta-analysis revealed that paternal socioeconomic characteristics, particularly education level, type of occupation, and decision-making roles, significantly influence childhood full immunization coverage in sub-Saharan Africa. Higher paternal education consistently emerged as a protective factor, associated with greater likelihood of children being fully immunized. While employment status generally supported better immunization outcomes, the type and stability of employment mattered, with informal or irregular work linked to lower immunization rates in some settings. Furthermore, paternal dominance in health-related decision-making was associated with lower vaccination coverage, whereas joint decision-making with mothers proved protective.

These findings highlight the importance of designing father-inclusive strategies that go beyond income generation to support health literacy, shared parenting, and equitable household decision-making. Public health interventions should target not only mothers but also fathers, particularly through education and community engagement, to enhance immunization uptake. Future research should distinguish between types of employment and explore how workplace policies, family dynamics, and gender norms interact to influence vaccination behavior.

CRediT authorship contribution statement

Godfrey Musuka: Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Enos Moyo:** Writing – original draft, Methodology, Formal analysis, Data curation. **Oscar Mano:** Writing – review & editing. **Roda Madziva:** Writing – review & editing. **Gashema Pierre:** Writing – original draft, Methodology, Formal analysis, Data curation. **Patrick Gad Iradukunda:** Writing – original draft, Methodology, Formal analysis, Data curation. **Abu Sadat Mohammad Sayem:** Writing – review & editing. **Tapiwa Dhliwayo:** Writing – review & editing. **Helena Herrera:** Writing – review & editing. **Constantine Mutata:** Writing – review & editing. **Tafadzwa Dzinamarira:** Writing – original draft, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2025.127695.

Data availability

No data was used for the research described in the article.

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