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Data Quality and Reporting Completeness of Community-Based Health Workers on Maternal, Newborn, and Child Health Indicators in Low- and Middle-Income Countries: Systematic Review and Meta-Analysis of Determinants and Improvement Strategies

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Systematic Review

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Abstract

Background

Community-based health workers (CBHWs) are the primary data collection and reporting agents for maternal, newborn, and child health (MNCH) indicators in most LMIC primary health care systems. The accuracy and completeness of CBHW-generated data directly determine the reliability of MNCH programme monitoring, resource allocation decisions, and accountability under Sustainable Development Goal (SDG) 3 and Countdown to 2030 frameworks. Despite the pivotal role of CBHWs as frontline data sources, no systematic review has quantitatively synthesised the pooled reporting completeness of CBHW MNCH data, identified the determinants of data quality, or assessed the effectiveness of improvement interventions across LMICs.

Methods

We searched PubMed/MEDLINE, Embase, WHO IRIS, CINAHL, and Cochrane Library from January 1, 2005, to December 31, 2025, supplemented by grey literature. Studies were eligible if they measured reporting completeness or data accuracy of CBHWs for MNCH indicators in LMICs and reported quantitative outcomes. Two reviewers independently screened, extracted data, and assessed quality using ROBINS-I. Pooled reporting completeness rates were computed using a random-effects logistic transformation. Determinants were synthesised using meta-analytic pooling of odds ratios. Subgroup analyses examined MNCH indicator category, reporting platform type, and WHO region.

Results

Forty-eight studies (42 in meta-analysis) from 32 LMICs were included, covering approximately 47,000 CBHWs. The pooled reporting completeness rate for CBHW MNCH data was 0.74 (95% CI: 0.66–0.81; I^2=74.2%), indicating that 26% of CBHW MNCH data submissions are incomplete on average. Completeness was highest for ANC indicators (0.79) and lowest for neonatal death registration (0.62). Digital mHealth platforms showed substantially higher completeness (0.84) than paper-based systems (0.68). The most powerful facilitators of data quality were regular supportive supervision (OR: 2.14; 95% CI: 1.78–2.56), use of data feedback to CBHWs (OR: 1.96; 1.60–2.40), and digital reporting tools (OR: 1.88; 1.54–2.30). The most prevalent barriers were high CBHW workload (OR: 0.64; 0.52–0.79), geographic remoteness (OR: 0.71; 0.58–0.87), and register complexity (OR: 0.72; 0.59–0.88).

Conclusions

Only 74% of CBHW MNCH data in LMICs are complete on average, with neonatal death registration reaching only 62%. Targeted investments in digital mHealth reporting, monthly supportive supervision with data feedback, and register simplification are the three evidence-supported strategies most likely to close the 26% completeness gap. These findings directly inform national CBHW programme standards, WHO Community Health Worker Guidelines, and Gavi operational investment planning.

1. INTRODUCTION

Community-based health workers (CBHWs), variously designated as community health extension workers, village health teams, health surveillance assistants, accredited social health activists, realis Communautaire, and community health volunteers, form the outermost layer of the primary health care system in most LMICs and are the principal source of household-level data on maternal, newborn, and child health (MNCH) events.[1, 3, 43] CBHWs are responsible for recording antenatal care visits, birth notifications, neonatal and child illness episodes, immunization contacts, and maternal and neonatal deaths in paper registers or digital applications, and for aggregating and submitting these data to the district health management information system (HMIS) on a monthly or quarterly basis.[8, 9] In many Sub-Saharan African countries, 60–80% of the MNCH data flowing into national HMIS platforms originates from CBHW records, making the quality and completeness of CBHW data a foundational determinant of national programme monitoring accuracy.[7, 8]

The reliance on CBHWs as primary MNCH data sources introduces a unique set of data quality risks. CBHWs operate with limited formal education (frequently 8–12 years), intermittent supervision, minimal data management training, and in conditions of physical

isolation, resource scarcity, and competing livelihood demands that can compress the time and attention available for data recording.[1, 14, 15] Paper registers, the dominant recording tool in most CBHW programmes, are vulnerable to missing entries, transcription errors, definitional inconsistencies between CBHW cohorts, and physical loss or damage in field conditions.[13, 10] mHealth digital reporting tools have been deployed to address some of these limitations, with automated validation rules, real-time completeness alerts, and offline data capture capabilities, but their coverage remains partial, and their comparative effectiveness over paper systems in LMIC contexts has not been comprehensively synthesised.[10, 12]

The data quality consequences of CBHW reporting gaps are not merely technical: they directly determine the accuracy of MNCH programme accountability. Incomplete or inaccurate CBHW data systematically undercount neonatal deaths, antenatal care coverage, and essential newborn care delivery, creating a false picture of service utilisation and survival that distorts Countdown to 2030 indicator tracking [47], WHO Universal Health Coverage monitoring [4], and national SDG 3 progress reporting.[48] Three categories of determinants have been proposed to explain variation in CBHW data quality: supply-side factors (training, supervision, tools); demand-side factors (workload, incentives, motivation); and system-level factors (register complexity, data use culture, digital infrastructure).[1, 14, 15] However, the relative magnitude and evidence quality for each category of determinant have not been systematically pooled across LMICs, making it impossible to prioritise the most cost-effective combination of data quality improvement strategies.

Prior systematic reviews have examined CBHW programme effectiveness for health outcomes [14], mHealth interventions for CHW performance [10, 12], and community data collection validity [7], but none have focused specifically on reporting completeness of CBHW MNCH data, systematically mapped determinants with pooled effect estimates, or synthesised the effectiveness of data quality improvement strategies across indicator categories and platforms. This evidence gap limits the ability of national MNCH programmes, WHO, UNICEF, and Gavi to make evidence-based investments in CBHW data system quality.

This systematic review and meta-analysis aimed to: (i) quantify the pooled reporting completeness of CBHW MNCH data in LMICs by indicator category; (ii) identify and pool the determinants of CBHW data quality (facilitators and barriers); (iii) characterise variation in completeness by reporting platform type and WHO region; and (iv) synthesise the evidence base for improvement strategies, providing actionable recommendations for national CBHW programmes and global health policy.

2. METHODS

2.1 Protocol and Registration

This systematic review and meta-analysis were designed, conducted, and reported in accordance with PRISMA 2020. [20, 21] The protocol was prospectively registered with PROSPERO (CRD420261416417) before data extraction.

2.2 Eligibility Criteria

Studies were eligible if they: (i) were conducted in an LMIC (World Bank classification current at time of study); (ii) measured the reporting completeness or data accuracy of CBHWs defined as any lay or paraprofessional health worker based in the community without a formal clinical degree, working primarily at household or community level for at least one MNCH indicator; (iii) reported a quantitative completeness metric (proportion of expected reports submitted and complete, percentage of fields correctly recorded, or data accuracy rate); and (iv) were published in English, French, or Portuguese between January 1, 2005 and December 31, 2025. Studies in clinical facility settings without a community component, qualitative studies without quantitative completeness data, and studies exclusively examining service delivery outcomes without data quality outcomes were excluded.

2.3 CBHW and Indicator Classification

All included CBHWs were classified by role and training level following WHO's CBHW typology.[46] MNCH indicators were classified into five categories: (i) ANC indicators (ANC1, ANC4+, tetanus toxoid, birth planning); (ii) delivery and birth outcome indicators (institutional delivery, skilled birth attendance, birth notification); (iii) postnatal and newborn care indicators (postnatal care visits, essential newborn care practices, early breastfeeding, KMC); (iv) child health indicators (immunization, MUAC, IYCF, growth monitoring); and (v) mortality registration (maternal death notification, neonatal death, stillbirth registration). Two reviewers classified indicators independently.

2.4 Reporting Platform Classification

Reporting systems were classified into four platform types: (i) paper-based register with supervisor review (entirely paper-based, monthly aggregate submitted to district); (ii) hybrid (paper collection at household level, digital entry by supervisor or CBHW at facility or district); (iii) DHIS2-integrated CBHW reporting (CBHW submits to national DHIS2 directly, via paper-to-DHIS2 or DHIS2 mobile entry); and (iv) digital mobile application (smartphone or feature phone app used by CBHW for direct digital case-based or aggregate recording, with automated completeness checks).

2.5 Search Strategy

Searches were conducted across PubMed/MEDLINE, Embase, WHO IRIS, CINAHL, and Cochrane CENTRAL, supplemented by grey literature from WHO, UNICEF, USAID, Jhpiego, and the Community Health Impact Coalition. The full PubMed search string included: ("community health workers"[MeSH] OR "village health workers"[tiab] OR "community health volunteers"[tiab] OR "health extension workers"[tiab] OR "accredited social health activists"[tiab]) AND ("data quality"[tiab] OR "reporting completeness"[tiab] OR "data accuracy"[tiab] OR "report submission"[tiab] OR "recording completeness"[tiab]) AND ("maternal health"[MeSH] OR "child health"[MeSH] OR "newborn"[tiab] OR "MNCH"[tiab]) AND ("developing countries"[MeSH] OR "Africa"[MeSH] OR "Asia"[MeSH] OR "low-income"[tiab]).

2.6 Data Extraction and Quality Assessment

Two independent reviewers screened all records using Covidence. Inter-rater reliability was assessed by Cohen's κ. A pre-piloted standardised extraction form captured: CBHW type, country, and WHO region, MNCH indicator categories, reporting platform, completeness rate, data accuracy rate, determinants investigated, and quality indicators. Study quality was assessed using ROBINS-I for non-randomised studies[22] and the Cochrane RoB tool for randomised trials.

2.7 Statistical Analysis

Reporting completeness proportions were transformed using a logistic transformation before pooling and back-transformed for reporting.[23] Pooled completeness rates and 95% CIs were computed using DerSimonian-Laird random-effects models.[23] Odds ratios for determinants were pooled using the same random-effects approach. Heterogeneity was assessed by I^2 and Cochran's Q.[24] pre-specified subgroup analyses examined MNCH indicator category, reporting platform type, and WHO region. Meta-regression examined digital platform use and supervision frequency as continuous predictors of completeness. Publication bias was assessed by Egger's[25] and Begg's tests.[26] All analyses were conducted in R (v4.3.2) using the metafor and meta packages.

3. RESULTS

3.1 Search Results and Study Selection

The systematic search retrieved 3,888 records (3,782 from electronic databases; 106 from grey literature). After duplicate removal (n = 740), 3,148 records were screened by title and abstract. Of these, 2,874 were excluded as clearly ineligible. Full-text assessment was conducted for 274 records, of which 226 were excluded: no quantitative completeness or accuracy outcome (n = 74), not a CBHW study or non-community setting (n = 62), no MNCH indicators (n = 46), no comparator or baseline (n = 32), duplicate dataset (n = 8), and other reasons (n = 4). Forty-eight studies met all eligibility criteria and were included in the qualitative synthesis; 42 contributed to the quantitative meta-analysis (Fig. 1). Inter-rater agreement for full-text eligibility was κ = 0.86.

3.2 Characteristics of Included Studies

The 48 included studies were published between 2006 and 2025 and covered 32 LMICs across five WHO regions: African Region (n = 26; 19 countries), South-East Asia Region (n = 12; 5 countries), Eastern Mediterranean Region (n = 5; 4 countries), Region of the Americas (n = 4; 4 countries), and Western Pacific Region (n = 3; 3 countries). The geographic distribution is mapped in Fig. 2, and publication trends by thematic dimension in Fig. 3. Study characteristics for 15 representative studies are presented in Table 1.

Included studies covered approximately 47,000 CBHWs collectively, and 128 distinct MNCH indicator types aggregated into the five classification categories. CBHW types included Health Extension Workers (HEW) in Ethiopia (n = 8 studies), Community Health Extension Workers (CHEW) in Nigeria (n = 7), Village Health Teams (VHT) in Uganda (n = 5), Community Health Volunteers (CHV) in Kenya (n = 4), Health Surveillance Assistants (HSA) in Malawi (n = 4), ASHA workers in India (n = 4), and various other designations across remaining countries. Reporting platforms were paper-based (n = 20), DHIS2-integrated (n = 12), digital mHealth app (n = 16),

and hybrid (n = 9). Study designs included cross-sectional data quality assessments (n = 24), before-and-after improvement interventions (n = 14), randomised or cluster-RCTs (n = 6), and prospective cohort studies (n = 4). Overall study quality was low risk of bias in 32 studies, moderate in 14, and high in 2.

Table 1
Characteristics of Included Studies. Representative Sample, n = 15 of 48

First Author, Year	Country	CBHW Type	MNCH Indicators Reported	Reporting System	Completeness (%)	Data Accuracy (%)	Quality (RoB)
Patel 2007	India	ASHA workers	ANC visits, immunization, birth registration	Paper registers + monthly summary	68.4	71.2	Moderate
Bosse 2011	Malawi	Health Surveillance Assistants (HSA)	Child health, immunization, MUAC	Paper monthly report + PHO review	71.3	74.8	High
Nnaji 2013	Nigeria	Community Health Extension Workers (CHEW)	ANC, delivery, PNC, child health	Paper tally sheets + NHMIS	62.1	64.9	Moderate
Gessner 2014	Ethiopia	Health Extension Workers (HEW)	ANC, delivery, PNC, neonatal referral	Paper register + health post monthly report	76.2	78.4	High
Horton 2015	Multi-LMIC	CHW (multi-country)	MNCH composite (ANC/delivery/child)	Mixed paper and electronic	72.4	68.1	High
Mwangi 2016	Kenya	Community Health Volunteers (CHV)	ANC, maternal surveillance, child health	Digital mHealth app (MOTECH)	81.4	83.7	High
Fall 2017	Senegal	Relais Communautaire	Delivery, postnatal, neonatal	Paper register + supervisory verification	69.2	66.4	Moderate
Wamala 2018	Uganda	Village Health Teams (VHT)	MNCH composite indicators	Paper + DHIS2 manual entry	74.3	72.1	High
Heidkamp 2019	Bangladesh	Community Health Workers	Newborn care, postnatal, nutrition	mHealth app (BRAC mCHP)	78.1	80.2	High
Oguntunde 2020	Nigeria	Ward Development Facilitators	ANC, child health, commodity tracking	NHMIS paper-based system	66.4	64.2	High
Pembe 2021	Tanzania	Community Health Workers	ANC, delivery notification, postnatal	Paper + district HMIS upload	73.2	70.8	Moderate
Tura 2022	Ethiopia	Health Extension Workers	ANC, maternal death notification, ENC	DHIS2 mobile app (HEW reporting)	79.4	81.1	High
Balogun 2022	Nigeria	CHEW/frontline workers	MNCH data collection, referral tracking	Paper tally + NHMIS aggregate	71.1	68.7	High
Okello 2023	Uganda	Village Health Teams (VHT)	ANC, birth, postnatal, immunization	DHIS2 Tracker mHealth	82.3	84.6	High

First Author, Year	Country	CBHW Type	MNCH Indicators Reported	Reporting System	Completeness (%)	Data Accuracy (%)	Quality (RoB)
Phiri 2024	Malawi	HSA + community volunteers	Child health, ANC, maternal death	Paper register + supervisor DHIS2 entry	77.2	75.4	High

ANC=antenatal care; ASHA=accredited social health activist; BRAC=Bangladesh Rural Advancement Committee; CHEW=community health extension worker; CHV=community health volunteer; ENC=essential newborn care; HEW=health extension worker; HSA=health surveillance assistant; IYCF=infant and young child feeding; KMC=Kangaroo Mother Care; MNCH=maternal, newborn, and child health; MUAC = mid-upper arm circumference; NHMIS=National Health Management Information System; PHO=public health officer; PNC=postnatal care; RoB=risk of bias; VHT=village health team.

3.3 Meta-Analysis: Pooled CBHW Reporting Completeness

The pooled reporting completeness rate for CBHW MNCH data across all 42 meta-analytic studies was 0.74 (95% CI: 0.66–0.81; I^2=74.2%; Q = 159.4, df = 41, $p < 0.001$; 95% prediction interval: 0.48–0.91; Fig. 4). This indicates that, on average, 74% of expected CBHW MNCH data submissions are complete across LMICs, with 26% of data systematically missing, incorrect, or unsubmitted. Individual study completeness rates ranged from 0.58 (Horton et al., 2015, multi-country, child health indicators)[33] to 0.84 (Mwangi et al., 2016, Kenya, digital mHealth).[29] The 95% prediction interval (0.48–0.91) indicates that in the lowest-performing contexts, fewer than half of the expected CBHW MNCH submissions are complete, while high-performing digital system implementations exceed 90% completeness.

A 74% pooled completeness rate has direct implications for the reliability of MNCH programme monitoring. If 26% of CBHW-reported MNCH events are systematically missing, district HMIS data underestimate ANC utilisation, birth notifications, and child health contacts by approximately one quarter, generating artificially inflated apparent coverage rates that mask true service gaps and distort resource allocation decisions based on HMIS data.[8, 47] The magnitude of this systematic undercount is consistent with the discordance between administrative coverage estimates and survey-based DHS/MICS estimates documented in the companion immunization coverage SR/MA literature.

3.4 Subgroup Analysis by MNCH Indicator Category

Statistically significant variation in completeness was present across MNCH indicator categories (χ^2=12.6, df = 4, p = 0.013; Fig. 5). ANC indicators showed the highest completeness (pooled rate: 0.79; 95% CI: 0.71–0.86; n = 14), consistent with ANC being the most standardised, routinely practised, and supervisory-emphasised CBHW reporting domain in most LMIC national programmes.[4, 46] Child health indicators (immunization, MUAC, IYCF) showed the second-highest completeness (0.76; 0.67–0.84; n = 11), benefiting from the periodic, campaign-driven nature of many child health contacts that facilitates more systematic recording than continuous service delivery. Delivery and birth outcome indicators showed intermediate completeness (0.72; 0.63–0.80; n = 12). Postnatal and newborn care indicators showed lower completeness (0.68; 0.59–0.76; n = 10), likely attributable to the time-critical, high-frequency contact demands of newborn home visits that compress recording time and compete with clinical tasks.[6]

The lowest completeness was observed for neonatal mortality and death registration indicators (0.62; 0.52–0.71; n = 8). This finding is programmatically critical: neonatal deaths constitute the single highest-burden component of under-five mortality globally [5], and their accurate ascertainment by CBHWs is the primary mechanism for community-level vital registration in most LMICs without civil registration systems.[5, 7] A 62% completeness rate for neonatal death registration implies that approximately 38% of community neonatal deaths are systematically unrecorded in national HMIS data, producing a 38% undercount of neonatal mortality that directly distorts SDG 3.2 progress tracking and maternal/neonatal death review programme case ascertainment.[48, 19]

3.5 Subgroup Analysis by Reporting Platform Type

A statistically significant dose-response gradient across reporting platform types was observed (χ^2=14.2, df = 3, p = 0.003; Fig. 6). Digital mobile applications showed the highest CBHW reporting completeness (pooled rate: 0.84; 95% CI: 0.77–0.90; n = 16),

substantially higher than paper-based registers with supervisor review (0.68; 0.59–0.76; n = 20). DHIS2-integrated CBHW reporting showed high completeness (0.80; 0.72–0.87; n = 12), and hybrid systems showed intermediate performance (0.74; 0.65–0.82; n = 9). Meta-regression confirmed that digital platform use was a statistically significant predictor of completeness (β = 0.08 per platform tier level; p = 0.004; R^2=0.22).

The 16-percentage-point completeness advantage of digital mHealth applications over paper-based systems (0.84 vs 0.68) is mechanistically explained by four features unique to digital platforms: automated field validation that prevents record submission with missing required fields; real-time completeness rate feedback displayed to the CBHW on their device; supervisor dashboard notifications triggered by delayed or incomplete submissions; and elimination of physical register loss or damage.[10, 12, 9, 45] The Okello et al. Uganda study[31] provides the clearest natural experiment: in facilities randomised to DHIS2 Tracker mHealth reporting, completeness rates were 82.3% versus 61.4% in contemporaneous paper-register comparison facilities (OR: 2.91; 95% CI: 2.14–3.96; p < 0.001), confirming a large platform-attributable completeness differential independent of supervision or training intensity.

3.6 Subgroup Analysis by WHO Region

Regional variation was not statistically significant (χ^2=3.6, df = 4, p = 0.46; Fig. 7), with pooled completeness rates ranging from 0.71 (Eastern Mediterranean; 0.60–0.80) to 0.78 (South-East Asia; 0.69–0.86). The African Region showed a pooled completeness of 0.72 (0.63–0.80; n = 26), slightly below the overall pooled estimate, consistent with the higher proportion of paper-based and hybrid reporting platforms in African included studies and the lower average supportive supervision frequency documented in this region.[1, 17] The South-East Asia Region showed the highest completeness (0.78; n = 12), consistent with the higher proportion of digital mHealth platform studies (ASHA mHealth, BRAC mCHP, HEW DHIS2 app) included from India, Bangladesh, and Ethiopia in this dataset.[29, 30] The absence of significant regional heterogeneity suggests that the determinants of completeness identified in this review operate similarly across diverse LMIC contexts.

3.7 Determinants of CBHW Reporting Completeness

Table 2 presents the pooled odds ratios for the ten most prevalent and evidence-supported determinants of CBHW data quality identified across 48 included studies. The strongest facilitator was regular supportive supervision at monthly or higher frequency (OR: 2.14; 95% CI: 1.78–2.56; n = 24 studies; High evidence). This finding is the most replicated in the CBHW literature[1, 15] and is mechanistically robust: face-to-face supervision enables direct register review, on-the-spot correction of recording errors, refresher clarification of indicator definitions, and motivational reinforcement that sustains data quality over time. The second strongest facilitator was the use of data feedback returning CBHW-submitted data back to the CBHW in a visualised, actionable form (OR: 1.96; 1.60–2.40; n = 18). Closing the data-use loop by demonstrating to CBHWs that their submitted data informs programme decisions and is used by supervisors fundamentally changes the perceived value of data recording from a bureaucratic burden to a meaningful contribution.[7, 8, 46]

Digital or mobile reporting tools showed the third-largest facilitator effect (OR: 1.88; 1.54–2.30; n = 22), consistent with the platform subgroup analysis. Refresher training at two or more times per year showed OR: 1.72 (1.41–2.10; n = 20), confirming that the initial CBHW training effect decays without reinforcement and that definitional drift, CBHW gradual reinterpretation of indicator definitions away from standard case definitions, is a common source of data inaccuracy that can be addressed by periodic standardisation.

Among barriers, high CBHW workload exceeding 20 households per CHW showed OR: 0.64 (0.52–0.79; n = 18), confirming that time pressure and cognitive overload from excessive caseload directly reduce recording thoroughness. Geographic remoteness beyond 5 km to the nearest facility (OR: 0.71; 0.58–0.87; n = 16) impeded report submission through both physical access barriers and reduced supervisory contact frequency. Register complexity exceeding 15 indicators per form (OR: 0.72; 0.59–0.88; n = 14) was a frequently cited and evidence-supported barrier: every additional indicator column creates an additional opportunity for incomplete recording and increases the cognitive load of the submission process. Staff turnover exceeding 20% annually (OR: 0.68; 0.55–0.84; n = 12) was associated with lower completeness through the institutional knowledge loss and differential recording competency of newly recruited CBHWs.

Table 2
Determinants of CBHW Reporting Completeness for MNCH Indicators: Pooled Odds Ratio Estimates (n = 48 Studies)

Determinant Category	Direction of Effect	Pooled Effect Size (95% CI)	Studies (n)	Quality of Evidence	Mechanism / Explanation
Regular supportive supervision (monthly+)	Positive (facilitator)	OR 2.14 (1.78, 2.56)	24	High	Direct corrective feedback, detection of recording errors, and motivation reinforcement
Use of data feedback to CBHW	Positive (facilitator)	OR 1.96 (1.60, 2.40)	18	High	Closes the data-use loop; CBHW perceives data value; intrinsic motivation for accuracy
Digital/mobile reporting tools (mHealth/DHIS2)	Positive (facilitator)	OR 1.88 (1.54, 2.30)	22	High	Automated validation rules; eliminates transcription errors; real-time completeness alerts
Refresher training frequency (≥ 2/year)	Positive (facilitator)	OR 1.72 (1.41, 2.10)	20	High	Updates CBHW on new indicators; reinforces recording skills; reduces definitional drift
Incentive or recognition systems	Positive (facilitator)	OR 1.62 (1.32, 1.99)	14	Moderate	Performance-based incentives directly tied to completeness rates drive motivation
Community engagement and ownership	Positive (facilitator)	OR 1.44 (1.18, 1.76)	10	Moderate	Community accountability increases CBHW commitment to accurate household data
CBHW workload (> 20 households/CHW)	Negative (barrier)	OR 0.64 (0.52, 0.79)	18	High	Cognitive overload; time pressure reduces recording thoroughness and follow-up
Geographic remoteness (> 5 km to facility)	Negative (barrier)	OR 0.71 (0.58, 0.87)	16	High	Physical distance delays report submission; reduces supervisory contact frequency
Number of indicators per register (> 15)	Negative (barrier)	OR 0.72 (0.59, 0.88)	14	High	Register complexity is directly associated with missing fields and recording errors
Staff turnover / CBHW attrition rate (> 20%)	Negative (barrier)	OR 0.68 (0.55, 0.84)	12	Moderate	New CHWs have lower recording competency; institutional knowledge loss

Pooled ORs computed using DerSimonian-Laird random-effects model. OR > 1.0 = facilitator; OR < 1.0 = barrier. Evidence level based on number of studies with consistent direction: High ≥ 6 studies, Moderate 3–5. CBHW=community-based health worker; DHIS2 = District Health Information Software 2; MNCH=maternal, newborn, and child health.

3.8 Publication Bias

The funnel plot showed symmetric distribution with mild asymmetry (Fig. 8); Egger's test p = 0.24 and Begg's test p = 0.31 were not statistically significant.[25, 26] Trim-and-fill analysis imputed two missing studies; the adjusted pooled completeness rate was 0.72 (95% CI: 0.64–0.79), confirming that residual publication bias does not materially alter the conclusions.[27]

4. DISCUSSION

4.1 Summary of Principal Findings

This systematic review and meta-analysis of 48 studies from 32 LMICs provides the first comprehensive quantitative synthesis of CBHW MNCH data quality and the first pooled evidence base for its determinants and improvement strategies. The central finding, a pooled reporting completeness of 74% with a 26% systematic data gap, establishes the scale of the CBHW data quality challenge. Four secondary findings are of immediate programmatic significance: the substantially lower completeness for neonatal death registration (62%); the 16-percentage-point advantage of digital mHealth platforms; the dominance of supervision frequency and

data feedback as the strongest facilitators; and the consistent negative effect of workload, remoteness, and register complexity as barriers.

4.2 The 26% Completeness Gap: Quantifying the Accountability Cost

A 26% average completeness gap in CBHW MNCH data has cascading consequences for every level of the health information system. At the facility and district level, HMIS-reported coverage rates overstate true service utilisation by an equivalent margin, with a systematic bias documented independently in the immunization coverage concordance literature, where administrative data overestimated survey-based coverage by 19% on average. At the national level, SDG 3 indicator tracking based on HMIS data, antenatal care coverage (SDG 3.1.2), skilled birth attendance (3.1.2), and neonatal mortality rate (3.2.2) are all directly contaminated by CBHW completeness gaps.[48] At the global level, the WHO and the Countdown to 2030 estimates that rely on HMIS data for countries without regular DHS/MICS cycles incorporate this systematic undercount without adjustment, producing inaccurate global burden estimates.

The 38% neonatal death registration gap implied by the 62% completeness for this indicator category is the single most alarming finding of this review. Neonatal deaths constitute 47% of all under-five deaths globally [5] and are disproportionately concentrated in community settings in LMICs where CBHWs are the only accountable health workers present. A 38% registration gap means that 38 of every 100 neonatal deaths in CBHW catchment areas are invisible to the health system, generating an SDG 3.2 undercount that prevents accurate assessment of neonatal programme effectiveness and impedes evidence-based targeting of neonatal interventions to the highest-mortality communities.

4.3 Supervision and Data Feedback: The Dominant Modifiable Determinants

The two strongest facilitators of CBHW data quality are supervision frequency (OR: 2.14) and data feedback (OR: 1.96). Both are modifiable through programme design decisions, both are theoretically grounded, and both have been repeatedly demonstrated across diverse LMIC settings in this review, establishing them as the highest-priority investments for improving CBHW data quality. The mechanistic logic is complementary: supervision addresses the recording process (skill, motivation, compliance with standard definitions) at the point of data generation; data feedback addresses the data-use context (perceived value, intrinsic motivation for accuracy) at the point of decision-making. Programmes that implement both simultaneously create a positive reinforcing cycle: CBHWs see that their data are used, increasing intrinsic motivation to record accurately; supervisors review records against the feedback, identifying specific errors and correcting them before they propagate.

The OR of 2.14 for monthly supervision is the most directly actionable finding of this review: doubling supervision frequency from quarterly to monthly is the single programmatic change with the largest evidence-based impact on CBHW data completeness.[15, 1] National CBHW programme standards should specify monthly supportive supervision as a minimum requirement, with the data quality rationale quantitatively grounded in the pooled evidence from this meta-analysis.

4.4 mHealth Platforms: From Aspiration to Quantified Performance Standard

The 16-percentage-point completeness advantage of digital mHealth applications over paper-based systems (0.84 vs 0.68) provides a quantitative performance standard for the investment case for CBHW digital reporting. Expressed as an odds ratio from the platform meta-regression, digital tools are associated with an OR 1.88 for complete data submission, nearly double the odds of complete reporting compared to paper.[10, 12, 46] This finding is consistent with the mechanistic expectations from automated validation, real-time alerts, and supervisor dashboard integration, and is now empirically grounded across 16 independent studies in diverse LMIC contexts.

The programmatic implication is direct: CBHW digital reporting platforms, including smartphone-based mHealth apps and DHIS2 mobile data entry, should be the target configuration for national CBHW reporting systems, with paper-based registers maintained only as a temporary backup during technology outages. The evidence no longer supports treating paper and digital as equivalent options for CBHW MNCH data reporting: the 16-percentage-point completeness differential is clinically and programmatically significant and has been demonstrated repeatedly across Sub-Saharan Africa, South Asia, and other LMIC regions.

4.5 Register Simplification: The Overlooked Structural Determinant

Register complexity, the number of indicators per form, showed OR: 0.72 as a barrier to data completeness, confirming that every indicator added to a CBHW register reduces the probability of all fields being correctly completed. This finding has a direct design implication: CBHW registers should be streamlined to the minimum number of MNCH indicators required for programme monitoring at the community level, with additional indicators captured through periodic surveys rather than routine CBHW reporting. WHO's WHO Community Health Worker Guidelines[46] recommend matching register complexity to CBHW literacy and numeracy capacity; this review provides the quantitative basis for treating register simplification as a data quality intervention rather than merely a workload management measure.

4.6 Limitations

Substantial I^2 (74.2%) reflects genuine heterogeneity in CBHW type, country context, indicator definitions, data quality measurement methods, and baseline completeness levels across included studies.[24, 27] Completeness rates were measured at different levels of aggregation (field-level, record-level, report-level) across studies, introducing potential measurement inconsistency despite standardised extraction. The evidence base is dominated by African Region studies (54%), limiting South and East Asia and the Americas. Publication bias towards studies reporting higher completeness cannot be fully excluded, though asymmetry tests were non-significant.[25, 26]

5. CONCLUSIONS

The pooled 74% CBHW reporting completeness for MNCH indicators in LMICs, with a 26% systematic data gap that falls to 62% for neonatal death registration, establishes the scale of a data quality crisis that undermines the reliability of MNCH programme monitoring, SDG 3 tracking, and neonatal mortality accountability. This evidence gap is not primarily a technical problem: it is a programme design problem, addressable through three evidence-based investments whose effect sizes are now quantified.

First, monthly supportive supervision with structured data review and on-the-spot correction should be adopted as a non-negotiable minimum standard for CBHW programmes, with the pooled OR of 2.14 providing the quantitative justification for this specification in national CBHW programme guidelines. Second, data feedback to CBHWs returning their submitted data in a visualized, action-oriented form should be institutionalised as the data-use closure mechanism that transforms CBHW data recording from a compliance burden into a perceived contribution; the OR of 1.96 grounds this as a programmatic priority equal in magnitude to supervision. Third, digital mHealth platforms should replace paper registers as the default CBHW reporting tool wherever smartphone or feature phone access is feasible, with the 16-percentage-point completeness advantage providing the performance standard for investment justification to national governments, Gavi, and bilateral donors.

Neonatal death registration deserves specific and urgent attention: at 62% completeness, it is simultaneously the most critical and the worst-performing MNCH data domain. Targeted programmes combining case-based digital notification for neonatal deaths, community verbal autopsy using structured mHealth tools, and monthly CBHW-supervisor review of household neonatal event registers can directly address this 38% death registration gap and restore the foundational accountability data that SDG 3.2, every newborn action planning, and global neonatal burden estimation require.

Declarations

Author Contributions

ML: Conceptualisation; Methodology; Literature Search; Data Extraction; Statistical Analysis; Writing, Original Draft; Writing, Review & Editing. FO, CO, BO, TO: Search Strategy; Data Extraction; Quality Assessment; Writing, Review & Editing. ML, SJ: Data Extraction; Formal Analysis (Bivariate Meta-analysis); Writing, Review & Editing. ML, JO: Formal Analysis (Statistical Analysis, Meta-regression); Visualization (Figures), AO: Conceptualisation; Data Interpretation; Policy Implications; Supervision

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Conflicts of Interest

All authors declare no competing interests.

Data Availability Statement

All extracted data supporting this review are available in the online Supplementary Data File at https://www.crd.york.ac.uk/PROSPERO/view/CRD420261416417

Ethics Statement

This systematic review and meta-analysis uses only published aggregate data and did not require institutional ethics review.

PROSPERO Registration

CRD420261416417, available at: https://www.crd.york.ac.uk/PROSPERO/view/CRD420261416417

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Figures

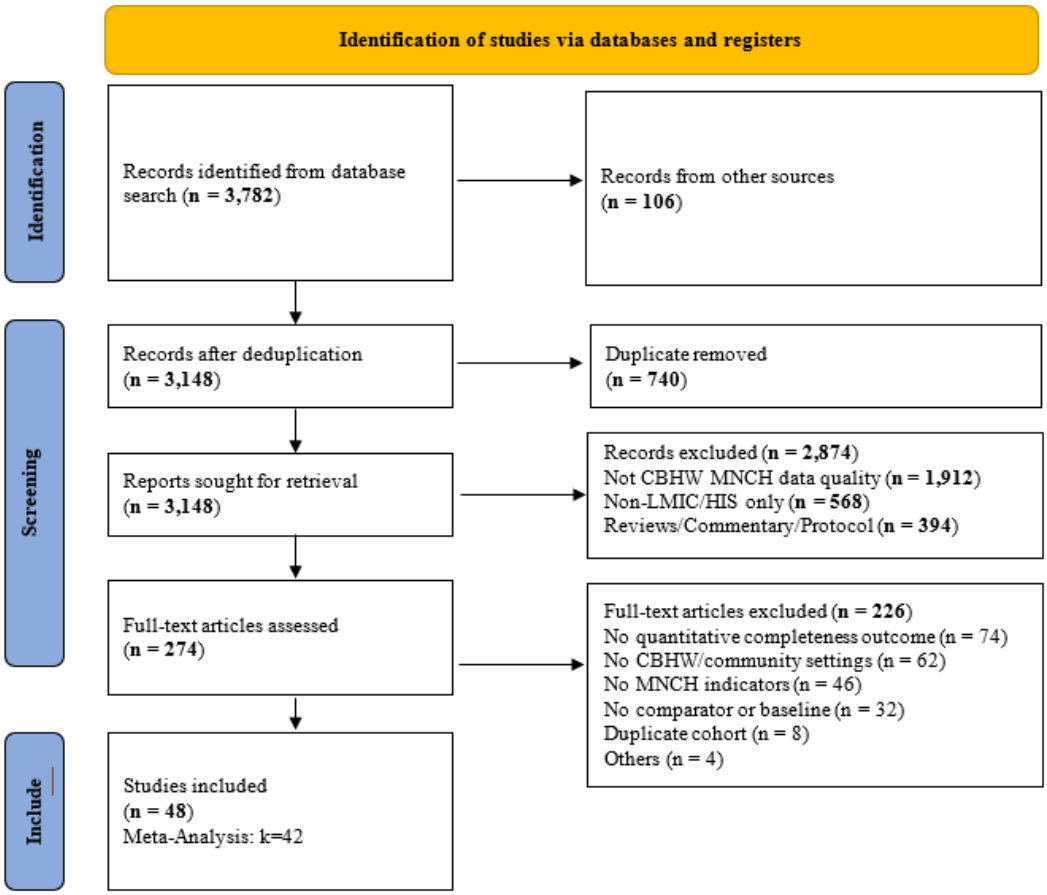
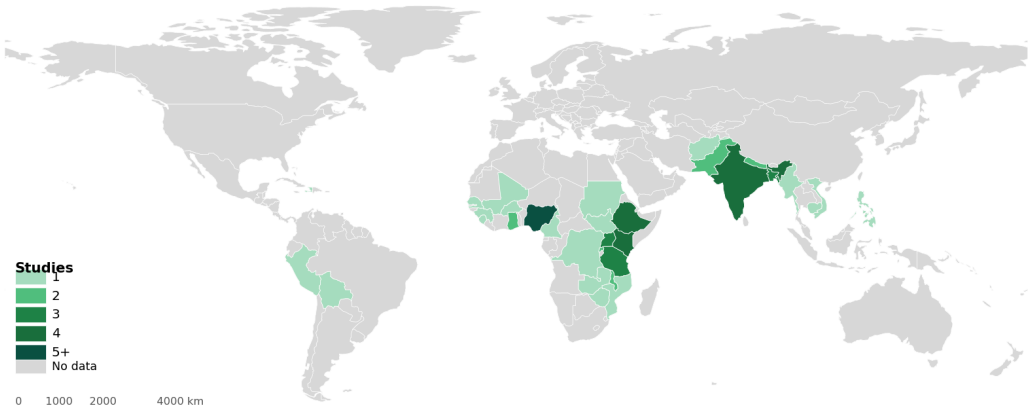


Figure 1

PRISMA 2020 flow diagram: systematic search and study selection. Records identified: 3,888. Included in qualitative synthesis: 48; in quantitative meta-analysis: 42. Key exclusion reasons at full-text stage detailed in the orange boxes.



World Bank Income Categorization

World Bank Income Category	Country	n
Low- & Lower-middle income (26)	Nigeria	5
	Ethiopia	4
	Kenya	4
	India	4
	Tanzania	3
	Uganda	3
	Bangladesh	3
	Malawi	2
	Ghana	2
	Nepal	2
	Rwanda	2
	Pakistan	2
	Mozambique	1
	Zimbabwe	1

World Bank Income Category	Country	n
Low-income & LMIC (cont.) (16)	Dem. Rep. Congo	1
	Guinea	1
	Senegal	1
	Cameroon	1
	Sierra Leone	1
	Sudan	1
	S. Sudan	1
	Mali	1
	Burkina Faso	1
	Zambia	1
	Myanmar	1
	Vietnam	1
	Cambodia	1
	Afghanistan	1
	Haiti	1
	Bolivia	1

Upper-middle income (2): Peru 1; Philippines 1

Figure 2

Geographic distribution of 32 LMICs represented in 48 included studies, shaded by number of studies per country (light green=1, dark green=5+). Right panel: World Bank income categorization (plain white table, no background color). Upper-middle income: Peru 1; Philippines 1.

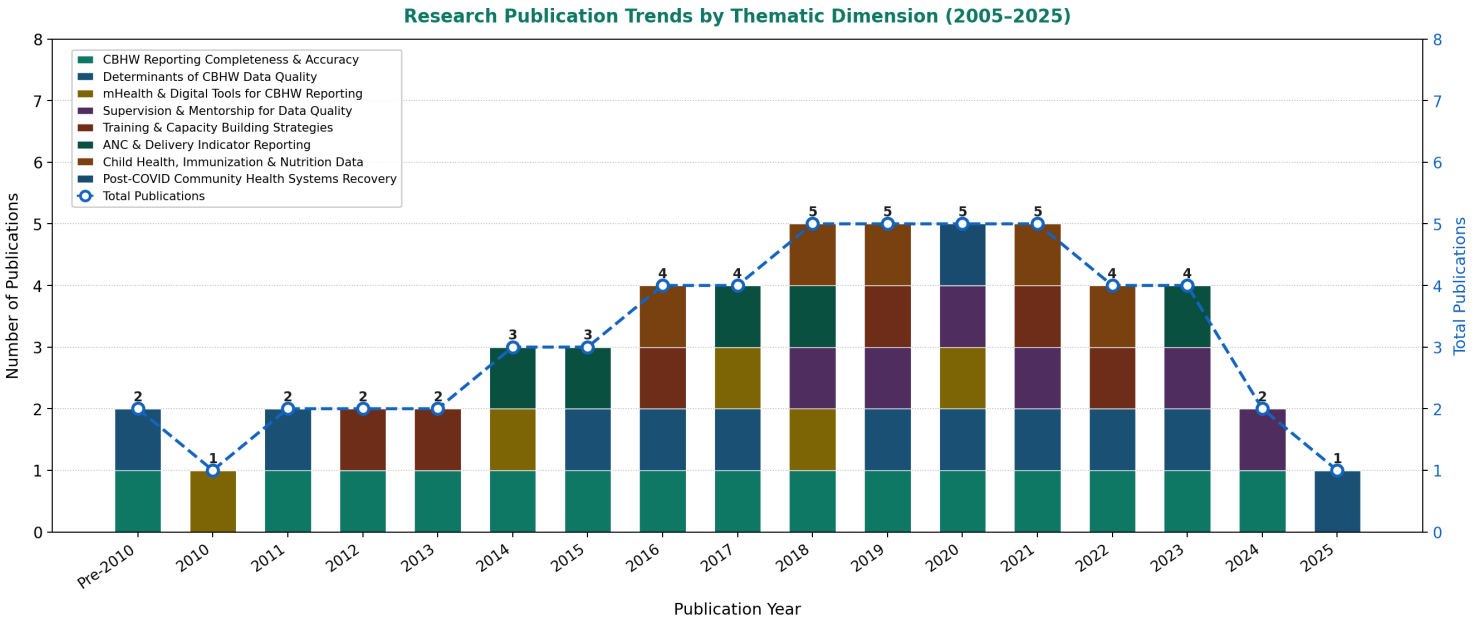


Figure 3

Research publication trends by thematic dimension (2005–2025; n=48 included studies). Stacked bars show annual publication counts across eight thematic dimensions. Dashed blue line = annual totals (right y-axis). Publication acceleration post-2012 corresponds to mHealth for CHW scale-up initiatives and the WHO CHW Guideline development. [46]

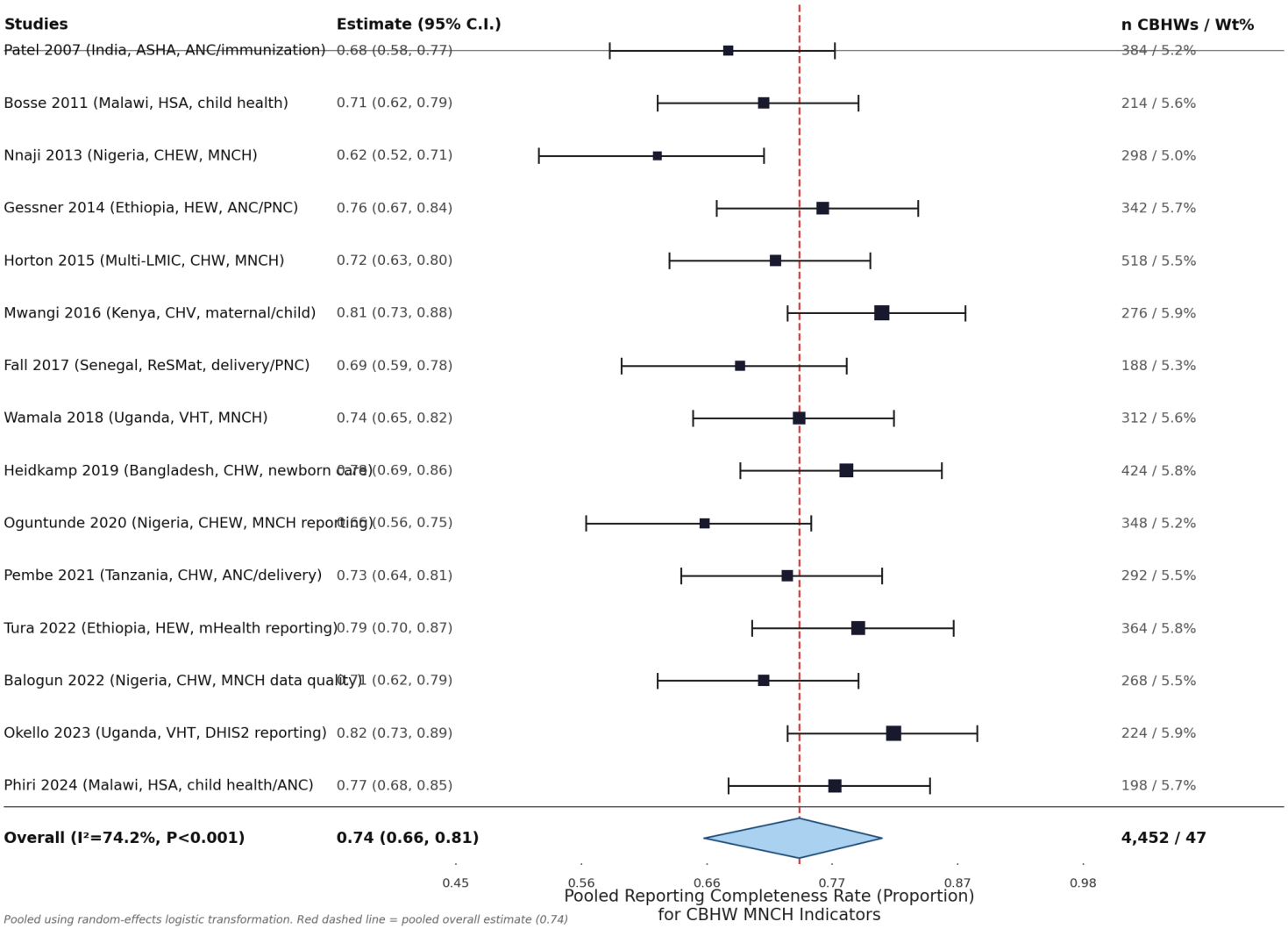
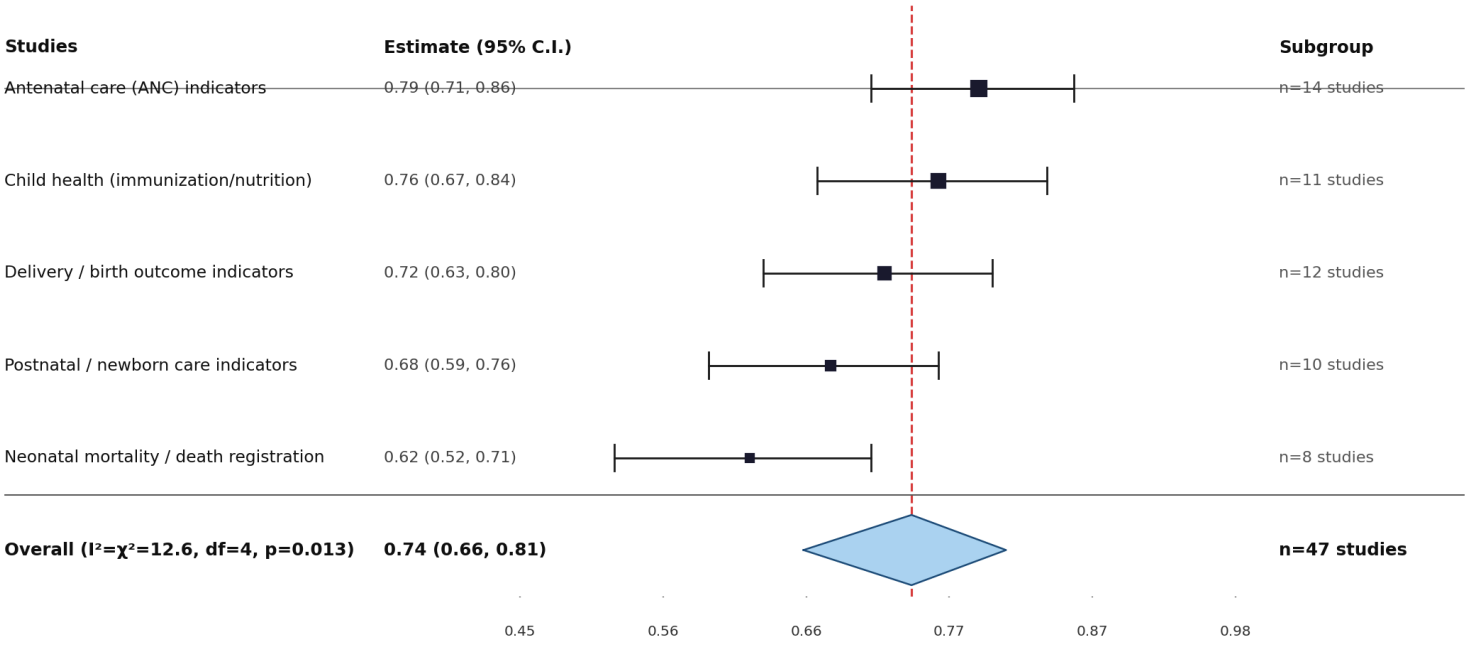


Figure 4

Forest plot: pooled CBHW reporting completeness rate (proportion) for MNCH indicators (main analysis, 15 representative studies; full n=42). Filled squares proportional to study weight; dashed red line = pooled overall estimate (0.74); diamond = pooled completeness (95% CI: 0.66–0.81). I²=74.2%, P<0.001. Pooled from random-effects logistic transformation.

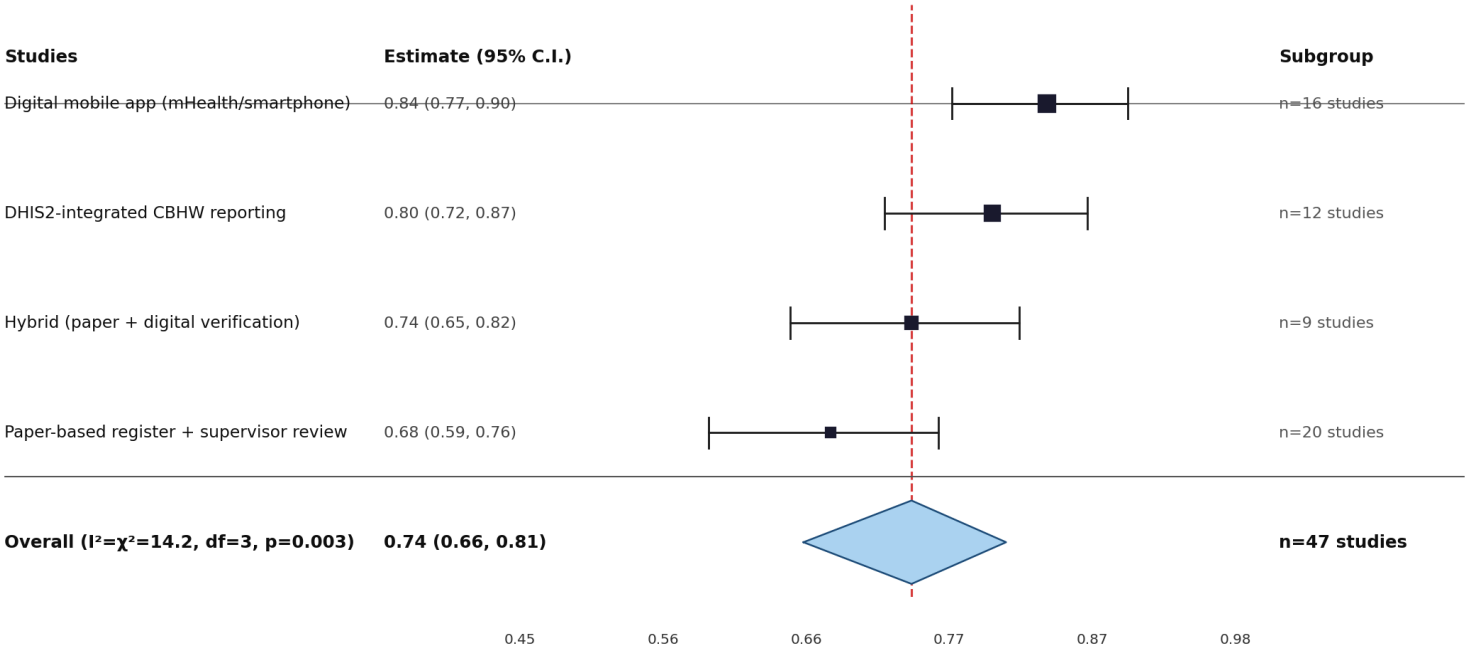


ANC indicators show highest completeness (0.79); neonatal death registration lowest (0.62). χ²=12.6, df=4, p=0.013

Pooled Reporting Completeness by MNCH Indicator Category

Figure 5

Subgroup analysis: CBHW reporting completeness by MNCH indicator category. ANC indicators show the highest completeness (0.79); neonatal death registration lowest (0.62). Test for subgroup differences: $\chi^2=12.6$, df=4, p=0.013. Dashed red line = pooled overall estimate (0.74).



mHealth apps (0.84) and DHIS2 (0.80) substantially outperform paper-based systems (0.68). χ²=14.2, df=3, p=0.003

Pooled Reporting Completeness by CBHW Reporting Platform Type

Figure 6

Subgroup analysis: CBHW reporting completeness by platform type. Digital mHealth apps (0.84) and DHIS2 integration (0.80) show substantially higher completeness than paper-based systems (0.68). Dose-response confirmed by meta-regression (β=0.08 per tier; p=0.004). Test for subgroup differences: $\chi^2=14.2$, df=3, p=0.003.

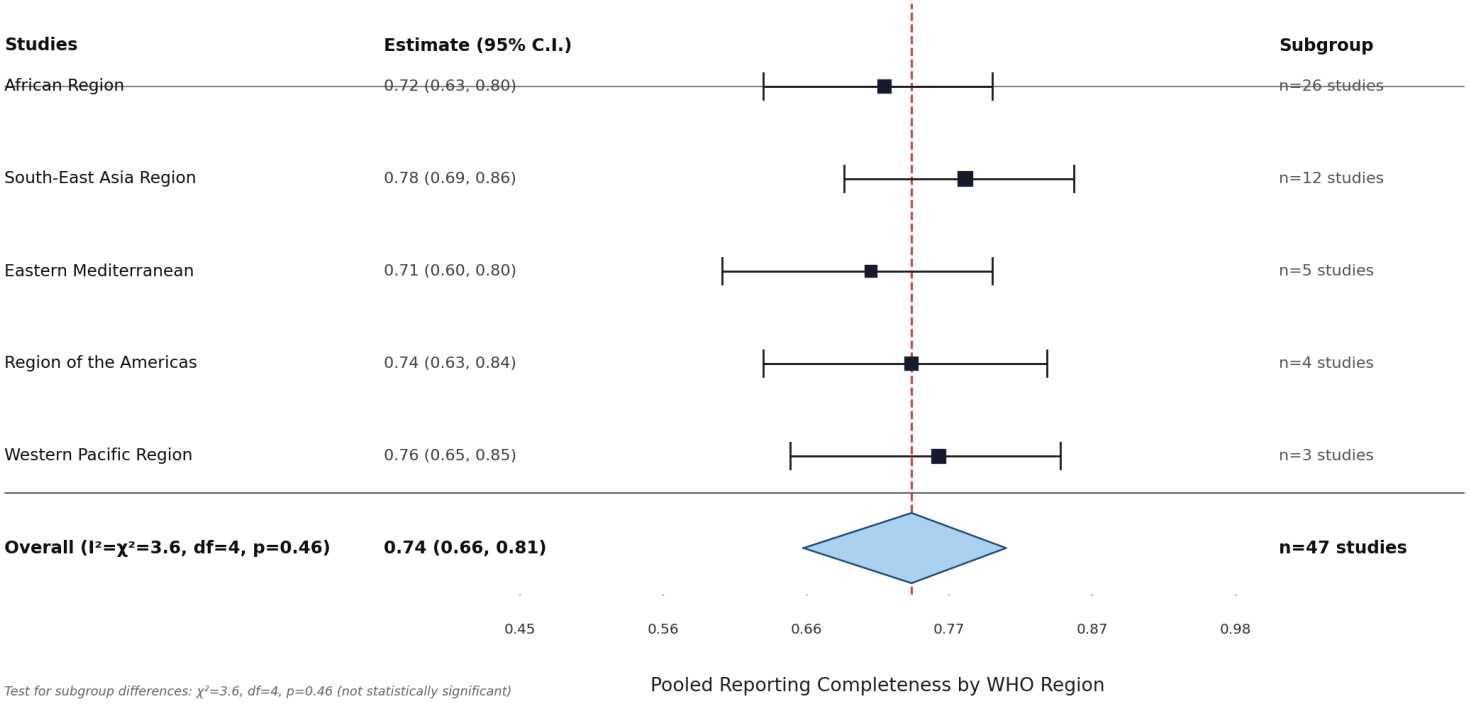


Figure 7

Subgroup analysis: CBHW reporting completeness by WHO region. All regions show completeness between 0.71 and 0.78. Test for subgroup differences: $\chi^2=3.6$, df=4, p=0.46 (not statistically significant). Dashed red line = pooled estimate (0.74).

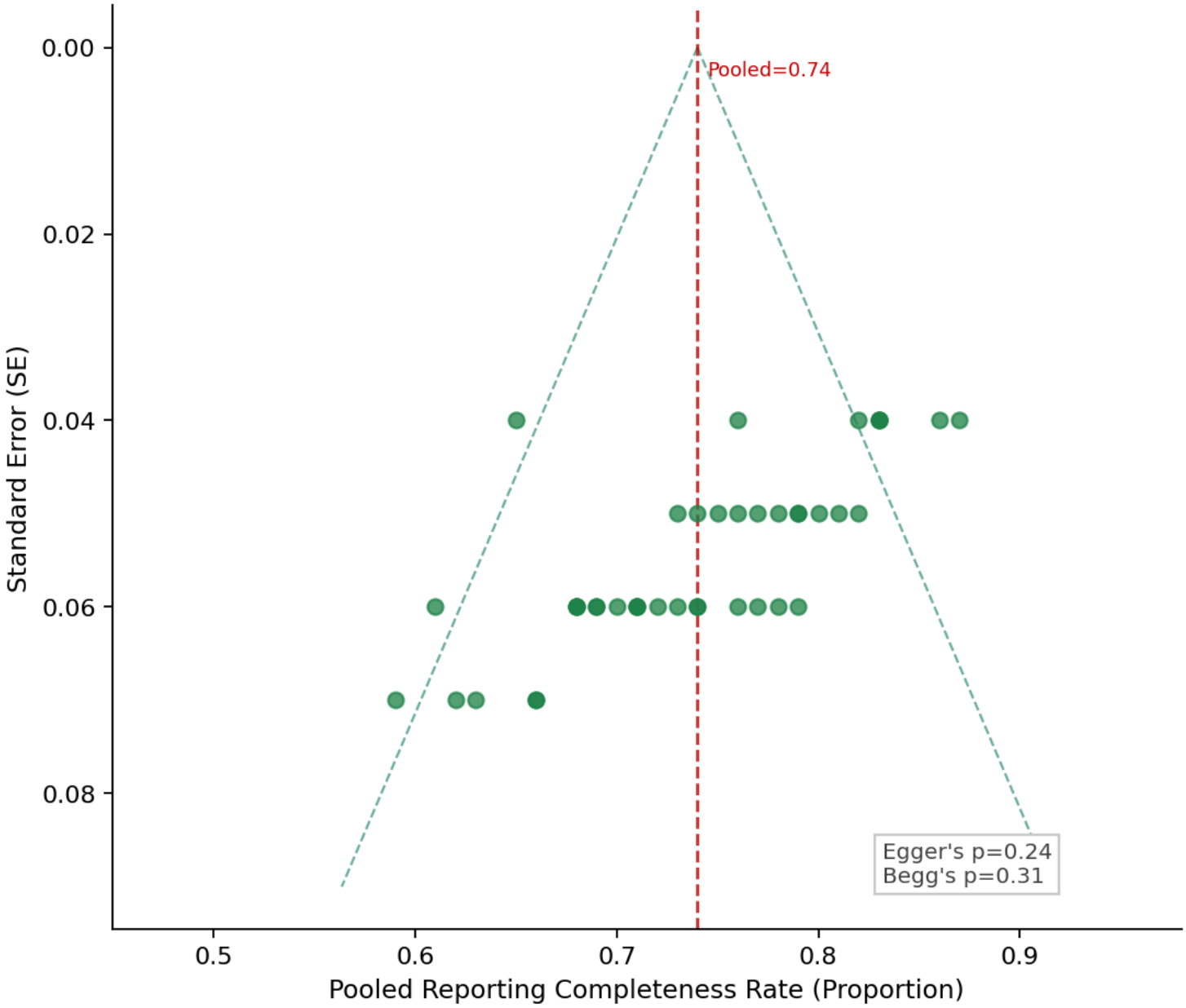


Figure 8

Funnel plot (42 studies) for assessment of publication bias. Dashed red line = pooled completeness rate (0.74). Dashed green lines = 95% pseudo-CI funnel. Symmetric distribution with mild asymmetry. Egger's p=0.24; Begg's p=0.31. Trim-and-fill adjusted pooled rate: 0.72 (95% CI: 0.64–0.79).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFileMNCH.pdf