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# Stock-outs of essential medicines among community health workers (CHWs) in low- and middle-income countries (LMICs): a systematic literature review of the extent, reasons, and consequences

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## Abstract

**Background:** This paper explores the extent of community-level stock-out of essential medicines among community health workers (CHWs) in low- and middle-income countries (LMICs) and identifies the reasons for and consequences of essential medicine stock-outs.

**Methods:** A systematic review was conducted and reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Five electronic databases were searched with a prespecified strategy and the grey literature examined, January 2006–March 2021. Papers containing information on (1) the percentage of CHWs stocked out or (2) reasons for stock-outs along the supply chain and consequences of stock-out were included and appraised for risk of bias. Outcomes were quantitative data on the extent of stock-out, summarized using descriptive statistics, and qualitative data regarding reasons for and consequences of stock-outs, analyzed using thematic content analysis and narrative synthesis.

**Results:** Two reviewers screened 1083 records; 78 evaluations were included. Over the last 15 years, CHWs experienced stock-outs of essential medicines nearly one third of the time and at a significantly ( $p < 0.01$ ) higher rate than the health centers to which they are affiliated (28.93% [CI 95%: 28.79–29.07] vs 9.17% [CI 95%: 8.64–9.70], respectively). A comparison of the period 2006–2015 and 2016–2021 showed a significant ( $p < 0.01$ ) increase in CHW stock-out level from 26.36% [CI 95%: 26.22–26.50] to 48.65% [CI 95%: 48.02–49.28] while that of health centers increased from 7.79% [95% CI 7.16–8.42] to 14.28% [95% CI 11.22–17.34]. Distribution barriers were the most cited reasons for stock-outs. Ultimately, patients were the most affected: stock-outs resulted in out-of-pocket expenses to buy unavailable medicines, poor adherence to medicine regimes, dissatisfaction, and low service utilization.

**Conclusions:** Community-level stock-out of essential medicines constitutes a serious threat to achieving universal health coverage and equitable improvement of health outcomes. This paper suggests stock-outs are getting worse,

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and that there are particular barriers at the last mile. There is an urgent need to address the health and non-health system constraints that prevent the essential medicines procured for LMICs by international and national stakeholders from reaching the people who need them the most.

**Keywords:** Community health workers, Frontline health workers, Supply chain, Stock out, Health system, Universal health coverage

## Background

Community health workers (CHWs) are paraprofessionals or lay individuals based in the community who provide health services to urban and rural communities [1]. The role of CHWs is increasingly recognized as key to achieving Universal Health Coverage and pandemic preparedness and response [2, 3]. CHWs continue to play critical roles in reaching communities with essential health services because of their social and geographical proximity to residents and the cost-effectiveness of their services [4–6]. Delivery of Integrated Community Case Management (iCCM), for example, has been shown to reduce child deaths from malaria, pneumonia, and diarrhea by up to 60% [7–11]—but only if CHWs have access to essential supplies. Essential medicines consist of drugs with a potential for safe treatment of priority conditions and these drugs make up the minimum medicine needs for a basic healthcare system [12]. CHWs are typically supplied with these drugs by a primary health center to which they are linked. Systematic and narrative reviews have found that stock-out of such essential medicines is a major hindrance to CHW productivity and motivation [13, 14]. Evidence suggests that stockout of essential medicine may result in poor clinical outcomes, including drug-resistant mutation and increased mortality [15].

Understanding the extent of, reasons for and consequences of stock-outs of essential medicines at the community level is critical for optimizing CHW programs [16]. Some projects, such as Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood (SC4CCM), implemented by JSI Research & Training Institute, have documented essential medicine stock-outs at the community level in several countries. However, there is no systematic literature review documenting the extent of CHW stock-outs and elucidating reasons for and consequences of community-level stock-out. This paper attempts to address this knowledge gap using a structured approach.

## Methods

We conducted a systematic review of published and grey literature on the extent of, causes of, and consequences of stock-outs at the CHW level and report it here in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]. Where

link health center data were available, it was analyzed, as in most settings, these centers are responsible for resupplying products to CHWs.

## Search strategy

The initial search was conducted between August and September 2018 and updated in March 2021. We reviewed peer-reviewed articles and grey literature published in four electronic databases: [1] PubMed, (2) Global Health via Ovid, (3) Web of Science, and (4) Embase via Ovid. In addition, we searched the Google and Google Scholar search engines and the World Health Organization's website for relevant articles during the same period (date last searched and search strategies used for the databases listed above can be found in Additional file 1: Appendix 1).

A team of supply chain (SC) experts was engaged in soliciting evidence-based, unpublished literature. Grey literature was accessed by requesting documents and reports from supply chain organizations (e.g., USAID, WHO, UNICEF VillageReach, Save the Children, JSI, MSH, Federal Ministries of health etc.). Different platforms, such as the Interagency Supply Chain Group (ISG), Child Health Task Force (CHTF), International Association of Public Health Logisticians (IAPHL), the Community Health Community of Practice, etc., were also approached.

## Inclusion and exclusion criteria

In this study, we defined CHWs as paraprofessionals or lay individuals based in the community who provide health services to urban and rural communities [1]. Several definitions of shortage and stock-out have been used in published and grey literature [18]. For this study, we defined stock-out as: *“the complete absence of a required medicine at a storage point or delivery point for at least 1 day.”* A study was included if it contained (a) information on the number or percentage of CHWs stocked out or (b) reasons for CHW stock-outs or (c) consequences of CHW stock-out.

## Selection and data extraction

Relevant data were systematically extracted from selected studies and tabulated in a Microsoft Excel spreadsheet. The following information was extracted from each study:

(1) Study characteristics (including author, title, publication date, year of study, method of study, the sample size of CHWs, the sample size of health centers, geographic area, and the list of essential medicines to be stocked by CHWs), (2) Quantification of stock-out (including number and percentage of CHWs or HFs stocked out), (3) Reasons for stock-out and (4) consequences of stock-out.

#### Assessment of risk of bias and quality of evidence

The Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) assessment tool [19, 20] was applied to quantitative information from the non-randomized studies (observational studies).

This tool comprises seven bias domains: (1) confounding; (2) selection of participants; (3) classification of intervention; (4) deviation from interventions; (5) missing outcome data; (6) measurement of outcomes; and (7) selection of reported result overall. Risk of bias was rated as: ?—no information; 1—low risk; 2—moderate risk; 3—serious risk; 4—critical risk; and not applicable (N/A)—if the study did not consider the criterion. A study was rated low risk of bias if it was ranked low for all domains; at moderate risk if ranked moderate in at least one domain; at serious risk of bias if it was ranked serious in at least one domain; and at critical risk of bias if it was ranked critical in at least one domain. Overall assessment for any single study was not less severe than the most severe assessment allocated for a single domain for that study.

Qualitative studies relevant to the two themes (reason for and consequence of stock-out) were rated using the GRADE Confidence in the Evidence from Reviews of Qualitative research (CERQual) approach to ascertain the confidence level that can be placed in the findings [21]. Rating was based on methodological limitations; relevance (of the findings in the context of the themes), coherence (of the data in explaining the themes) and adequacy of the data (quantity and richness of data that explain the themes). The overall confidence level was rated down by at least one level for each component for which serious concerns were identified. Overall rating was either high, moderate, low, or very low [22].

Two review authors independently rated all the included studies and resolved any disagreement by reciprocal consulting [20].

#### Data analysis

We analyzed only articles published since 2006 to ensure that findings are contemporarily relevant. This cutoff date provides 15 years of data to analyze and corresponds to the period in which CHWs gained renewed attention following the WHO declaration of health workforce shortage [23].

We compared the stock-out rate in the period (2006–2015) before the declaration of sustainable development goals (SDG) and after (2016–2021) to assess quantitative changes in the extent of stock-out. Descriptive statistics of stock-out rates among CHWs and health centers were computed based on the numbers reported by various studies. A two-sample test of means was applied to determine whether a statistical link existed between the CHW and health center stock-out rates over the entire period and for each of the two entities (CHWs and health centers) over the pre and post SDG era (see Additional file 1: Appendix 2).

Using thematic content analysis [24], reasons for stock-out were mapped to relevant segments of the supply chain drawn from structural commonalities of supply chains across countries [25, 26]. Consequences of stock-out were inductively organized based on institutions or individuals affected (Additional file 1: Appendix 3). To create a complete record of findings irrespective of publication year, we documented findings from articles published before 2006 (Additional file 1: Appendix 4).

## Results

### Description of included papers

The systematic review builds on an earlier search which included 48 reports, with 34 of these retained after double screening. As shown in the PRISMA diagram (Additional file 1: Appendix 5), our search of both published and unpublished literature resulted in a total of 1896 records. After the deletion of duplicates, 813 records had their titles and abstracts screened, and 71 records from this screening underwent full-text screening. The 44 records found eligible from this screening were added to the 34 records from the previous search to inform this systematic review. Despite not setting a geographical search limit, all 78 articles are from LMICs including 47 from Africa, 10 from Asia and 21 from more than one country. Thirty-eight of these articles were published in the period 2006–2015, 40 published between 2016 and 2021 and six articles (not included in results for lack of contemporary relevance) published before 2006. Articles published between 2006 and 2021 include 28 articles that contain quantified information on CHW stock-out rate and 67 studies with reasons for and consequences of stock-outs at community level with some studies contributing to both quantitative and qualitative findings.

### Quantitative findings: extent of stock-out

Twenty-eight articles involving 62,372 CHWs and 2,383 health centers described community level stock-outs of essential medicines. Overall, 28.93% [CI 95%: 28.79–29.07] of the CHWs and 9.17% [CI 95%: 8.64–9.70] of the health centers experienced stock-outs of essential

medicines during the entire review period. A comparison of the period 2006–2015 and 2016–2021 showed that CHW stock-out level increased from 26.36% [CI 95%: 26.22–26.50] to 48.65% [CI 95%: 48.02–49.28] while that of health centers increased from 7.79% [95% CI 7.16–8.42] to 14.28% [95% CI 11.22–17.34].

Hypothesis testing showed a significant difference ( $p < 0.01$ ) in stock-out levels between CHWs and health centers for the entire review period and each of CHWs and health centers between the two comparison periods (Additional file 1: Appendix 2).

### Qualitative findings: reasons for stock-out at different levels of the supply chain

Reasons for stock-out were grouped under four segments of the supply chain drawing from international descriptions of the supply chain [25, 26]. We present these reasons in the order products move from the central level of the supply chain to CHWs: procurement, distribution, storage and community-level stock management. Overall, issues relating to distribution were the most frequently reported.

#### Procurement

Less than half ( $n = 19$ ) of included papers with qualitative findings described procurement challenges as reasons for stock out (Additional file 1: Appendix 3). The challenges include:

- a. *Financial issues* There were challenges with inadequate funding from limited domestic budgetary allocation, delayed disbursements [27–35] and an over-reliance on unpredictable external funding, especially as termination of donor agreement often leads to disruption in supply [33, 35, 36].

Furthermore, direct financial allocations to health centers often ignore the population size they cater for and the demands of the community health service provision and disbursement are often delayed and lower than the amount allocated [37].

- b. *Governance and coordination of national procurement* A key reason for stock-out was delays in procurement from lack of or inadequate governance structure [38]. Other governance-related challenges were lengthy and unclear procurement process [27, 33, 34], frequent changes in key leadership positions within the Ministry of Health with resultant delay in obtaining approval to import medicines into the country [39], and delay in receiving international and domestic orders [40, 41].
- c. *Logistic management* Insufficient medicine procurement at the central store [42–45] was explained by

poor forecasting at district and national levels [38] and unanticipated increased demand, especially with an influx of internally displaced persons (IDPs) during crisis situations [29].

#### Distribution

More than half ( $n = 40$ ) of included papers with qualitative findings described distribution challenges as reasons for stock-out (Additional file 1: Appendix 3). The challenges include:

- a. *Policies* Lack of or delay in implementing formal policies that stipulate the products that CHWs are permitted to manage and dispense, and policies that formally integrate CHWs into the national supply chain, contribute to CHW stock-outs [35, 41, 46–48]. This includes failure to disseminate policies to health centers resulting in refusal or reticence to supply CHWs with stock [27, 49]. Health centers were often considered to be the “last mile”; therefore, CHW stock is, in some cases, compiled with and viewed as health center stock. Furthermore, restrictive guidelines were preventing the distribution of medicines such as zinc supplement to CHWs [50].
- b. *Logistic management* Logistic-related stock-out was explained by weak supply chain systems [29, 30, 35, 45, 51–53] from complex and multi-level supply chains [35, 37, 54, 55], fragmentation and duplication from stand-alone supply chains for vertical health programs that work independently of the national supply chain [29, 32, 37, 50]. Consequently, there was mismanagement of supplies [33], including suspected theft of medicines at different levels of the chain [33, 44, 56], insufficient deliveries [44] and delays [57] from central stores.
- c. *Information management* Poor communication and coordination between different levels of the supply chain made obtaining information to inform supply chain decisions difficult, especially distribution [35, 58]. This included poor visibility of consumption data due to irregular submission of logistics reports of CHW link health center [59] and no system to track that supply reached the last mile [37, 60]. This may explain the frequently used push system of distribution with a fixed supply that is not data-driven, and which ignores increased demand from awareness campaigns and consequently can result in wastage in some centers and shortage in others [35, 44, 61, 62] and expiry of medicine in centers with supply in excess of their demand [49, 50].
- d. *Transportation* Delays were often reported in transportation from the district to the health center and

subsequently the community. The distance and time required to reach the health centers for resupply [27, 32, 38, 42, 53, 60, 63–67] was also an issue, explained in part by difficult road conditions or terrain [29, 32, 33, 35, 54, 55, 57, 60, 66], especially during the rainy season [29, 51, 60] with floods making some places unreachable [29]. Relatedly, insecurity during travel was often a concern, especially in conflict-affected areas [29, 40].

CHWs had limited motivation to travel to pick up medicines [53] as they often lacked enough time and transport fare for collection [31, 32, 65]. Lack of dedicated funding for collection was limiting product availability at the community level [27, 29, 35, 37, 49, 54, 55, 67–70]. Where third-party logistic companies were considered for distribution to centers including CHW link health centers, engagement was often delayed by bureaucracy [29].

- e. *Human resource management*: CHW stock-out resulted from lack of responsiveness to stock-out reports by health centers or district stores [69], perhaps due to a lack of technical competence for managing logistics activities [32, 33, 55] and poor supervisory support [59, 68]. While in general CHWs have been found to follow procedures and perform simple tasks correctly given sufficient orientation and supervision, CHWs were not always guaranteed supplies at the link health center, as this was sometimes threatened by “power tussle” and tense relationship between them and health center workers [29]. In addition, link health centers delay in processing CHWs’ refill requests [29], prioritize their own needs over those of CHWs [36] and may use medicines meant for CHWs to top up their supply especially if availability is tracked at health center level but not CHW level [27, 29, 40, 58, 71]. In addition, link health center often experience stock-out too [49, 65, 66], partly explained by over-prescription of free medicines [29] and may be pressured to appropriate CHWs’ stock.

### Storage

Less than half ( $n=7$ ) of included papers with qualitative findings describing storage challenges as reasons for stock-out at CHW and health center levels (Additional file 1: Appendix 3). These include limited or inadequate or improper storage space, which led to CHW stock-outs. The issue of inadequate storage space is not unique to CHWs, who typically store supplies in a box in their homes but also relevant for health centers [36, 37, 66, 72]. Inadequate or inefficient use of space at health center

often meant they are unable to keep enough stock to resupply CHWs.

The poor storage conditions have tendencies to compromise the stability and potency of medicines [32, 35, 66, 68, 73]. Furthermore, insecure storage space has the potential for theft [35].

### Community-level stock management

Less than half ( $n=29$ ) of included papers with qualitative findings described challenges relating to community-level stock management as reasons for stock-out (Additional file 1: Appendix 3). The challenges include:

- a. *Human resource management*: Human resource challenges include shortage of trained staff dedicated to stocktaking and forecasting [27, 35, 36, 44, 54], limited training opportunities and supportive supervision on supply chain management at the health center level [30, 32, 42, 43, 50, 54, 60, 74–77]. CHWs with low literacy/numeracy capacity experienced challenges in reporting and submitting data [58]. This challenge was aggravated when they managed many products, leading to inadequacy in stock management [54]. Hence, data from CHWs may be sparse and of low-quality. In addition, complicated, data-intensive stock-taking was unmanageable for the capacity available at health center and time constraints limit the ability of health center staff to adequately manage logistics [37]. Overall, inadequate training, supervision and poor numeracy skills constrain proper data collection, and utilization, which often leads to poor demand-forecasting, and poor data visibility of community-level consumption data for consolidation into district-level quantification and decision making [35, 37, 53, 58, 60, 65, 70, 74, 78]. Data were often not accurate or, where accurate, did not support decision making [29, 70]. At health center and CHW levels, poor data collection and use make it difficult to accurately estimate needs, contributing to expiry of medicines at the community level [33].
- b. *Logistic management* There were often no standard procedures or formulas for calculating resupply quantities for CHWs and who should be notified if centers are understocked [32, 58, 68, 70]. Insufficient amounts of medicines from poor forecasting [29, 40, 41, 45, 69, 71] do not respond to increased demand for services, including the provision of medicines [28]. CHWs and health center staff report to multiple places using lengthy non-standardized forms that are not user-friendly, thereby creating a slow flow of data necessary to inform supply planning [55, 58, 77]. In addition, poor communication between the health

center and central store limits effective planning for stock needs [37].

### **Qualitative findings: consequences of stock-outs of essential medicines on stakeholders**

#### **Program**

Five articles described consequences of stock-out on the program, including limited program performance and impact [34, 69, 75, 79] with some programs experiencing stalled implementation [29]. Overall, stock-outs reduce acceptability and confidence of the population in CHW programs [69].

#### **Health center**

Seven articles described how stock-out affect CHW link health centers. These consequences include increased workload (demand) from case referrals that CHWs couldn't treat due to stock-out [29, 30, 51]. Health centers with stockout function poorly or are unable to provide services [45, 56, 61]. They may be accused of theft by end-users [56], forced to improvise with other (non-ideal) materials when a medicine is unavailable [46].

#### **CHWs**

Fifteen articles considered the consequences of stock-out on CHWs to include demotivation from community members' complaints about lack of medicines [47, 57, 69, 80, 81] and consequent loss of reputation and recognition [82], with some CHWs incurring out-of-pocket expenses to preserve reputation [32, 62]. Ultimately, this may result in job attrition [29, 47, 51].

Stock-out at national levels led to CHWs experiencing a long wait for medicine supply after training [27], thereby limiting their service delivery [52, 79, 82–84] and led to depreciation of CHW competency in medicine administration [47].

#### **End-users**

Twenty-six papers considered the consequences of stock-out on end-users. Community-level stock-outs meant end-users were not offered services and were referred to the health center by CHWs [29, 33, 66, 73, 85]. Some family planning end-users were uncomfortable with these referrals as health center services were not as discreet as those offered by CHWs [66], resulting in change of contraceptive methods, while others stopped usage [62]. End-users self-referred themselves from a health centers without stock to those with stock [86, 87] based on dissatisfaction from consultations without medicines [88], delay in accessing care within the community due to referrals [69], incurring out-of-pocket cost to buy unavailable medicines [29, 46, 57, 66,

89, 90]. End-users of routine medicines had poor compliance to medicine regimens when they lost access to free medicines [30, 90], and others received inappropriate treatment [91], including underdosing with a resultant incomplete recovery and development of medicine resistance [59]. Overall, end-users had a poor perception of and little confidence in CHWs implementing programs with a medicine stock-out. Consequently, this accounted for low utilization of services [29, 30, 40, 47, 51, 55, 62, 75, 79, 88].

Some end-users resorted to alternative vendors (rather than CHWs and health centers) [92] including herbalists, and hawkers [93], which could put them at risk of receiving counterfeit and substandard medicines.

### **Risk of bias and quality of evidence**

Using ROBINS-I, 12 of the 28 studies with quantitative findings were evaluated to have a serious overall risk of bias, nine moderate, six low and one had no information for assessing risk of bias.

As shown in (Additional file 1: Appendix 6), the “confounding domain” was a significant contributor to the increased risk of bias of the seven domains of ROBINS-I. The major confounding issue being the co-interventions such as community-focused programs that may have improved availability of essential medicines in the intervention communities. Therefore, the extent of stock-out described in this review may be lower than what obtains in many communities in LMICs, and stakeholders may benefit from primary research to assess the level of local stock-out.

Of the 67 studies with qualitative findings, 12 were considered to have high quality of evidence, 48 moderate quality and seven have low quality. The overall CERQual assessment, explained in a Summary of Qualitative Findings table (Additional file 1: Appendix 7), includes a narrative explanation of the CERQual assessment that highlights issues on methodological limitation and adequacy of data. In light of what we can describe as moderate level of evidence, stakeholders may conduct methodologically sound primary research to identify and quantify the context-relevant reasons and consequences of stock-out in their environment which would guide future interventions. Sensitivity analysis was conducted in which studies at high risk of bias were excluded from the analysis. As shown in Table 6b of Additional file 1: Appendix 6, the stockout rate was even higher among CHWs (52.78%) but lower in health facilities (7.14%), suggesting that without co-interventions (the vast majority of studies were downgraded for confounding), CHWs may experience worse stockout rates.

## Discussion

This review explores the extent, reasons, and consequences of community-level stock-out to provide evidence to guide last-mile supply chain strengthening. It shows that most studies focused primarily on sub-Saharan African countries, perhaps reflecting the popularity of community case management approach or uneven burden of stock-out in sub-Saharan Africa. This review indicates that CHWs were out of stock nearly one third of the time and shows a significantly ( $p < 0.01$ ) higher stock-out rate among CHWs (28.93%) in comparison to the health centers to which they are affiliated (9.17%). This may be explained by the fact that CHWs are often not included in health worker registries used for supply forecasting [94] or are last in line to receive essential supplies in the event of unforeseen shortages [95].

Of note, the health center stock-out rate from our review is lower than rates of between 45.60% and 70.60% documented by WHO in their study of public health sector health facilities across 36 LMICs in 2008 [96]. The lower value from our review may be explained (at least in part) by the co-interventions to improve community-level stocks and support from implementing partners.

Worrisome, however, is the increase in stock-out rate during the period 2016–2021 at both CHW and health center levels, despite growing political commitment to CHWs. Increased commitment must translate to tangible interventions and policy reviews to address all the health and non-health system challenges contributing to stock-outs. If left unattended, it could cause severe setbacks to the universal health coverage and equitable achievement of post-2015 agenda.

This review notes problems relating to distribution as a significant cause of stock-out in LMICs and acknowledges that the private sector could play key roles in strengthening this portion of the supply chain [97]. Nonetheless, the reasons for stock-out are multi-dimensional and would require a multi-sectoral and system approach including coordination of government and donor financing, building quantification into the routine health information system and leveraging mobile technology, enacting and governing policies that support last-mile distribution, capacity building, supervision and motivation of the health workforce on supply chain management and design of simplified stock management tools for CHWs [10].

## Study limitations

We contacted several professionals to access unpublished literature to enrich our findings. That said, the included studies have used various reporting metrics to present stock-outs at the CHW and health center levels

which limited possibilities for analysis. Standard criteria for reporting stock-out are recommended for future studies.

While we included only articles published from 2006 to 2021, we compensated for this by comparing our findings with the extent of stock-out and common themes in the reasons for and consequences of stock-out in the period pre-dating 2006 and found no remarkable variance (Additional file 1: Appendix 4).

## Conclusions

Community-level stock-out of essential medicines constitute a serious threat to universal health coverage and equitable improvement of health outcomes. This evidence suggests they are getting worse, rather than better and that CHWs and end-users are disproportionately affected. To ensure equitable and sustainable access to essential medicines, there is a need for intensive remediation of the barriers outlined.

## Abbreviations

CHW: Community Health Worker; GRADE: Grading of Recommendations Assessment, Development and Evaluation; IAPHL: International Association of Public Health Logisticians; iCCM: Integrated Community Case Management; ISG: Interagency Supply Chain Group; JSI: John Snow, Inc.; LMICs: Low- and middle-income countries; LMIS: Logistics Management Information System; MSH: Management Sciences for Health; SC4CCM: Improving Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood; SHWG: Systems for Health Working Group; USAID: United States Agency for International Development; WHO: World Health Organization.

## Supplementary Information

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**Additional file 1.** Appendices 1–7.

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## Author contributions

MB, BS, and HSD designed the study. AO and AP performed the search and the initial data extraction. MB and AO analyzed and interpreted the data. HSD and EB assisted in collecting the data and in editing the manuscript. MB and AO drafted and edited the manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**

All data generated or analyzed during this study are included in its additional information file.

**Declarations****Ethics approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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**References**

1. HRSA. Community Health Workers National Workforce Study. Washington DC; 2007.
2. Frymus D, Kok M, Koning K De, Quain E. Community Health Workers and Universal Health Coverage. Knowledge gaps and a need based global research agenda by 2015. *Global Health Workforce Alliance*. 2013;(December).
3. Ballard M, Bancroft E, Nesbit J, Johnson A, Holeman I, Foth J, et al. Prioritising the role of community health workers in the COVID-19 response. *BMJ Glob Health*. 2020;5:23.
4. Vaughan K, Kok MC, Witter S, Dieleman M. Costs and cost-effectiveness of community health workers: Evidence from a literature review. Vol. 13, *Human Resources for Health*. BioMed Central Ltd.; 2015. p. 71.
5. Tulenko K, Møgedal S, Afzal MM, Frymus D, Oshin A, Pate M, et al. Community health workers for universal health-care coverage: from fragmentation to synergy. *Bull World Health Organ*. 2013;91(11):847–52.
6. Nepomnyashchiy L, Westgate C, Wang A, Olsen H, Yadav P. Protecting Community Health Workers PPE Needs and Recommendations for Policy Action [Internet]. Centre for Global Development. 2020 [cited 2021 May 13]. p. 1–12. Available from: <https://www.cgdev.org/publication/protecting-community-health-workers-ppe-needs-and-recommendations-policy-action>.
7. Lassi ZS, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. *Cochrane Database Syst Rev*. 2015;2015(3).
8. Amouzou A, Morris S, Moulton LH, Mukanga D. Assessing the impact of integrated community case management (iCCM) programs on child mortality: review of early results and lessons learned in sub-Saharan Africa. *J Global Health*. 2014;4(2).
9. Ballard M, Montgomery P. Systematic review of interventions for improving the performance of community health workers in low-income and middle-income countries. *BMJ Open*. 2017;7(10): e014216.
10. Steele P, Subramanian L, Tolani F, Ltd A. Interventions to Improve Access to Medicine in Developing Countries: Mapping WHO's Building Blocks and Supply Chain Functions. Vol. 3, *Acta Scientific Pharmaceutical Sciences*. 2019.
11. Baker K, Akasiima M, Wharton-Smith A, Habte T, Matata L, Nanyumba D, et al. Performance, acceptability, and usability of respiratory rate timers and pulse oximeters when used by frontline health workers to detect symptoms of pneumonia in Sub-Saharan Africa and Southeast Asia: protocol for a Two-Phase, Multisite, Mixed-Methods Tri. *JMIR Res Protocols*. 2018;7(10):e10191.
12. WHO. WHO Model List of Essential Medicines. World Health Organization. 2017.
13. Zulu JM, Kinsman J, Michelo C, Hurtig AK. Integrating national community-based health worker programmes into health systems: a systematic review identifying lessons learned from low-and middle-income countries. *BMC Public Health*. 2014;14(1).
14. Gopalan SS, Mohanty S, Das A. Assessing community health workers' performance motivation: a mixed-methods approach on India's Accredited Social Health Activists (ASHA) programme. *BMJ Open*. 2012;2(5):e001557.
15. Phuong JM, Penm J, Char B, Oldfield LD, Moles R. The impacts of medication shortages on patient outcomes: a scoping review. *PLoS One* [Internet]. 2019;14(5):e0215837. <https://doi.org/10.1371/journal.pone.0215837>.
16. Cometto G, Ford N, Pfaffman-Zambruni J, Akl EA, Lehmann U, McPake B, et al. Health policy and system support to optimise community health worker programmes: an abridged WHO guideline. *Lancet Glob Health*. 2018;18:1–8.
17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, vol. 372. *BMJ Publishing Group*; 2021.
18. WHO. Meeting Report: Technical Definitions of Shortages and Stockouts of Medicines and Vaccines. World Health Organization. 2016;(October):1–29.
19. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. *BMJ (Online)*. 2016;355.
20. Schünemann HJ, Cuello C, Akl EA, Mustafa RA, Meerpohl JJ, Thayer K, et al. GRADE guidelines: 18. How ROBINS-I and other tools to assess risk of bias in nonrandomized studies should be used to rate the certainty of a body of evidence. *J Clin Epidemiol*. 2019;111:105–14.
21. Lewin S, Booth A, Glenton C, Munthe-Kaas H, Rashidian A, Wainwright M, et al. Applying GRADE-CERQual to qualitative evidence synthesis findings: introduction to the series. *Implement Sci*. 2018;13(1):1–10.
22. Lewin S, Bohren M, Rashidian A, Munthe-Kaas H, Glenton C, Colvin CJ, et al. Applying GRADE-CERQual to qualitative evidence synthesis findings—paper 2: How to make an overall CERQual assessment of confidence and create a Summary of Qualitative Findings table. *Implement Sci*. 2018;25:13.
23. WHO. Working together for health. *The World Health Report*. 2006;
24. Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. Vol. 15, *Nursing and Health Sciences*. John Wiley & Sons, Ltd; 2013. p. 398–405.
25. Yadav P. Health product supply chains in developing countries: Diagnosis of the root causes of underperformance and an agenda for reform. *Health Syst Reform*. 2015;1(2):142–54.
26. Prashant. Integration of Vaccine Supply Chains with Other Health Commodity Supply Chains A framework for decision-making. 2013.
27. Callaghan-Koru JA, Gilroy K, Hyder AA, George A, Nsona H, Mtimuni A, et al. Health systems supports for community case management of childhood illness: lessons from an assessment of early implementation in Malawi. *BMC Health Serv Res*. 2013;13(1):55.
28. Namazzi G, Waiswa P, Nakakeeto M, Nakibuuka VK, Namutamba S, Najjemba M, et al. Strengthening health facilities for maternal and newborn care: experiences from rural eastern Uganda. *Glob Health Action*. 2015;8(1):24271.
29. Global Fund, WHO, UNICEF. Integrated Community Case Management (iCCM) in Sub-Saharan Africa: Successes & Challenges with Access, Speed & Quality Thematic review report. 2018.
30. World Health Organization. Summative evaluation of the WHO Rapid Access Expansion Initiative Volume 3: Country Briefs. Vol. 3, WHO Evaluation Office. 2018.
31. Brunie A, Mercer S, Chen M, Andrianantoandro T. Expanding understanding of community health worker programs: a cross-sectional survey on the work, satisfaction, and livelihoods of CHWs in Madagascar. *Inquiry (United States)*. 2018;1(55):1–8.
32. Village Reach. Exploring New Distribution Models for Vaccines and other Health Commodities Adapted to the on the Ground Realities of the Equateur and Tshuapa Provinces, Democratic Republic of Congo. 2015.
33. Doherty T, Besada D, Zembe W, Daniels K, Kinney M, Kerber K, et al. Report on the summative external evaluation of the Integrated Health

- System Strengthening programme in Ethiopia, Mali, Mozambique, Ghana, Malawi and Niger. 2014.
34. Ndou T, van Zyl G, Hlahane S, Goudge J. A rapid assessment of a community health worker pilot programme to improve the management of hypertension and diabetes in Emfuleni sub-district of Gauteng Province, South Africa. (Special Issue: Building new knowledge.). *Glob Health Action*. 2013;6:19228.
  35. Mukasa B, Ali M, Farron M, Van de Weerd R. Contraception supply chain challenges: a review of evidence from low- and middle-income countries. *Eur J Contracept Reprod Health Care*. 2017;22(5):384–90.
  36. Anand A, Favero R, Dentinger C, Ralaivaomisa A, Ramamonjisoa S, Rabozakandraina O, et al. Malaria case management and elimination readiness in health facilities of five districts of Madagascar in 2018. *Malaria J*. 2020;19(351).
  37. Village Reach. An Assessment of Maternal & Neonatal Health Commodities in Sengerema District, Tanzania June 2014. 2014.
  38. Rao VB, Schellenberg D, Ghani AC. Overcoming health systems barriers to successful malaria treatment. *Trends Parasitol*. 2013;29(4):164–80.
  39. Thein ST, Khin HSS, Thi A, Grp ACT. Insights into the availability and distribution of oral artemisinin monotherapy in Myanmar: evidence from a nationally representative outlet survey. *Malaria J*. 2017;16.
  40. Miller NP, Zunong N, Al-Sorouri TAA, Alqadasi YM, Ashraf S, Siameja C. Implementing integrated community case management during conflict in Yemen. (Research Theme: Community health in emergencies). *J Global Health*. 2020;10(2).
  41. Panda B, Pati S, Nallala S, Chauhan AS, Anasuya A, Som M, et al. How supportive supervision influences immunization session site practices: a quasi-experimental study in Odisha, India. *Glob Health Action*. 2015;8:25772.
  42. Wagenaar BH, Gimbel S, Hoek R, Pfeiffer J, Michel C, Manuel JL, et al. Stock-outs of essential health products in Mozambique—longitudinal analyses from 2011 to 2013. *Trop Med Int Health TM & IH*. 2014;19(7):791–801.
  43. Smith S, Agarwal A, Crigler L, Gallo M, Finlay A, Homsí FA, et al. Community Health Volunteer Program Functionality and Performance in Madagascar: a synthesis of qualitative and Quantitative Assessments. 2013.
  44. Lufesi NN, Andrew M, Aursnes I. Deficient supplies of drugs for life threatening diseases in an African community. *BMC Health Serv Res*. 2007;7(1):86.
  45. Henriksson DK, Fredriksson M, Waiswa P, Selling K, Peterson SS. Bottleneck analysis at district level to illustrate gaps within the district health system in Uganda. *Glob Health Action*. 2017;10(1):1327256.
  46. Sumankuuro J, Crockett J, Wang S. Perceived barriers to maternal and newborn health services delivery: a qualitative study of health workers and community members in low and middle-income settings. *BMJ Open*. 2018;8(11):e021223.
  47. Asweto CO, Alzain MA, Andrea S, Alexander R, Wang W. Integration of community health workers into health systems in developing countries: opportunities and challenges. *Fam Med Commun Health*. 2016;4(1):37–45.
  48. Shelley KD, Belete YW, Phiri SC, Musonda M, Kawesha EC, Muleya EM, et al. Implementation of the community health assistant (CHA) cadre in Zambia: a process evaluation to guide future scale-up decisions. *J Community Health*. 2016;41(2):398–408.
  49. Ruizendaal E, Dierickx S, Grietens KP, Schallig H, Pagnoni F, Mens PF. Success or failure of critical steps in community case management of malaria with rapid diagnostic tests: a systematic review. *Malaria J*. 2014;13.
  50. Pronyk P, Nemeser B, Maliqi B, Springstubb N, Sera D, Karimov R, et al. The UN Commission on Life Saving Commodities 3 years on: Global progress update and results of a multicountry assessment. *TT - Lancet Global Health*. 2016;4(4):e276–86.
  51. Strachan C, Wharton-Smith A, Sinyangwe C, Mubiru D, Ssekitooleko J, Meier J, et al. Integrated community case management of malaria, pneumonia and diarrhoea across three African countries: a qualitative study exploring lessons learnt and implications for further scale up. (Themed Issue: Current scientific evidence for integrated community health worker). *J Global Health*. 2014;4(2).
  52. Phiri SC, Prust ML, Chibawe CP, Misapa R, Van Den Broek JW, Wilimink N. Assessing successes and challenges in the scale-up of a national, public sector community health worker cadre in Zambia: A qualitative study. *BMC Proceedings Conference: 1st International Symposium on Community Health Workers Uganda*. 2017;11(6 Supplement 1).
  53. Shieshia M, Noel M, Andersson S, Felling B, Alva S, Agarwal S, et al. Strengthening community health supply chain performance through an integrated approach: using mHealth technology and multilevel teams in Malawi. (Themed Issue: Current scientific evidence for integrated community case management (iCCM) in Africa: findings. *J Global Health*. 2014;4(2).
  54. Chandani Y, Noel M, Pomeroy A, Andersson S, Pahl MK, Williams T. Factors affecting availability of essential medicines among community health workers in Ethiopia, Malawi, and Rwanda: solving the last mile puzzle. (Special supplement on Integrated Community Case Management). *Am J Trop Med Hyg*. 2012;87(5 Supplement):120–6.
  55. Village Reach. Outsourcing Transport to Improve Health at the Last Mile: a case study The Long Road to Health. 2016.
  56. Nabugoomu J, Seruwagi GK, Corbett K, Horton S, Hanning R. Perceived opportunities and challenges of family and community members in supporting teen mothers in rural Eastern Uganda. *Afr J Reprod Health*. 2020;24(3):88–100.
  57. Rawal LB, Kharel C, Yadav UN, Kanda K, Biswas T, Vandelanotte C, et al. Community health workers for non-communicable disease prevention and control in Nepal: a qualitative study. *BMJ Open*. 2020;10(12).
  58. Chandani Y, Noel M, Andersson S, Ombeva A, Shieshia M, Heaton A, et al. Improving community level supply chain performance using team-led, data driven solutions in Malawi and Rwanda. *Am J Trop Med Hyg*. 2013;89(5):327–8.
  59. Bagonza J, Rutebemberwa E, Eckmanns T, Ekirapa-Kiracho E. What influences availability of medicines for the community management of childhood illnesses in central Uganda? Implications for scaling up the integrated community case management programme Health policies, systems and management in low and middle-income countries. *BMC Public Health*. 2015;15(1):1180.
  60. Andersson S, Chandani Y, Felling B, Heaton A, Noel M, Pahl M, et al. Using a theory of change model to improve supply chains for community case management in resource limited settings. *Am J Trop Med Hyg*. 2010;83(5):31.
  61. Adyya G, Flederjohann J, Reddy H, Raman VR, Stuckler D, Vellakkal S. Barriers and prospects of India's conditional cash transfer program to promote institutional delivery care: a qualitative analysis of the supply-side perspectives. *BMC Health Serv Res*. 2018;18(40).
  62. Kok M, Tolani M, Mtonga W, Salamba T, Mwabungulu T, Munthali A, et al. Enabling and hindering factors of health surveillance assistants' roles in the provision of contraceptive services in Mangochi, Malawi. *Reprod Health*. 2020;17(1):1–13.
  63. Lemay NV, Sullivan T, Jumbe B, Perry CP. Reaching remote health workers in Malawi: baseline assessment of a pilot mhealth intervention. *J Health Commun*. 2012;17(SUPPL. 1):105–17.
  64. Mulugeta A, Tessema M, Hsellasie K, Seid O, Kidane G, Kebede A. Examining means of reaching adolescent girls for iron supplementation in Tigray, Northern Ethiopia. *Nutrients*. 2015;7(11):9033–45.
  65. Printz N. Availability of malaria products at the last mile: an analysis of facility-and community-level logistics data. *Am J Trop Med Hyg*. 2015;93(4 Supp):294.
  66. Cover J, Blanton E, Ndiaye D, Walugembe F, Lamontagne DS. Operational assessments of Sayana Press provision in Senegal and Uganda. *Contraception*. 2014;89(5):374–8.
  67. Williams T, Andersson S, Chandani Y, Felling B, Roche G, Pahl M, et al. Results of baseline assessments of community case management supply chains in Malawi and Ethiopia. *Am J Trop Med Hyg*. 2010;83(5):31.
  68. Project D. Mozambique: Strengthening the Community Health Worker Supply Chain. Final Report, May 2014.
  69. Altaras R, Montague M, Graham K, Strachan CE, Senyonyo L, King R, et al. Integrated community case management in a peri-urban setting: a qualitative evaluation in Wakiso District, Uganda. *BMC Health Serv Res*. 2017;17(1):785.
  70. Chandani Y, Andersson S, Heaton A, Noel M, Shieshia M, Mwiroti A, et al. Making products available among community health workers: evidence for improving community health supply chains from Ethiopia, Malawi, and Rwanda. (Themed Issue: Current scientific evidence for integrated community case management (iCCM) in Africa: finding. *J Global Health*. 2014;4(2).

71. Blanas DA, Ndiaye Y, Nichols K, Jensen A, Siddiqui A, Hennig N. Barriers to community case management of malaria in Saraya, Senegal: training, and supply-chains. *Malaria J.* 2013;12(1).
72. Surakat OA, Sam-Wobo SO, Ademolu KO, Adekunle MF, Adekunle ON, Monsuru AA, et al. Assessment of community knowledge and participation in onchocerciasis programme, challenges in ivermectin drug delivery, distribution and non-compliance in Ogun State, southwest Nigeria. *Infect Dis Health.* 2018;23(3):137–45.
73. Chipukuma HM, Halwiindi H, Zulu JM, Azizi SC, Jacobs C. Evaluating fidelity of community health worker roles in malaria prevention and control programs in Livingstone District, Zambia-A bottleneck analysis. *BMC Health Serv Res.* 2020;20(1):612.
74. Andersson S, Chandani Y, Misomali A, Chimphanga B, Shieshia M, Noel M, et al. Cstock-a simple, affordable mhealth solution for improving visibility of community health logistics data. *Am J Trop Med Hyg.* 2013;89(5):26.
75. Smith Paintain L, Willey B, Kedenge S, Sharkey A, Kim J, Buj V, et al. Community health workers and stand-alone or integrated case management of malaria: a systematic literature review. *Am J Trop Med Hyg.* 2014;91(3):461–70.
76. Umulisa N, Uwimana A, Mugeni C, Mukarugwiro B, Mutwiwa S, Brieger WR, et al. Performance of community health workers in providing integrated community case management services (ICCM) in eight districts of Rwanda. *Am J Trop Med Hyg.* 2018;99(4 Supp):32.
77. JSI. BASELINE ASSESSMENT FOR CSTACK. 2018.
78. SC4CCM. Malawi Community Health Supply Chain Midline Evaluation Report [Internet]. 2013 [cited 2022 May 9]. Available from: [www.jsi.com](http://www.jsi.com).
79. Munos M, Guiella G, Robertson T, Maïga A, Tiendrebeogo A, Tam Y, et al. Independent evaluation of the rapid scale-up program to reduce under-five mortality in Burkina Faso. *Am J Trop Med Hyg.* 2016;94(3):584–95.
80. Aisha SF, Memon AA. Combination of hot-hypertonic saline and pressure dressing in the management of parotid fistula. *J Coll Phys Surg Pak JCPSP.* 2015;25(12):897–9.
81. Shaista B, Rozina K, Khan SA, Nazish B. Challenges and experiences of Lady Health Workers working in polio campaigns in District Nowshera, Khyber Pakhtunkhwa, Pakistan. *Pak J Public Health.* 2017;7(2):75–8.
82. Stekelenburg J, Kyanamina SS, Wolffers I. Poor performance of community health workers in Kalabo District, Zambia. *Health Policy.* 2003;65(2):109–18.
83. Bagonza J, Kibira SP, Rutebemberwa E. Performance of community health workers managing malaria, pneumonia and diarrhoea under the community case management programme in central Uganda: a cross sectional study. *Malar J.* 2014/09/19. 2014;13:367.
84. Sunguya BF, Mlunde LB, Rakesh A, Jimba M. Towards eliminating malaria in high endemic countries: the roles of community health workers and related cadres and their challenges in integrated community case management for malaria: a systematic review. *Malaria J.* 2017;16(10).
85. Baynes C, Mboya D, Likasi S, Maganga D, Pemba S, Baraka J, et al. Quality of sick child-care delivered by community health workers in Tanzania. *Int J Health Policy Manag.* 2018;7(12):1097–109.
86. Janse van Rensburg-Bonthuyzen E, Engelbrecht M, Steyn F, Jacobs N, Schneider H, van Rensburg D. Resources and infrastructure for the delivery of antiretroviral therapy at primary health care facilities in the Free State Province, South Africa. *SAHARA J.* 2008;5(3):106–12.
87. Moti Tolera J, Abdurehman A, Abdiwahab H, Alula T. Exploring barriers to reproductive, maternal, child and neonatal (RMNCH) health-seeking behaviors in Somali region, Ethiopia. *PLoS ONE.* 2019;14(3):e0212227.
88. Sakeah E, McCloskey L, Bernstein J, Yeboah-Antwi K, Mills S, Doctor HV. Is there any role for community involvement in the community-based health planning and services skilled delivery program in rural Ghana? *BMC Health Services Res.* 2014;14.
89. Naanyu V, Wade TJ, Ngetich A, Mulama K, Nyaga L, Pell R, et al. A qualitative exploration of barriers to health-facility-based delivery in Bomachoge-Borabu and Kaloleni, Kenya. *Int J Gynecol Obstet.* 2021;153:273–9.
90. Kavle J, Landry M, Gottwalt A. Community-based distribution of iron-folic acid supplementation: a review of evidence and program implications for anemia programming for women and girls. *Ann Nutr Metab.* 2017;71:562.
91. Gilroy KE, Callaghan-Koru JA, Cardemil CV, Nsona H, Amouzou A, Mtimuni A, et al. Quality of sick child care delivered by Health Surveillance Assistants in Malawi. *Health Policy Plan.* 2013;28(6):573–85.
92. Rutebemberwa E, Nsabagasani X, Pariyo G, Tomson G, Peterson S, Kallander K. Use of drugs, perceived drug efficacy and preferred providers for febrile children: implications for home management of fever. *Malaria J.* 2009;8.
93. Opwora AS, Laving AM, Nyabola LO, Olenja JM. Who is to blame? Perspectives of caregivers on barriers to accessing healthcare for the under-fives in Butere District, Western Kenya. *BMC Public Health.* 2011;2011(11):272.
94. UNICEF. Development of a National Georeferenced Community Health Worker Master List Hosted in a Registry [Internet]. 2021 [cited 2022 May 6]. Available from: <https://www.unicef.org/documents/implementation-support-guide-development-national-georeferenced-community-health-worker>.
95. CAF-Africa. Protecting the Community Health Workforce During COVID-19: Getting PPE to the last mile [Internet]. 2021 [cited 2022 May 6]. Available from: [https://cafafrica.org/wp-content/uploads/2020/11/VR\\_CAF-Africa\\_FullReport\\_final-1.pdf](https://cafafrica.org/wp-content/uploads/2020/11/VR_CAF-Africa_FullReport_final-1.pdf).
96. Cameron A, Ewen M, Ross-Degnan D, Ball D, Laing R. Medicine prices, availability, and affordability in 36 developing and middle-income countries: a secondary analysis. *The Lancet.* 2009;373(9659):240–9.
97. Hayford K, Privor-Dumm L, Levine O, Hopkins Bloomberg J. Improving Access to Essential Medicines Through Public-Private Partnerships. 2004.

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