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How primary healthcare workers obtain information during consultations to aid safe prescribing in low-income and lower middle-income countries: a systematic review

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ABSTRACT

Background We systematically reviewed the evidence on how primary healthcare workers obtain information during consultations to support decision-making for prescribing in low and lower middle-income countries.

Methods We searched electronic databases, consulted the Healthcare Information For All network, hand searched reference lists, ran citation searches of included studies and emailed authors of identified papers. Two reviewers extracted data and appraised quality with relevant tools.

Results Of 60,497 records found, 23 studies met our inclusion criteria. Fourteen studies were observational and nine were interventional. Frequently mentioned sources of information were books, leaflets, guidelines, aids and the internet. These sources were sometimes out of date and health workers reported being confused which to use. Internet access varied and even when it was available, use was limited by technical issues. Of the five electronic tools that were assessed, four had positive outcomes. Tools assisted prescribers with medicine selection and dosage calculations, which increased prescribing accuracy. The quality of reporting varied but was overall low.

Discussion Studies indicated a lack of up-to-date and relevant medicine information in low and lower middle-income settings. Internet-based sources appeared to be useful when it is possible to download content for offline use and to update when there is internet access. Electronic tools showed promise, but their accuracy needs to be validated and they should focus on giving actionable advice to guide prescribers.

BACKGROUND

Consultations by primary healthcare workers in low and middle-income countries make up the majority of healthcare interactions globally, yet little is known about how healthcare workers access information during consultations. This is important because it can be challenging for healthcare professionals to keep up to date with the expansion in medical knowledge and updated guidelines and recommended treatment regimens. These challenges could be further investigated by this study.
compounded in low and middle-income countries with less robust continuing professional development systems and more limited internet access. The WHO Medicines Report 2011 reports that ‘Globally, most prescribers receive most of their prescribing information from the pharmaceutical industry and in many countries, this is the only information they receive.’ Unsafe and inappropriate prescribing is a huge problem, especially in low and middle-income countries, where many patients are given at least one drug per consultation. Antimicrobial resistance is a rising global health threat caused by the overuse of antibiotics. ‘Rational’ use of medicines depends largely on the ability of the health worker to make the correct diagnosis and then treat accordingly. Previous research has reported various issues related to inappropriate and unsafe prescribing. One of these issues is medication errors, meaning errors of dose or route of administration, and to errors of communication between prescriber and dispenser. Also, healthcare workers can prescribe the wrong medicine, with or without a failure to correctly diagnose the case. Also there is a wide variation in the availability and quality of health information and relevance to different settings with respect to their language, geographical focus and technical level. Out-of-date offline resources might not have incorporated changes in medical knowledge and guidance that have occurred over time, such as new antibiotic regimen and diagnostic tests. When healthcare workers act on incorrect information this can lead to incorrect diagnosis and inappropriate prescribing.

With ‘healthcare information’ we mean information that guides healthcare workers to prescribe at the point of care. This includes guiding them whether to prescribe a medicine, which medicine and details of the dose, route of administration, frequency of administration and duration of treatment. Examples of healthcare information resources are point-of-care decision tools, formularies, books, manuals, guidelines and protocols, rather than routine health information such as patient history, records and local epidemiological reports. This includes free and for-purchase materials, both in digital and offline forms.

To guide correct prescribing (including diagnosis and, where appropriate, selection of medicine), correct information is important as point-of-care information for consultations. Factors influencing whether healthcare providers attempt to access information during consultations include previous training and availability of the information, which could include internet access. Additional influencing factors might be how common or rare a condition is, the prescriber’s familiarity with the treatment in question, whether it is a condition where the consequences of prescribing errors could be severe (eg, high risk of adverse effects, or if child dosing required), if the patient is being treated for comorbidities and a risk of drug interaction is suspected, and level of awareness of the need for information.

A previous systematic review found that digital health tools targeting primary healthcare workers had not been extensively studied. While there is a large amount of health information available, it is unclear to what extent primary healthcare workers access such information to aid prescribing. Therefore, this review aims to review the evidence on how primary healthcare workers obtain health information during consultations to support prescribing decision-making in low and lower middle-income economies.

**METHODS**

A protocol of this systematic review was previously published and follows the Cochrane Collaboration and Centre for Review and Dissemination methodology for conducting systematic reviews where possible. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used for reporting (online supplementary file 1).

**Criteria for considering studies**

We included observational studies, such as cross-sectional surveys, cohort studies, qualitative studies (eg, interview studies and focus groups), mystery client studies, and intervention studies, such as randomised controlled trials (RCT) and non-randomised studies (eg, controlled studies, before-and-after studies, interrupted time series studies). We only included studies reported in English that were published after 2000 to provide up-to-date and relevant evidence.

We included studies involving primary healthcare workers in low and lower middle-income countries who prescribe or dispense medication or order medical tests, such as doctors, clinical officers, nurses, midwives, pharmacists, drugstore vendors (with varying qualifications) or community health workers. Primary healthcare workers encompass a diverse range of healthcare cadres such as doctors, clinical officers, nurses, pharmacists and drugstore vendors and are often the first level of contact of individuals, the family and the community with the national health system. We excluded studies focusing on secondary care or hospital settings, allied health professionals, for example, physiotherapists and traditional medicine health workers.

We included any interventions to improve access to healthcare information during a consultation for prescribing, for example, tools and aids (possible interventions could use digital resources, books, protocols, and so on). Also, studies that did not focus on an intervention (eg, observational studies) were included. We did not include studies focusing on interventions that aimed to improve the quality of care, supervision or mentoring of healthcare workers unless they also included tools or aids for healthcare workers that were available during the consultation. We included any type of comparator interventions and studies that did not use a comparator.
The primary outcome of this review is the proportion of healthcare workers obtaining healthcare information during consultations or transactions (ie, from the time when the patient arrives to leaving) from different sources (eg, use of books, guidelines, digital resources, peer networks, no information—memory). Secondary outcomes are any change in healthcare provider knowledge or behaviour (eg, prescribing in intervention studies), clinical outcomes, adverse outcomes (eg, misconceptions resulting from out-of-date or incorrect information, whether obtaining information to guide prescribing relevant to a consultation affects the quality of a consultation; eg, patients trust a healthcare worker less or perceive a lack of empathy when a health worker looks up information) and use of resources.\(^\text{11}\)

**Information sources and search strategy**

Relevant articles were identified by searching electronic databases: MEDLINE through Ovid; EMBASE through Ovid; CABI Global Health through Ovid; WHO Global Health Library; POPLINE; Africa-Wide Information; Library, Information, Science and Technology Dibase; Web of Science; Cochrane Central Register of Controlled Trials (CENTRAL); WHO International Clinical Trials Registry Platform; and ClinicalTrials.gov. In addition, the Healthcare Information For All (HIFA) network was consulted for relevant publications and emailed authors of identified papers to identify additional articles. After identifying eligible studies, we ran citation searches of included studies (eg, in Google Scholar, Scopus or Web of Knowledge).\(^\text{11}\)

Final search strategies were tailored to different databases with a medical research librarian (John Eyes). No study design filter was used as both quantitative and qualitative studies were included. We used the titles, abstracts and keywords of a set of articles for which we knew that met our inclusion criteria to define a search strategy that returned all these articles.\(^\text{11}\)

**Data management, collection and analysis**

We excluded duplicate references by comparing titles, authors and digital object identifiers between similar search results using two software programs (EndNote and EPPI-Reviewer). Two reviewers screened titles and abstracts of search results against the inclusion and exclusion criteria. One reviewer retrieved a full-text paper when a study included participants who are primary healthcare workers in low or lower-middle-income economies, and it assessed one or more relevant outcome measures. Two reviewers assessed full texts for eligibility, and any disagreement was resolved through discussion with a third author.\(^\text{11}\)

Data were extracted from included studies using a standardised Excel form that included general information (title, authors, date, and so on), study characteristics (study design, aim, duration, inclusion and exclusion criteria), risk of bias (depending on study design), participants (description, geographic location setting, and so on), intervention (if appropriate and to include sources of online or offline information used), outcomes (as specified above, other outcomes, adverse events) and results (outcomes, times of assessment). We piloted the data extraction form on a small number of studies to develop the final data extraction form. Two reviewers extracted data from the included studies.\(^\text{11}\)

Quality assessment was undertaken by two reviewers. Any disagreements were resolved by consensus and the opinion of a third reviewer. The methods specified in the Cochrane Collaboration tool for assessing the risk of bias were used. Three bias assessment categories were used: low, high and unclear risk, as specified in the Cochrane Collaboration Handbook.\(^\text{12}\) For other types of studies we used adapted versions of the following: the Cochrane Recommend tool for assessing Risk of Bias in Non-randomised Studies of Interventions;\(^\text{16}\); the Critical Appraisal Skills Programme tool for qualitative studies;\(^\text{17}\); and the Appraisal tool for Cross-Sectional Studies (AXIS).\(^\text{18}\)

We provide a narrative overview of findings and tabular summaries of extracted data. It was not possible to perform a meta-analysis due to differences in study populations, interventions and outcomes.\(^\text{11}\)

We provide a narrative overview of subgroups including different study types, interventions (eg, digital vs analogue), cadres of healthcare workers and geographic regions. We use the term ‘observational studies’ for any type of study where the investigators asked about the use of information sources but did not deliver training or introduce a particular source of information or tool. We use the term ‘intervention studies’ for any type of study that assessed an intervention, such as RCTs, before-and-after studies, comparison studies and evaluations of information tools.\(^\text{11}\)

**Patient and public involvement**

The broader HIFA network was consulted for comments and suggestions at various stages during the systematic review. Patients were not involved in the design or analysis of this review.\(^\text{11}\)

**RESULTS**

**Results of the search**

We conducted searches in February 2018 and found 60 497 records after removing duplicates (figure 1). Teams of two reviewers screened the 60 497 records and narrowed this down to 993 records which were then screened again by two reviewers (MHvV and NTH). We assessed 127 full-text articles for eligibility; whether they involved primary healthcare workers in low or lower-middle-income economies who prescribe and/or dispense medication. We included 19 studies on which we conducted citation searches in July 2019 which resulted in finding a further four studies. Finally, 23 studies met our inclusion criteria: 14 observational studies shown in table 1, and 9 intervention studies shown in table 2.
Description of studies

Table 1 shows that of the 14 included observational studies, nine used surveys of which three additionally used qualitative methods. The other five observational studies were qualitative studies of which three used interviews and two focus groups. Study samples varied from 12 to 192. Eleven studies were conducted in Africa, two in Asia and one in Oceania. Studies took place in pharmacies, or health facilities and involved pharmacists, health workers and community health workers.

Table 2 shows that of nine included intervention studies, there was one cluster RCT, one study comparing tools without randomisation, two before-and-after studies and four studies evaluating the development and/or implementation of a tool. Two intervention studies were part of the larger ‘Algorithm for Management of Childhood Illness’ (ALMANACH) project and two studies assessed the medication dosing app using ‘CommCare’. Four studies used quantitative, two qualitative and three mixed methods. Study samples varied from 3 to 3914. Six studies were conducted in Africa, one in Asia and two in South America. Studies took place in health facilities and involved health workers and/or community health workers.

We excluded 104 full-text studies with reasons provided (online supplementary file 2), mostly because they were not about information seeking during the consultation.

Quality assessment of included studies

Among the observational studies the best reported domain was a clear statement of the aim of qualitative and cross-sectional studies. For qualitative studies, the relationship between the researcher and the participants was often unclear. For both qualitative and cross-sectional studies, the rationale for choosing the specific method was frequently not clearly stated. Also, in survey studies, the issue of non-responders was often not appropriately addressed (online supplementary file 3).

Among the intervention studies, the cluster RCT reported using block randomisation but did not mention allocation concealment. Other intervention studies were likely to suffer from performance and detection bias and other biases due to small sample sizes (online supplementary file 3).

Primary outcome in observational studies

All observational studies reported on the use of health-care information during consultations, which is reported in table 3 for nine studies involving a survey and in table 4 for the five qualitative studies. The most mentioned information sources used during consultations were books, leaflets, guidelines, a flip chart and reporting form aid, and the internet. A survey conducted in Harare, Zimbabwe, in 2006 found that 28 out of 46 community pharmacists (61%) used
Table 1 Participants, interventions, comparators, outcomes and study designs (PICOS) of observational studies (n=14)

| ID   | Reference                        | Study design                     | Aimed to determine                                | Country     | Setting                                                                 | Participants                                                                 | n  | Outcomes                                                                 |
|------|----------------------------------|----------------------------------|---------------------------------------------------|-------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------|----|--------------------------------------------------------------------------|
| 71   | Udezi et al                      | Cross-sectional survey           | Medication information needs                       | Nigeria     | Urban pharmacies; Enugu state capital                                   | 32 community and 26 hospital pharmacists                                   | 58 | Sources of medication information                                       |
| 127  | Anasi et al                      | Cross-sectional survey           | Use of the internet for professional practice      | Nigeria     | Community pharmacies                                                     | 115 community pharmacists                                                  | 115| Searching for drug and disease-related information                       |
| 76   | Wabe et al                       | Cross-sectional survey           | Knowledge, attitude and practice of patient counselling | Ethiopia   | Drug retail outlets; urban                                              | 12 pharmacists, 43 ‘drugists’, 3 pharmacy technicians, 6 health assistants | 64 | Sources of medication information                                       |
| 113  | Asmelashe Gelayee et al          | Cross-sectional survey           | Medication information needs and resources         | Ethiopia    | Community pharmacies/drug stores; Gondar town                            | 48 community pharmacists                                                   | 48 | Sources of medication information                                       |
| 74   | Usanga et al                     | Cross-sectional survey           | Information technology use and attitudes           | Zimbabwe    | Community pharmacies; Harare                                             | 46 community pharmacists                                                   | 46 | Facilities in pharmacies, use the internet                               |
| 107  | Kamuhabwa and Kisoma             | Cross-sectional survey           | Factors that influence prescribing                 | Tanzania    | Public and private health facilities in Dar es Salaam                    | Medical specialists, medical officers, intern doctors                     | 192| Sources of medication information                                       |
| 31   | Rusatira et al                   | Online survey and interviews      | User requirements, available resources and potential | Rwanda      | All 44 district hospitals                                                | 97 surveyed doctors and 16 interviewed general practitioners               | 113| Internet access, frequency of use and sources                           |
| 95   | Graham et al                     | Observation of consultations, focus groups, in-depth interviews | Adherence to guidelines, rational antibiotics use, adherence | Zambia      | Districts of Luapula northern provinces                                 | 55 caregivers+90 community health workers                                  | 145| Use of aids                                                               |
| 21   | Samiak and Vince                 | Semiquantitative cross-sectional survey | Use of the Paediatric Standard Treatment Book       | Papua New Guinea | Urban clinics and rural health centres                                   | 61 nurses and 45 community health workers                                  | 106| Use of book and reasons for non-use                                      |
| 8    | Agbo et al                       | Semistructured interviews         | Knowledge and prescription patterns                | Nigeria     | Primary health centre in Jos North; urban                               | 4 health personnel involved in the consultation and treatment of the patients and nurse in charge of drugstore | 4  | Availability and use of guidelines                                      |
| 126  | Oduor et al                      | Semistructured interviews         | How and why providers and patients used technologies | Kenya       | Health facility in Migori; rural                                       | 27 medical practitioners, 9 patients with HIV                              | 36 | Sources and technologies used to manage patients                         |
| 41   | Reynolds et al                   | Interviews                        | Perceptions on malaria diagnosis                   | Afghanistan | 22 health centres; 10 north and 12 east                                 | Doctors, nurses, medical assistants, one assistant doctor (or feldsher, an assistant physician trained under the Russian system) and one community health supervisor | 39 | Availability and use of guidelines                                      |
| 53   | Perwaiz Iqbal and Rahman          | Focus groups                      | Perceptions on resistant tuberculosis diagnosis     | Pakistan    | Shifa College of Medicine, Islamabad                                     | 12 general practitioners                                                   | 12 | Availability and use of guidelines                                      |
| 49   | Park et al                       | Focus groups                      | Information needs, perceptions of Wikipedia as a clinical tool | Botswana    | Clinics, health posts within 10km district hospitals; rural              | 113 health workers across district hospitals, clinics and health posts     | 113| Information needs and perceptions                                       |
| ID | Ref | Study design | Aim | Intervention | Comparator | Country | Setting | Participants | n   | Outcomes |
|----|-----|--------------|-----|-------------|------------|---------|---------|--------------|-----|----------|
| 39 | Rambaud-Althaus et al | Pilot cluster randomised controlled study | To compare smartphone and paper-based versions | Electronic version of Algorithm for Management of Childhood Illness (ALMANACH) | Paper version | Tanzania | 9 health facilities in Dar es Salaam | 48 health workers; paper n=18, electronic n=30, and 504 children | 552 | Proportion of children appropriately managed |
| 63 | Shao et al | Qualitative in-depth interviews and focus group discussions | To assess health worker’s perceptions on uptake | Mobile-based medicine dosing tool App CommCare for different medications | Paper-based tool | Mexico, Guatemala | Small rural mountain towns | 17 community health workers; Mexico n=11, Guatemala n=6 | 40 | Views on correct treatment |
| 120 | Palazuelos et al | Mixed methods comparison: survey and interviews | To compare perceptions on the mobile and paper versions | Algorithms for treatment of respiratory diseases | Usual care | Tunisia | 28 primary healthcare clinics in Tunis | 73 general practitioners; 2366 patients at baseline, 1475 impact survey | 3914 | Media prescription, average cost and perceptions |
| 125 | Segal et al | Before-and-after study | To measure the app’s usability and effect on patient-centredness | Treatment algorithm to determine antidepressant dose | None | Tanzania | HIV clinic, northern hospital | 20 depressed patients (1 moved out, 2 lost to follow-up) and their healthcare providers | 17 | Patient Health Questionnaire-9 Item Score |
| 2 | Abouda et al | Before-and-after study | To report on the impact of using integrated syndromic guidelines | Mobile-based system for cardiovascular disease | None | India | 3 health centres, Andhra Pradesh | 3 primary health centre physicians | 3 | Use of tool, confidence in prescribing |
| 121 | Catalani et al | Evaluation: site observations, key informant interviews, lab simulation and usability testing | To develop and evaluate a clinical decision support system | Patient-specific clinical decision support system for tuberculosis treatment | None | Kenya | 24 rural clinics in the West | 24 key informants (medical superintendents, clinicians, Ministry of Health officials, laboratory managers, pharmacy managers, medical directors, TB care providers, administrators and programme managers, data quality workers and community health workers); 217 pseudopatients; 9 clinicians | 250 | Perceptions on use |
| 124 | Bessat et al | Evaluation of implementation | To investigate clinician insights on the tool | Electronic version of Integrated Management of Childhood Illness | None | Burkina Faso | 10 primary care facilities | 21 health workers | 21 | Perception of its medical content, usability |

TB, tuberculosis.
| ID  | Reference                                      | Quantitative results | Qualitative findings                                      |
|-----|-----------------------------------------------|----------------------|-----------------------------------------------------------|
| 71  | Udezi et al.^[19]                            | Mean: 4.97 SD: 1.67  | Never search the internet for medicine info               |
|     | Most used (midpoint=3.5): Index of Essential Medicines | Mean: 4.91 SD: 1.72  | n=8 7% n=115 NA                                          |
| 127 | Anasi et al.[^20]                             | n=46 40%             | Most used: British National Formulary                     |
|     | Several times a day search the internet for medicine info | n=61 53%             | n=8 7% n=115 NA                                          |
| 76  | Wabe et al.^[20]                             | n=46 72%             | Most used: leaflets                                       |
|     | Most used: books n=40 63%                    | Mean: 4.4 SD: 1.87 n=58 NA |
| 113 | Asmelash et al.[^21]                         | n=47 98%             | Most used: leaflets n=46 72%                             |
|     | Most used (sometimes and always combined): books | n=46 96%             | n=45 94% n=48 NA                                          |
| 74  | Usanga et al.[^21]                           | n=28 61%             | Most used: Google n=23 50%                               |
|     | Use of internet for practice                 | mean: 4.4 SD: 1.87 n=58 NA |
| 107 | Kamuhabwa and Kisoma^[22]                    | n=175 91%            | Most used: books n=40 96%                                |
|     | Routinely search for info to guide prescribing | Mean: 4.4 SD: 1.87 n=58 NA |
| 31  | Rusatira et al.[^21]                          | n=67 69%             | Not satisfied with use of Ministry of Health guidelines   |
|     | Most used: smartphone for information check  | Mean: 4.4 SD: 1.87 n=58 NA |
| 95  | Graham et al.[^21]                           | n=134 25%            | 'When interacting with patients, Medscape (preferred by 4 doctors) and UpToDate (preferred by 3 doctors) are the most preferred apps for quick information access. Medscape has an edge over UpToDate partly because it can be accessed offline with limited features whereas UpToDate requires Internet connectivity, which makes it undesirable when on the field mentoring patients.' |
|     | Use flip chart job aid in % of consultations | n=177 33%            | 'Although the low utilisation of these tools may be due to the presence of the observer, these data could suggest that the community health workers are confident in their ability to recall the diagnostic algorithm and danger signs, given the high level of adherence to the guidelines.' |
| 21  | Samiak and Vince^[22]                        | n=97 92%             | n=537 'Reported reasons for not using the book included: confidence in management without the book, taking too much time, too busy, too many steps to follow, ashamed to use the book in front of patients and finding it hard to use.' |

NA, not applicable.
the internet for practice and 29 (50%) mentioned using Google.24 A more recent survey in Nigeria in 2016 found that 46 out of 115 community pharmacists (40%) searched the internet several times a day for drug information and only 8 (7%) never searched the internet.30 A study observing community health worker consultations with children who had suspected pneumonia in Zambia found low use of the flip chart and reporting form aid and suggested this might be because community health workers were confident in their recall of the diagnostic integrated community case management algorithm.29 Reasons for not using books were that it took too much time to use them,23 prescribers felt confident in their decisions, were too busy or felt ashamed to use it in front of patients.23 Health workers participating in interviews in Afghanistan used malaria guidelines for prescribing medication27 while in Nigeria, these were not available and this was a challenge for health workers to work efficiently.25 Health workers participating in focus groups in Botswana (published 2016) considered the available guidelines and other Ministry of Health materials were outdated and were confused about which internet-based sources to use.7 General practitioners participating in focus groups in Pakistan were also confused regarding the use of international or national tuberculosis guidelines.28

In terms of secondary outcomes in observational studies, four studies reported on resource-related outcomes, one on behaviour and one on knowledge (online supplementary file 4). A survey in Zimbabwe found that 28 out of 46 (61%) pharmacies had internet access, 33 had networked computers (72%) and 3 access to electronic databases (7%).24 A survey in Ethiopia (undertaken in 2009) found that only 7 out of 48 (15%) pharmacies had internet access.21 Forty-nine out of 97 (51%) general practitioners in hospitals in Rwanda had access to Wi-Fi.
in their hospitals (year of research unstated; published 2016). Focus groups in Botswana found that while many facilities had internet access, use was limited because of ‘technical installation issues, connection, password access, costs, lack of time, and lack of devices’. Ninety-three out of 106 health workers (88%) in Papua New Guinea had the Paediatric Standard Treatment Book with them. Twenty-eight out of 64 pharmacy workers (44%) in Ethiopia said they lacked the knowledge for rational prescribing and needed updated information.

### Secondary outcomes in interventional studies

All nine intervention studies reported on health worker behaviour-related outcomes (table 5). The cluster RCT in Tanzania reported significantly higher (p<0.001) proportions of children appropriately managed in the two intervention arms: 62% in paper (range: 55%–74%, n=171); and 63% in the electronic arm (range: 52%–72%, n=167), compared with 37% in the control arm (range: 29%–44%, n=160). The accompanied qualitative study revealed that the algorithm (ALMANACH) helped health workers point out that the ALMANACH assisted them to reduce antibiotic and antimalarial prescription as the device walked them step-by-step through the consultation starting from diagnosis to treatment including calculation of proper dosage of required drugs. Thus, the majority of the study participants (10 smartphone/11 tablet) stated that both devices reduced antibiotic prescription compared to routine practice. “Yes, before I was prescribing antibiotics as antibiotics, I was just prescribing antibiotics, but truly now you don’t believe, now I know many diseases are febrile diseases, they don’t need antibiotics.” (IDI, female, smartphone, very high uptake)

| ID | Author | Behaviour-related findings |
|----|--------|---------------------------|
| 39 | Rambaud-Althaus et al | The proportion of children appropriately managed (antimalarials, antibiotics, zinc, and rehydration prescribed when needed only) was similar in the two intervention arms: 62% in paper (range: 55%–74%, n=171); and 63% in the electronic arm (range: 52%–72%, n=167). The proportion of children appropriately managed was significantly lower (p<0.001) in the control arm (37%, range: 29%–44%, n=166) than in the paper (RR=1.7 [1.3–2.2]) and electronic arm (1.7 [1.3–2.2]). |
| 63 | Shao et al | Health workers pointed out that the ALMANACH assisted them to reduce antibiotic and antimalarial prescription as the device walked them step-by-step through the consultation starting from diagnosis to treatment including calculation of proper dosage of required drugs. Thus, the majority of the study participants (10 smartphone/11 tablet) stated that both devices reduced antibiotic prescription compared to routine practice. “Yes, before I was prescribing antibiotics as antibiotics, I was just prescribing antibiotics, but truly now you don’t believe, now I know many diseases are febrile diseases, they don’t need antibiotics.” (IDI, female, smartphone, very high uptake)

More than half of the respondents (8 smartphone/7 tablet) highlighted that the ALMANACH enabled correct treatment. “There are many advantages; first, the phone is a reference point in the sense that if you have forgotten what the patient is suffering from, or treatment or medication, by following the instructions in the phone you will know the diagnosis and medicine to that diagnosis. So the phone helps a lot.” (IDI, male, smartphone, very low uptake)

| 120 | Palazuelos et al | Use of the mHealth tool generally resulted in more accurate answers when compared to the paper-based tool. For 6 of 7 practice test questions, the mean score among those who answered with the mHealth tool was notably higher than the mean score among respondents who answered with the paper-based tool. In general, the difference was greatest in the questions that asked for pediatric doses based on age and weight, as opposed to standardized doses and courses for adults. Although not coded nor quantified, the majority of the errors with each tool followed a few general themes. For the paper-based tool, the community health workers often found it challenging to find the 3 different dosing elements needed (dose, schedule, and duration) as they were often disparate without any clear pattern to follow. For the mHealth tool, the community health workers produced a wrong result if they inadvertently entered information incorrectly at some stage of the algorithm (ie, if they entered in a wrong gender, age, weight, etc.).

Overall, the CHWs in both countries accepted the mHealth tool as a satisfactory tool that was appropriate for use in dosing a medicine. Some CHWs noted that using the mHealth tool on a phone would be a way to gain credibility in the community. The people, upon seeing us look in the book, think badly of us. With the phone, they think we are important.

| 2 | Abouda et al | The number of drugs prescribed per patient who received drug prescription decreased by 18.8% in the impact survey (3.2 vs 2.6, p<0.001).

| 125 | Segal et al | Dosing accuracy improved from 64.7% (among 156 prescriptions) to 92.4% (among 210 prescriptions) when providers used the app. Dosages prescribed after implementation were 40% more likely to be correct (relative risk: 1.39; 95% CI 1.16 to 1.68; p=0.0005). All providers appeared to dose medications more accurately after the intervention.

| 87 | Adams et al | The study nurse correctly identified all algorithm-induced antidepressant recommendations (n=74, 100%) and communicated all to the study clinical officer.

| 47 | Praveen et al | Among those not on medications, 31% (11/36) were recommended for treatment by the decision support tool. The physician commenced all these patients (n=11) on BP-lowering treatment.

| 121 | Catalani et al | ‘Although providers rated the messages relatively highly, they found the accuracy and actionability of the clinical decision support system problematic. Providers indicated that roughly over a quarter of the reminders were not correct for that particular patient and that particular day. Moreover, slightly less than half of the reminders were not considered actionable on that day.’

| 124 | Bessat et al | ‘Positive effects were mentioned to be better management of children (5 IDI, 1 FGD), facilitation in treatment decision-making and dosage calculation (7IDI, 1 FGD), standardization of treatment (2IDI) and rational use of medicines (6IDI). The application guides the clinician through the assessment of the child up to the treatment and the counseling part. At the end, a free text question gives room to the clinician to add additional classifications and treatments. Half of the study participants reported not to add an antibiotic when the application did not recommend it, and mentioned it helped them to rationalize the use of drugs. However, the other half of the participants (6IDI, 1FGD) admitted to sometimes add an antibiotic even though the application did not recommend it. Reasons mentioned were: to calm or treat cough (5IDI), to prevent re-consultation (2IDI, 1FGD), to cover severe diseases or prevent worsening of the disease (3IDI) and in cases of fever with a negative malaria RDT result (1IDI, 1FGD).’
workers to reduce prescriptions as the device provided them with calculations and appropriate dosing of the required medication. A qualitative study in Burkina Faso also found that an electronic Integrated Management of Childhood Illness tool helped half of the health workers to rationalise the use of drugs. However, the other half prescribed an antibiotic—even when the application did not recommend it—in the belief that this might calm or treat cough, prevent patients from returning or prevent worsening of the disease. A before-and-after study in Guatemala found that all general practitioners said the integrated syndromic disease guidelines had improved their knowledge after training but thought the translation of symptoms in Arabic to French could be confusing. An evaluation in Kenya found that clinicians had insufficient knowledge about isoniazid preventive therapy for tuberculosis and therefore simple alerts or reminders were inadequate without information on which steps to take. The qualitative study accompanying the RCT found that rational judgement was not compromised when using the ALMANACH. Two intervention studies reported on a patient outcome (online supplementary file 4). A feasibility study in Tanzania on an antidepressant medication dosing tool found the average Patient Health Questionnaire-9 Item Scores among 17 completers significantly decreased from 20 (SD: 3) at baseline to 8 (SD: 2) at week 12 (p<0.001). A before-and-after study of a medication dosing app in Guatemala observed no change in patient-centredness. Another four studies reported on the use of resources (online supplementary file 4). Only one study mentioned costs explicitly; the average cost of drug prescription per patient who was prescribed any drug was reduced by 19.3% in the impact survey from 8.2 to 6.75 Tunisian dinars (p<0.001).

**DISCUSSION**

**Summary of main results**

To our knowledge, this is the largest ever systematic review on how primary healthcare workers obtain health information during consultations to support decision-making for prescribing in low and lower middle-income countries. Of the 60 497 records found, 23 studies met our inclusion criteria. Most studies were conducted in Africa (n=17). Of 14 observational studies, nine used surveys of which three additionally used qualitative methods. The other five observational studies were qualitative studies of which three used interviews and two focus groups. Frequently mentioned sources of information were books, leaflets, guidelines, aids and the internet. Reasons for not using books included the excessive time to use them, prescribers felt confident in their decisions, were too busy or felt ashamed to use them in front of patients. Also, these sources were sometimes out of date and health workers were confused which ones to use, particularly for websites. Internet access varied across settings and even when available, use was sometimes limited because of technical issues. The nine intervention studies included one RCT and an accompanying qualitative study, one study comparing electronic and paper-based tools, two before-and-after studies and four studies evaluating the development and/or implementation of a tool. Of the five electronic tools that were assessed after training health workers how to use them in these studies, four were assessed positively. Medication tools helped health workers to appropriately prescribe by providing them with calculations for appropriate medicine doses, which increased prescribing accuracy. One tool was not found actionable. Also, medication was sometimes still prescribed when a tool did not recommend it in the belief that it might prevent patients from returning or prevent worsening of the disease.

**Strengths and weaknesses**

Our review followed, where possible, the Cochrane Collaboration and Centre for Review and Dissemination methodology for conducting systematic reviews and we reported our findings based on guidelines from PRISMA statement. This meant that a comprehensive search and assessment of the evidence was conducted. The interventions researched in the studies were diverse and took place in different countries. Therefore, it was not possible to conduct an appropriate meta-analysis.

Most studies took place in low and lower middle-income countries in Africa. Research has shown that there can be a difference between the medicines prescribed and those dispensed. Our review did not report on whether the medicine was dispensed. Few studies specifically aimed to assess how primary healthcare workers accessed information during consultations and more studies on this topic are required. Another limitation is that the term ‘primary healthcare worker’ is generalised and lacks distinction among levels of education and healthcare delivery, which in many studies was not clearly described. Community health workers often can only prescribe one malarial, antibiotic, oral rehydration solution and zinc, which they can prescribe using a syndromic approach. Primary healthcare workers at health centres may have a few more choices of medicines, but often also lack diagnostic tools to prescribe the correct medicine and dose, or not to prescribe at all. Particularly in the publicly funded lower levels of healthcare systems, healthcare workers usually can only prescribe a small number of medicines. They are usually able to prescribe medicines that can be purchased by patients at pharmacies, depending on the patient’s ability to pay and availability of medicines which can be limited by stock-outs. In the private sector, practitioners
and pharmacists and local drug distributors can prescribe in certain settings and are often keen on prescribing medicines that provide them the highest profit. While the effectiveness of the private sector is typically limited in low-income countries, patients still prefer to go there for different reasons, including that medicines in the private sector are more competitively priced and accessible than in the public sector. To improve prescribing in these settings, incentives and training are important to consider in addition to the availability of up-to-date and high-quality information.

Furthermore, assessment of costs was very limited in the included studies. Only one study mentioned costs explicitly; the average cost of drug prescription per patient who was prescribed any drug was reduced by 19.3% in the impact survey from 8.2 to 6.75 Tunisian dinars (p<0.001). Another study conducted in Botswana found that while many facilities had internet access, use was limited because of ‘technical installation issues, connection, password access, costs, lack of time, and lack of devices’.

Quality of the evidence
The quality of reporting varied and was low overall. We found only one RCT which reported using block randomisation but did not mention allocation concealment. Other intervention studies were likely to suffer from performance and detection bias, and other bias due to small sample sizes. The observational studies were reported with varying quality. It is crucial that future studies improve their methodology to enhance the strength of the evidence.

Agreements and disagreements with other studies or reviews
Unsafe prescribing by primary healthcare workers has been attributed to weak medication systems, poor environmental conditions or staff shortages, poor education, inadequate training and lack of knowledge and skills. Previous studies in Africa have suggested variations in knowledge about the basics of how to diagnose and manage common diseases are commonplace and often associated with suboptimal, ineffective and dangerous healthcare practices. One study in our review found that a considerable proportion of pharmacy workers (44%) in Ethiopia said they lacked prescribing-related knowledge and needed updated information. An evaluation in Kenya found that clinicians had insufficient knowledge about isoniazid preventive therapy for tuberculosis and therefore simple alerts or reminders were inadequate without information on which steps to take.

A cohort study on prescribing patterns of evidence-based heart failure medicine concluded that improved uptake of guidance for prescribing is necessary to improve patient outcomes. Another systematic review found that most of the interventions to improve healthcare worker performance have focused on ‘supervision’ as opposed to ‘tools and aids’ such as protocols and/or charts. Our review fills this gap by providing evidence on tools and aids. The most mentioned information sources used during consultations were books, leaflets, guidelines, a flip chart and reporting form aid, and the internet. The nine intervention studies assessed tools such as electronic versions of algorithms for the management of childhood illness and mobile-based medicine and dosing tools for different diseases (general, respiratory disease, depression, cardiovascular disease).

Prescribing rationally, therapeutically and safely becomes ever more complicated as the number of widely available medicines increases and medical knowledge expands. The WHO Model Essential Medicines List (EML) listed 212 medicines in its first edition in 1977 more than doubling to 460 medicines in the 2019 21st edition. The WHO considers the EML a ‘flagship tool to expand access to medicines’ which is necessary for the achievement of Sustainable Development Goal 3. Furthermore, in practice, the ELM only covers a small fraction of the medicines that are commonly available and used or misused worldwide. Up-to-date medicine information and the means of making it accessible and acceptable to prescribers at the point of care must accompany the expanding access to medicines if those seeking medical care are to benefit. Such information needs to go beyond information about individual medicines, to include guidance on the selection of medicines.

CONCLUSION
This systematic review found a small number of low-quality studies showing a lack of up-to-date and relevant medicine information resources in low and lower middle-income settings. Internet-based sources are useful when it is possible to download content for offline use and to regularly update when there is internet access. Given the fundamental importance of safe and effective prescribing, and its dependence on reliable information (whether retained through training or available at point of care), it is remarkable that the available research tells us little about the prescribing information needs of primary health workers, and how these needs can be progressively met. Electronic tools to help healthcare workers to prescribe medication showed promise, but their accuracy needs to be validated. Such tools should focus on actionable advice that guides prescribers through the different steps that need to be taken to prescribe safely.

Future work needs to improve quality of research methodology, provide a clear description of the context, assess costs and cost-effectiveness and consider interactions between the availability and use of information and other factors that influence prescribing. Future conduct of observational studies could provide evidence of what really happens at different levels of the health delivery system, which will likely vary substantially in different countries and even between regions of the same countries, as well as in response to different diseases. Changing drug protocols may need training and widespread
information dissemination as well as an enabling environment to make change possible.

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**Contributors**
CS and MIVH jointly wrote the review. MIVH and MB conducted the searches. All the authors screened the references. MIVH and NDT extracted the data and assessed the quality of included studies. CS and NPW provided extensive comments on the review. All authors reviewed the final draft of the review.

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**Competing interests**
None declared.

**Patient and public involvement**
Patients and/or the public were involved in the design, conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication**
Not required.

**Ethics approval**
No ethics approval was required. The review will inform efforts that aim to improve the prescribing practices of healthcare workers in low and middle-income countries. Findings were disseminated through the Healthcare Information For All network.

**Provenance and peer review**
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**Data availability statement**
Data sharing is not applicable as no data sets were generated and/or analysed for this study.

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