









# Overdiagnosis and overuse of diagnostic and screening tests in low-income and middle-income countries: a scoping review

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## ABSTRACT

**Objective** Overdiagnosis and overuse of healthcare services harm individuals, take resources that could be used to address underuse, and threaten the sustainability of health systems. These problems are attracting increasing attention in low-income and middle-income countries (LMICs). Unaware of any review of relevant evidence, we conducted a scoping review of the evidence around overdiagnosis and overuse of diagnostic and screening tests in LMICs.

**Design** Scoping review.

**Methods** We searched PubMed, Embase, PsycINFO, Global Index Medicus for relevant studies published until 24 May 2021, with no restrictions on date or language. We categorised included studies by major focus (overdiagnosis, overuse of tests, or both) and main themes (presence or estimates of extent; drivers; consequences and solutions).

**Results** We identified 2763 unique records and included 162 articles reporting on 154 studies across 55 countries, involving over 2.8 million participants and/or requests for tests. Almost half the studies focused on overdiagnosis (70; 45.5%), one-third on overuse of tests (61; 39.6%) and one-fifth on both (23; 14.9%). Common overdiagnosed conditions included malaria (61; 39.6%) and thyroid cancer (25; 16.2%), estimated to be >70% in China. Overused tests included imaging (n=25 studies) such as CT and MRI; laboratory investigations (n=18) such as serological tests and tumour markers; and procedures (n=14) such as colonoscopy. Drivers included fear of conflict with patients and expanding disease definitions. Common consequences included unnecessary treatments such as antimalarials, and wasted resources, with costs of malaria overdiagnosis estimated at US\$86 million in Sudan in 1 year alone. Only 9% of studies discussed solutions, which included addressing inappropriately lowered diagnostic thresholds and reforming test-ordering processes.

**Conclusions** Overdiagnosis and overuse of tests are widespread in LMICs and generate significant harm and waste. Better understanding of the problems and robust evaluation of solutions is needed, informed by a new global alliance of researchers and policy-makers.

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ The problems of overdiagnosis and overuse of healthcare services harm individuals, take resources that could be used to address the underuse of effective healthcare interventions, and threaten the sustainability of healthcare systems.
- ⇒ These challenges are attracting increasing attention in high-income countries. However, little is known about the evidence around the overdiagnosis and overuse of healthcare services in low-income and middle-income countries (LMICs).

## WHAT THIS STUDY ADDS

- ⇒ This is a comprehensive scoping review of 154 studies (on >2.8 million participants and/or requests for tests) in 55 LMICs. Common overdiagnosed conditions included malaria and thyroid cancer; and common overused tests included imaging such as CT and MRI; laboratory investigations such as serological tests and tumour markers; and procedures such as colonoscopy.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Overdiagnosis to continue to expand activities within LMICs, and for national and global stakeholders to devote increased attention to addressing the harms and waste of unnecessary healthcare services.

## INTRODUCTION

The problems of overdiagnosis and overuse of healthcare services harm individuals, take resources that could be used to address the underuse of effective healthcare interventions, and threaten the sustainability of healthcare systems.<sup>1-6</sup> The Organisation for Economic Cooperation and Development (OECD) estimates 20% of healthcare spending in its member nations may be wasted and better spent on genuine needs.<sup>6</sup> Multiple global initiatives have been launched to address these problems, including Right Care<sup>7</sup> and Choosing Wisely.<sup>8</sup> Although the extent of overdiagnosis and overuse in low-income and middle-income



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countries (LMICs) is unknown, these challenges are especially important in LMICs where health expenditure in relation to the gross domestic product is significantly lower, and waste threatens both population health and the 'viability of public budgets'.<sup>1</sup> Tackling underuse of medical interventions, including evidence-based screening programmes such as cervical cancer screening, is clearly a priority in LMICs, reinforcing the need to reduce waste in these settings.<sup>2</sup> Addressing the problems of overdiagnosis and overuse of healthcare services in LMICs may assist in supporting efforts to achieve sustainability, fairness and equity of health systems worldwide, including universal health coverage as a central part of the United Nations Sustainable Development Goals.<sup>1,7</sup>

The problems of overuse and overdiagnosis in LMICs are attracting increasing attention. Choosing Wisely, the clinician-led campaign aiming to reduce unnecessary tests, treatments and procedures, is growing internationally.<sup>9</sup> Several LMICs countries, including Brazil, India, Iran and some sub-Saharan African countries, are adopting and implementing the campaign.<sup>10-12</sup> Country-specific scoping reviews of the evidence are emerging,<sup>13</sup> and a workshop at the 2019 international Preventing Overdiagnosis scientific conference called for more research and actions on the problem in LMICs, including a new global network.<sup>14</sup> A WHO official has said as the world moves towards universal health coverage, it is critical to tackle 'the waste and the inadvertent iatrogenic harm' caused by overdiagnosis and overuse, and that 'the 194 Ministries of health with whom WHO works all face this problem'.<sup>15</sup> Against the backdrop of the COVID-19 pandemic, there are increasing calls for health systems to tackle the harm and waste of unneeded care in a post-pandemic recovery.<sup>16</sup>

To identify gaps in knowledge, inform future agendas for research and action, and help build a global network to advance this work, a broad scoping review of the relevant evidence is needed. Initial consultations with a small team of researchers, including from LMICs, and preliminary literature searches, identified a potentially large amount of evidence to scope, spanning overdiagnosis and overuse of diagnostic tests, medications and surgical procedures. In this scoping review, our objective is to review available evidence around overdiagnosis and overuse of diagnostic and screening tests in LMICs. Overuse is broadly defined as 'the provision of healthcare services for which the potential for harm exceeds the potential for benefit'.<sup>17</sup> Overdiagnosis happens when people receive a diagnostic label that causes them more harm than good, for example, when someone is diagnosed with cancer that would never go on to cause harm.<sup>18,19</sup>

## METHODS

### Protocol and registration

We conducted a systematic scoping review of the available evidence around overdiagnosis and overuse of diagnostic and screening tests in LMICs in accordance with the Joanna Briggs Institute guidance<sup>20</sup> and reported it

following the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) Extension for Scoping Reviews guidelines.<sup>21</sup>

### Search strategy and selection criteria

We searched four electronic databases: PubMed, Embase, PsycINFO, Global Index Medicus from inception until 24 May 2021, using Cochrane EPOC's LMIC search filter and MeSH terms and free text about overdiagnosis and overuse of diagnostic and screening tests, with no restrictions on language. Detailed search strategies are available in online supplementary appendix 1. We also emailed at least one corresponding author of included articles from the last 5 years from each country included in the review to identify any relevant and important grey literature, such as government reports.

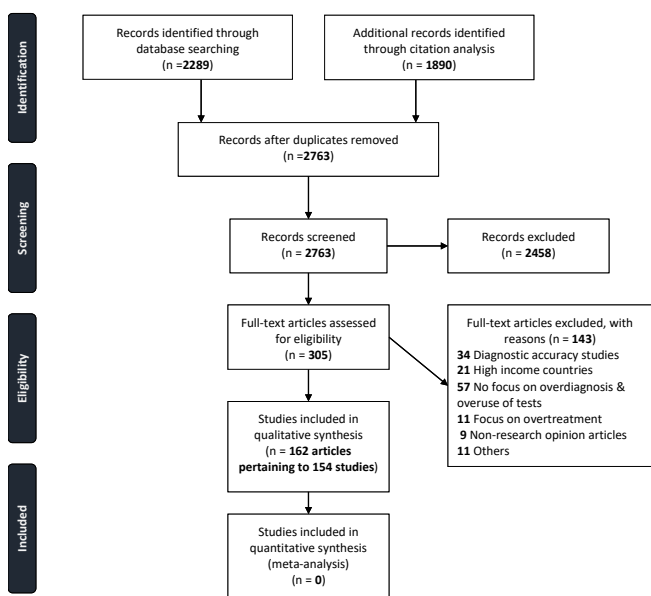
We included both primary studies and systematic reviews of quantitative and qualitative studies, from one or more LMICs,<sup>22</sup> which investigated the presence or estimates of the extent of overdiagnosis or overuse of tests, drivers of the problems, consequences of the problems such as waste or harm, and potential solutions. Where studies included LMICs and non-LMICs, we included these but only collected and synthesised the data pertaining to LMICs. We excluded non-research opinion pieces such as case reports and series, studies that primarily focused on the overuse of treatments, such as medications and surgical procedures, studies that do not have a major focus on overdiagnosis or overuse of tests, and diagnostic accuracy studies.

### Screening and data synthesis

Pairs of review authors (LA, MA-Z, EA, HG, TP and RM) independently screened titles and abstracts, and then full text once it was obtained, and disagreements were resolved by discussion or reference to a third author (LA or RM). To ensure reliability among screeners, all pairs independently screened a random sample of 30 citations and continued discussion until acceptable agreement was attained. A data charting form was developed and independently piloted on a random sample of five included articles. A single author from each screening team (LA, MA-Z, EA, HG, TP and RM) extracted information relevant to (1) publication and study characteristics, such as sample size, study design, type and location and (2) overdiagnosis and overuse of diagnostic and screening tests, such as the condition or test evaluated and (3) key findings. For data analysis, we categorised included studies by whether the major focus was overdiagnosis, overuse of tests or both, and by main themes: presence or estimates of extent, drivers, consequences and solutions.

### Patient and public involvement

Patients or members of the public were not involved in the design, conduct or reporting of this research.



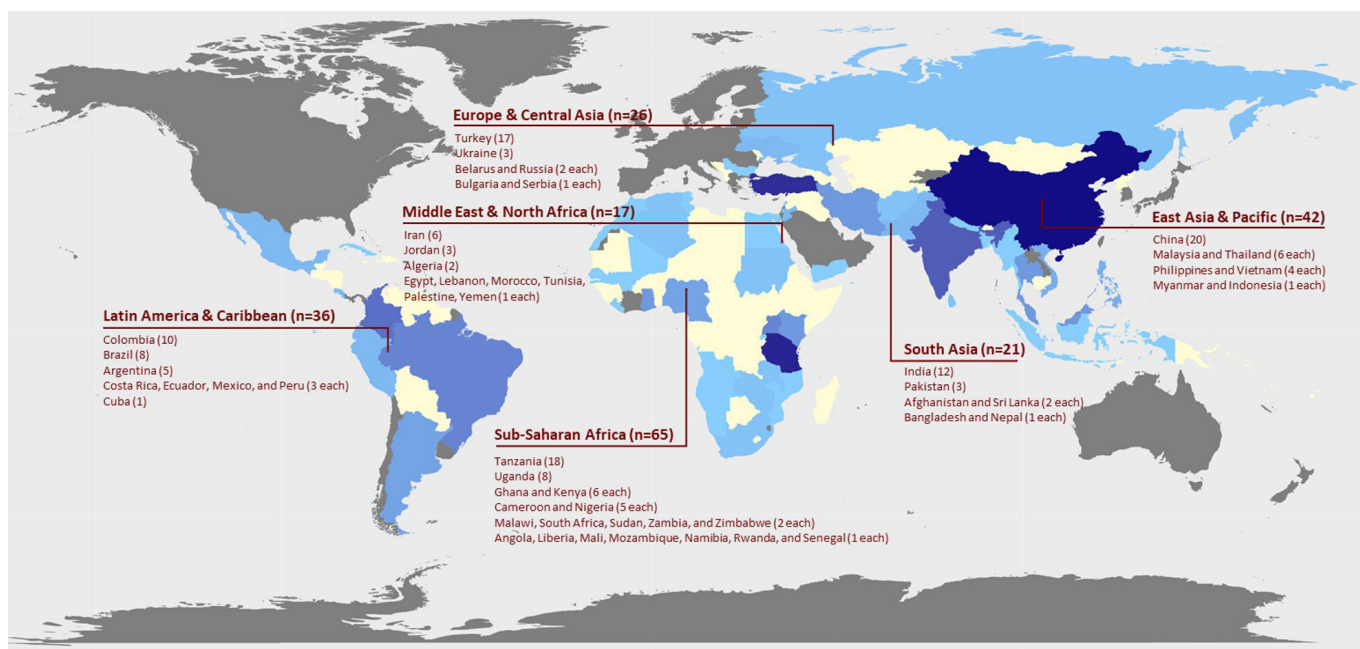
**Figure 1** PRISMA flow chart of study selection process. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

**RESULTS**

We identified 2289 records through electronic database searching, and 1890 more through backward citation analysis, for a total of 2763 unique records. After screening titles and abstracts, we excluded 2458 records, resulting in 305 records being considered for full-text screening. Of the full-text articles screened, 143 were

excluded with reasons recorded, leaving a total of 162 articles (reporting on 154 studies) included in this scoping review (figure 1).

The 154 included studies collectively report on more than 2.8 million participants and/or requests for tests conducted (median 834; IQR: 302–4457). Studies reported across 55 countries (of all 135 LMICs economics—countries and territories) distributed across 6 regions: 74 sub-Saharan Africa, 45 East Asia and Pacific, 28 Europe and Central Asia, 42 Latin America and the Caribbean, 23 the Middle East and North Africa, 22 South Asia (figure 2). Twelve studies were multinational, 21 studies were conducted in China; 20 Tanzania; 19 Turkey; 12 India and Iran each; 11 Colombia and Brazil each; 10 Ghana; 8 Uganda; 7 Malaysia; 6 Kenya and Thailand each; and 5 from each of Argentina, Vietnam, Mexico, Cameroon and Nigeria (figure 2). There has been a marked increase in the number of included studies per year, with most studies (n=108, 70.1%) published within the past 10 years. Most studies were written in English (136; 88.3%), 11 (7.1%) in Spanish, 5 (3.2%) Turkish and 1 (0.65%) in Chinese and Persian each. The health-care settings were secondary care in 58 studies (37.7%), community in 23 (14.9), primary care in 21 (13.6%) and mixed settings in 36 (23.4%) studies. Of the 154 included studies, 125 (81.2%) were observational, 125 (81.2%) were quantitative and 145 (94.2%) were primary original studies. Table 1 provides a summary of key characteristics of included studies and online supplemental table S1 provides a complete list of included studies.



**Figure 2** Studies of overdiagnosis and overuse of tests in low-income and middle-income countries (LMICs). Seventy-four studies in 19 of the 46 LMICs in sub-Saharan Africa, 45 in 7 of the 23 LMICs in East Asia and Pacific, 28 in 6 of the 20 LMICs in Europe and central Asia, 42 in 8 of the 25 LMICs in Latin America and the Caribbean, 23 in 9 of the 13 LMICs in the middle East and North Africa, and 22 in 6 of the 8 LMICs in South Asia. The darker the blue gradient, the more studies originated from the country. White colour indicates countries that have no relevant studies that could be identified. Grey colour indicates high-income countries.

**Table 1** Characteristics of included studies (n=154)

	N (%)
<b>Publication year</b>	
1999–2010	46 (29.9)
2011–2022	108 (70.1)
<b>Language of publication</b>	
English	136 (88.3)
Spanish	11 (7.1)
Turkish	5 (3.2)
Mandarin	1 (0.7)
Persian	1 (0.7)
<b>Income group</b>	
Single country	142 (92.2)
Low income	14 (9.1)
Lower middle income	59 (38.3)
Upper middle income	69 (44.8)
Multiple countries	12 (7.8)
<b>Study design</b>	
Interventional (e.g., RCT)	17 (11.0)
Randomised trials (e.g., cluster RCTs)	13 (8.4)
Observational (e.g., cross-sectional)	125 (81.2)
Cross sectional (e.g., survey)	78 (50.6)
Prospective cohort	34 (22.1)
Secondary research (e.g., review)	9 (5.8)
<b>Analysis approach</b>	
Quantitative	125 (81.2)
Qualitative	23 (14.9)
Mixed	6 (3.9)
<b>Condition</b>	
Malaria and other infectious	61 (39.6)
Thyroid cancer and other cancers	25 (16.2)
Heart and lung diseases	15 (9.7)
Diabetes	4 (2.6)
Mental illnesses	2 (1.3)
Other	8 (5.2)
Not specified	39 (25.3)
<b>Diagnostic or screening tests</b>	
Imaging (e.g., CT scan, MRI)	25 (16.2)
CT scan (e.g., multidetector CT)	7 (4.5)
MRI (e.g., multiparametric MRI)	8 (5.2)
X-ray (e.g., mammography, DXA) & US	6 (3.9)
Multiple imaging types	4 (2.6)
Lab investigations (e.g., blood tests)	18 (11.7)
Blood tests (e.g., full blood count, lipid)	9 (5.8)
Serological tests (e.g., hepatitis, HIV tests)	5 (3.2)
Others (e.g., tumour markers, d-dimer)	4 (2.6)
Procedures (e.g., colonoscopy)	14 (10.1)
Endoscopies (e.g., colonoscopies)	9 (6.2)

Continued

**Table 1** Continued

	N (%)
Urogenital (e.g., prostate biopsies and pap smears)	3 (1.9)
Others (e.g., coronary angiographies)	2 (1.3)
Not specified	97 (62.2)
<b>Financial implications mentioned</b>	
Considered	29 (18.8)
Not considered	125 (81.2)
<b>Main contexts</b>	
Overdiagnosis	70 (45.5)
Overuse of tests	61 (39.6)
Both	23 (14.9)

DXA, dual-energy X-ray absorptiometry; RCT, randomised controlled trials; US, ultrasound scan.

**Estimates of overdiagnosis and/or overuse of tests in LMICs**

Of the 154 included studies, 72 (46.8%) reported on the presence and/or extent of overdiagnosis and/or overuse of tests in LMICs. Almost two-thirds of those studies addressed the overuse of tests (n=45; 62.5%), while 27 (37.5%) studies addressed the problem of overdiagnosis.

Conditions covered include malaria, chronic obstructive pulmonary disease and diabetes, with thyroid cancer the most frequent condition identified in this set of studies, (n=17; 23.6%). For example, an international analysis of population-based cancer registries, involving over half a million patients aged 20–74 years across the five continents, found very high and increasing incidence rates of thyroid cancer in several LMICs, contrasted with generally stable low mortality rates.<sup>23</sup> The combination of increasing incidence of thyroid cancer and stable thyroid cancer mortality is strong evidence suggesting overdiagnosis, which is attributed to increased thyroid cancer screening in LMICs, and is a pattern that has been seen in high-income countries such as Korea.<sup>23 24</sup> A 2021 study of 35 cancer registries in China, including 27 842 patients with thyroid cancer, estimated that overdiagnosis accounted for 83.1% and 77.3% of thyroid cancer in women and men respectively.<sup>25</sup> Table 2 provides a summary of the key themes and findings.

Studies of test overuse found generally high rates across imaging, laboratory tests and procedures (table 2). For example, a large analysis of 5418 adults in Lebanon found a high rate of inappropriate use of coronary angiography (n=2457, 45.3%) potentially attributed to the wide case-based reimbursement by public insurance schemes.<sup>26</sup> Similarly, MRIs for low back pain were deemed inappropriate for over half (53.3%) of 400 patients in a study in Iran, with an inappropriate MRI twice as likely in a private hospital compared with a public hospital.<sup>27</sup> A 2018 study of 325 adults who underwent colonoscopy in Sri Lanka in 4 hospitals estimated that more than one-third of colonoscopies were inappropriate (38.8%).<sup>28</sup> By contrast, a rare exception in the review, was a study of 301

**Table 2** Main findings grouped to the main themes addressed in a set of included studies (n=154)

Study	Key findings
<b>Estimation of overdiagnosis and/or overuse of diagnostic and screening tests (n=72)</b>	
Vaccarella 2021 (47 countries) A population-based study of 159 registries including 8049 children and adolescents with thyroid cancer. <sup>53</sup>	Rapid increase in the incidence rates of thyroid cancer among children and adolescents in almost all countries, although thyroid cancer mortality rates remained low in these countries. This epidemiological pattern mirrored the pattern in adults—suggesting a major role of overdiagnosis, which, in turn, can lead to overtreatment, lifelong medical care and side effects that can negatively affect quality of life.
Panato 2020 (India) A population-based study of 14 cancer registries of >5% of Indian population. <sup>43</sup>	Thyroid cancer incidence rates increased by 37% and 27% in women and men between 2006–2008 and 2012–2014, respectively. Overdiagnosis accounted for >50% of thyroid cancer in women. Authors concluded that ‘As a society, we must do what it takes to minimise harms to patients and to the already overstretched healthcare systems of these countries’.
Ozbek 2010 (Turkey) A retrospective study of 56349 patients admitted to a university hospital between 2007–2009. <sup>54</sup>	More than 1/10 of hepatitis B tests were unnecessary, resulting in an economic loss of approximately US\$20 000 over 3 years in a single hospital.
Zhang 2018 (China) A retrospective study of 2706 patients in the respiratory, thoracic surgery, and oncology departments of 3 hospitals between 2014 and 2015. <sup>45</sup>	The inappropriate use of tumour markers was widespread, ranging between 58% and 79%. This resulted in a financial burden equivalent to 7.69%–12.00% of examination expenses and 1.35%–2.11% of hospitalisation costs.
<b>Drivers of overdiagnosis and/or overuse of diagnostic and screening tests (n=27)</b>	
Soares 2019 (Brazil) A nationwide population-based survey of 13 625 men older than 40 years. <sup>55</sup>	Prostate cancer screening with digital rectal examination is very prevalent in Brazil (63.3%–41.6%) – most frequently carried out within private health insurance, which increase the risk of overdiagnosis and overtreatment.
Chandler 2008 (Tanzania) A qualitative ethnographic study of 2082 patient consultations with 34 clinicians over a period of 3 months. <sup>30</sup>	Four key drivers of malaria overdiagnosis identified: flawed training, peer pressure and professional norms, perceived patients’ preferences, and limited quality diagnostic resources and support.
<b>Consequences of overdiagnosis and/or overuse of diagnostic and screening tests (n=41)</b>	
Kavosi 2021 (Iran) A cross-sectional study of 385 participants had undergone brain MRI in three public teaching hospitals. <sup>56</sup>	More than one-fifth of brains MRIs were inappropriate—resulting in a financial burden of almost US\$100 000 in 1 year in just three hospitals—17 times Iran’s GDP per capita.
A-Elgayoum 2009 (Sudan) A retrospective study of 3203 patients from 95 health facilities. <sup>57</sup>	Malaria overdiagnosis was widely recognised in Sudan, with massive economic burden—estimated to be US\$86 million in 2000.
<b>Solutions for the problem of overdiagnosis and/or overuse of diagnostic and screening tests (n=14)</b>	
Henao-Villada 2016 (Colombia) A before and after study of 1365 children with bronchiolitis to evaluate the impact of guideline implementation. <sup>58</sup>	A marked increase in the proportion of bronchiolitis patients with an appropriate diagnosis and management (36.4% vs 44.5%) and a further decrease in the use of low value care such as unnecessary haemogram (33.2% vs 26.6%).

Malaysian children who underwent endoscopies, which found that only a very small proportion was considered inappropriate.<sup>29</sup>

### Drivers

Twenty-seven of the 154 included studies (17.5%) explored the drivers of overdiagnosis and overuse of tests. Key drivers identified include individual-level drivers such as fear of litigation and conflicts with patients, and personal financial incentives, and system-level drivers such as limited clinical training and resources, and expanding disease definitions and lowered diagnostic thresholds.<sup>30 31</sup> A large survey of over 500 physicians in China identified two major drivers of overuse of unnecessary tests: financial returns and avoiding potential conflicts with patients. The authors recommended improving patient–doctor relationships and reforming the remuneration scheme.<sup>32</sup>

An anthropological study in Vietnam similarly identified financial return for doctors as a key driver of the overuse of ultrasound.<sup>33</sup> A qualitative study in Tanzania identified a potential conflict in the patient–doctor relationship over access to tests and treatments, as an important challenge in addressing overdiagnosis and overtreatment of malaria.<sup>34</sup> Another driver of overdiagnosis was expanding disease definitions and lowering diagnostic thresholds, identified by an analysis of two nationwide surveys of over 150 000 adults in China. Authors estimated that just a small change in the diagnostic thresholds of diabetes, hyperlipidaemia and hypertension could increase the number of people diagnosed by over 350 million, and increase the cost by more than ¥270 billion, the equivalent of 56% of the total health budget in China.<sup>31</sup> A study of the incidence of thyroid cancer in 34 OECD countries,

## Box 1 Malaria—overdiagnosis, misdiagnosis, overtreatment

Our scoping review found many studies investigating the problems of overdiagnosis of malaria and subsequent overtreatment with antimalarial medication.<sup>37 38</sup> We also identified a small number of qualitative studies investigating drivers of these problems, essential for identifying effective strategies to reduce overdiagnosis and overuse.<sup>34</sup>

### Overdiagnosis or misdiagnosis?

An important context for these findings is that many papers tended to use the terms ‘overdiagnosis’ and ‘misdiagnosis’ interchangeably. A strict and narrow definition of overdiagnosis excludes situations where a person with one disease has been wrongly diagnosed or misdiagnosed, with another disease.<sup>59</sup> While many participants with other serious disease in these studies have clearly been harmed by being misdiagnosed as having malaria, others may have met the strict criteria for being overdiagnosed, if they had a simple or self-limiting fever and received a diagnosis for and treatment of malaria.<sup>60</sup> Given the complex clinical reality of fever management in low-income and middle-income country (LMIC) settings, and the broad nature of this scoping review, we have deferred to the LMIC authors and included studies using the term overdiagnosis, even if this has included what is clearly misdiagnosis, provided there was data on the extent of subsequent overtreatment.

### Unintended consequences?

The roll-out of rapid diagnostic tests has been shown in multiple studies to reduce the rates of malaria diagnosis and overtreatment with antimalarials, to varying degrees.<sup>38 61</sup> While welcoming these positive public health impacts, some authors have identified ‘unintended consequences’.<sup>38 62</sup> Showing evidence of large increases in antibiotic prescribing, Hopkins *et al* have concluded that without additional interventions, the introduction of these tests ‘can unintentionally exchange presumptive overuse of antimalarials for presumptive overuse of antibiotics’,<sup>62</sup> which has critical implications for another global issue, antibiotic resistance.<sup>63 64</sup>

including several LMICs, found that the lower ‘the share of the public sector on health expenditure’, the higher the ‘incidence of thyroid cancer’ and concluded that ‘increases in the proportion of public coverage of health-care expenditure may help reduce the overdiagnosis of thyroid cancer’.<sup>35</sup>

### Consequences

Of the 154 included studies, 41 (26.6%) examined the consequences of overdiagnosis and/or overuse of tests—most looking at subsequent overuse of medications and the costs of wasted resources. More than two-thirds of these studies (36; 87.8%) focused on malaria. The malaria studies tended to compare new diagnostic processes (e.g., rapid diagnostic tests) with routine approaches (e.g., presumptive clinical diagnosis), often finding that ‘malaria is massively overdiagnosed’ and overtreated with antimalarial medication,<sup>36</sup> with the important caveat that in many studies the terms overdiagnosis and misdiagnosis were used interchangeably (box 1). For example, a cluster randomised controlled trial of 4603 people with

symptoms suggestive of malaria evaluated the impact of providing rapid diagnostic tests for malaria on rates of overdiagnosis and overtreatment of malaria in Ghana. The study, published in 2015, found a substantial reduction in the use of antimalarial treatment among those who were malaria slide-negative, from 88% in the control group to 32% in the intervention group.<sup>37</sup> Similarly, a trial with over 15 500 people in Uganda found a dramatic reduction of 72.6% (95% CI 46.7% to 98.4%) in overdiagnosis and overtreatment of malaria.<sup>38</sup> Studies have also reported subsequent consequences of overdiagnosis and overuse of tests on costs. For example, a study of a small sample of 285 requests for pre-operative tests for children in Thailand found over 50% were inappropriate, wasting an estimated total of 19 000 Baht. To put this in context, highlighting the impact of overuse of tests on financial costs, Thailand’s national insurance scheme was named the 30 Baht scheme, taking its name from the flat fee charged for health services.<sup>59</sup>

### Potential solutions

Only 14 of the 154 included studies (9.1%) discussed potential solutions for the problems of overdiagnosis and overuse of tests. Possible solutions reported include individual-level solutions such as increasing clinicians’ awareness of the issues of overdiagnosis and overtesting and improving access and training for efficient diagnostic approaches such as decision support tools, and system-level solutions such as reforming the process of disease definitions and reorganising ordering systems for requesting diagnostic tests. A 2015 cluster randomised trial in Tanzania involving over 44 000 people found intensive behavioural interventions for prescribers and patients, including ‘small group training with SMS’, helped drive the overprescription of antimalarials down close to zero.<sup>40</sup> A study in Turkey found that a simple reorganisation of one hospital’s test ordering page resulted in a significant decrease in ordering of a range of unnecessary tests (between 12.6% and 85.0%)—savings equivalent to US\$371 183 in just 1 year in one hospital.<sup>41</sup> Another study in Turkey evaluated the impact of a new risk factor-based screening strategy on the unnecessary testing for the diagnosis of gestational diabetes and found a significant reduction of 50% in unnecessary testing.<sup>42</sup>

## DISCUSSION

To our knowledge, this is the first scoping review of its kind, summarising evidence for the problems of overdiagnosis and overuse of tests in LMICs. We analysed 154 studies from 55 different LMIC countries, predominantly middle income, with most reporting on the extent of these problems and their consequences for overtreatment and unnecessary healthcare services, few investigating drivers, and even fewer, potential solutions. The available evidence comes largely from observational studies, with a significant minority from randomised controlled trials. Our findings provide strong evidence to encourage

efforts such as Choosing Wisely and Preventing Overdiagnosis to continue to expand activities within LMICs, and for national and global stakeholders to devote increased attention to addressing the harms and waste of unnecessary healthcare services.

The review has shown that overdiagnosis and overtreatment of thyroid cancer and malaria have attracted widespread attention within LMIC settings, although these are just 2 of 38 conditions covered in our review. Estimated rates of overdiagnosis of 50% of thyroid cancer diagnosed among women in parts of India,<sup>43</sup> and over 75% of men and women in China<sup>25</sup> demand urgent responses. An international analysis of the mortality and incidence of thyroid cancer in 25 population-based registries (from both high-income and LMICs) showed that the pattern of overdiagnosis and variations in the rates of incidence of thyroid cancers are very similar among LMICs compared with high-income countries.<sup>23</sup> This might reflect shared common drivers and potential solutions to the problem of overdiagnosis and overuse of tests between LMICs and high-income countries. Overuse of a wide range of tests including CT and MRI scans, blood tests and endoscopies also emerged as a common problem, causing harm and waste in limited-resource settings. Two recent studies, from Brazil<sup>44</sup> and China<sup>45</sup> identified rates of inappropriate ordering of tumour markers, both in excess of 50%, underscoring the need for better regulation of the use of emerging medical technologies. A small number of qualitative studies identified drivers of these problems including fear of litigation and conflicts with patients, financial incentives, and expanding disease definitions.<sup>30 32</sup> The few studies exploring solutions tended to focus on evaluating new diagnostic processes designed to reduce overdiagnosis, such as the rapid diagnostic tests for malaria, or administrative reforms to reduce overtesting.

Our review has some important limitations and strengths. Given the necessary breadth of a scoping review, we have included studies using a range of definitions of the key concepts of overdiagnosis and overuse of tests. For example, as discussed in **box 1**, some proportion of what is described as overdiagnosis in some malaria studies is clearly misdiagnosis. But whether the problems meet strict and changing academic definitions are far less important than tackling what are clear and widespread problems with diagnostic processes that cause harm and waste via overtreatment of malaria, and undertreatment of undiagnosed conditions. Another limitation arises from excluding studies which did not fully meet our inclusion criteria, but raise valuable concerns about potential overdiagnosis or misdiagnosis across a range of infectious and non-infectious conditions, including HIV,<sup>46</sup> cervical abnormalities,<sup>47</sup> appendicitis<sup>48</sup> and *Entamoeba histolytica*,<sup>49</sup> suggesting the review findings may be underestimating the existence of these problems in LMICs. A final limitation arises from this being a broad scoping review, with no critical appraisal of the quality of included studies. Strengths of this review are found in

its comprehensive search with no language restrictions, adherence to gold-standard methodology, including paired independent screening and involvement of review authors from LMIC settings.

The results of this scoping review in LMICs on overdiagnosis and overuse of tests have added to knowledge about the nature and extent of these problems, but have also identified important gaps, which can inform both research and action agendas. On the research front, there is a clear need for national and global estimates of the extent of harm<sup>19</sup> and cost of waste from overdiagnosis and overuse of tests, to inform both policy and wider social responses. This scoping review has also reinforced the need for better guidance on optimum methods for investigating overdiagnosis. Development and evaluation of both narrow and broad solutions to reduce overdiagnosis and overuse of tests are clearly needed, using randomised trials where feasible. Different medical conditions will require different approaches, with solutions tailored to specific drivers. For example, the overdiagnosis of malaria by compassionate professionals will demand very different responses to more commercially driven screening and treatment of benign thyroid tumours. On the action front, this review will also inform the development of a new global network of researchers and health policy workers interested in advancing this agenda. We plan to contact all authors of included studies inviting them to join an international community of practice, planning meetings and research collaborations. Alongside the challenges of confronting these complex and counterintuitive problems are opportunities to share data and learn from each other's experience, across both high-income countries and LMICs. There are already movements, such as Choosing Wisely and Quaternary Prevention,<sup>50 51</sup> building such networks. And as flagged above, working with colleagues from LMICs, we intend to conduct a separate scoping review of the evidence about the overuse of medications in LMICs.

The WHO has observed that the global move towards universal health coverage is making the problems of overdiagnosis and overuse of healthcare services more pressing,<sup>14 15</sup> and a recent World Bank report makes clear that providing 'high-quality health services' means minimising harm and waste.<sup>52</sup> To achieve universal health coverage, especially in the post-pandemic recovery, there is a clear need for health systems to focus more on what matters most, and direct resources to where they are most needed. Tackling underuse of evidence-based healthcare services,<sup>2</sup> including diagnostic and screening tests, can only benefit from an enhanced effort to reduce overdiagnosis and overuse. Addressing medical excess and prioritising higher-value healthcare are becoming increasingly important global priorities.

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