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Published in:
BMJ Global Health

DOI:
10.1136/bmjgh-2022-008696

BMJ Global Health

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

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To cite: Albarqouni L, Arab-Zozani M, Abukmail E, *et al*. Overdiagnosis and overuse of diagnostic and screening tests in low-income and middle-income countries: a scoping review. *BMJ Global Health* 2022;**7**:e008696. doi:10.1136/bmjgh-2022-008696

Handling editor Seye Abimbola

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjgh-2022-008696).

Received 1 February 2022
Accepted 12 July 2022

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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.[1–6] 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.[6] Multiple global initiatives have been launched to address these problems, including Right Care[7] and Choosing Wisely.[8] Although the extent of overdiagnosis and overuse in low-income and middle-income

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.'[1] 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.[2] 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.[1 7]

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.[9] Several LMICS countries, including Brazil, India, Iran and some sub-Saharan African countries, are adopting and implementing the campaign.[10–12] Country-specific scoping reviews of the evidence are emerging,[13] 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.[14] 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.'[15] 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.[16]

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.'[17] 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.[18 19]

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[20] and reported it following the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) Extension for Scoping Reviews guidelines.[21]

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,[22] 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.

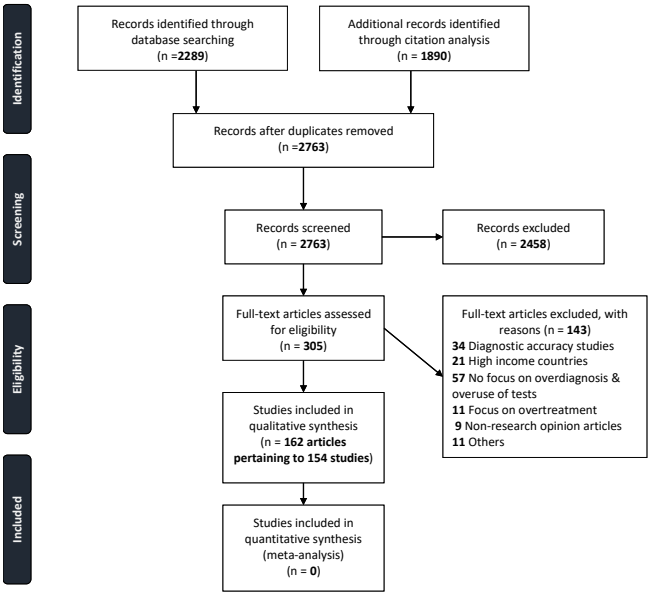

Figure 1 PRISMA flow chart of study selection process. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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 conducetd 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 healthcare 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.

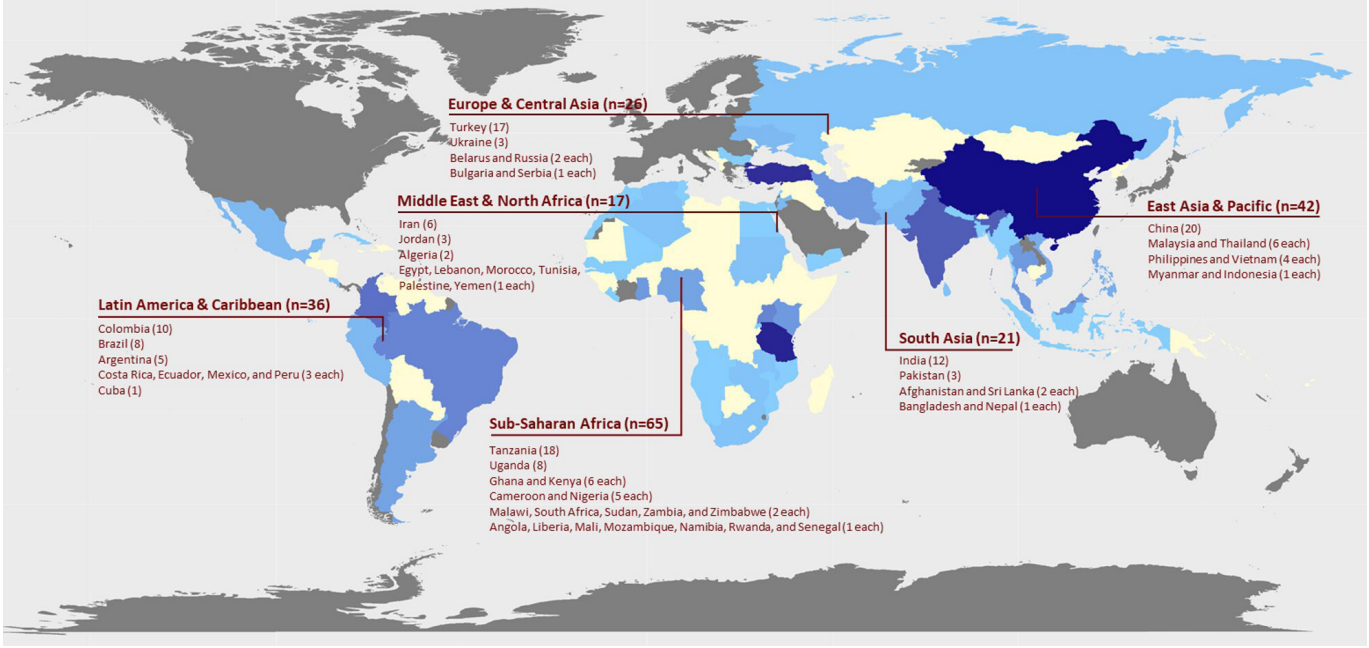

Figure 2 Studies of overdiagnosis and overuse of tests in low-income and middle-income countries (LMICs). Seventy-four studies in 19 of the 46 LMICs in sub-Saharan Africa, 45 in 7 of the 23 LMICs in East Asia and Pacific, 28 in 6 of the 20 LMICs in Europe and central Asia, 42 in 8 of the 25 LMICs in 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 (%)
Publication year	
1999–2010	46 (29.9)
2011–2022	108 (70.1)
Language of publication	
English	136 (88.3)
Spanish	11 (7.1)
Turkish	5 (3.2)
Mandarin	1 (0.7)
Persian	1 (0.7)
Income group	
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)
Study design	
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)
Analysis approach	
Quantitative	125 (81.2)
Qualitative	23 (14.9)
Mixed	6 (3.9)
Condition	
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)
Diagnostic or screening tests	
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)
Urogenital (e.g., prostate biopsies and pap smears)	3 (1.9)
Others (e.g., coronary angiographies)	2 (1.3)
Not specified	97 (62.2)
Financial implications mentioned	
Considered	29 (18.8)
Not considered	125 (81.2)
Main contexts	
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.[23] 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.[23 24] 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.[25] 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.[26] 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.[27] 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%).[28] 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
Estimation of overdiagnosis and/or overuse of diagnostic and screening tests (n=72)	
Vaccarella 2021 (47 countries) A population-based study of 159 registries including 8049 children and adolescents with thyroid cancer.[53]	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.[43]	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 56 349 patients admitted to a university hospital between 2007–2009.[54]	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.[45]	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.
Drivers of overdiagnosis and/or overuse of diagnostic and screening tests (n=27)	
Soares 2019 (Brazil) A nationwide population-based survey of 13 625 men older than 40 years.[55]	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.[30]	Four key drivers of malaria overdiagnosis identified: flawed training, peer pressure and professional norms, perceived patients' preferences, and limited quality diagnostic resources and support.
Consequences of overdiagnosis and/or overuse of diagnostic and screening tests (n=41)	
Kavosi 2021 (Iran) A cross-sectional study of 385 participants had undergone brain MRI in three public teaching hospitals.[56]	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.[57]	Malaria overdiagnosis was widely recognised in Sudan, with massive economic burden—estimated to be US$86 million in 2000.
Solutions for the problem of overdiagnosis and/or overuse of diagnostic and screening tests (n=14)	
Henao-Villada 2016 (Colombia) A before and after study of 1365 children with bronchiolitis to evaluate the impact of guideline implementation.[58]	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.[29]

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.[30 31] 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.[32] An anthropological study in Vietnam similarly identified financial return for doctors as a key driver of the overuse of ultrasound.[33] 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.[34] 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.[31] 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.[37 38] We also identified a small number of qualitative studies investigating drivers of these problems, essential for identifying effective strategies to reduce overdiagnosis and overuse.[34]

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.[59] 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.[60] 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.[38 61] While welcoming these positive public health impacts, some authors have identified 'unintended consequences'.[38 62] 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',[62] which has critical implications for another global issue, antibiotic resistance.[63 64]

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 healthcare expenditure may help reduce the overdiagnosis of thyroid cancer'.[35]

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,[36] 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.[37] 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.[38] 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.[39]

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.[40] 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.[41] 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.[42]

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,[43] and over 75% of men and women in China[25] 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.[23] 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[44] and China[45] 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.[30 32] 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,[46] cervical abnormalities,[47] appendicitis[48] and entamoeba histolytica,[49] 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[19] 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,[50 51] building such networks. And as flagged above, working with colleagues from LMICs, we intend to conduct a seperate 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,[14 15] and a recent World Bank report makes clear that providing 'high-quality health services' means minimising harm and waste.[52] 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,[2] 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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Contributors LA and RM conceived the idea and all the authors helped in the study design. LA, MA-Z, EA, HG, TP and RM assessed study eligibility and extracted data. LA and RM analysed the data and wrote the first draft of the manuscript. All authors contributed to the interpretation and subsequent edits of the manuscript. LA and RM had full access to all of the data in the study and takes responsibility for the data and the integrity of the study. LA is the guarantor.

Funding None specific for this study. LA is supported by by a research fellowship funded by the National Health and Medical Research Council (NHMRC Investigator grant, grant No 2008379). RM is supported by a research fellowship funded by the National Health and Medical Research Council (NHMRC, grant No 1124207) and a chief investigator on a Centre for Research Excellence (grant No 1104136) and have helped organise Preventing Overdiagnosis conferences. All other authors declare no competing interests.

Disclaimer The funders had no role in the design, conduct, reporting, or dissemination plans for this study.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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Supplementary Materials

Supplementary 1: Search strategy
Supplementary 2: Table S1. Detailed characteristics of all included studies

Supplementary 1: Search strategy

PubMed

("Medical Overuse"[Mesh] OR "Unnecessary Procedures"[Mesh] OR Overdiagnosis[tiab] OR "Over-diagnosis"[tiab] OR "Over diagnosis"[tiab] OR "Unnecessary Procedures"[tiab] OR Overtreating[tiab] OR Overtreatment[tiab] OR Overmedicalization[tiab] OR Overmedicalisation[tiab] OR ((Overuse[ti] OR Unnecessary[ti] OR Unwarranted[ti] OR Inappropriate[ti] OR De-implementation[tiab] OR Deimplementation[tiab]) AND (Medication[tiab] OR Therapeutic[tiab] OR Antibiotics[tiab] OR Operation[tiab] OR Operations[tiab] OR Medical[ti])))

AND

(Overdiagnosis[tiab] OR "Over-diagnosis"[tiab] OR "Over diagnosis"[tiab] OR ((Overuse[ti] OR Overtreatment[tiab]) AND (Tests[tiab] OR Test[tiab] OR Screening[tiab])) OR (("Diagnosis"[Mesh] OR "diagnosis"[sh] OR "diagnostic imaging"[sh] OR Diagnosis[tiab] OR Diagnostic[tiab] OR "Visual assessment"[tiab] OR "Visual assessment"[tiab]) AND ("Unnecessary Procedures"[Mesh] OR "Medical Overuse"[Mesh] OR Threshold[tiab] OR Thresholds[tiab] OR Overuse[tiab])))

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("Unnecessary Procedure"/exp OR Overdiagnosis:ti,ab OR Over-diagnosis:ti,ab OR "Over diagnosis":ti,ab OR "Unnecessary Procedures":ti,ab OR Overtreating:ti,ab OR Overtreatment:ti,ab OR Overmedicalization:ti,ab OR Overmedicalisation:ti,ab OR ((Overuse:ti OR Unnecessary:ti OR Unwarranted:ti OR Inappropriate:ti OR De-implementation:ti,ab OR Deimplementation:ti,ab) AND (Medication:ti,ab OR Therapeutic:ti,ab OR Antibiotics:ti,ab OR Operation:ti,ab OR Operations:ti,ab OR Medical:ti)))

AND

(Overdiagnosis:ti,ab OR Over-diagnosis:ti,ab OR "Over diagnosis":ti,ab OR ((Overuse:ti OR Overtreatment:ti,ab) AND (Tests:ti,ab OR Test:ti,ab OR Screening:ti,ab)) OR ((Diagnosis/exp OR Diagnosis:ti,ab OR Diagnostic:ti,ab OR "Visual assessment":ti,ab OR "Visual assessment":ti,ab) AND ("Unnecessary Procedure"/exp OR Threshold:ti,ab OR Thresholds:ti,ab OR Overuse:ti,ab)))

AND

(afghanistan OR albania OR algeria OR "american samoa" OR angola OR antigua OR barbuda OR argentina OR armenia OR armenian OR aruba OR azerbaijan OR bahrain OR bangladesh OR barbados OR belarus OR byelarus OR belorussia OR byelorussian OR belize OR "british honduras" OR benin OR dahomey OR bhutan OR bolivia OR bosnia OR herzegovina OR botswana OR bechuanaland OR brazil OR brasil OR bulgaria OR "burkina faso" OR "burkina fasso" OR "upper volta" OR burundi OR urundi OR "cabo verde" OR "cape verde" OR cambodia OR kampuchea OR "khmer republic" OR cameroon OR cameron OR cameroun OR "central african republic" OR "ubangi shari" OR chad OR chile OR china OR colombia OR comoros OR "comoro islands" OR mayotte OR congo OR zaire OR "costa rica" OR "cote divoire" OR "cote d ivoire" OR "cote divoire" OR "cote d ivoire" OR "ivory coast" OR croatia OR cuba OR cyprus OR "czech republic" OR czechoslovakia OR djibouti OR "french somaliland" OR dominica OR "dominican republic" OR ecuador OR egypt OR "united arab republic" OR "el salvador" OR "equatorial guinea" OR "spanish guinea" OR eritrea OR estonia OR eswatini OR swaziland OR ethiopia OR fiji OR gabon OR "gabonese republic" OR gambia OR

georgia OR georgian OR ghana OR "gold coast" OR gibraltar OR greece OR grenada OR guam OR guatemala OR guinea OR guyana OR guiana OR haiti OR hispaniola OR honduras OR hungary OR india OR indonesia OR timor OR iran OR iraq OR "isle of man" OR jamaica OR jordan OR kazakhstan OR kazakh OR kenya OR korea OR kosovo OR kyrgyzstan OR kirghizia OR kirgizstan OR "kyrgyz republic" OR kirghiz OR laos OR "lao pdr" OR "lao peoples democratic republic" OR latvia OR lebanon OR lesotho OR basutoland OR liberia OR libya OR "libyan arab jamahiriya" OR lithuania OR macau OR macao OR macedonia OR madagascar OR "malagasy republic" OR malawi OR nyasaland OR malaysia OR maldives OR "indian ocean" OR mali OR malta OR micronesia OR kiribati OR "marshall islands" OR nauru OR "northern mariana islands" OR palau OR tuvalu OR mauritania OR mauritius OR mexico OR moldova OR moldovian OR mongolia OR montenegro OR morocco OR ifni OR mozambique OR "portuguese east africa" OR myanmar OR burma OR namibia OR nepal OR "netherlands antilles" OR nicaragua OR niger OR nigeria OR oman OR muscat OR pakistan OR panama OR "papua new guinea" OR paraguay OR peru OR philippines OR philipines OR phillipines OR phillippines OR poland OR "polish peoples republic" OR portugal OR "portuguese republic" OR "puerto rico" OR romania OR russia OR "russian federation" OR ussr OR "soviet union" OR "union of soviet socialist republics" OR rwanda OR ruanda OR samoa OR "pacific islands" OR polynesia OR "samoan islands" OR "sao tome" AND principe OR "saudi arabia" OR senegal OR serbia OR seychelles OR "sierra leone" OR slovakia OR "slovak republic" OR slovenia OR melanesia OR "solomon island" OR "solomon islands" OR "norfolk island" OR somalia OR "south africa" OR "south sudan" OR "sri lanka" OR ceylon OR "saint kitts" AND nevis OR "st kitts" AND nevis OR "saint lucia" OR "st lucia" OR "saint vincent" OR "st vincent" OR grenadines OR sudan OR suriname OR surinam OR syria OR "syrian arab republic" OR tajikistan OR tadjikistan OR tadzhikistan OR tadzhik OR tanzania OR tanganyika OR thailand OR siam OR "timor leste" OR "east timor" OR togo OR "togolese republic" OR tonga OR trinidad OR tobago OR tunisia OR turkey OR turkmenistan OR turkmen OR uganda OR ukraine OR uruguay OR uzbekistan OR uzbek OR vanuatu OR "new hebrides" OR venezuela OR vietnam OR "viet nam" OR "middle east" OR "west bank" OR gaza OR palestine OR yemen OR yugoslavia OR zambia OR zimbabwe OR "northern rhodesia" OR "global south" OR "africa south of the sahara" OR "sub saharan africa" OR "subsaharan africa" OR "central africa" OR "north africa" OR "northern africa" OR magreb OR maghrib OR sahara OR "southern africa" OR "east africa" OR "eastern africa" OR "west africa" OR "western africa" OR "west indies" OR "indian ocean islands" OR caribbean OR "central america" OR "latin america" OR "south america" OR "central asia" OR "north asia" OR "northern asia" OR "southeastern asia" OR "south eastern asia" OR "southeast asia" OR "south east asia" OR "western asia" OR "east europe" OR "eastern europe" OR "developing country" OR "developing countries" OR "developing nation" OR "developing nations" OR "developing population" OR "developing populations" OR "developing world" OR "less developed country" OR "less developed countries" OR "less developed nation" OR "less developed nations" OR "less developed world" OR "lesser developed countries" OR "lesser developed nations" OR "under developed country" OR "under developed countries" OR "under developed nations" OR "under developed world" OR "underdeveloped country" OR "underdeveloped countries" OR "underdeveloped nation" OR "underdeveloped nations" OR "underdeveloped population" OR "underdeveloped populations" OR "underdeveloped world" OR "middle income country" OR "middle income countries" OR "middle income nation" OR "middle income nations" OR "middle income population" OR "middle income populations" OR "low income country" OR "low income countries" OR "low income nation" OR "low income nations" OR "low income population" OR "low income populations" OR "lower income country" OR "lower income countries" OR "lower income nations" OR "lower income population" OR "lower income populations" OR "underserved countries" OR "underserved nations" OR "underserved population" OR "underserved populations" OR "under served population" OR "under served populations" OR "deprived countries" OR "deprived population" OR "deprived populations" OR "poor country" OR "poor countries" OR "poor nation" OR "poor nations" OR "poor population" OR "poor populations" OR "poor world" OR "poorer countries" OR "poorer nations" OR "poorer population" OR "poorer populations" OR "developing economy" OR "developing economies" OR "less developed economy" OR "less developed economies" OR "underdeveloped economies" OR "middle income economy" OR "middle income economies" OR "low income economy" OR "low income economies" OR "lower income economies" OR

"low gdp" OR "low gnp" OR "low gross domestic" OR "low gross national" OR "lower gdp" OR "lower gross domestic" OR lmic OR lmics OR "third world" OR "lami country" OR "lami countries" OR "transitional country" OR "transitional countries" OR "emerging economies" OR "emerging nation" OR "emerging nations")

PsycINFO

(Overdiagnosis.ti,ab. OR Over-diagnosis.ti,ab. OR "Over diagnosis".ti,ab. OR ((Overuse.ti. OR Overtreatment.ti,ab.) AND (Tests.ti,ab. OR Test.ti,ab. OR Screening.ti,ab.)) OR ((exp Diagnosis/ OR "Diagnosis" OR "Diagnostic Imaging" OR Diagnosis.ti,ab. OR Diagnostic.ti,ab. OR "Visual assessment".ti,ab. OR "Visual assessment".ti,ab.) AND (Thresholds.ti,ab. OR Overuse.ti,ab.)))

AND

(afghanistan.mp. OR albania.mp. OR algeria.mp. OR "american samoa".mp. OR angola.mp. OR antigua.mp. OR barbuda.mp. OR argentina.mp. OR armenia.mp. OR armenian.mp. OR aruba.mp. OR azerbaijan.mp. OR bahrain.mp. OR bangladesh.mp. OR barbados.mp. OR belarus.mp. OR byelarus.mp. OR belorussia.mp. OR byelorussian.mp. OR belize.mp. OR "british honduras".mp. OR benin.mp. OR dahomey.mp. OR bhutan.mp. OR bolivia.mp. OR bosnia.mp. OR herzegovina.mp. OR botswana.mp. OR bechuanaland.mp. OR brazil.mp. OR brasil.mp. OR bulgaria.mp. OR "burkina faso".mp. OR "burkina fasso".mp. OR "upper volta".mp. OR burundi.mp. OR urundi.mp. OR "cabo verde".mp. OR "cape verde".mp. OR cambodia.mp. OR kampuchea.mp. OR "khmer republic".mp. OR cameroon.mp. OR cameron.mp. OR cameroun.mp. OR "central african republic".mp. OR "ubangi shari".mp. OR chad.mp. OR chile.mp. OR china.mp. OR colombia.mp. OR comoros.mp. OR "comoro islands".mp. OR mayotte.mp. OR congo.mp. OR zaire.mp. OR "costa rica".mp. OR "cote d'ivoire".mp. OR "cote d' ivoire".mp. OR "cote divoire".mp. OR "cote d ivoire".mp. OR "ivory coast".mp. OR croatia.mp. OR cuba.mp. OR cyprus.mp. OR "czech republic".mp. OR czechoslovakia.mp. OR djibouti.mp. OR "french somaliland".mp. OR dominica.mp. OR "dominican republic".mp. OR ecuador.mp. OR egypt.mp. OR "united arab republic".mp. OR "el salvador".mp. OR "equatorial guinea".mp. OR "spanish guinea".mp. OR eritrea.mp. OR estonia.mp. OR eswatini.mp. OR swaziland.mp. OR ethiopia.mp. OR fiji.mp. OR gabon.mp. OR "gabonese republic".mp. OR gambia.mp. OR georgia.mp. OR georgian.mp. OR ghana.mp. OR "gold coast".mp. OR gibraltar.mp. OR greece.mp. OR grenada.mp. OR guam.mp. OR guatemala.mp. OR guinea.mp. OR guyana.mp. OR guiana.mp. OR haiti.mp. OR hispaniola.mp. OR honduras.mp. OR hungary.mp. OR india.mp. OR indonesia.mp. OR timor.mp. OR iran.mp. OR iraq.mp. OR "isle of man".mp. OR jamaica.mp. OR jordan.mp. OR kazakhstan.mp. OR kazakh.mp. OR kenya.mp. OR korea.mp. OR kosovo.mp. OR kyrgyzstan.mp. OR kirghizia.mp. OR kirgizstan.mp. OR "kyrgyz republic".mp. OR kirghiz.mp. OR laos.mp. OR "lao pdr".mp. OR "lao people's democratic republic".mp. OR latvia.mp. OR lebanon.mp. OR lesotho.mp. OR basutoland.mp. OR liberia.mp. OR libya.mp. OR "libyan arab jamahiriya".mp. OR lithuania.mp. OR macau.mp. OR macao.mp. OR macedonia.mp. OR madagascar.mp. OR "malagasy republic".mp. OR malawi.mp. OR nyasaland.mp. OR malaysia.mp. OR maldives.mp. OR "indian ocean".mp. OR mali.mp. OR malta.mp. OR micronesia.mp. OR kiribati.mp. OR "marshall islands".mp. OR nauru.mp. OR "northern mariana islands".mp. OR palau.mp. OR tuvalu.mp. OR mauritania.mp. OR mauritius.mp. OR mexico.mp. OR moldova.mp. OR moldovian.mp. OR mongolia.mp. OR montenegro.mp. OR morocco.mp. OR ifni.mp. OR mozambique.mp. OR "portuguese east africa".mp. OR myanmar.mp. OR burma.mp. OR namibia.mp. OR nepal.mp. OR "netherlands antilles".mp. OR nicaragua.mp. OR niger.mp. OR nigeria.mp. OR oman.mp. OR muscat.mp. OR pakistan.mp. OR panama.mp. OR "papua new guinea".mp. OR paraguay.mp. OR peru.mp. OR philippines.mp. OR philipines.mp. OR phillipines.mp. OR phillippines.mp. OR poland.mp. OR "polish people's republic".mp. OR portugal.mp. OR "portuguese republic".mp. OR "puerto rico".mp. OR romania.mp. OR russia.mp. OR "russian federation".mp. OR ussr.mp. OR "soviet union".mp. OR "union of soviet socialist republics".mp. OR rwanda.mp. OR ruanda.mp. OR samoa.mp. OR "pacific islands".mp. OR polynesia.mp. OR "samoan islands".mp. OR "sao tome" AND principe.mp. OR "saudi arabia".mp. OR senegal.mp. OR serbia.mp. OR seychelles.mp. OR "sierra leone".mp. OR slovakia.mp. OR "slovak republic".mp. OR slovenia.mp. OR melanesia.mp. OR "solomon island".mp. OR "solomon islands".mp. OR "norfolk island".mp. OR

somalia.mp. OR "south africa".mp. OR "south sudan".mp. OR "sri lanka".mp. OR ceylon.mp. OR "saint kitts" AND nevis.mp. OR "st kitts" AND nevis.mp. OR "saint lucia".mp. OR "st lucia".mp. OR "saint vincent".mp. OR "st vincent".mp. OR grenadines.mp. OR sudan.mp. OR suriname.mp. OR surinam.mp. OR syria.mp. OR "syrian arab republic".mp. OR tajikistan.mp. OR tadjikistan.mp. OR tadzhikistan.mp. OR tadzhik.mp. OR tanzania.mp. OR tanganyika.mp. OR thailand.mp. OR siam.mp. OR "timor leste".mp. OR "east timor".mp. OR togo.mp. OR "togolese republic".mp. OR tonga.mp. OR trinidad.mp. OR tobago.mp. OR tunisia.mp. OR turkey.mp. OR turkmenistan.mp. OR turkmen.mp. OR uganda.mp. OR ukraine.mp. OR uruguay.mp. OR uzbekistan.mp. OR uzbek.mp. OR vanuatu.mp. OR "new hebrides".mp. OR venezuela.mp. OR vietnam.mp. OR "viet nam".mp. OR "middle east".mp. OR "west bank".mp. OR gaza.mp. OR palestine.mp. OR yemen.mp. OR yugoslavia.mp. OR zambia.mp. OR zimbabwe.mp. OR "northern rhodesia".mp. OR "global south".mp. OR "africa south of the sahara".mp. OR "sub saharan africa".mp. OR "subsaharan africa".mp. OR "central africa".mp. OR "north africa".mp. OR "northern africa".mp. OR magreb.mp. OR maghrib.mp. OR sahara.mp. OR "southern africa".mp. OR "east africa".mp. OR "eastern africa".mp. OR "west africa".mp. OR "western africa".mp. OR "west indies".mp. OR "indian ocean islands".mp. OR caribbean.mp. OR "central america".mp. OR "latin america".mp. OR "south america".mp. OR "central asia".mp. OR "north asia".mp. OR "northern asia".mp. OR "southeastern asia".mp. OR "south eastern asia".mp. OR "southeast asia".mp. OR "south east asia".mp. OR "western asia".mp. OR "east europe".mp. OR "eastern europe".mp. OR "developing country".mp. OR "developing countries".mp. OR "developing nation".mp. OR "developing nations".mp. OR "developing population".mp. OR "developing populations".mp. OR "developing world".mp. OR "less developed country".mp. OR "less developed countries".mp. OR "less developed nation".mp. OR "less developed nations".mp. OR "less developed world".mp. OR "lesser developed countries".mp. OR "lesser developed nations".mp. OR "under developed country".mp. OR "under developed countries".mp. OR "under developed nations".mp. OR "under developed world".mp. OR "underdeveloped country".mp. OR "underdeveloped countries".mp. OR "underdeveloped nation".mp. OR "underdeveloped nations".mp. OR "underdeveloped population".mp. OR "underdeveloped populations".mp. OR "underdeveloped world".mp. OR "middle income country".mp. OR "middle income countries".mp. OR "middle income nation".mp. OR "middle income nations".mp. OR "middle income population".mp. OR "middle income populations".mp. OR "low income country".mp. OR "low income countries".mp. OR "low income nation".mp. OR "low income nations".mp. OR "low income population".mp. OR "low income populations".mp. OR "lower income country".mp. OR "lower income countries".mp. OR "lower income nations".mp. OR "lower income population".mp. OR "lower income populations".mp. OR "underserved countries".mp. OR "underserved nations".mp. OR "underserved population".mp. OR "underserved populations".mp. OR "under served population".mp. OR "under served populations".mp. OR "deprived countries".mp. OR "deprived population".mp. OR "deprived populations".mp. OR "poor country".mp. OR "poor countries".mp. OR "poor nation".mp. OR "poor nations".mp. OR "poor population".mp. OR "poor populations".mp. OR "poor world".mp. OR "poorer countries".mp. OR "poorer nations".mp. OR "poorer population".mp. OR "poorer populations".mp. OR "developing economy".mp. OR "developing economies".mp. OR "less developed economy".mp. OR "less developed economies".mp. OR "underdeveloped economies".mp. OR "middle income economy".mp. OR "middle income economies".mp. OR "low income economy".mp. OR "low income economies".mp. OR "lower income economies".mp. OR "low gdp".mp. OR "low gnp".mp. OR "low gross domestic".mp. OR "low gross national".mp. OR "lower gdp".mp. OR "lower gross domestic".mp. OR lmic.mp. OR lmics.mp. OR "third world".mp. OR "lami country".mp. OR "lami countries".mp. OR "transitional country".mp. OR "transitional countries".mp. OR "emerging economies".mp. OR "emerging nation".mp. OR "emerging nations".mp.)

Global Index Medicus (WPRIM (Western Pacific); LILACS (Americas); IMSEAR (South-East Asia); IMEMR (Eastern Mediterranean); AIM (Africa))

(“Medical Overuse” OR “Unnecessary Procedures” OR Overdiagnosis OR “Over diagnosis” OR “Unnecessary Procedures” OR Overtreating OR Overtreatment OR Overmedicalisation OR Overmedicalisation OR

((Overuse OR Unnecessary OR Unwarranted OR Inappropriate OR De-implementation OR Deimplementation) AND (Medication OR Therapeutic OR Antibiotics OR Operation OR Operations OR Medical)))
AND
(Overdiagnosis OR Over-diagnosis OR "Over diagnosis" OR ((Overuse OR Overtreatment) AND (Tests OR Test OR Screening)) OR ((Diagnosis OR "Diagnosis" OR "Diagnostic Imaging" OR Diagnosis OR Diagnostic OR "Visual assessment" OR "Visual assessment") AND ("Unnecessary Procedures" OR "Medical Overuse" OR Threshold OR Thresholds OR Overuse)))

Supplementary 2: Table S1. Detailed characteristics of all included studies

Table S1. Characteristics of included studies in the scoping review (n=129)

Author, Year Country, Income level	Title, Journal	Study design, Analysis approach, Sample size	Condition, Diagnostic or screening Test,	Main context, Main theme, financial implications
Ahmadi K et al 2014 Iran, Upper middle income	Impact of intravenous acetaminophen therapy on the necessity of cervical spine imaging in patients with cervical spine trauma Chin J Traumatol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1309)	Condition: Trauma Test: Imaging - CT, X-ray	Overuse of tests Potential Solutions Financial Impact: No
Alimoglu O et al 2020 Turkey, Upper middle income	Do all detected thyroid cancers correspond to 'real cancer'? Br J Surg	Observational e.g. cohort or cross-sectional studies Quantitative (n= 335)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Almenas M et al 2018 Latin America,	Prevención cuaternaria: como hacer, como ensiñar Rev bras med fam comunidade	Observational e.g. cohort or cross-sectional studies Mixed (n= 309)	Condition: N/A Test: N/A	Both Potential Solutions Financial Impact:

Alpay Ozbek O et al 2007 Turkey, Upper middle income	[Unnecessary test repeats in viral hepatitis serology] Mikrobiyol Bul	Observational e.g. cohort or cross-sectional studies Quantitative (n= 23705)	Condition: Infectious Test: Pathology - Hepatitis	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Al-Selwi K 2009 Yemen, Low income	Overdiagnosis of malaria among the health services providers in Hodeida-Yemen Giornale Italiano di Medicina Tropicale	Observational e.g. cohort or cross-sectional studies Qualitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact:
Ameyaw E et al 2014 Ghana, Lower middle income	The outcome of a test-treat package versus routine outpatient care for Ghanaian children with fever: a pragmatic randomized control trial Malar J	Interventional e.g. randomised trial Quantitative (n= 240)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact:
Ansah EK et al 2015 Ghana, Lower middle income	The impact of providing rapid diagnostic malaria tests on fever management in the private retail sector in Ghana: a cluster randomized trial BMJ	Interventional e.g. randomised trial Quantitative (n= 4603)	Condition: Infectious Test: N/A	Both Potential Solutions Financial Impact: No

Arena TR et al 2014 Brazil, Upper middle income	[Spending with unnecessary complementary tests for hypertension and diabetes in health services] Rev Gaucha Enferm	Observational e.g. cohort or cross-sectional studies Quantitative (n= 293)	Condition: CVD Test: N/A	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Aroonpruksakul N et al 2015 Thailand, Upper middle income	The prevalence of inappropriate blood tests in pediatric patients scheduled for elective surgery in Thailand: A retrospective chart review Asian Biomedicine	Observational e.g. cohort or cross-sectional studies Quantitative (n= 285)	Condition: N/A Test: Pathology - Pre-operative tests	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Aske H et al 2015 Cameroon, Lower middle income	Febrile Illness and Intravenous Antimalarial Treatment at a District Hospital in Cameroon West Afr J Med	Observational e.g. cohort or cross-sectional studies Quantitative (n= 91)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Attard SM et al 2015 China, Upper middle income	Implications of iron deficiency/anemia on the classification of diabetes using HbA1c Nutr Diabetes	Observational e.g. cohort or cross-sectional studies Quantitative (n= 7308)	Condition: Diabetes Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No

Aydoğdu M et al 2014 Turkey, Upper middle income	Wells score and pulmonary embolism rule out criteria in preventing over investigation of pulmonary embolism in emergency departments Tuberkuloz ve Toraks	Observational e.g. cohort or cross-sectional studies Quantitative (n= 108)	Condition: CVD Test: Imaging - CT & US	Overuse of tests Potential Solutions Financial Impact: Yes
Bhattacharyya A et al 2012 India, Lower middle income	A Comparative Study of the Management Decisions by IMNCI Algorithm and by Pediatricians of a Teaching Hospital for the Children Between 2 Months to 5 Years Indian J Community Med	Observational e.g. cohort or cross-sectional studies Quantitative (n= 131)	Condition: Infectious Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Bohara TP et al 2018 Nepal, Lower middle income	Appropriateness of Indications of Upper Gastrointestinal Endoscopy and its Association With Positive Finding JNMA J Nepal Med Assoc	Observational e.g. cohort or cross-sectional studies Quantitative (n= 79)	Condition: N/A Test: Procedure - GI Endoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Borges A et al 2018 Colombia, Costa Rica, Brazil, Ecuador,	Thyroid Cancer Incidences From Selected South America Population-Based Cancer Registries: An Age-Period-Cohort Study J Glob Oncol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 7889)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No

Bruxvoort K et al 2011 Tanzania, Lower middle income	Over and under-use of artemisinin based combination therapy at public health facilities in three regions of Tanzania Am J Trop Med Hyg	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1779)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact:
Buendía JA et al 2020 Colombia, Upper middle income	A predictive model of inappropriate use of medical tests and medications in Bronchiolitis Pan Afr Med J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1930)	Condition: Lung Test: Pathology and Imaging	Overuse of tests Drivers and factors related to OD or overuse of tests Financial Impact: Yes
Caliskan E et al 2004 Turkey, Upper middle income	A population-based risk factor scoring will decrease unnecessary testing for the diagnosis of gestational diabetes mellitus Acta Obstet Gynecol Scand	Observational e.g. cohort or cross-sectional studies Quantitative (n= 425)	Condition: Diabetes Test: N/A	Overdiagnosis Potential Solutions Financial Impact: Yes
Chan TH et al 2006 Malaysia, Upper middle income	Appropriateness of colonoscopy using the ASGE guidelines: experience in a large Asian hospital Chin J Dig Dis	Observational e.g. cohort or cross-sectional studies Quantitative (n= 380)	Condition: N/A Test: Procedure - GI Endoscopy, colonoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Chandler CI et al 2008 Tanzania, Lower middle income	Malaria overdiagnosis: is patient pressure the problem? Health Policy Plan	Observational e.g. cohort or cross-sectional studies Qualitative (n= 669)	Condition: Infectious Test: Pathology	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No

Chandler CI et al 2014 Tanzania, Lower middle income	The development of effective behaviour change interventions to support the use of malaria rapid diagnostic tests by Tanzanian clinicians Implement Sci	Observational e.g. cohort or cross-sectional studies Qualitative (n= 231)	Condition: Infectious Test: N/A	Both Potential Solutions Financial Impact: No
Chandler CI et al 2008 Tanzania, Lower middle income	Guidelines and mindlines: why do clinical staff over-diagnose malaria in Tanzania? A qualitative study Malar J	Observational e.g. cohort or cross-sectional studies Qualitative (n= 34)	Condition: Infectious Test: N/A	Both Drivers and factors related to OD or overuse of tests Financial Impact: No
Chipwaza B et al 2014 Tanzania, Lower middle income	Community knowledge and attitudes and health workers' practices regarding non-malaria febrile illnesses in eastern Tanzania PLoS Negl Trop Dis	Observational e.g. cohort or cross-sectional studies Qualitative (n= 107)	Condition: Infectious Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No
Cui Y et al 2021 China, Upper middle income	Trend dynamics of thyroid cancer incidence among China and the U.S. adult population from 1990 to 2017: a joinpoint and age-period-cohort analysis BMC Public Health	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
D'Acremont V et al 2011 Tanzania, Lower middle income	Reduction of anti-malarial consumption after rapid diagnostic tests implementation in Dar es Salaam: a before-after and cluster randomized controlled study Malar J	Interventional e.g. randomised trial Quantitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Dai S, Huang B, Zou Y, Guo J, Liu Z, Pi D, et al 2018 China, Upper middle income	The HEART score is useful to predict cardiovascular risks and reduces unnecessary cardiac imaging in low-risk patients with acute chest pain Medicine (Baltimore)	Observational e.g. cohort or cross-sectional studies Quantitative (n= 244)	Condition: CVD Test: N/A	Overuse of tests Potential Solutions Financial Impact: No
Dejsomritrutai W et al 2016 Thailand, Upper middle income	Impact of GLI-2012 spirometric references and lower limit of normal on prevalence of COPD in older urban Thai persons Journal of the Medical Association of Thailand	Observational e.g. cohort or cross-sectional studies Qualitative (n= 3094)	Condition: Lung Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Demir S et al 2016 Turkey, Upper middle income	Unnecessary repeated total cholesterol tests in biochemistry laboratory Biochemia Medica	Observational e.g. cohort or cross-sectional studies Quantitative (n= 86817)	Condition: N/A Test: Pathology	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Esteban S et al 2017 Argentina, Upper middle income	Colonoscopy overuse in colorectal cancer screening and associated factors in Argentina: a retrospective cohort study BMC Gastroenterol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 389)	Condition: Cancer Test: Procedure - GI Endoscopy, colonoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Faust C et al 2015 Senegal, Lower middle income	Assessing drivers of full adoption of test and treat policy for malaria in Senegal Am J Trop Med Hyg	Observational e.g. cohort or cross-sectional studies Quantitative (n= 28527)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Fehintola FA et al 2010 Nigeria , Lower middle income	Malaria: passive case detection and healthcare providers' choices of chemotherapy Afr J Med Med Sci	Observational e.g. cohort or cross-sectional studies Quantitative (n= 630)	Condition: Infectious Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Floriani ID, Borgmann AV, Barreto MR, Ribeiro ER 2022 China, Turkey,	Exposure of pediatric emergency patients to imaging exams, nowadays and in times of covid-19: an integrative review Rev Paul Pediatr (Ed Port, Online)	Review Qualitative (n= N/A)	Condition: Trauma Test: Imaging - CT, X-ray, US	Overuse of tests Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Ganiele MdlN et al 2016 Argentina, Upper middle income	Excesivo rastreo de osteoporosis en mujeres menores de 65 años: estudio de corte transversal Salud colect	Observational e.g. cohort or cross-sectional studies Quantitative (n= 4310)	Condition: Diabetes Test: Imaging	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Genç O et al 2014 Turkey, Upper middle income	[Inappropriate use of serological tests for hepatitis B virus in Evliya Celebi Education and Research Hospital of Dumlupinar University, Kütahya] Mikrobiyol Bul	Observational e.g. cohort or cross-sectional studies Qualitative (n= 179640)	Condition: Infectious Test: Pathology - Hepatitis	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Y

Georgakis MK et al 2018 11 countries (Belarus, Croatia, Cyprus,Greece, Malta, Poland, Portugal, Romania, Slovenia, Turkey,Ukraine),	Neuroblastoma among children in Southern and Eastern European cancer registries: Variations in incidence and temporal trends compared to US Int J Cancer	Review Quantitative (n= 1859)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Gómez-Landeros O et al 2020 Mexico, Upper middle income	[Radio-diagnostic congruence improvement in a first-level unit] Rev Med Inst Mex Seguro Soc	Interventional e.g. randomised trial Quantitative (n= N/A)	Condition: N/A Test: Imaging	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Gonzaga MA, Kiguli-Malwadde E, Businge F, Byanyima RK 2010 Uganda, Low income	Utilisation of obstetric sonography at a peri-urban health centre in Uganda Pan Afr Med J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 105)	Condition: N/A Test: Imaging - US	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Goonetilleke MPB et al 2013 Sri Lanka, Lower middle income	An audit on the outcome of children referred to the paediatric cardiology unit with a previous echocardiographic diagnosis of mitral valve prolapse	Observational e.g. cohort or cross-sectional studies Qualitative (n= 141)	Condition: CVD Test: Imaging - Echo	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Günaşti S et al 2010 Turkey, Upper middle income	Evaluation of a guideline for etiological diagnosis of chronic urticaria Turkiye Klinikleri Journal of Medical Sciences	Observational e.g. cohort or cross-sectional studies Quantitative (n= 903)	Condition: Others Test: N/A	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No

Hajeer MH et al 2018 Jordan, Upper middle income	The rising trend in papillary thyroid carcinoma. True increase or over diagnosis? Saudi Med J	Review Quantitative (n= 313)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Hamer DH et al 2007 Zambia, Lower middle income	Improved diagnostic testing and malaria treatment practices in Zambia JAMA	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1717)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Harchut K et al 2013 Tanzania, Lower middle income	Over-diagnosis of malaria by microscopy in the Kilombero Valley, Southern Tanzania: an evaluation of the utility and cost-effectiveness of rapid diagnostic tests Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 9575)	Condition: Infectious Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Harutyunyan V 2010 Tanzania, Lower middle income	Quality assurance of malaria rapid diagnostic tests (RDT) and its implication for clinical management of malaria Am J Trop Med Hyg	Diagnostic Test Accuracy Mixed (n= 513)	Condition: Infectious Test: N/A	Overdiagnosis Potential Solutions Financial Impact:
Hawkes S et al 1999 Banglasdesh , Lower middle income	Reproductive-tract infections in women in low-income, low-prevalence situations: assessment of syndromic management in Matlab, Bangladesh Lancet	Observational e.g. cohort or cross-sectional studies Quantitative (n= 465)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes

He AJ 2014 China, Upper middle income	The doctor-patient relationship, defensive medicine and overprescription in Chinese public hospitals: evidence from a cross-sectional survey in Shenzhen city Soc Sci Med	Observational e.g. cohort or cross-sectional studies Qualitative (n= 504)	Condition: N/A Test: N/A	Overuse of tests Drivers and factors related to OD or overuse of tests Financial Impact: No
Henao-Villada R et al 2016 Colombia, Upper middle income	Impact of the implementation of an evidence-based guideline on diagnostic testing, management, and clinical outcomes for infants with bronchiolitis Ther Adv Respir Dis	Interventional e.g. randomised trial Quantitative (n= 1365)	Condition: Lung Test: N/A	Overuse of tests Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact:
Ho T, Cusack RP, Chaudhary N, Satia I, Kurmi OP 2019 Africa (Uganda, Nigeria, Malawi, Cameroon); Central and South America (Peru, Mexico, Brazil, Colombia); South-East Asia (China, Vietnam, Malaysia, Thailand, Indonesia, Philippines, Taiwan *Note there are also HIC reported from SEA region),	Under- and over-diagnosis of COPD: a global perspective Breathe (Sheff)	Review Unclear (n= N/A)	Condition: Lung Test: Procedure - Spirometry	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No

Hu XF et al 2017 China, Upper middle income	[The impact of broadened diagnostic criteria on the prevalence of hypertension, hyperlipidemia and diabetes mellitus in China] Zhonghua Yu Fang Yi Xue Za Zhi	Observational e.g. cohort or cross-sectional studies Quantitative (n= 154067)	Condition: CVD Test: N/A	Overdiagnosis Impact of expanding disease definitions and thresholds Financial Impact: Yes
Hume JC et al 2008 Mozambique, Low income	Household cost of malaria overdiagnosis in rural Mozambique Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 535)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Ishengoma DS et al 2011 Tanzania, Lower middle income	Declining burden of malaria in a rural community in Muheza district northeastern Tanzania over a period of 18 years (1992-2010) and its impact on antimalarial prescription Am J Trop Med Hyg	Observational e.g. cohort or cross-sectional studies Quantitative (n= 5755)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Ishengoma DS et al 2011 Tanzania, Lower middle income	Accuracy of malaria rapid diagnostic tests in community studies and their impact on treatment of malaria in an area with declining malaria burden in north-eastern Tanzania Malar J	Diagnostic Test Accuracy Quantitative (n= 23793)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Janovsky C et al 2018 Brazil, Upper middle income	Thyroid cancer burden and economic impact on the Brazilian public health system Arch Endocrinol Metab	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Javed H et al 2019 Pakistan, Lower middle income	Increased trend of unnecessary use of radiological diagnostic modalities in Pakistan: radiologists perspective Int J Qual Health Care	Observational e.g. cohort or cross-sectional studies Qualitative (n= 105)	Condition: N/A Test: Imaging	Overuse of tests Drivers and factors related to OD or overuse of tests Financial Impact: No
Kahama-Maro J et al 2011 Tanzania, Lower middle income	Low quality of routine microscopy for malaria at different levels of the health system in Dar es Salaam Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 20386)	Condition: Infectious Test: N/A	Overdiagnosis Potential Solutions Financial Impact: No

Kamolratanapiboon K et al 2019 Thailand, Upper middle income	Inappropriate use of D-dimer and impact on the test characteristics for deep vein thrombosis exclusion Scand J Clin Lab Invest	Observational e.g. cohort or cross-sectional studies quantitative (n= 300)	Condition: CVD Test: Pathology - D-dimer	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact:
Kaur S, Singh V, Dutta AK, Chandra J 2011 India, Lower middle income	Validation of IMNCI algorithm for young infants (0-2 months) in India Indian J Pediatr	Observational e.g. cohort or cross-sectional studies Quantitative (n= 419)	Condition: Infectious Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:
Kavosi Z et al 2021 Iran, Upper middle income	The inappropriateness of brain MRI prescriptions: a study from Iran Cost Eff Resour Alloc	Observational e.g. cohort or cross-sectional studies Qualitative (n= 385)	Condition: N/A Test: Imaging - MRI	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Y
Kılınçarslan MG et al 2019 Turkey, Upper middle income	Prevalence and associated factors of inappropriate repeat test Postgrad Med J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 673794)	Condition: N/A Test: Pathology	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Kumar N et al 2011 Kenya, Lower middle income	Educational needs and causes of false diagnosis of atypical squamous cells of unknown significance at a university hospital African Journal of Reproductive Health	Observational e.g. cohort or cross-sectional studies Unclear (n= 6500)	Condition: Cancer Test: Procedure - Pap smear	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact:

Lee WS et al 2013 Malaysia, Upper middle income	Appropriateness, endoscopic findings and contributive yield of pediatric gastrointestinal endoscopy World J Gastroenterol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 301)	Condition: N/A Test: Procedure - GI Endoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Leslie T et al 2017 Afghanistan, Low income	Use of malaria rapid diagnostic tests by community health workers in Afghanistan: cluster randomised trial BMC Med	Interventional e.g. randomised trial Quantitative (n= 2400)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Leslie T et al 2012 Afghanistan, Low income	Overdiagnosis and mistreatment of malaria among febrile patients at primary healthcare level in Afghanistan: observational study BMJ	Observational e.g. cohort or cross-sectional studies Quantitative (n= 2381)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Li M et al 2021 China, Upper middle income	Mapping overdiagnosis of thyroid cancer in China Lancet Diabetes Endocrinol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 27842)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Li R et al 2020 China, Upper middle income	A rapidly increasing trend of thyroid cancer incidence in selected East Asian countries: Joinpoint regression and age-period-cohort analyses Gland Surg	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact:

Lortet-Tieulent J et al 2019 Ecuador, Thailand, Algeria, Argentina, Brazil, China, India, Turkey, Costa Rica, Belarus, Colombia, Peru, Uruguay, Vietnam, Philippines, Chile, Ukraine, Russia, Jordan, Zimbabwe, Kenya, Malaysia, Iran, Uganda,	Thyroid cancer "epidemic" also occurs in low- and middle-income countries Int J Cancer	Observational e.g. cohort or cross-sectional studies Quantitative (n= 599851)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
M F et al 2005 Iran, Upper middle income	[Identification and prediction of overdiagnosis of dystocia]	Observational e.g. cohort or cross-sectional studies Qualitative (n= 248)	Condition: Trauma Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No
Mamova A et al 2017 Kenya, Lower middle income	Misdiagnosing of malaria as RTI decreased after introduction of RDTs in rural areas of Kenya Neuro Endocrinol Lett	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact:
Manguin S et al 2017 Angola, Lower middle income	Malaria overdiagnosis and subsequent overconsumption of antimalarial drugs in Angola: Consequences and effects on	Observational e.g. cohort or cross-sectional studies Quantitative (n= 724)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or

	human health Acta Trop			Overuse of tests Financial Impact: No
Masanja IM et al 2012 Tanzania, Lower middle income	Increased use of malaria rapid diagnostic tests improves targeting of anti-malarial treatment in rural Tanzania: implications for nationwide rollout of malaria rapid diagnostic tests Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1471)	Condition: Infectious Test: N/a	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact:
Masika PM et al 2006 Tanzania, Lower middle income	Over-diagnosis of malaria is not a lost cause Malar J	Interventional e.g. randomised trial Quantitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Mathew IE et al 2017 India, Lower middle income	Rising Thyroid Cancer Incidence in Southern India: An Epidemic of Overdiagnosis? J Endocr Soc	Review Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Maung K et al 2015 Malaysia, Upper middle income	Assessment of documentation of DSM-IV-TR Criteria A for diagnosis of schizophrenia in psychiatric unit, tertiary hospital, Malaysia Clin Ter	Observational e.g. cohort or cross-sectional studies quantitative (n= 107)	Condition: Mental Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact:

Mbonye AK et al 2010 Uganda , Low income	Symptom-based diagnosis of malaria and its implication on antimalarial drug use in pregnancy in Central Uganda: results from a community trial Int J Adolesc Med Health	Interventional e.g. randomised trial Quantitative (n= 2785)	Condition: Infectious Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Mbonye AK et al 2015 Uganda, Low income	A Cluster Randomised Trial Introducing Rapid Diagnostic Tests into Registered Drug Shops in Uganda: Impact on Appropriate Treatment of Malaria PLoS One	Interventional e.g. randomised trial Quantitative (n= 15517)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
McPherson K et al 2018 Palestine, Lower middle income	The overestimation and the inappropriate promotion of the benefits of mammographic screening in breast cancer research and interventions in the Gaza Strip Lancet	Observational e.g. cohort or cross-sectional studies Qualitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No
Mendonça DR et al 2020 Brazil, Upper middle income	Implementation of the Choosing Wisely Campaign at a Medical Clinic Internship Rev bras educ méd	Interventional e.g. randomised trial quantitative (n= 208)	Condition: N/A Test: N/A	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact:

Mianji F et al 2020 Iran, Upper middle income	The Globalization of Biological Psychiatry and the Rise of Bipolar Spectrum Disorder in Iran Cult Med Psychiatry	Observational e.g. cohort or cross-sectional studies Qualitative (n= 25)	Condition: Mental Test: N/A	Both Drivers and factors related to OD or overuse of tests Financial Impact: No
Mosha JF et al 2010 Tanzania, Lower middle income	Cost implications of improving malaria diagnosis: findings from north-eastern Tanzania PLoS One	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Mudawi HM et al 2012 Sudan, Low income	American Society for Gastrointestinal Endoscopy guidelines for appropriate use of colonoscopy: are they suitable for African patients? Trop Doct	Observational e.g. cohort or cross-sectional studies Quantitative (n= 311)	Condition: N/A Test: Procedure - GI Endoscopy, colonoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Muwonge R et al 2014 India, Lower middle income	Evaluation of cytology and visual triage of human papillomavirus-positive women in cervical cancer prevention in India International Journal of Cancer	Interventional e.g. randomised trial Quantitative (n= 42768)	Condition: Cancer Test: N/A	Both Potential Solutions Financial Impact: No

Mwanziva C et al 2011 Tanzania, Lower middle income	Defining malaria burden from morbidity and mortality records, self treatment practices and serological data in Magugu, Babati District, northern Tanzania Tanzan J Health Res	Observational e.g. cohort or cross-sectional studies Quantitative (n= 470)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Na R et al 2017 China, Upper middle income	Prostate health index significantly reduced unnecessary prostate biopsies in patients with PSA 2-10 ng/mL and PSA >10 ng/mL: Results from a Multicenter Study in China Prostate	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1538)	Condition: Cancer Test: Procedure - Prostate biopsy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Nankabirwa J et al 2009 Uganda, Low income	Malaria misdiagnosis in Uganda--implications for policy change Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1763)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Nascimento-Júnior VP et al 2021 Brazil, Upper middle income	Inappropriate requests for tumor markers in patients aged 50 years and older: lessons not learned Geriatr, Gerontol Aging (Impr)	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1112)	Condition: N/A Test: Pathology - Tumor marker	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Nguyen MH et al 2009 Vietnam, Lower middle income	Reproductive tract infections in northern Vietnam: health providers' diagnostic dilemmas Women Health	Observational e.g. cohort or cross-sectional studies Mixed (n= 748)	Condition: Infectious Test: N/A	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: No

Niu XK et al 2017 China, Upper middle income	Developing a nomogram based on multiparametric magnetic resonance imaging for forecasting high-grade prostate cancer to reduce unnecessary biopsies within the prostate-specific antigen gray zone BMC Med Imaging	Observational e.g. cohort or cross-sectional studies quantitative (n= 151)	Condition: Cancer Test: Imaging - MRI	Overdiagnosis Impact of expanding disease definitions and thresholds Financial Impact:
Nomhwange TI et al 2009 Nigeria, Lower middle income	Diagnosis of malaria in children's outpatient departments in Abuja, Nigeria Trop Doct	Observational e.g. cohort or cross-sectional studies Quantitative (n= 1000)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Nsutebu EF et al 2002 Cameroon, Lower middle income	The increase in occurrence of typhoid fever in Cameroon: overdiagnosis due to misuse of the Widal test? Trans R Soc Trop Med Hyg	Observational e.g. cohort or cross-sectional studies Qualitative (n= 84)	Condition: Infectious Test: Imaging	Overdiagnosis Drivers and factors related to OD or overuse of tests Financial Impact: Misdiagnosis of typhoid fever leads to unnecessary expenditure and exposure of patients to the side-effects of antibiotics
Olcay A et al 2017 Turkey, Upper middle income	The opinion of Turkish cardiologists on current malpractice system and an alternative patient compensation system proposal: PCS study group Turk Kardiyol Dern Ars	Observational e.g. cohort or cross-sectional studies Qualitative (n= 253)	Condition: N/A Test: unclear	Overuse of tests Drivers and factors related to OD or overuse of tests Financial Impact:

Osei-Kwakye K et al 2013 Ghana, Lower middle income	The benefits or otherwise of managing malaria cases with or without laboratory diagnosis: the experience in a district hospital in Ghana PLoS One	Observational e.g. cohort or cross-sectional studies Quantitative (n= 936)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Ozbek OA et al 2004 Turkey, Upper middle income	Application of hepatitis serology testing algorithms to assess inappropriate laboratory utilization J Eval Clin Pract	Observational e.g. cohort or cross-sectional studies Quantitative (n= 3341)	Condition: Infectious Test: Pathology - Hepatitis	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Ozbek OA et al 2010 Turkey, Upper middle income	[Inappropriately ordered tests from hepatitis B vaccinated subjects] Mikrobiyol Bul	Observational e.g. cohort or cross-sectional studies Quantitative (n= 88174)	Condition: Infectious Test: Pathology - Hepatitis	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Panato C et al 2020 India, Lower middle income	Thyroid Cancer Incidence in India Between 2006 and 2014 and Impact of Overdiagnosis J Clin Endocrinol Metab	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Pema AK et al 2018 South Africa, Upper middle income	Demand management by electronic gatekeeping of test requests does not influence requesting behaviour or save costs dramatically Ann Clin Biochem	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: N/A Test: Pathology	Overuse of tests Drivers and factors related to OD or overuse of tests Financial Impact: yes

Pezeshki MZ et al 2020 Iran, Upper middle income	Medical Overuse in the Iranian Healthcare System: A Systematic Scoping Review and Practical Recommendations for Decreasing Medical Overuse During Unexpected COVID-19 Pandemic Opportunity Risk Manag Healthc Policy	Review Mixed (n= N/A)	Condition: N/A Test: N/A	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Pizzanelli M et al 2016 Latin America ,	Prevención Cuaternaria: Ética Médica, Evaluación y Eficiencia en los Sistemas de Salud Rev bras med fam comunidade	Review Qualitative (n= N/A)	Condition: N/A Test: N/A	Both Potential Solutions Financial Impact: No
Rehmani R et al 1999 Pakistan, Lower middle income	Analysis of blood tests in the emergency department of a tertiary care hospital Postgrad Med J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 6401)	Condition: N/A Test: Pathology	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Reyburn H et al 2007 Tanzania, Lower middle income	Rapid diagnostic tests compared with malaria microscopy for guiding outpatient treatment of febrile illness in Tanzania: randomised trial BMJ	Interventional e.g. randomised trial Quantitative (n= 2416)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Reyburn H et al 2004 Tanzania, Lower middle income	Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: a prospective study BMJ	Observational e.g. cohort or cross-sectional studies Quantitative (n= 17313)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Salgado MV et al 2016 Argentina, Upper middle income	Sobreuso de mamografía para rastreo en un hospital académico de Buenos Aires Rev argent salud publica	Observational e.g. cohort or cross-sectional studies Quantitative (n= 399)	Condition: Cancer Test: Imaging - Mammography	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact:
Samarakoon Y et al 2018 Sri Lanka, Lower middle income	Appropriateness of colonoscopy according to EPAGE II in a low resource setting: a cross sectional study from Sri Lanka BMC Gastroenterol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 325)	Condition: N/A Test: Procedure - GI Endoscopy, colonoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Sator L et al 2019 Turkey, South Africa, China, Nigeria, Phillipines, India, Tunisia,	Overdiagnosis of COPD in Subjects With Unobstructed Spirometry: A BOLD Analysis Chest	Observational e.g. cohort or cross-sectional studies Quantitative (n= 16177)	Condition: Lung Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Savitha MR et al 2008 India, Lower middle income	Redefining the World Health Organization algorithm for diagnosis of pneumonia with simple additional markers Indian J Pediatr	Observational e.g. cohort or cross-sectional studies Quantitative (n= 50)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Schmulson MJ 2008 Mexico, Upper middle income	[Limited diagnostic testing can decrease the direct economic impact of irritable bowel syndrome] Rev Med Chil	Observational e.g. cohort or cross-sectional studies quantitative (n= 98)	Condition: GIT Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Limited diagnostic testing recommended by the LATAM Consensus for IBS can significantly decrease the economic impact of this disease in Mexico
Sibai AM et al 2008 Lebanon, Upper middle income	The appropriateness of use of coronary angiography in Lebanon: implications for health policy Health Policy Plan	Observational e.g. cohort or cross-sectional studies Quantitative (n= 5418)	Condition: N/A Test: Procedure - Coronary angiography	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Sievers AC et al 2008 Rwanda, Low income	Reduced paediatric hospitalizations for malaria and febrile illness patterns following implementation of a community-based malaria control programme in rural Rwanda World Hosp Health Serv	Observational e.g. cohort or cross-sectional studies Quantitative (n= 551)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Silva HS et al 2019 Brazil, Upper middle income	Abdominal Computed Tomography in the Emergency Room: Overuse of Medical Technologies and the Depreciation of Clinical Diagnosis Rev bras educ méd	Observational e.g. cohort or cross-sectional studies Qualitative (n= 834)	Condition: N/A Test: Imaging - CT	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact:

Skarbinski J et al 2009 Kenya, Lower middle income	Effect of malaria rapid diagnostic tests on the management of uncomplicated malaria with artemether-lumefantrine in Kenya: a cluster randomized trial Am J Trop Med Hyg	Interventional e.g. randomised trial Quantitative (n= 1540)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
SM AE et al 2009 Sudan, Low income	Malaria overdiagnosis and burden of malaria misdiagnosis in the suburbs of central Sudan: special emphasis on artemisinin-based combination therapy era Diagn Microbiol Infect Dis	Observational e.g. cohort or cross-sectional studies Quantitative (n= 3613)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Sodhi KS et al 2015 India, Lower middle income	Clinical application of 'Justification' and 'Optimization' principle of ALARA in pediatric CT imaging: "How many children can be protected from unnecessary radiation?" Eur J Radiol	Observational e.g. cohort or cross-sectional studies quantitative (n= 1302)	Condition: N/A Test: Imaging - CT	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact:
Sonkar SC et al 2016 India, Lower middle income	Comparative analysis of syndromic and PCR-based diagnostic assay reveals misdiagnosis/ overtreatment for trichomoniasis based on subjective judgment in symptomatic patients Infect Dis Poverty	Diagnostic Test Accuracy Quantitative (n= 820)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No

Steinhardt LC et al 2014 Malawi, Low income	Patient-, health worker-, and health facility-level determinants of correct malaria case management at publicly funded health facilities in Malawi: results from a nationally representative health facility survey Malar J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 2155)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Tachi K et al 2011 Ghana, Lower middle income	Appropriateness and diagnostic yield of referrals for oesophagogastroduodenoscopy at the Korle Bu Teaching Hospital West Afr J Med	Observational e.g. cohort or cross-sectional studies Quantitative (n= 375)	Condition: N/A Test: Procedure - GI Endoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Tambe J et al 2020 Cameroon, Lower middle income	Multidetector computed tomography utilization in an urban sub-Saharan Africa setting: user characteristics, indications and appropriateness Pan Afr Med J	Observational e.g. cohort or cross-sectional studies Quantitative (n= 511)	Condition: N/A Test: Imaging - CT	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Tan YM et al 2004 Malaysia, Upper middle income	Appropriateness of colonoscopy in a university hospital Med J Malaysia	Observational e.g. cohort or cross-sectional studies Quantitative (n= 499)	Condition: N/A Test: Procedure - GI Endoscopy, colonoscopy	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No

Tawiah T et al 2016 Ghana, Lower middle income	Cost-Effectiveness Analysis of Test-Based versus Presumptive Treatment of Uncomplicated Malaria in Children under Five Years in an Area of High Transmission in Central Ghana PLoS One	Interventional e.g. randomised trial Quantitative (n= 3046)	Condition: Infectious Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: Yes
Timire C et al 2019 Zimbabwe, Lower middle income	Targeted active screening for tuberculosis in Zimbabwe: are field digital chest X-ray ratings reliable? Public Health Action	Observational e.g. cohort or cross-sectional studies Quantitative (n= 230)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Torres-Castro I et al 2011 Colombia, Upper middle income	[Lipid profile frequency and relevancy as an initial test for peripheral vertigo] Rev Salud Publica (Bogota)	Observational e.g. cohort or cross-sectional studies Quantitative (n= 201)	Condition: Others Test: Pathology	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes

Vaccarella S et al 2021 Ukraine, Russia, Bulgaria, Turkey, China, Thailand, Vietnam, Jordan, Philippines, India, Pakistan, Puerto Rico, Colombia, Peru, Costa Rica, Ecuador, Cuba, Argentina, Morocco, Algeria, Egypt, Kenya, Mali, Uganda,	Global patterns and trends in incidence and mortality of thyroid cancer in children and adolescents: a population-based study Lancet Diabetes Endocrinol	Observational e.g. cohort or cross-sectional studies Quantitative (n= 8049)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Van Dillen J et al 2007 Namibia, Upper middle income	Overdiagnosis of malaria in hospitalized patients in Namibia Trop Doct	Observational e.g. cohort or cross-sectional studies Quantitative (n= 176)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Vassilakos P et al 2021 Cameroon, Lower middle income	A cross-sectional study exploring triage of human papillomavirus (HPV)-positive women by visual assessment, manual and computer-interpreted cytology, and HPV-16/18-45 genotyping in Cameroon Int J Gynecol Cancer	Diagnostic Test Accuracy Quantitative (n= 1598)	Condition: Cancer Test: N/A	Both Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Veedu JS et al 2019 India, Lower middle income	Overdiagnosis of thyroid cancer: A problem of greater access to healthcare Anticancer Research	Observational e.g. cohort or cross-sectional studies Quantitative (n= N/A)	Condition: Cancer Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No

Velicković JV et al 2013 Serbia, Upper middle income	Routine chest radiographs in the surgical intensive care unit: can we change clinical habits with no proven benefit? Acta Chir Iugosl	Observational e.g. cohort or cross-sectional studies Quantitative (n= 97)	Condition: N/A Test: Imaging - X-ray	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: No
Visser T et al 2017 Liberia, Ghana, Myanmar, Uganda, Tanzania. Nigeria, Kenya, Zambia,	Introducing malaria rapid diagnostic tests in private medicine retail outlets: A systematic literature review PLoS One	Review Quantitative (n= N/A)	Condition: Infectious Test: N/A	Overdiagnosis Impact on further testing or treatment i.e. consequence of OD or Overuse of tests Financial Impact: No
Xie M et al 2020 China , Upper middle income	Impacts of Different Spirometry Reference Equations and Diagnostic Criteria on the Frequency of Airway Obstruction in Adult People of North China Int J Chron Obstruct Pulmon Dis	Observational e.g. cohort or cross-sectional studies Quantitative (n=)	Condition: Lung Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No
Xu Y et al 2016 China, Upper middle income	Plasma glucose and hemoglobin A1c for the detection of diabetes in Chinese adults J Diabetes	Observational e.g. cohort or cross-sectional studies Quantitative (n= 98658)	Condition: Diabetes Test: N/A	Overdiagnosis Overdiagnosis or Overuse of tests estimation Financial Impact: No

Yilmaz FM et al 2016 Turkey, Upper middle income	Impact of laboratory test use strategies in a Turkish hospital PLoS One	Observational e.g. cohort or cross-sectional studies Quantitative (n= 480000)	Condition: N/A Test: Pathology	Overuse of tests Potential Solutions Financial Impact: Yes
Zhang H et al 2018 China, Upper middle income	Extent and cost of inappropriate use of tumour markers in patients with pulmonary disease: a multicentre retrospective study in Shanghai, China BMJ Open	Observational e.g. cohort or cross-sectional studies Quantitative (n= 2706)	Condition: Lung Test: Pathology - Tumor marker	Overuse of tests Overdiagnosis or Overuse of tests estimation Financial Impact: Yes
Zhao J et al 2017 China , Upper middle income	Risk assessment models to evaluate the necessity of prostate biopsies in North Chinese patients with 4-50 ng/mL PSA Oncotarget	Observational e.g. cohort or cross-sectional studies Quantitative (n= 702)	Condition: Cancer Test: N/A	Overuse of tests Potential Solutions Financial Impact: No